DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES

OF THE

UNITED STATES

CALENDAR YEAR

1908

PART II—NONMETALLIC PRODUCTS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1909

CONTENTS.

ILLUSTRATIONS.

MINERAL RESOURCES OF THE UNITED STATES FOR 1908—PART II.

COAL.

By Edward W. Parker.

INTRODUCTION.

The year 1908 will be remembered as one of general depression in the coal-mining industry and comparable to some extent with the lean years 1894, 1895, and 1896, yet the total production in 1908 exceeded that of any year in our history with the single exception of 1907, the year of record-making activity and production. In 1907, or at least until the panic developed in October, the principal complaint of operators was the scarcity of labor to work the mines and of railroad cars and motive power to transport the product. No such difficulties were experienced in 1908, for although the output in the year under review was 13.4 per cent less than in 1907, there was a pronounced increase in the number of men employed, both in the anthracite and bituminous mines, and the transportation equipment was at all times ample to take care of the diminished tonnage.

When the general depression and resultant light demand for coal in 1908 are considered the stability of prices was exceptionally well maintained, the values showing a falling off only slightly in access of the decrease in production. The principal reasons for this were as follows: (1) There was no reduction in wages and consequently no lessening of the cost of production. (2) A large part of the product was sold on contracts made in the more prosperous months of 1907. (3) Buyers, particularly of bituminous coal, were more exacting in their requirements and demanded a higher grade fuel than they were willing to accept in 1907, when operators could dispose of less attractive grades without difficulty. The natural results were less net returns to the producers in 1908 than the figures indicate. The close control under which the anthracite mines of Pennsylvania are operated permits the regulation of the production according to the demand and makes it possible to maintain prices at practically uniform schedules from year to year.

During the flush times of the decade preceding 1908 history in one important particular repeated itself. Stimulated by the continued prosperity and constantly increasing development in the iron and steel trade and in other manufacturing lines of industry, the impulse to exploit new territory and to open new mines was rampant, notwithstanding the fact that there has not been a time during that period when, with a full complement of men, and with sufficient transportation facilities, the mines already developed have not been able to furnish from 50 to 75 per cent more than the production. The opening of every new mine has, with rare exceptions, meant the further spreading out of an already inadequate supply of railroad cars, the laws prohibiting any favoritism in this respect, and the migration of miners from the old mines to the new ones where the conditions of labor are apt to be, for a while at least, less onerous. If the reaction in 1908 results in any tendency to a restriction of new exploitations, it will have had some salutary influence on the industry.

ACKNOWLEDGMENTS.

The statistics contained in these reports could not be secured in their completeness without the good will and disinterested cooperation of the individual coal-mine operators and the officials of corporations engaged in the industry. The writer desires to express his sincere appreciation of the assistance received from these sources.

In the collection of the statistics of coal, as of other mineral products, the Federal Survey has had in 1908 the efficient cooperation of the state geological surveys of Maryland, Dr. William Bullock Clark, state geologist; of Virginia, Dr. James L. Watson, director; of Georgia, Dr. S. W. McCallie, state geologist; of Alabama, Dr. Eugene A. Smith, state geologist; of Kentucky, Prof. C. J. Norwood, director; of Illinois, Dr. H. Foster Bain, formerly director, and Mr. F. W. De Wolf, acting director; of Iowa, Prof. S. W. Beyer, Iowa State College; of Missouri, Dr. H. A. Buehler, state geologist, and the aid rendered by these gentlemen and their assistants is gratefully acknowledged. Acknowledgments are also due to the secretaries of boards of trade and to other local authorities for contributions to the portion of this report included under the caption "Coal trade review." Recognition of these by name is given in connection with their contributions. The report on the production of Pennsylvania anthracite has been, as for several years past, prepared by Mr. William W. Ruley, chief of the bureau of anthracite statistics, in Philadelphia.

UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the short ton of 2,000 pounds, although it is necessary in a few instances to use the long ton. All of the anthracite product is mined and sold on the basis of the long ton of 2,240 pounds. Hence, when considering the production of Pennsylvania anthracite the long ton is used. The long ton is also used in the statistics of imports and exports. In all other cases where the production is reported in long tons the figures have been reduced to short tons, and unless otherwise expressly stated the short ton is meant when any quantity is expressed in the text.

SUMMARY OF STATISTICS IN 1908.

Total production in 1908, 415,842,698 short tons; spot value, $532,314,117.

Pennsylvania anthracite.—Total production in 1908, 74,347,102 long tons (equivalent to 83,268,754 short tons); spot value, $158,178,849.

Bituminous and lignite.—Total production, 332,573,944 short tons; spot value, $374,135,268.

The history of the coal-mining industry in 1908 was in marked contrast to that of the preceding year. During 1907 the production of both anthracite and bituminous coal reached the highest point ever recorded. During the first ten months of 1907, or until the panic started in October, the demand in all parts of the United States had been of a record-breaking character and the production seemed to be limited only by the inability of the operators to secure labor and transportation facilities. In addition to this the year 1907 was one of general peace throughout the coal-mining region. There were few instances of labor disaffection and what time was lost was not sufficient to affect the total production. In comparison with the conditions which existed in 1907 the record made in 1908 was in striking contrast. The most powerful influence was of course the effect of the panic which began in October, 1907, and continued throughout the entire twelve months of 1908. Added to this there was in the organized States of the bituminous regions a general suspension of operations on April 1, pending the adjustment of the wage scale. In the anthracite region the agreements which were made in 1906 were for a period of three years, or to March 31, 1909, so that there was no general suspension of mining among the anthracite workers. A third unfavorable influence was the protracted drought in the Eastern and Middle States, which began early in the summer and lasted well into the winter months. In the southwestern States of Arkansas, Kansas, and Oklahoma the coal production was influenced less by the financial conditions than by the competition of coal with fuel oil and natural gas, which has been developed through the bringing in of the mid-continent and Louisiana fields. A short cotton crop, and consequently lessened demand from ginning establishments, also adversely affected the coal production of these States.

In 1907, when the maximum output of both anthracite and bituminous coal was recorded, the total production amounted to 480,363,424 short tons, valued at $614,798,898, of which 85,604,312 short tons (or 76,432,421 long tons), valued at $163,584,056, were Pennsylvania anthracite, and 394,759,112 short tons, valued at $451,214,842, were bituminous, semibituminous, and lignite, with scattered lots of anthracite and semianthracite. Compared with these records made in 1907, the production in 1908 showed a decrease of 64,520,726 short tons, or 13.43 per cent, in quantity, and of $82,484,781, or 13.42 per cent in value. In spite of the depressed conditions in 1908 the decrease in the production of Pennsylvania anthracite was only 2,335,558 short tons, or 2.73 per cent, in quantity and $5,405,207, or 3.3 per cent in value. A considerable falling off in the demand was naturally to be expected in view of the adverse conditions and especially in the great manufacturing centers of the East where anthracite is so largely used, yet the results as recorded were gratifying and indicate that as limited as the territory is for the consumption of anthracite some curtailment in the individual demand was probably, to a large extent, offset by the increased population in the anthracite-producing territory. In the production of bituminous coal, however, the decrease in 1908 as compared with 1907 amounted to 62,185,168 short tons, or 15.75 per cent, and of $77,079,574, or 17.08 per cent in value. In the face of the demoralized trade conditions, the insignificantly larger decrease in the percentage of value as compared with the production is notable and was in part due to the necessity of maintaining prices, because of the fact that in most of the important producing States operations are carried on under agreement with the United Mine Workers of America, there was no cut in mining wages so that the cost of mining was relatively as high as in the more prosperous years of 1906 and 1907. Another reason for the slight falling off in values was the fact that on account of the trade conditions consumers were more exacting in their demands than they were in 1906 and 1907, when operators were able to market practically all of the coal they could mine. This caused a larger percentage of slack and other salable coal to be thrown on the dumps in 1908, so that the returns to the operators were considerably less than appears in the statistical record.

It is to be noted that of the 30 States and Territories which produced coal in 1907 and 1908 there were only 3 in which increased production was shown in the latter year, the exceptions being California, Oregon, and Texas. The increases in the first two were unimportant. The increase in Texas was due in part to the continued decrease in the production of petroleum in the State, to the rapid growth of population, and to the comparatively prosperous conditions which prevailed in that Commonwealth. Utah was exceptional in that it showed a decrease of 5.18 per cent in the quantity of coal produced, but an increase of 5.39 per cent in the value of the output. Massachusetts in 1908 appears for the first time as a coal producer, a small quantity (50 tons) of lignite having been mined in Vineyard Haven for local use during that year. Of the total decrease of 62,185,168 short tons in the production of bituminous coal approximately 30 per cent, or 18,061,478 short tons, was in the quantity of coal made into coke. The largest decrease was in the production of bituminous coal in Pennsylvania, this State showing a decrease of 32,963,650 short tons, or 21.95 per cent in quantity, and of $36,847,723, or 23.67 per cent in value. Of the total decrease in Pennsylvania bituminous coal production nearly 14,000,000 tons was in the quantity of coal made into coke. The second largest decrease was suffered by West Virginia, whose output declined 6,193,740 short tons, or 12.88 per cent in quantity, and $7,837,576, or 16.38 per cent in value. Ohio, the fourth State in producing importance, had the third largest decrease in 1908, the output in that year being 5,871,780 short tons, or 18.27 per cent less than in 1907, with a decrease in value of $7,427,042, or 21.03 per cent. Illinois, the second in rank among the coal-producing States, suffered less than any of the other important coal producers, the decrease in quantity amounting to 3,657,456 short tons, or 7.13 per cent in quantity and $4,709,135, or 8.61 per cent in value.

As noted above, the decrease in value was less than might have been expected when the general conditions affecting the coal mining industry in 1908 are considered. The average price per ton for bituminous coal and lignite, as shown by the statistics for 1908, was $1.12, 2 cents less than the average price in 1907 and 1 cent more than that of 1906. The average price of anthracite at the mines in Pennsylvania was $2.35 per long ton both in 1907 and 1908. In obtaining these average prices it should be remembered that the average price of bituminous coal is based on all of the coal sold or used at the mines, either for coke making or in the operation of the properties. Only the bituminous coal actually wasted is excluded from the valuation, and this is also not included in the statement of production. The coal used at the mines of the anthracite region of Pennsylvania is composed principally of culm, which until quite recently, except for that used in the operation of the mines, has been thrown upon the dumps and wasted. In recent years, however, with the establishment of washeries for the saving of the small sizes of coal produced, and also for the recovery from culm banks of that previously wasted, a marketable value is placed upon this formerly disregarded product. An arbitrary value of 20 cents per long ton has been placed upon the colliery consumption of anthracite.

It should also be remembered that considerable quantities of both anthracite and bituminous coal are sold at much less than the cost of production. Attention has been called in previous reports to the unwarranted criticisms which are made upon the apparent discrepancy between the prices shown by these averages and those which the public (particularly the private consumer) is obliged to pay for fuel. Such criticisms are evidently made by persons ignorant of the fact that all the profits on mining operations in the anthracite region are actually made on sizes above pea coal, and that this represents little more than 60 per cent of the total production. All of the buckwheat, rice, barley, and other sizes below pea coal shipped from the anthracite region, and which are used entirely for steaming purposes in competition with bituminous coal, are sold at prices considerably below the actual cost of production. In the bituminous region, particularly outside the coking coal fields, a large proportion of the product is marketed as screened coal, and in many cases the slack and other sizes below nut are sold at less than the cost of mining. A criticism made with possibly more apparent justice is that prices to large consumers are considerably less than those made to small manufacturers and to the individual consumers, and that the latter are taxed in this way for the benefit of the former; but while such criticism may be based upon facts, is is difficult to see, when such conditions exist in all lines of industry, how any exception can be brought about in favor of the individual consumers of coal.

Attention has also been called in previous reports to the rapid growth in the coal-mining industry, and to the fact that in each decade the output has been practically doubled. The year 1908 was a notable exception to the general increase, but it was essentially an exception. When the country has recovered from the effects of the financial depression of that year, however, a continual increase in the annual production may be looked for.

The statistics of coal production in the past show that up to the close of 1865 the total production had amounted to 284,890,055 short tons. In the decade from 1866 to 1875, inclusive, the production amounted to 419,425,104 tons, making the total production up to the close of 1875, 704,315,159 tons. In the following decade, from 1876 to 1885, inclusive, the production amounted to 847,760,319 tons, something more than double the total production up to the beginning of that decade. At the close of 1885 the total production amounted to 1,552,075,478 tons, and the production for the ten years ending with 1895 was 1,586,098,641 tons. The total production to the close of 1895 amounted to 3,138,174,119 short tons. In the decade ending December 31, 1905, the total production amounted to 2,832,402,746 short tons, and the grand total from the beginning of coal mining amounted to 5,970,576,865, short tons. The average annual production from 1896 to 1905 was 283,240,275 short tons, compared with which the average production for the three years from 1906 to 1908, inclusive, was 436,787,800 short tons, showing an increase of 153,547,525 short tons, or 54.2 per cent.

This great increase in the production of coal, when considered with the increase in the population, furnishes some further interesting comparisons. Going back for a period of a little over fifty years, or to the middle of the last century, and comparing the statistics of coal production with the increased population, it is found that in 1850, according to the United States census for that year, the production of the coal amounted to 6,445,681 tons, when the population of the country amounted to 23,191,876 persons. The per capita production of coal in that year is thus seen to have been 0.278 ton. In 1860, ten years later, the population was 31,443,321 persons, and the coal production amounted to 16,139,736 tons, or an average of 0.514 ton per person. At the census of 1870 the population of the United States amounted to 38,558,371; the coal production of that year amounted to 36,806,560 short tons, a per capita average of 0.96 ton. Ten years later, when the population was 50,189,209, the coal output amounted to 76,157,944 short tons, or 1.52 tons per capita. In 1890 the population had grown to 63,069,756, an increase of 25 per cent over 1880, while the coal production had grown to 157,770,963 short tons, or a per capita output of 2.52 tons. At the taking of the Twelfth Census, in 1900, the increase in population amounted to 22 per cent, the total number of persons reported being 76,303,387, while more than 70 per cent had been added to the coal production, with a total of 269,684,027 short tons, or an average of 3.53 tons for each inhabitant. In other words, while the population from 1850 to 1900 showed an increase of 230 per cent, the production of coal increased 4,084 per cent. The Director of the Bureau of the Census estimated the population of the United States on June 1, 1907, at about 85,500,000 persons, making the per capita production in that year 5.6 tons, so that in less than sixty years the per capita production of coal in the United States had increased from a little more than one-quarter of a ton to 5½ tons. Estimating the population of the United States in 1908 at 87,000,000 persons, the per capita production for that year is found to have been 4.78 short tons.

It is true that in the earlier years covered by this résumé the proportion of wood used for fuel was larger than it is at the present time, but the actual consumption of wood for fuel purposes is probably as great to-day, or possibly greater, than it was fifty years ago. It should also be remembered that in addition to the production of coal there has been a great increase in the use of oil for fuel purposes, and natural gas still remains an important factor in this regard.

The coal mines of the United States gave employment in 1908 to a total of 690,438 men, against 680,492 in 1907 and 640,780 in 1906. The increase in the number of men employed in 1908, as compared with 1907, gives a reasonably fair indication of the condition of the labor market in 1908. The surplus of labor was general throughout the country, as shown by the fact that in most of the coal-producing States, notwithstanding a decreased production, the number of men employed in 1908 was larger than in 1907. The number of men employed in the anthracite region of Pennsylvania increased from

167,234 in 1907 to 174,174 in 1908, while the bituminous mine workers increased from 513,258 to 516,264. So far as the employment of labor is concerned, the effect of the business depression in the coal-mining industry is shown in the fewer number of days worked in 1908 as compared with 1907. In the anthracite region the average number of days worked in 1908 was 200, against 220 in 1907, while in the bituminous mines the average number of days decreased from 234 in 1907 to 193 in 1908. Owing to the fewer number of days worked in both the anthracite and bituminous fields, the average production for each man employed was less in 1908 than in 1907. In the production of anthracite the average output made by each man in 1908 was 478 short tons, against 512 tons in 1907. The average bituminous production for each man employed was 644 short tons, against 769 tons in 1907. For the same reason that the average tonnage for each employee for the full year decreased, the average daily tonnage for each employee increased, the fewer number of days worked in 1908 impelling the mine workers to greater effort on such days as the mines were operated. The average daily tonnage per man in the anthracite region in 1908 was 2.39, against 2.33 in 1907, being the largest daily average made since 1903. The average daily production of bituminous coal for each man employed was 3.34 in 1908 against 3.29 in 1907.

The statistics relating to the use of machines in the mining of coal in the bituminous mines of the United States, the details of which are to be found on subsequent pages of this report, show that in 1908 the total quantity of coal mined by machines amounted to 123,183,334 short tons. The total production of coal in the States where machines were employed was 328,270,373 short tons, so that the machine-mined product was equivalent to 37.5 per cent of the total production in these States. In 1907 the machine-mined product amounted to 138,547,823 short tons, or 35.71 per cent of the total production in States where mining machines were employed, and in 1906, 118,847,527 short tons, or 35.1 per cent. The machine-mined production in 1908, as shown above, was less than in 1907, but there has been a steady increase in the percentage that the machine-mined coal bears to the total output of the States where mining machines have been installed, and also in the number of machines in use. The number of mining machines employed in the bituminous coal mines of the United States has increased from 6,658 in 1903, to 7,663 in 1904, 9,184 in 1905, 10,212 in 1906, 11,144 in 1907, and 11,569 in 1908. The percentages of machine-mined production in these years have been, respectively, 28.18, 28.80, 33.67, 35.10, 35.71, 37.5. The average production for each machine in use in 1908 was 10,648, against 12,381 tons in 1907, 11,638 tons in 1906, and 11,258 tons in 1905, the lower average in 1908 being due to the fewer number of days the mines were worked and the decrease in tonnage for that year. Of the 11,569 machines in use in 1908, 6,380 were of the pick or puncher type, 4,992 were chain breast, and 197 were long-wall machines. These include 26 pick and 238 chain shearing machines.

Pennsylvania, as the leading State in the total production of bituminous coal, leads also in the number of machines employed and in the total machined-mine production, there being in 1908 5,103 machines employed in the bituminous coal mines of Pennsylvania. The machine-mined production in that State amounted to 52,447,809 short tons, or 44.76 per cent of its total in 1908. Ohio leads in the percentage of coal mined by machines, and has for several years been second in the total quantity of machine-mined coal, although West Virginia in both 1907 and 1908 had more machines in use than did Ohio. In 1908 there were 1,343 machines employed in the coal mines of Ohio, and the machine-mined product amounted to 19,799,140 short tons, or 75.37 per cent of the total. West Virginia employed 1,574 machines, by the use of which 16,653,174 short tons, or 39.75 per cent of the total, were mined. Illinois employed 1,217 machines and produced 15,045,004 short tons of machine-mined coal, or 31.57 per cent of the total. Kentucky, which stands seventh in the rank of coal-producing States, was second in the percentage of machine-mined coal to the total in 1908, something over half of the total output of the State being machine mined.

So far as the interruption to mining operations because of labor disaffection is concerned, the year 1908 was in marked contrast to 1907, which year, nothwitstanding the unprecedented production and high prices, was notable as one of comparative peace throughout the coal-mining regions. There were fewer men idle because of strikes or lockouts in 1907 than in any year since 1901, and the amount of time lost from this cause in that year was the smallest in a decade. In the spring of 1908 the wage agreement, which had been made in 1906 for two years, expired and on April 1 there was in the "organized" States a general suspension of mining operations pending the renewal of the wage agreement. The suspension, however, was of a pacific character, and while the mines were closed down there was, as a general thing, good feeling between the contending parties, and there were, with the exception of Alabama, few instances of disorder or violence. The exception in Alabama was not a part of the general suspension, but was the result of an effort by the United Mine Workers of America to strengthen the organization in that State. It does not seem to have been well considered and was not in any way successful from the miners' standpoint. The most protracted idleness was at one mine in Washington, where 226 men were idle during the entire year. In West Virginia, which is a conspicuous example of a nonunion State, 501 men were idle for an average of 144 days. In the organized States, where the suspensions were in effect until the wage agreement was signed, the average time lost, with few exceptions, was less than thirty days, and in most cases the period of idleness had been anticipated, and operating companies and consumers had provided against it by storing considerable quantities of coal, little inconvenience being the result.

In the anthracite region of Pennsylvania the wage agreement made in 1906 was for three years and the mines in that district were not affected by the general suspension. The total number of men idle because of labor disaffections in the bituminous regions was 145,145, and the average time lost by each was 38 days.

The total number of working days lost in the bituminous regions alone was 5,449,938, while in 1907 the total number of days lost was 462,392.

The United States Geological Survey makes no attempt to collect direct the statistics covering the fatal and nonfatal accidents occurring in the mines of the country. The statistics presented in the subsequent pages are compiled from the reports received from the mine inspectors or other State officials having in charge the administration of state inspection laws. Casualty statistics are therefore incomplete to the extent represented by those States in which there are no mine inspection laws. These exceptions are, however, of comparative unimportance as practically all of the important coal-mining States now have inspection laws, and the officials in charge of their execution compile the statistics of accidents in each year. In some cases these are for the fiscal year, but in most cases they cover calendar years and coincide with the period for which the statistics of production are given in this report. The States from which the accident statistics are reported contribute over 98 per cent of the total coal product of the United States. In the record of fatal and nonfatal accidents the year 1907 was the worst in the history of coal production in this country. During December of that year there were four separate disasters, all in the Appalachian bituminous coal field, and each attended with the sacrifice of many lives. The most serious of these disasters was that at Monongah, W. Va., and made that State responsible for more than 50 per cent of the deaths due to gas and dust explosions in 1907. The record made in 1908 was in favorable contrast to that of 1907, but still the number of victims was regrettably large. In the 22 States from which reports were received in 1908 there were 2,450 men killed and 6,772 injured in the coal mines during the year, while in 1907 in the 18 States from which reports were received there were 3,125 men killed and 5,316 injured.

Practically the entire output of both anthracite and bituminous coal in the United States is consumed within the country. The total exports of coal in 1908 amounted to 13,275,558 short tons, which, deducted from the production of 415,842,698 tons, shows a consumption of coal of domestic production amounting to 402,567,140 short tons. If to this are added the imports, which in 1908 amounted to 1,645,444 short tons, the total consumption of coal in the United States in 1908 (considering as negligible the stocks on hand at the beginning and end of the year) is shown to have been 404,212,584 tons, which is equivalent to 97 per cent of the domestic production.

Most of the coal imported into the United States is classed as bituminous or shale, only a comparatively small quantity of anthracite being brought into this country. The imports of bituminous coal are principally to points on the Pacific Coast and to the port of Boston, where considerable quantities of bituminous slack are imported from Canada and used at the Otto-Hoffmann coke ovens at Everett, near Boston. The exports of both anthracite and bituminous coal are principally to Canada.

In considering the coal product of the United States these reports include not only the coal marketed, either by shipment to distant points or sold locally, but that consumed by mine employees and by the mine owners in the operation of the collieries. The latter factor is usually considered and reported as colliery consumption. There are occasional exceptions in the bituminous fields, where the operators, who use only slack, an otherwise waste product, do not report this item in their statement of production and do not deem it of any value; it is not considered as a portion of the mine product, nor is the miner paid for it in wages. Such exceptions are few and the quantity is negligible. The quantity of coal consumed in the manufacture of coke is also considered in this report.

The quantity of coal consumed in the manufacture of coke at the mines in 1908 was 32,228,344 short tons, as compared with 50,289,822 tons in 1907, a decrease of 18,061,478 short tons, or 35.9 per cent, as compared with a decrease of 13.4 per cent in the total production. The coal shipped to market and used in the manufacture of coke, and sold locally (which is considered the marketable product) amounted in 1908 to 398,642,321 short tons, compared with 462,802,051 short tons in 1907, and 399,323,294 short tons in 1906. The colliery consumption in the anthracite region, which consists practically altogether of culm, averages from 8 to 10 per cent of the total anthracite output. In 1908, out of a total production of 83,268,754 short tons of anthracite, 8,614,540 tons were used at the mines for steam and heat. The colliery consumption of bituminous coal amounts to between 2 and 3 per cent of the total production, and in 1908, out of a total of 332,-573,944 tons of bituminous coal mined, 8,585,837 tons were used in the operation of the properties.

PRODUCTION.

The statistics of the production of coal in the United States in 1907 and 1908, by States, with the distribution of the product for consumption, are shown in the following tables:

Coal production of the United States in 1907, by States and Territories, in short tons.

State or Territory.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	11,144,452	216,547	522,793	2,366,662	14,250,454	$18,405,468	$1.29	242	21,388
Arkansas	2,556,226	22,715	91,497		2,670,438	4,473,693	1.68	190	5,085
California and Alaska	14,265	6,014	3,810		24,089	91,813	3.81	187	76
Colorado	8,409,624	258,069	296,279	1,826,264	10,790,236	15,079,449	1.40	258	14,223
Georgia	204,890	5,780	10,700	141,031	362,401	499,686	1.38	262	808
Idaho [a]	300	7,278	10		7,588	31,119	4.10	121	22
Illinois	46,908,118	2,775,321	1,625,112	8,595	51,317,146	54,687,382	1.07	218	65,581
Indiana	12,887,937	755,061	342,715		13,985,713	15,114,300	1.08	197	21,022
Iowa	6,774,144	617,771	182,407		7,574,322	12,258,012	1.62	230	15,585
Kansas	6,957,953	172,859	191,637		7,322,449	11,159,698	1.52	225	12,439
Kentucky	9,911,715	476,739	254,679	109,991	10,753,124	11,405,038	1.06	210	16,971
Maryland	5,427,882	48,461	56,285		5,532,628	6,623,697	1.20	263	5,880
Michigan	1,792,598	129,434	113,826		2,035,858	3,660,833	1.80	234	3,982
Missouri	3,495,133	437,072	65,731		3,997,936	6,540,709	1.64	214	8,448
Montana	1,793,475	73,609	89,534	60,239	2,016,857	3,907,082	1.94	268	2,735
New Mexico	2,038,475	36,205	56,000	498,279	2,628,959	3,832,128	1.46	269	2,970
North Dakota	218,308	118,102	11,350		347,760	560,199	1.61	223	562
Ohio	29,738,788	1,859,906	542,425	1,300	32,142,419	35,324,746	1.10	199	46,833
Oklahoma (Indian Territory)	3,381,420	58,882	161,957	40,399	3,642,658	7,433,914	2.04	216	8,398
Oregon	39,095	14,840	17,046		70,981	166,304	2.34	231	184
Pennsylvania	110,009,673	1,941,132	3,040,183	35,152,189	150,143,177	155,664,026	1.04	255	163,295
Tennessee	5,741,988	135,000	129,653	803,602	6,810,243	8,490,334	1.25	232	12,052
Texas	1,584,576	27,118	36,375		1,648,069	2,778,811	1.09	244	4,227
Utah	1,287,649	22,149	65,308	572,441	1,947,607	2,959,709	1.52	258	2,203
Virginia	2,359,806	78,704	96,653	2,175,732	4,710,895	4,807,533	1.02	241	6,670
Washington	3,365,097	90,762	134,265	90,408	3,680,532	7,679,801	2.09	273	5,945
West Virginia	39,942,715	932,652	773,526	6,442,690	48,091,583	47,846,630	.99	230	59,029
Wyoming	5,881,055	74,001	297,934		6,252,990	9,732,668	1.56	275	6,645
Total bituminous	323,867,357	11,392,183	9,209,750	50,289,822	394,759,112	451,214,842	1.14	234	513,258
Pennsylvania anthracite	75,553,838	1,698,851	8,351,623		85,604,312	163,584,056	1.91	220	167,234
Grand total	399,421,195	13,091,034	17,561,373	50,289,822	480,363,424	614,798,898	1.28	231	680,492

Includes the production of Nebraska and Nevada.

Coal production of the United States in 1908, by States and Territories, in short tons.

State or Territory.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	8,465,564	136,368	398,341	2,604,320	11,604,593	$14,647,891	$1.26	222	19,197
Arkansas	1,991,188	14,793	72,376		2,078,357	3,499,470	1.68	145	5,337
California and Alaska	14,192	3,109	4,561		21,862	69,650	3.19	220	49
Colorado	7,786,422	245,493	331,104	1,271,954	9,634,973	13,586,988	1.41	212	14,523
Georgia	184,040	930	8,400	71,452	264,822	364,279	1.38	261	670
Idaho	5,379	50			5,429	21,832	4.02	160	24
Illinois	43,468,245	2,696,972	1,491,514	2,959	47,659,690	49,978,247	1.05	185	68,035
Indiana	11,371,188	610,410	333,292		12,314,890	13,084,297	1.06	174	18,380
Iowa	6,345,590	650,481	165,239		7,161,310	11,706,402	1.63	214	16,021
Kansas	5,923,183	154,904	167,024	397	6,245,508	9,292,222	1.49	181	13,916
Kentucky	9,420,514	481,209	260,075	84,755	10,246,553	10,317,162	1.01	186	16,996
Maryland	4,288,306	38,054	50,733		4,377,093	5,116,753	1.17	220	6,079
Massachusetts		50			50	150	3.00		
Michigan	1,674,425	87,223	73,371		1,835,019	3,322,904	1.81	207	4,247
Missouri	2,927,648	342,953	46,714		3,317,315	5,444,907	1.64	169	8,988
Montana	1,679,547	101,846	79,529	59,268	1,920,190	3,771,248	1.96	224	3,146
New Mexico	1,953,851	23,063	40,909	450,114	2,467,937	3,368,753	1.37	197	3,448
North Dakota	187,095	121,286	12,361		320,742	522,116	1.63	181	631
Ohio	24,208,224	1,494,630	564,749	3,036	26,270,639	27,897,704	1.06	161	47,407
Oklahoma	2,747,033	47,472	153,611		2,948,116	5,976,504	2.03	172	8,651
Oregon	45,375	22,518	18,366		86,259	236,021	2.74	249	214
Pennsylvania	91,360,007	1,801,292	2,817,237	21,200,991	117,179,527	118,816,303	1.01	201	165,961
Tennessee	5,568,671	93,143	102,715	434,642	6,199,171	7,118,499	1.15	209	11,812
Texas	1,823,640	52,754	18,983		1,895,377	3,419,481	1.80	254	4,400
Utah	1,527,165	28,697	61,789	229,141	1,846,792	3,119,338	1.69	227	2,664
Virginia	2,344,308	67,900	110,671	1,736,163	4,259,042	3,868,524	.91	200	6,208
Washington	2,715,920	106,244	134,109	68,670	3,024,943	6,690,412	2.21	202	5,484
West Virginia	36,440,822	641,527	805,012	4,010,482	41,897,843	40,009,054	.95	185	56,861
Wyoming	5,150,298	76,552	263,052		5,489,902	8,868,157	1.62	217	6,915
Total bituminous	281,617,840	10,141,923	8,585,837	32,228,344	332,573,944	374,135,268	1.12	193	516,264
Pennsylvania anthracite	72,933,252	1,720,962	8,614,540		83,268,754	158,178,849	1.90	200	174,174
Grand total	354,551,092	11,862,885	17,200,377	32,228,344	415,842,698	532,314,117	1.28	195	690,438

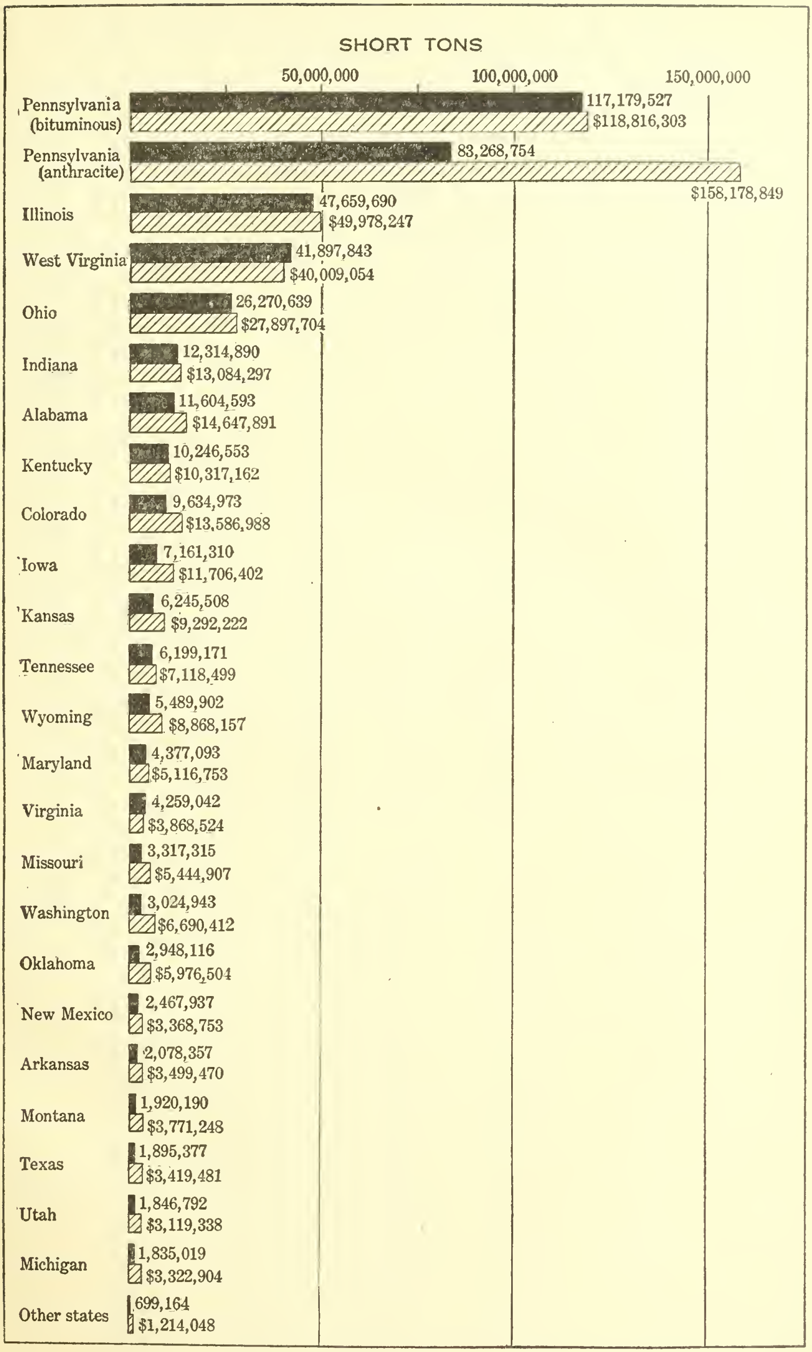

FIGURE 1.—Production of coal in the United States in 1908, by States.

Out of the 30 States in which coal was produced in 1908, there were only four that showed a larger output in that year than in 1907. These were California, Massachusetts, Oregon, and Texas, the last mentioned being the only one whose annual production exceeds a million tons and whose gain in 1908 was of any significance. The increased production in Texas was due to the fact that notwithstanding the industrial depression the State was in a prosperous condition, and its population has been increasing through immigration in the last two or three years. The greatest decrease was in the production of bituminous coal in Pennsylvania, the leading coal-producing State, whose output declined nearly 33,000,000 short tons, or 22 per cent, in quantity, and nearly $37,000,000, or 24 per cent, in value. The difference between the 1907 and 1908 production of bituminous coal in Pennsylvania was larger than the entire output of any other State, with the exception of Illinois and West Virginia. The production of Pennsylvania anthracite decreased 2,335,558 short tons, or 2.73 per cent, in quantity, and $5,405,207, or 3.3 per cent, in value, so that the total decrease in Pennsylvania's output of coal was 35,299,208 short tons in quantity, and $42,252,930 in value. Next to Pennsylvania, the most important decrease was shown in West Virginia, whose output fell off 6,193,740 short tons, or 12.88 per cent, in quantity, and $7,837,576, or 8.88 per cent, in value. Ohio's production decreased 5,871,780 short tons in quantity, and $7,427,042 in value. Illinois's output decreased 3,657,456 short tons, and $4,709,135, and Alabama 2,645,861 short tons, and $3,757,577. The total decrease for the year, as shown in the following table, was 64,520,726 short tons in quantity, and $82,484,781 in value, the percentages of which were 13.43 in quantity and 13.42 in value. Of the total decrease 2,335,558 short tons were anthracite and 62,185,168 tons bituminous coal.

Quantity and value of coal produced in the United States, 1904–1908, in short tons.

State or Territory.	1904.		1905.	
	Quantity.	Value.	Quantity.	Value.
Alabama	11,262,046	$13,480,111	11,866,069	$14,387,721
Arkansas	2,009,451	3,102,660	1,934,673	2,880,738
California and Alaska	79,582	377,306	80,824	395,975
Colorado	6,658,355	8,751,821	8,826,429	10,810,978
Georgia and North Carolina	390,191	476,996	353,548	456,184
Idaho	3,480	13,730	[a] 5,882	[a] 17,846
Illinois	36,475,060	39,941,993	38,434,363	40,577,592
Indiana	10,842,189	12,004,300	11,895,252	12,492,255
Indian Territory	3,046,539	5,532,066	2,924,427	5,145,358
Iowa	6,519,933	10,504,406	6,798,609	10,586,381
Kansas	6,333,307	9,640,771	6,423,979	9,350,542
Kentucky	7,576,482	7,868,192	8,432,523	8,385,232
Maryland	4,813,622	5,729,085	5,108,539	5,831,760
Massachusetts				
Michigan	1,342,840	2,424,935	1,473,211	2,512,697
Missouri	4,168,308	6,801,751	3,983,378	6,291,661
Montana	1,358,919	2,194,548	1,643,832	2,823,350
New Mexico	1,452,325	1,904,499	1,649,933	2,190,231
North Dakota	271,928	389,052	317,542	424,778
Ohio	24,400,220	26,579,738	25,552,950	26,486,740
Oregon	111,540	243.588	109,641	282,495
Pennsylvania bituminous	97,938,287	94,428,219	118,413,637	113,390,507
Tennessee	4,782,211	5,642,393	5,766,690	6,577,881
Texas	1,195,944	1,983,636	1,200,684	1,968,558
Utah	1,493,027	1,943,440	1,332,372	1,793,510
Virginia	3,410,914	2,921,911	4,275,271	3,777,325
Washington	3,137,681	5,120,931	2,864,926	5,141,258
West Virginia	32,406,752	28,647,014	37,791,580	32,341,790
Wyoming	5,178,556	6,747,909	5,602,021	7,336,951
Total bituminous	278,659,689	305,397,001	315,062,785	334,658,294
Pennsylvania anthracite	73,156,709	138,974,020	77,659,850	141,879,000
Grand total	351,816,398	444,371,021	392,722,635	476,537,294

[a] Includes production of Nevada.

Quantity and value of coal produced in the United States, 1904–1908, in short tons—Con.

State or Territory.	1906.		1907.	
	Quantity.	Value.	Quantity.	Value.
Alabama	13,107,963	$17,514,786	14,250,454	$18,405,468
Arkansas	1,864,268	3,000,339	2,670,438	4,473,693
California and Alaska	30,831	78,684	24,089	91,813
Colorado	10,111,218	12,735,616	10,790,236	15,079,449
Georgia and North Carolina	[a] 332,107	[a] 424,004	[a] 362,401	[a] 499,686
Idaho	[b] 6,165	[b] 24,238	[c] 7,588	[c] 31,119
Illinois	41,480,104	44,763,062	51,317,146	54,687,382
Indiana	12,092,560	13,116,261	13,985,713	15,114,300
Iowa	7,266,224	11,619,455	7,574,322	12,258,012
Kansas	6,024,775	8,979,553	7,322,449	11,159,698
Kentucky	9,653,647	9,809,938	10,753,124	11,405,038
Maryland	5,435,453	6,474,793	5,532,628	6,623,697
Massachusetts				
Michigan	1,346,338	2,427,404	2,035,858	3,660,833
Missouri	3,758,008	6,118,733	3,997,936	6,540,709
Montana	1,829,921	3,240,357	2,016,857	3,907,082
New Mexico	1,964,713	2,638,986	2,628,959	3,832,128
North Dakota	305,689	451,382	347,760	560,199
Ohio	27,731,640	30,346,580	32,142,419	35,324,746
Oklahoma (Indian Territory)	2,860,200	5,482,366	3,642,658	7,433,914
Oregon	79,731	212,338	70,981	166,304
Pennsylvania bituminous	129,293,206	130,290,651	150,143,177	155,664,026
Tennessee	6,259,275	7,667,415	6,810,243	8,490,334
Texas	1,312,873	2,178,901	1,648,069	2,778,811
Utah	1,772,551	2,408,381	1,947,607	2,959,769
Virginia	4,254,879	4,183,991	4,710,895	4,807,533
Washington	3,276,184	5,908,434	3,680,532	7,679,801
West Virginia	43,290,350	41,051,939	48,091,583	47,846,630
Wyoming	6,133,994	8,013,528	6,252,990	9,732,668
Total bituminous	342,874,867	381,162,115	394,759,112	451,214,842
Pennsylvania anthracite	71,282,411	131,917,694	85,604,312	163,584,056
Grand total	414,157,278	513,079,809	480,363,424	614,798,898

State or Territory.	1908.		Increase (+) or decrease (−), 1908.		Percentage of increase or decrease, 1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	11,604,593	$14,647,891	− 2,645,861	−$3,757,577	−18.57	−20.42
Arkansas	2,078,357	3,499,470	− 592,081	− 974,223	−22.17	−21.78
California and Alaska	21,862	69,650	− 2,227	− 22,163	− 9.24	−24.14
Colorado	9,634,973	13,586,988	− 1,155,263	− 1,492,461	−10.71	− 9.90
Georgia	264,822	364,279	− 97,579	− 135,407	−26.93	−27.10
Idaho	5,429	21,832	− 2,159	− 9,287	−28.45	−29.84
Illinois	47,659,690	49,978,247	− 3,657,456	− 4,709,135	− 7.13	− 8.61
Indiana	12,314,890	13,084,297	− 1,670,823	− 2,030,003	−11.95	−13.43
Iowa	7,161,310	11,906,402	− 413,012	− 551,610	− 5.45	− 4.50
Kansas	6,245,508	9,292,222	− 1,076,941	− 1,867,476	−14.71	−16.73
Kentucky	10,246,553	10,317,162	− 506,571	− 1,087,876	− 4.71	− 9.54
Maryland	4,377,093	5,116,753	− 1,155,535	− 1,506,944	−20.89	−22.75
Massachusetts	50	150	+ 50	+ 150		
Michigan	1,835,019	3,322,904	− 200,839	− 337,929	− 9.87	− 9.23
Missouri	3,317,315	5,444,907	− 680,621	− 1,095,802	−17.02	−16.75
Montana	1,920,190	3,771,248	− 96,667	− 135,834	− 4.79	− 3.48
New Mexico	2,467,937	3,368,753	− 161,022	− 463,375	− 6.12	−12.09
North Dakota	320,742	522,116	− 27,018	− 38,083	− 7.77	− 6.80
Ohio	26,270,639	27,897,704	− 5,871,780	− 7,427,042	−18.27	−21.03
Oklahoma	2,948,116	5,976,504	− 694,542	− 1,457,410	−19.07	−19.60
Oregon	86,259	236,021	+ 15,278	+ 69,717	+21.52	+41.92
Pennsylvania bituminous	117,179,527	118,816,303	−32,963,650	−36,847,723	−21.95	−23.67
Tennessee	6,199,171	7,118,499	− 611,072	− 1,371,835	− 8.97	−16.16
Texas	1,895,377	3,419,481	+ 247,308	+ 640,670	+15.01	+23.06
Utah	1,846,792	3,119,338	− 100,815	+ 159,569	− 5.18	+ 5.39
Virginia	4,259,042	3,868,524	− 451,853	− 939,009	− 9.59	−19.54
Washington	3,024,943	6,690,412	− 655,589	− 989,389	−17.81	−12.88
West Virginia	41,897,843	40,009,054	− 6,193,740	− 7,837,576	−12.88	−16.38
Wyoming	5,489,902	8,868,157	− 763,088	− 864,511	−12.20	− 8.88
Total bituminous	332,573,944	374,135,268	−62,185,168	−77,079,574	−15.75	−17.08
Pennsylvania anthracite	83,268,754	158,178,849	− 2,335,558	− 5,405,207	− 2.73	− 3.30
Grand total	405,842,698	532,314,117	−64,520,726	−82,484,781	−13.43	−13.42

[a] Georgia only. [b] Includes production of Nevada. [c] Includes production of Nebraska and Nevada.

Compared with the phenomenal rapidity with which the production of bituminous coal in the United States has grown during the last quarter of a century, the anthracite industry of Pennsylvania has remained almost stationary. The maximum production of both anthracite and bituminous coal was obtained in 1907, in which year, as shown in the preceding table, the output of anthracite amounted to 85,604,312 short tons, while during the four preceding years it averaged a little less than 75,000,000 short tons. From 1891 to 1900 the annual production of anthracite ranged between 50,000,000 and 60,000,000 tons, and it is believed by many who are familiar with the anthracite industry that the maximum production has about been reached, although there are some who predict that before the period of decline arrives a total of 100,000,000 long tons (112,000,000 short tons) will be mined. In 1880, according to the Tenth Census, the production of anthracite amounted to 28,649,812 short tons, and in the same year the bituminous production amounted to 42,831,758 short tons. In 1890 the production of anthracite had grown to 41,489,858 long tons, or 46,468,641 short tons, while the bituminous production amounted to 111,302,322 short tons. In 1900 the anthracite output had increased to 51,221,353 long tons, or 57,367,915 short tons, a gain of 23.5 per cent, while the bituminous production had grown to 212,316,112 short tons, or 90.8 per cent. In the next seven years the anthracite production had shown a gain of 49.2 per cent to 76,432,421 long tons, or 85,604,312 short tons, while the bituminous production gained 85.9 per cent to 394,759,112 short tons. In 1908 the production of anthracite decreased to 74,347,102 long tons, or 83,268,754 short tons, and bituminous coal to 332,573,944 short tons. The production of anthracite in 1907 included 4,301,082 long tons, or 4,817,212 short tons, most of which was recovered from the old culm banks by washing and was not actually a part of the mine product for that year. The washery output in 1908 was 3,646,250 long tons, or 4,083,800 short tons.

The accompanying diagram (fig. 2) illustrates the comparative growth of anthracite and bituminous coal from 1856 to 1908. Prior to 1870 the larger production was of Pennsylvania anthracite. Since 1870 the production of bituminous coal has rapidly outstripped that of anthracite. The output of anthracite in 1908 was 74,347,102 long tons, or 83,268,754 short tons, an increase over 1880 of 48,766,913 long tons (54,618,942 short tons), or 190.6 per cent. The production of bituminous coal in the same time has increased from 42,831,758 short tons to 332,573,944 short tons, an increase of 289,742,186 short tons, or 676.5 per cent. Anthracite was at one time an important factor in blast-furnace practice, but its use in that line of industry has now almost entirely ceased, having been supplanted by coke made from bituminous coal. The principal demand for anthracite will be in the future, as it has been in the more recent past, restricted largely to domestic trade, for which such sizes as furnace, egg, stove, and chestnut are required. The breaking down of the lump coal, which was formerly a marketable product, for the preparation of the domestic sizes results in a much larger proportion of the small or undesirable sizes, all of which are sold at less than the cost of production. As shown in the subsequent pages of this report, the percentage of these small sizes has increased from 23.1 per cent in 1890 to 40.74 per cent in 1908, while the percentage of sizes above

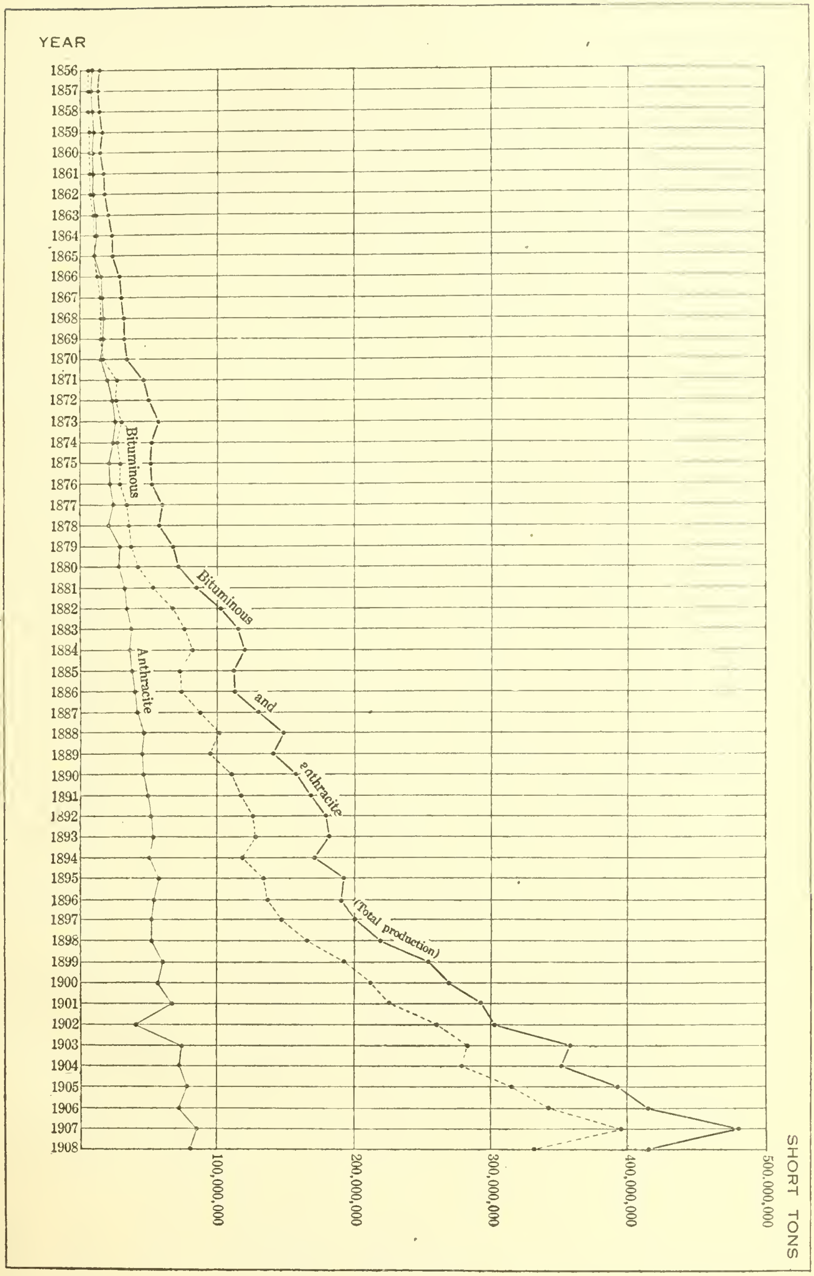

FIGURE 2.—Yearly production of anthracite and bituminous coal from 1856 to 1908, in short tons.

pea coal, or what may be termed the profitable sizes, has decreased from 77 to 59.26 per cent. All of the profits on the mining operations must be obtained from the prepared domestic sizes, while the revenue obtained from the smaller sizes, which are sold largely for steaming purposes, in competition with bituminous coal, serves only to reduce the cost of the domestic sizes. The conditions under which the anthracite mines are operated, the greater depths to which the workings are carried, the consequent increased expense of mining, and the increasing tendency in the cost of labor, all contribute to making anthracite fuel more and more a luxury. No hope is held out to the consumer that anthracite will in the future be sold at lower prices than those which prevail to-day; but, on the other hand, there is every reason to believe that prices must advance in accordance with the increasing cost of production. It is only by reason of economical administration that prices are not higher than they are.

During recent years the anthracite operators have adopted the policy of making an allowance of 50 cents per ton from circular prices for domestic coal purchased in April of each year, with an advance of 10 cents per ton for each succeeding month until the schedule prices are restored in September. This has had a more salutary effect in steadying the anthracite trade than any other action taken by those controlling the anthracite industry. Its purpose is to encourage the purchase of coal in the spring and early summer, making the cellars of the consumers the storage places for the following winter, and at the same time causing the mines to be operated more regularly, and thus giving more steady employment to employees throughout the year.

The statistics covering the distribution of the coal production of the United States for consumption have been obtained only since 1889. These are shown in the following table, by five-year periods since 1890 and annually since 1906:

Distribution of the coal product of the United States, 1890, 1895, 1900, 1905–1908, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.
1890	128,365,965	9,009,285	5,063,953	15,331,760
1895	158,380,289	9,655,505	6,677,539	18,404,197
1900	223,782,088	9,077,242	9,189,746	27,634,951
1905	324,059,447	12,208,687	14,042,173	42,412,328
1906	341,526,755	11,640,238	14,833,984	46,156,301
1907	399,421,195	13,091,034	17,561,373	50,289,822
1908	354,551,092	11,862,885	17,200,377	32,228,344

Year.	Total product.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1890	157,770,963	$176,804,573	$1.12	216	318,204
1895	193,117,530	197,799,043	1.02	195	382,879
1900	269,684,027	306,688,164	1.14	212	448,581
1905	392,722,635	476,537,294	1.21	212	626,035
1906	414,157,278	513,079,809	1.24	209	640,780
1907	480,363,424	614,798,898	1.28	231	680,492
1908	415,842,698	532,314,117	1.28	195	690,438

Production of coal in the United States, 1880, 1885, 1890, 1895, and 1900–1908.

Year.	Pennsylvania anthracite.			Bituminous coal.		
	Quantity.		Value.	Quantity.		Value.
	Long tons.	*Short tons.*		*Long tons.*	*Short tons.*	
1880	25,580,189	28,649,812	$42,196,678	38,242,641	42,831,758	$58,443,718
1885	34,228,548	38,335,974	76,671,948	65,021,715	72,824,321	82,347,648
1890	41,489,858	46,468,641	66,383,772	99,377,073	111,302,322	110,420,801
1895	51,785,122	57,999,337	82,019,272	120,641,244	135,118,193	115,779,771
1900	51,221,353	57,367,915	85,757,851	189,567,957	212,316,112	220,930,313
1901	60,242,560	67,471,667	112,504,020	201,632,276	225,828,149	236,422,049
1902	36,940,710	41,373,595	76,173,586	232,336,468	260,216,844	290,858,483
1903	66,613,454	74,607,068	152,036,448	252,454,775	282,749,348	351,687,933
1904	65,318,490	73,156,709	138,974,020	248,803,293	278,659,689	305,397,001
1905	69,339,152	77,659,850	141,879,000	281,306,058	315,062,785	334,658,294
1906	63,645,010	71,282,411	131,917,694	306,138,274	342,874,867	381,162,115
1907	76,432,421	85,604,312	163,584,056	352,463,493	394,759,112	451,214,842
1908	74,347,102	83,268,754	158,178,849	296,941,021	332,573,944	374,135,268

Year.	Total.		
	Quantity.		Value.
	Long tons.	*Short tons.*	
1880	63,822,830	71,481,570	$100,640,396
1885	99,250,263	111,160,295	159,019,596
1890	140,866,931	157,770,963	176,804,573
1895	172,426,366	193,117,530	197,799,043
1900	240,789,310	269,684,027	306,688,164
1901	261,874,836	293,299,816	348,926,069
1902	269,277,178	301,590,439	367,032,069
1903	319,068,229	357,356,416	503,724,381
1904	314,121,783	351,816,398	444,371,021
1905	350,645,210	392,722,635	476,537,294
1906	369,783,284	414,157,278	513,079,809
1907	428,895,914	480,363,424	614,798,898
1908	371,288,123	415,842,698	532,314,117

In the following table is presented a statement showing how the coal production of the five principal States, Pennsylvania, Illinois, West Virginia, Ohio, and Alabama, has grown, relatively to the total production, since 1860. The statistics are for each ten years from 1860 to 1900, and annually from 1901 to 1908, inclusive. It will be observed that Pennsylvania, which produced nearly three-fourths (74 per cent) of the total output of the United States in 1860, has produced less than 50 per cent in each of the last seven years. In 1908 Pennsylvania produced 48.2 per cent of the total. West Virginia, which was not a separate State in 1860, produced less than 2 per cent in 1870, and in 1908 produced 10.1 per cent of the total output. Illinois's percentage has more than doubled, from 5 in 1860 to 11.5 in 1908. Ohio's percentage has decreased from 8.7 to 6.3, and Alabama, which in 1860 produced less than one-tenth of 1 per cent, has produced approximately 3 per cent since 1890.

Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860–1908, in short tons.

Year.	Total production, United States.	Pennsylvania.		West Virginia.	
		Production.	Percentage of total production.	Production.	Percentage of total production.
1860	14,610,042	10,806,628	74.0	....	....
1870	33,035,580	23,462,793	71.0	608,878	1.8
1880	71,481,570	47,074,975	65.9	1,829,844	2.6
1890	157,770,963	88,770,814	56.3	7,394,654	4.7
1900	269,684,027	137,210,241	50.9	22,647,207	8.4
1901	293,299,816	149,777,613	51.1	24,068,402	8.2
1902	301,590,439	139,947,962	46.4	24,570,826	8.1
1903	357,356,416	177,724,246	49.7	29,337,241	8.2
1904	351,816,398	171,094,996	48.6	32,406,752	9.2
1905	392,722,635	196,073,487	49.9	37,791,580	9.6
1906	414,157,278	200,575,617	48.4	43,290,350	10.5
1907	480,363,424	235,747,489	49.1	48,091,583	10.0
1908	415,842,698	200,448,281	48.2	41,897,843	10.1

Year.	Illinois.		Ohio.		Alabama.	
	Production.	Percentage of total production.	Production.	Percentage of total production.	Production.	Percentage of total production.
1860	728,400	5.0	1,265,600	8.7	10,200	0.07
1870	2,624,163	7.9	2,527,285	7.7	11,000	.03
1880	6,115,377	8.6	6,008,595	8.4	323,972	.45
1890	15,292,420	9.7	11,494,506	7.3	4,090,409	2.6
1900	25,767,981	9.6	18,988,150	7.0	8,394,275	3.1
1901	27,331,552	9.3	20,943,807	7.1	9,099,052	3.1
1902	32,939,373	10.9	23,519,894	7.8	10,354,570	3.4
1903	36,957,104	10.3	24,838,103	7.0	11,654,324	3.3
1904	36,475,060	10.4	24,400,220	6.9	11,262,046	3.2
1905	38,434,363	9.8	25,552,950	6.5	11,866,069	3.0
1906	41,480,104	10.0	27,731,640	6.7	13,107,963	3.2
1907	51,317,146	10.7	32,142,419	6.7	14,250,454	3.0
1908	47,659,690	11.5	26,270,639	6.3	11,604,593	2.8

PRODUCTION OF COAL IN THE UNITED STATES FROM THE EARLIEST TIMES TO THE CLOSE OF 1908.

So far as known, the first mention of the occurrence of coal in the United States is made in the journal of Father Hennepin, a French Jesuit missionary, who in 1679 recorded the site of a "cole mine" on Illinois River, near the present city of Ottawa, Ill. The first actual mining of coal was in the Richmond basin, Virginia, about seventy years after Father Hennepin's discovery in Illinois, but the first records of production from the Virginia mines were for the year 1822, when, according to one authority, 54,000 tons were mined. Ohio probably ranks second in priority of production, as coal was discovered there in 1755, but the records of production date back only to 1838. The mining of anthracite in Pennsylvania began about 1790, and it is said that in 1807 55 tons were shipped to Columbia, Pa. Reports of the anthracite coal trade are usually begun with the year 1820, when 365 long tons, 1 ton for each day of the year, were shipped to Philadelphia from the Lehigh region. Prior to this, however, in 1814, a shipment of 22 tons was made from Carbondale, also to Philadelphia, and in the following table the production is considered to have begun in that year. It is probable that the actual production prior to 1820 was between 2,500 and 3,000 tons.

In the following table is presented a statement of the total production of anthracite in Pennsylvania since 1814, of bituminous coal since 1820, and the total annual production to the close of 1908. During the period covered by this table the total production of anthracite in Pennsylvania has amounted to 2,014,779,075 short tons, and the bituminous coal to 5,266,161,190 short tons, indicating that of the total output 27.7 per cent has been from the anthracite mines of Pennsylvania and 72.3 per cent has been bituminous coal.

The annual production of each State, from the time of earliest record to the close of 1908, is given in connection with the discussion of the production in the respective States.

Production of coal in the United States from 1814 to the close of 1908, in short tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.
1814	22	....	22
1815	50	....	50
1816	75	....	75
1817	100	....	100
1818	200	....	200
1819	350	....	350
1820	450	3,000	3,450
1821	1,322	....	1,322
1822	4,583	54,000	58,583
1823	8,563	60,000	68,563
1824	13,685	67,040	80,725
1825	42,988	75,000	117,988
1826	59,194	88,720	147,914
1827	78,151	94,000	172,151
1828	95,500	100,408	195,908
1829	138,086	102,000	240,086
1830	215,272	104,800	320,072
1831	217,842	120,100	337,942
1832	447,550	146,500	594,050
1833	600,907	133,750	734,657
1834	464,015	136,500	600,515
1835	690,854	134,000	824,854
1836	842,832	142,000	984,832
1837	1,071,151	182,500	1,253,651
1838	910,075	445,452	1,355,527
1839	1,008,322	552,038	1,560,360
1840	967,108	1,102,931	2,070,039
1841	1,182,441	1,108,700	2,291,141
1842	1,365,563	1,244,494	2,610,057
1843	1,556,753	1,504,121	3,060,874
1844	2,009,207	1,672,045	3,681,252
1845	2,480,032	1,829,872	4,309,904
1846	2,887,815	1,977,707	4,865,522
1847	3,551,005	1,735,062	5,286,067
1848	3,805,942	1,968,032	5,773,974
1849	3,995,334	2,453,497	6,448,831
1850	4,138,164	2,880,017	7,018,181
1851	5,481,065	3,253,460	8,734,525
1852	6,151,957	3,664,707	9,816,664
1853	6,400,426	4,169,862	10,570,288
1854	7,394,875	4,582,227	11,977,102
1855	8,141,754	4,784,919	12,926,673
1856	8,534,779	5,012,146	13,546,925
1857	8,186,567	5,153,622	13,340,189
1858	8,426,102	5,548,376	13,974,478
1859	9,619,771	6,013,404	15,633,175
1860	8,115,842	6,494,200	14,610,042
1861	9,799,654	6,688,358	16,488,012
1862	9,695,110	7,790,725	17,485,835
1863	11,785,320	9,533,742	21,319,062
1864	12,538,649	11,066,474	23,605,123
1865	11,891,746	11,900,427	23,792,173
1866	15,651,183	13,352,400	29,003,583
1867	16,002,109	14,722,313	30,724,422
1868	17,003,405	15,858,555	32,861,960
1869	17,083,134	15,821,226	32,904,360
1870	15,664,275	17,371,305	33,035,580
1871	19,342,057	27,543,023	46,885,080
1872	24,233,166	27,220,233	51,453,399
1873	26,152,837	31,449,643	57,602,480
1874	24,818,790	27,787,130	52,605,920
1875	22,485,766	29,862,554	52,348,320
1876	22,793,245	30,486,755	53,280,000
1877	25,660,316	34,841,444	60,501,760
1878	21,689,682	36,245,918	57,935,600
1879	30,207,793	37,898,006	68,105,799
1880	28,649,812	42,831,758	71,481,570
1881	31,920,018	53,961,012	85,881,030
1882	35,121,256	68,429,933	103,551,189
1883	38,456,845	77,250,680	115,707,525
1884	37,156,847	82,998,704	120,155,551
1885	38,335,974	72,824,321	111,160,295
1886	39,035,446	74,644,981	113,680,427
1887	42,088,197	88,562,314	130,650,511
1888	46,619,564	102,040,093	148,659,657
1889	45,546,970	95,682,543	141,229,513
1890	46,468,641	111,302,322	157,770,963
1891	50,665,431	117,901,238	168,566,669
1892	52,472,504	126,856,567	179,329,071
1893	53,967,543	128,385,231	182,352,774
1894	51,921,121	118,820,405	170,741,526
1895	57,999,337	135,118,193	193,117,530
1896	54,346,081	137,640,276	191,986,357
1897	52,611,680	147,617,519	200,229,199
1898	53,382,644	166,593,623	219,976,267
1899	60,418,005	193,323,187	253,741,192
1900	57,367,915	212,316,112	269,684,027
1901	67,471,667	225,828,149	293,299,816
1902	41,373,595	260,216,844	301,590,439
1903	74,607,068	282,749,348	357,356,416
1904	73,156,709	278,659,689	351,816,398
1905	77,659,850	315,062,785	392,722,635
1906	71,282,411	342,874,867	414,157,278
1907	85,604,312	394,759,112	480,363,424
1908	83,268,754	332,573,944	415,842,698
	2,014,779,075	5,266,161,190	7,280,940,265

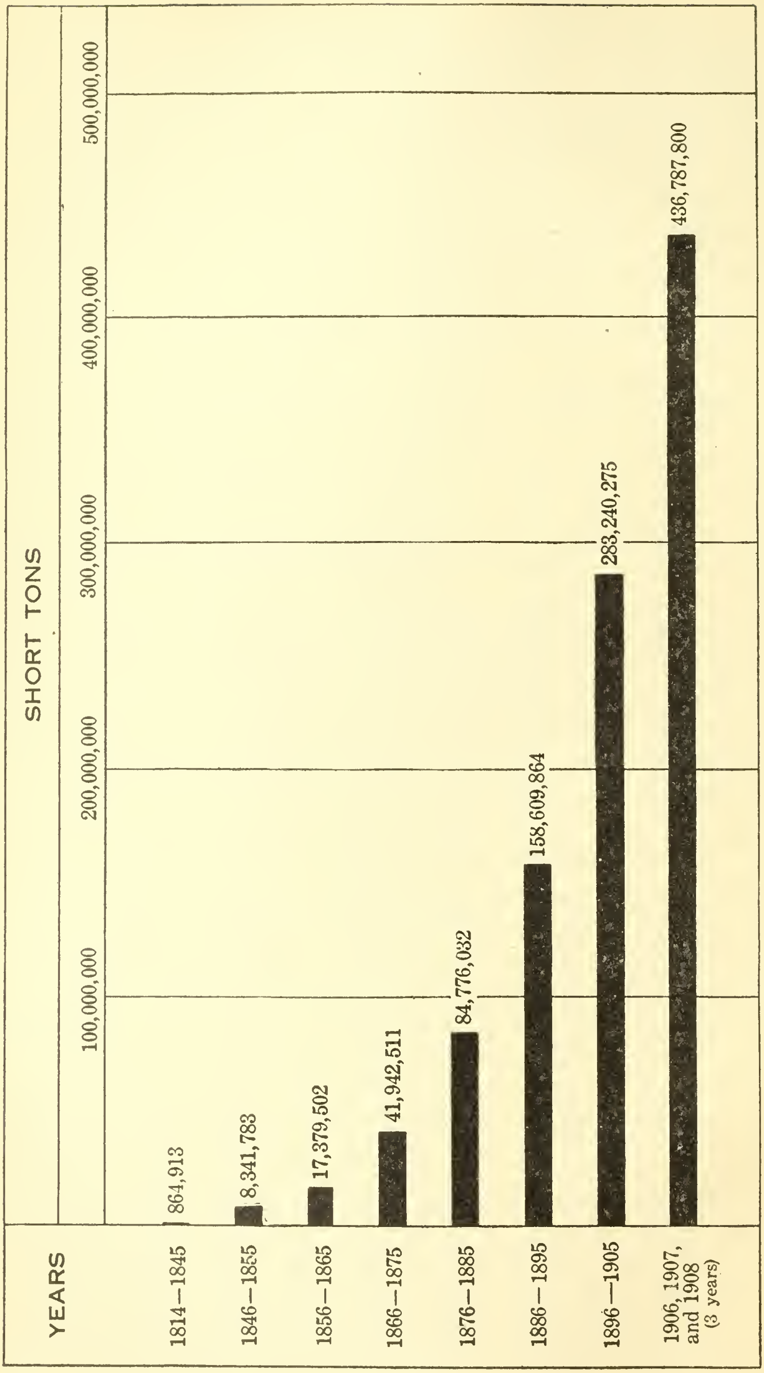

FIGURE 3.—Average yearly production of coal for each decade in the United States since 1814, in short tons.

COAL FIELDS OF THE UNITED STATES.

The coal areas of the United States are divided, for the sake of convenience, into two great divisions—anthracite and bituminous.

The areas in which anthracite is produced are confined almost exclusively to the eastern part of Pennsylvania, and usually when the anthracite fields of the United States are referred to those of eastern Pennsylvania are considered. This region is included in the counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, Dauphin, and Sullivan, and underlies an area of about 480 square miles. In addition to these well-known anthracite fields of Pennsylvania there are two small areas in the Rocky Mountain region where the coal has been locally anthracited, although the production from these districts has never amounted to as much as 100,000 tons in any one year. One of these localities is in Gunnison County, Colo., and the other in Santa Fe County, N. Mex. The coal, although only locally metamorphosed, is a true anthracite and of a good quality. In previous years some coal which was classed as anthracite was mined and sold in New England. The productive area was confined to the eastern part of Rhode Island and the counties of Bristol and Plymouth, in Massachusetts. This product, however, is in reality a graphitic and not an anthracite coal, and is no longer mined for fuel purposes. The production in the last few years has been included with the graphite production.

The bituminous and lignite fields are scattered widely over the United States and include an area of something over 496,000 square miles. The previous classification of these coal areas as published in earlier volumes of the report, Mineral Resources of the United States, has been changed as a result of conferences among the geologists working under Marius R. Campbell in the economic geology of coal. The areas are divided, primarily, into 6 provinces, as follows:

(1) The eastern province, which includes all of the bituminous areas of the Appalachian region; the Atlantic coast region, which includes the Triassic fields near Richmond and the Deep and Dan rivers fields of North Carolina, and also the anthracite region of Pennsylvania. (2) The Gulf province, which includes the lignite fields of Alabama, Mississippi, Louisiana, Arkansas, and Texas. (3) The interior province, which includes all the bituminous areas of the Mississippi Valley region and the coal fields of Michigan. This province is subdivided into the eastern region, which embraces the coal fields of Illinois, Indiana, and western Kentucky; the western region, which includes the fields of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Oklahoma; and the southwestern region, which includes the coal fields of Texas. The Michigan fields are designated as the northern region of the interior province. (4) The northern, or Great Plains, province, which includes the lignite areas of North and South Dakota and the bituminous and subbituminous areas of northeastern Wyoming and northern and eastern Montana. (5) The Rocky Mountain province, which includes the coal fields of the portions of Montana and Wyoming which are in the mountainous districts of those States, and all the coal fields of Utah, Colorado, and New Mexico. (6) The Pacific coast province, which includes all of the coal fields of California, Oregon, and Washington.

A map of the coal fields of the United States, prepared by M. R. Campbell, was published in the report, Mineral Resources of the United States, 1907. Copies of the report on the production of coal in 1907, with the accompanying map, may be obtained upon application to the Director of the United States Geological Survey. This map contains a statement covering the character and geologic age of the coals, and an estimated tonnage of the various fields. The estimates of tonnage have been slightly revised from more recently collated data. The revised estimates place the total original coal supply of the United States at 3,076,204,000,000 short tons, of which 1,922,979,000,000 short tons are considered to be easily accessible, and 1,153,225,000,000 short tons accessible with difficulty. Classified by the character of the coal, the original supply consisted of 21,000,000,000 short tons of anthracite, 1,661,457,000,000 tons of bituminous coal, 650,157,000,000 tons of subbituminous coal, and 743,590,000,000 tons of lignite.

The total production of coal in the United States at the close of 1908 was 7,280,940,265 short tons, which, including the waste involved in the mining and preparation, represented an exhaustion of 11,870,049,900 tons, leaving as the apparent supply still available, 3,064,334,011,000 tons, or 99.6 per cent of the original supply; that is to say, up to the beginning of 1909 only 0.4 of 1 per cent of the original supply of coal has been exhausted. The quantity of coal still available at the close of 1908 was 7,369 times the production in that year, and 4,913 times the exhaustion represented by that production.

In the following table a statement is given showing the area known to contain coal in the various States, by fields, the estimated original supply, the total production of each State and field in 1908, the total production in each to the close of 1908, and the estimated supply still available. For more extended descriptions of the coal fields of the various States the reader is referred to the bibliography of the publications relating to coal contained in the final pages of this report.

Coal fields of the United States and their production in 1908.

	Area.[a]	Estimated original contents.	Production in 1908.	Total production to close of 1908.	Total exhaustion to close of 1908.	Estimated available supply.	Percentage of original supply still available.
ANTHRACITE.	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	
Pennsylvania	480	21,000,000,009	83,268,754	2,014,779,075	4,030,000,000	16,970,000,000	80.8
Colorado and New Mexico	29	(*b*)	41,658	(*b*)	(*b*)	(*b*)	(*b*)
Total	509	21,000,000,000	83,310,412	2,014,779,075	4,030,000,000	16,970,000,000	80.8
BITUMINOUS.[c]							
Eastern province.							
Atlantic coast region:							
Virginia	150	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)
North Carolina	60	200,000,000	....	476,805	715,000	199,285,000	99.6
Appalachian region:							
Pennsylvania	14,200	112,574,000,000	117,179,527	1,963,248,780	2,945,000,000	109,629,000,000	97.4
Ohio	12,660	86,028,000,000	26,270,639	519,039,997	779,000,000	85,249,000,000	99.1
Maryland	455	8,044,000,000	4,377,093	151,983,641	228,000,000	7,816,000,000	97.2
Virginia	1,750	22,500,000,000	4,259,042	61,488,194	92,000,000	22,408,000,000	99.6
West Virginia	17,000	150,000,000,000	41,897,843	476,096,382	715,000,000	149,285,000,000	99.5
Eastern Kentucky	10,270	67,787,000,000	4,446,433	55,713,473	84,000,000	67,703,000 000	99.9
Tennessee	4,400	25,665,000,000	6,199,171	90,503,772	135,000,000	25,530,000,000	99.5
Georgia	167	933,000,000	264,822	8,388,518	12,500,000	920,500,000	98.7
Alabama	8,430	68,903,000,000	11,604,593	176,338,903	264,000,000	68,639,000,000	99.6
Total	69,332	542,434,000,000	216,499,163	3,502,801,660	5,254,500,000	537,179,500,000	99.0
Interior province.							
Northern region:							
Michigan	11,000	12,000,000,000	1,835,019	15,677,962	23,500,000	11,976,500,000	99.8
Eastern region:							
Indiana	6,500	44,169,000,000	12,314,890	171,755,280	258,000,000	43,911,000,000	99.4
Western Kentucky	6,400	36,241,000,000	5,800,120	76,937,654	115,000,000	36,126,000,000	99.7
Illinois	35,600	240,000,000,000	47,659,690	693,527,999	1,040,000,000	238,960,000,000	99.6
Total	48,500	320,410,000,000	65,774,700	942,220,933	1,413,000,000	318,997,000,000	99.6

[a] Known to contain workable coal.
[b] Included in Rocky Mountain and northern Great Plains provinces.
[c] Includes brown coal or lignite, semianthracite, semibituminous, etc., and scattering lots of anthracite.
[d] Included in Appalachian region.

Coal fields of the United States and their production in 1908—Continued.

	Area.	Estimated original contents.	Production in 1908.	Total production to close of 1908.	Total exhaustion to close of 1908.	Estimated available supply.	Percentage of original supply still available.
BITUMINOUS—continued.							
Interior province—Continued.							
Western and southwestern regions: [a]	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	
Iowa	12,560	29,160,000,000	7,161,310	148,770,102	223,000,000	28,937,000,000	99.2
Missouri	16,700	40,000,000,000	3,317,315	100,935,421	151,000,000	39,849,000,000	99.6
Kansas	3,100	7,022,000,000	6,245,508	97,421,712	146,000,000	6,876,000,000	97.9
Arkansas	1,684	1,887,000,000	2,078,357	25,834,758	39,000,000	1,848,000,000	97.9
Oklahoma	10,000	79,278,000,000	2,948,116	42,793,131	64,200,000	79,213,800,000	99.9
Texas	10,200	31,000,000,000	1,895,377	16,340,325	25,000,000	30,975,000,000	99.9
Total	54,244	188,347,000,000	23,645,983	432,095,449	648,200,000	187,698,800,000	99.7
Rocky Mountain and northern Great Plains provinces.							
Arizona	30	60,000,000				60,000,000	
North Dakota	31,240	500,000,000,000	320,742	3,105,000	4,650,000	499,995,350,000	+99.9
Montana	34,067	303,060,000,000	1,920,190	26,659,323	40,000,000	303,020,000,000	+99.9
South Dakota	2,000	10,000,000,000				10,000,000,000	
Wyoming	20,568	424,085,000,000	5,489,902	83,308,667	125,000,000	423,960,000,000	+99.9
Utah	13,130	196,458,000,000	1,846,792	20,683,974	31,000,000	196,427,000,000	+99.9
Colorado	10,105	371,770,000,000	9,621,153	122,303,309	183,000,000	371,587,000,000	+99.9
New Mexico	13,331	163,780,000,000	2,440,099	24,793,369	37,000,000	163,743,000,000	+99.9
Idaho	200	600,000,000	5,429	32,694	49,000	599,951,000	+99.9
Total	124,671	1,969,813,000,000	21,644,307	280,886,336	420,699,000	1,969,392,301,000	+99.9
Pacific coast province and Alaska.							
Washington	1,100	20,000,000,000	3,024,943	46,133,640	69,000,000	19,931,000,000	99.7
Oregon	230	1,000,000,000	86,259	1,876,651	2,800,000	997,200,000	99.7
California	500	1,000,000,000	18,755	5,049,700	7,575,000	992,425,000	99.2
Alaska			3,107	40,614	60,900		
Total	1,830	22,000,000,000	3,133,064	53,100,605	79,435,900	21,920,625,000	99.6
Total production, including colliery consumption	[b] 310,296	3,076,204,000,000	[c] 415,842,698	[d] 7,280,940,265	11,870,049,900	3,064,334,011,000	99.6

[a] Including Texas lignite fields of Gulf province.

[b] Not including 160,705 square miles of which little is known but which may contain workable coals, and 31,805 square miles where coal lies under heavy cover and is not at present available.

[c] Includes 50 short tons reported from Massachusetts.

[d] Includes 38,901 440 short tons of production between 1871 and 1888, principally colliery consumption, which was not included in the distribution by States.

In the following table are the statistics of the production of each of the various regions from 1887 to the close of 1908:

Total production of each region, 1887-1908, in short tons.

	Anthracite.	Bituminous.		
		Atlantic coast.	Appalachian.	Northern.
Area[a] .... square miles..	[b] 519	210	69,332	11,000
Year.				
1887	39,548,255	30,000	55,888,088	71,461
1888	43,971,688	33,000	60,966,245	81,407
1889	45,600,487	49,633	62,972,222	67,431
1890	46,468,641	29,608	73,008,102	74,977
1891	50,665,931	37,645	77,984,563	80,307
1892	52,537,467	43,889	83,122,190	77,990
1893	54,061,121	36,878	81,207,168	45,979
1894	51,992,671	68,979	76,278,748	70,002
1895	58,066,516	82,682	90,167,596	112,322
1896	54,425,573	103,483	90,748,305	92,882
1897	52,680,756	116,950	97,128,220	223,592
1898	53,429,739	38,938	114,239,156	315,722
1899	60,514,201	28,353	129,843,906	624,708
1900	57,466,319	57,912	142,298,208	849,475
1901	67,538,536	12,000	150,501,214	1,241,241
1902	41,467,532	39,206	173,274,861	964,718
1903	74,679,799	35,393	185,600,161	1,367,619
1904	73,228,783	9,100	182,606,561	1,342,840
1905	77,734,673	1,557	212,633,324	1,473,211
1906	71,342,659	....	233,473,524	1,346,338
1907	85,666,404	....	266,501,527	2,035,858
1908	83,310,412	....	216,499,163	1,835,019

	Bituminous.			
	Eastern.	Western and Southwestern.	Rocky Mountain, etc.	Pacific coast and Alaska.
Area[a] .... square miles..	48,500	54,244	124,671	1,830
Year.				
1887	14,478,883	10,172,634	3,646,280	854,308
1888	19,173,167	11,842,764	4,583,719	1,385,750
1889	16,240,314	10,036,356	5,048,413	1,214,757
1890	20,075,840	10,470,439	6,205,782	1,435,914
1891	20,327,323	11,023,817	7,245,707	1,201,376
1892	23,001,653	11,635,185	7,577,422	1,333,266
1893	25,502,809	11,651,296	8,468,360	1,379,163
1894	22,430,617	11,503,623	7,175,628	1,221,238
1895	23,599,469	11,749,803	7,998,594	1,340,548
1896	25,539,867	11,759,966	7,925,280	1,391,001
1897	26,414,127	13,164,059	8,854,182	1,641,779
1898	25,816,874	13,988,436	10,042,759	2,104,643
1899	33,181,247	15,320,373	11,949,463	2,278,941
1900	35,358,164	17,549,528	13,398,556	2,705,865
1901	37,450,871	19,665,985	14,090,362	2,799,607
1902	46,133,024	20,727,495	16,149,545	2,834,058
1903	52,130,856	23,171,692	16,981,059	3,389,837
1904	51,682,313	23,273,482	16,344,516	3,328,803
1905	55,255,541	23,265,750	19,303,188	3,055,391
1906	59,457,660	23,086,348	22,064,003	3,386,746
1907	71,598,256	26,856,622	23,929,155	3,775,602
1908	65,774,700	23,645,983	21,644,307	3,133,064

[a] Known to contain workable coal.
[b] Includes 29 square miles in Colorado and New Mexico.

The following table shows how the production in the six principal bituminous areas has developed since 1887, and how the percentages of the total produced by each during the last five years compare with one another. The production in the northern region of Michigan shows the largest percentage of increase in the period since 1887, while the percentage of the total contributed by the Pacific coast has decreased.

Production of the six principal bituminous coal regions in 1887, 1904, 1905, 1906, 1907, and 1908, compared, in short tons.

Region.	1887.		1904.		1905.		1906.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Appalachian	55,888,088	63.11	182,606,561	65.53	212,633,324	67.49	233,473,524	68.10
Eastern	14,478,883	16.50	51,682,313	18.55	55,255,541	17.54	59,457,660	17.34
Western	10,172,634	11.49	23,273,482	8.35	23,265,750	7.38	23,086,348	6.73
Northern	71,461	.08	1,342,840	.48	1,473,211	.47	1,346,338	.39
Rocky Mountain	3,646,280	4.15	16,344,516	5.87	19,303,188	6.13	22,064,003	6.44
Pacific coast	854,308	1.00	3,328,803	1.19	3,055,391	.97	3,386,746	.99

Region.	1907.		1908.		Increase in 1908 over 1887.		Decrease in 1908 from 1907.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage.	Quantity.	Percentage.
Appalachian	266,501,527	67.51	216,499,163	65.10	160,611,075	287.38	50,002,364	18.76
Eastern	71,598,256	18.13	65,774,700	19.78	51,295,817	354.28	5,823,556	8.13
Western	26,856,622	6.80	23,645,983	7.11	13,473,349	132.45	3,210,639	11.95
Northern	2,035,858	.52	1,835,019	.55	1,763,558	2,467.86	200,839	9.87
Rocky Mountain	23,929,155	6.06	21,644,307	6.51	17,998,027	493.60	2,284,848	9.55
Pacific coast	3,775,602	.96	3,133,064	.94	2,278,756	266.74	642,538	17.02

RANK OF COAL-PRODUCING STATES.

In the following tables the coal-producing States are arranged according to their rank in 1907 and 1908, first in the quantity of coal produced, and then according to the value of product, with the percentage of both quantity and value contributed by each State. Pennsylvania, of course, far outstrips all other States in the quantity and value of the coal product. The production of anthracite alone is nearly equal to the combined output of Illinois and West Virginia, which rank second and third, respectively, while the production of bituminous coal in Pennsylvania is more than one and a quarter times the combined output of the other two States. Until 1902 Pennsylvania, in its aggregate production of anthracite and bituminous coal, contributed more than 50 per cent of the total output of the United States, and in 1880 two-thirds of the total production was from Pennsylvania mines. Pennsylvania's proportion of the total has been steadily falling on account of the fact that the output of anthracite has not increased in the same ratio as that of bituminous coal in other States. On account of the higher value of anthracite, Pennsylvania's proportion in this respect still exceeds 50 per cent of the total, the combined value of anthracite and bituminous coal in that State in 1908 equaling 52 per cent of the total.

With the exception of one year (1906) Illinois has held second place for a quarter of a century. In 1906, because of the suspension of operations in the coal mines of Illinois in the spring of the year, West Virginia advanced to second place, but with the return to normal conditions in 1907 Illinois resumed its former position and more than maintained it in 1908. Ohio continues as fourth in rank, but in point of tonnage Indiana has supplanted Alabama as fifth in rank, and Kentucky has supplanted Colorado as seventh. Alabama continues to rank fifth in point of value of the product, while Colorado has supplanted Indiana in this respect. There were no other changes among the other more important coal-producing States from 1907 to 1908.

Rank of coal-producing States in 1907, with quantity and value of product and percentage of each.

Production.				Value.			
Rank.	State or Territory.	Quantity (short tons).	Percentage of total production.	Rank.	State or Territory.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	85,604,312	17.8		Anthracite	$163,584,056	26.6
	Bituminous	150,143,177	31.3		Bituminous	155,664,026	25.3
2	Illinois	51,317,146	10.7	2	Illinois	54,687,582	8.9
3	West Virginia	48,091,583	10.0	3	West Virginia	47,846,630	7.8
4	Ohio	32,142,419	6.7	4	Ohio	35,324,746	5.7
5	Alabama	14,250,454	3.0	5	Alabama	18,405,468	3.0
6	Indiana	13,985,713	2.9	6	Indiana	15,114,300	2.5
7	Colorado	10,790,236	2.2	7	Colorado	15,079,449	2.4
8	Kentucky	10,753,124	2.2	8	Iowa	12,258,012	2.0
9	Iowa	7,574,322	1.6	9	Kentucky	11,405,038	1.9
10	Kansas	7,322,449	1.5	10	Kansas	11,159,698	1.8
11	Tennessee	6,810,243	1.4	11	Wyoming	9,732,668	1.6
12	Wyoming	6,252,990	1.3	12	Tennessee	8,490,334	1.4
13	Maryland	5,532,628	1.2	13	Washington	7,679,801	1.2
14	Virginia	4,710,895	1.0	14	Oklahoma (Indian Territory)	7,433,914	1.2
15	Missouri	3,997,936	.8	15	Maryland	6,623,697	1.1
16	Washington	3,680,532	.8	16	Missouri	6,540,709	1.1
17	Oklahoma (Indian Territory)	3,642,658	.8	17	Virginia	4,807,533	.8
18	Arkansas	2,670,438	.6	18	Arkansas	4,473,693	.7
19	New Mexico	2,628,959	.5	19	Montana	3,907,082	.6
20	Michigan	2,035,858	.4	20	New Mexico	3,832,128	.6
21	Montana	2,016,857	.4	21	Michigan	3,660,833	.6
22	Utah	1,947,607	.4	22	Utah	2,959,769	.5
23	Texas	1,648,069	.3	23	Texas	2,778,811	.4
24	Georgia	362,401	.1	24	North Dakota	560,199	.1
25	North Dakota	347,760	.1	25	Georgia	499,686	.1
26	Oregon	70,981		26	Oregon	166,304	.1
27	California and Alaska	24,089		27	California and Alaska	91,813	
28	Idaho	[a] 7,588		28	Idaho	[a] 31,119	
		480,363,424	100.0			614,798,898	100.0

[a] Includes production of Nebraska and Nevada.

Rank of coal-producing States in 1908, with quantity and value of product and percentage of each.

Production.				Value.			
Rank.	State or Territory.	Quantity (short tons).	Percentage of total production.	Rank.	State or Territory.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	83,268,754	20.0		Anthracite	$158,178,849	29.7
	Bituminous	117,179,527	28.2		Bituminous	118,816,303	22.3
2	Illinois	47,659,690	11.5	2	Illinois	49,978,247	9.4
3	West Virginia	41,897,843	10.1	3	West Virginia	40,009,054	7.5
4	Ohio	26,270,639	6.3	4	Ohio	27,897,704	5.2
5	Indiana	12,314,890	3.0	5	Alabama	14,647,891	2.8
6	Alabama	11,604,593	2.8	6	Colorado	13,586,988	2.6
7	Kentucky	10,246,553	2.5	7	Indiana	13,084,297	2.5
8	Colorado	9,634,973	2.3	8	Iowa	11,706,402	2.2
9	Iowa	7,161,310	1.7	9	Kentucky	10,317,162	1.9
10	Kansas	6,245,508	1.5	10	Kansas	9,292,222	1.7
11	Tennessee	6,199,171	1.5	11	Wyoming	8,868,157	1.7
12	Wyoming	5,489,902	1.3	12	Tennessee	7,118,499	1.3
13	Maryland	4,377,093	1.0	13	Washington	6,690,412	1.3
14	Virginia	4,259,042	1.0	14	Oklahoma	5,976,504	1.1
15	Missouri	3,317,315	.8	15	Missouri	5,444,907	1.0
16	Washington	3,024,943	.7	16	Maryland	5,116,753	1.0
17	Oklahoma	2,948,116	.7	17	Virginia	3,868,524	.7
18	New Mexico	2,467,937	.6	18	Montana	3,771,248	.7
19	Arkansas	2,078,357	.5	19	Arkansas	3,499,470	.7
20	Montana	1,920,190	.5	20	Texas	3,419,481	.6
21	Texas	1,895,377	.5	21	New Mexico	3,368,753	.6
22	Utah	1,846,792	.4	22	Michigan	3,322,904	.6
23	Michigan	1,835,019	.4	23	Utah	3,119,338	.6
24	North Dakota	320,742	.1	24	North Dakota	522,116	.1
25	Georgia	264,822	.1	25	Georgia	364,279	.1
26	Oregon	86,259		26	Oregon	236,021	.1
27	California and Alaska	21,862		27	California and Alaska	69,650	
28	Idaho	5,429		28	Idaho	21,832	
29	Massachusetts	50		29	Massachusetts	150	
		415,842,698	100.0			532,314,117	100.0

KINDS OF COAL PRODUCED IN THE UNITED STATES.

In the general discussion of the coal production of the United States only two divisions are considered, anthracite and bituminous, the latter product including the small anthracite output of Colorado and New Mexico. In the bituminous production, however, in addition to the small Rocky Mountain output of anthracite, is also included the production of coals generally classed as semianthracite, semibituminous, cannel, block, splint, and lignite or subbituminous. In the following table the production of these varieties of coal in 1907 and 1908 is reported as prepared from the schedules returned to the Geological Survey. It should be stated, however, that this classification makes no claim to technical exactness. It has been compiled from the replies of the producers to the inquiry "Kind of coal produced," on the schedules, and such replies are in some minor cases based on quite uncertain knowledge. It is believed, however, that in this classification the quantity of each kind of coal produced is approximately indicated. It is sufficiently correct for practical purposes and shows that in addition to the production of anthracite in Pennsylvania, there were 27,838 tons of anthracite mined in New Mexico and 13,820 tons in Colorado, in 1908. The semianthracite production is principally from Arkansas, about one-third of the output of that State being classed as semianthracite. Smaller quantities of semianthracite are also produced in Oklahoma and Virginia. The semianthracite production of the Bernice basin in Pennsylvania has been included in that of anthracite. Semibituminous coal was produced in 15 States in 1907 and in 16 States in 1908. West Virginia stands first in this respect, with Maryland second, Pennsylvania third, Montana fourth, and Colorado fifth. Wyoming led in the production of lignite, or subbituminous coal, in 1907, and was superceded by Colorado in 1908, with Wyoming second, Texas third, New Mexico fourth, and North Dakota fifth. In the cases of North Dakota and Texas the production included in this class is entirely lignite, or brown coal, while in the other States it is for the greater part subbituminous coal, or black lignite. The classification formerly of what was called black lignite in the Rocky Mountain States was an error, as that product is entirely distinct from the true lignite or brown coal. It is not lignitic in chemical composition nor physical characteristics but lies between the lignite, or brown coal, and the true bituminous coal, and in order that a proper distinction may be made, the term "subbituminous" has been adopted by the United States Geological Survey as properly applicable. West Virginia and Kentucky are credited with the entire production of splint coal, the former State being by far the more important. Indiana has practically the monopoly in the production of block coal, although small tonnages are reported from Illinois, Ohio, Kentucky, Iowa, Tennessee, and Oklahoma. A comparatively small amount of cannel coal is produced in Pennsylvania, West Virginia, Ohio, Indiana, Kentucky, Iowa, and Missouri.

Classification of the coal product of the United States in 1907, by States and Territories, in short tons.

State or Territory.	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semi-anthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	145,678,526	85,604,312	4,432,514			17,365		14,772	235,747,489
Illinois	51,317,146								51,317,146
West Virginia	38,222,196		4,634,755			59,636	[a] 5,161,315	13,681	48,091,583
Ohio	32,129,834					12,185		400	32,142,419
Alabama	14,235,232		500					14,722	14,250,454
Indiana	13,087,844					[b] 857,214		[c] 40,655	13,985,713
Colorado	8,288,306	42,222	666,954	1,792,754					10,790,236
Kentucky	10,381,681		59,544			4,071	210,242	97,586	10,753,124
Iowa	7,489,617					73,905		10,800	7,574,322
Kansas	7,322,449								7,322,449
Tennessee	6,710,401		99,842						6,810,243
Wyoming	1,331,406		743,978	4,177,606					6,252,990
Maryland	1,660,297		3,872,331						5,532,628
Virginia	4,590,853		85,120		34,922				4,710,895
Missouri	3,942,821					53,256		1,859	3,997,936
Washington	3,051,846		354,228	274,458					3,680,532
Oklahoma (Indian Territory)	3,562,124				80,534				3,642,658
Arkansas	1,767,263		11,344		891,831				2,670,438
New Mexico	1,981,768	19,870		627,321					2,628,959
Michigan	2,035,858								2,035,858
Montana	1,280,744		644,052	92,061					2,016,857
Utah	1,809,570			138,037					1,947,607
Texas	899,371		38,766	707,732				2,200	1,648,069
Georgia	129,535		232,866						362,401
North Dakota				347,760					347,760
Oregon				70,981					70,981
California			4,000	9,950					13,950
Alaska	1,050			9,089					10,139
Idaho [d]	4,088			3,500					7,588
	362,911,826	85,666,404	15,880,794	8,251,249	1,007,287	1,077,632	5,371,557	196,675	480,363,424

[a] Includes 61,000 tons of semisplint coal.
[b] Includes 17,350 tons of semiblock coal.
[c] Includes 2,200 tons of semicannel coal.
[d] Includes Nebraska's and Nevada's production.

Classification of the coal product of the United States in 1908, by States and Territories, in short tons.

State or Territory.	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semianthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	113,915,977	83,268,754	3,238,946		297			24,307	200,448,281
Illinois	47,609,595		39,000			11,095			47,659,690
West Virginia	33,299,669		4,352,619				4,181,186	64,369	41,897,843
Ohio	26,261,132					8,642		865	26,270,639
Indiana	11,423,824		48,257			[a] 812,579		30,230	12,314,890
Alabama	[b] 11,604,593								11,604,593
Kentucky	9,716,584		166,243			5,000	269,592	[c] 89,134	10,246,553
Colorado	7,323,762	13,820	416,085	1,881,306					9,634,973
Iowa	7,076,096					62,496		22,718	7,161,310
Kansas	6,245,508								6,245,508
Tennessee	6,195,971					3,200			6,199,171
Wyoming	4,282,828		266,310	940,764					5,489,902
Maryland	1,105,789		3,271,304						4,377,093
Virginia	4,163,915		59,360		35,767				4,259,042
Missouri	3,307,583		5,549					4,183	3,317,315
Washington	2,604,195		193,792	226,956					3,024,943
Oklahoma	2,701,183		182,198		63,535	1,200			2,948,116
New Mexico	1,898,299	27,838	2,750	539,050					2,467,937
Arkansas	1,375,739		24,122		678,496				2,078,357
Montana	1,197,906		608,423	113,861					1,920,190
Texas	1,047,407			847,970					1,895,377
Utah	1,736,468		940	109,384					1,846,792
Michigan	1,835,019								1,835,019
North Dakota				320,742					320,742
Georgia	264,822								264,822
Oregon				86,259					86,259
California	9,000			9,755					18,755
Idaho	2,429			3,000					5,429
Alaska	196			2,911					3,107
Massachusetts				50					50
	308,205,489	83,310,412	12,875,898	5,082,008	778,095	904,212	4,450,778	235,806	415,842,698

[a] Includes 23,577 tons of semiblock coal.

[b] Includes 5,260 tons of semicannel coal.

[c] Includes 6,201 tons of semicannel coal.

LABOR STATISTICS.

In the following tables are shown the number of men employed and the average time worked in the coal mines of the United States during the last five years, by States, and the total number employed in the anthracite and bituminous mines, and the average working time since 1890. The total number of men employed in 1908 was 690,438, against 680,492 in 1907 and 640,780 in 1906. Of the total number of employees in 1908, 516,264, or 74.8 per cent, were bituminous mine workers, and 174,174, or 25.2 per cent, were employed in the anthracite mines of Pennsylvania. The average number of days worked in the anthracite mines in 1908 was 200, against 220 in 1907. The bituminous mine workers averaged 193 days in 1908, against 234 in 1907. The average time made by the employees in the bituminous mines in 1908 was less than in any year since 1896. The average number of days made by all the mine workers in 1908 was 195, having been 231 in 1907 and 209 in 1906.

Statistics of labor employed in coal mines of the United States, 1904–1908, by States.

State or Territory.	1904.		1905.		1906.		1907.		1908.	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	216	17,811	225	19,595	237	20,555	242	21,388	222	19,197
Arkansas	165	4,580	177	4,192	165	4,298	190	5,085	145	5,337
California	a 282	a 168	a 294	a 144	a 253	a 56	a 187	a 76	a 220	a 49
Colorado	261	8,123	255	11,020	268	11,368	258	14,223	212	14,523
Georgia	b 223	b 906	b 266	b 816	279	737	262	808	261	670
Idaho	c 112	c 32	c 107	c 37	c 157	c 25	d 121	d 22	160	24
Illinois	213	54,685	201	58,053	192	61,988	218	65,581	185	68,035
Indiana	177	19,587	151	25,323	175	20,970	197	21,022	174	18,380
Iowa	213	15,629	209	15,113	224	15,260	230	15,585	214	16,021
Kansas	213	12,198	212	11,926	165	14,355	225	12,439	181	13,916
Kentucky	197	14,235	200	14,685	212	15,272	210	16,971	186	16,996
Maryland	226	5,671	252	5,948	250	6,438	263	5,880	220	6,079
Michigan	183	3,549	186	3,696	173	3,971	234	3,982	207	4,247
Missouri	206	10,137	194	8,962	185	9,557	214	8,448	169	8,988
Montana	243	2,505	243	2,181	243	2,394	268	2,735	224	3,146
New Mexico	228	1,849	234	2,108	242	2,070	269	2,970	197	3,448
North Dakota	192	554	187	626	209	488	223	562	181	631
Ohio	175	43,634	176	43,399	167	45,438	199	46,833	161	47,407
Oklahoma (Indian Territory)	199	8,487	188	7,712	166	8,251	216	8,398	172	8,651
Oregon	149	334	242	316	224	209	231	184	249	214
Pennsylvania bituminous	196	135,100	231	143,629	231	152,099	255	163,295	201	165,961
Tennessee	217	10,416	222	11,928	229	11,452	232	12,052	209	11,812
Texas	220	2,921	238	3,008	227	3,048	242	4,227	254	4,400
Utah	294	1,374	247	1,361	288	1,572	258	2,203	227	2,664
Virginia	238	5,165	241	5,730	250	5,131	241	6,670	200	6,208
Washington	243	5,287	227	4,765	266	4,529	273	5,945	202	5,484
West Virginia	197	47,235	209	48,389	220	50,960	230	59,029	185	56,861
Wyoming	262	5,660	236	5,977	281	5,934	275	6,645	217	6,915
Total bituminous	202	437,832	211	460,629	213	478,425	234	513,258	193	516,264
Pennsylvania anthracite	200	155,861	215	165,406	195	162,355	220	167,234	200	174,174
Grand total	202	593,693	212	626,035	209	640,780	231	680,492	195	690,438

a Includes Alaska. b Includes North Carolina. c Includes Nevada. d Includes Nebraska and Nevada.

It is interesting to note that although the production of both anthracite and bituminous coal in 1908 was less than in 1907, there was an increase of nearly 10,000 in the number of men employed in the mines. The production of bituminous coal decreased 62,185,168 short tons, or 15.75 per cent, while there was an increase of about 3,000 in the number of men employed. In the anthracite mines the number of men employed increased from 167,234 in 1907 to 174,174 in 1908, while the production decreased from 85,604,312 short tons to 83,268,754 short tons. Because of the larger number of men employed and the fewer number of days worked in both the anthracite and bituminous mines in 1908 as compared with 1907, the average output per man for the year decreased in each case, but also on account of the fewer number of days worked there was a greater "intensity" of labor during the time the mines were in operation. This is shown by the increase in the average output per day for each man employed. The average production of anthracite for each man employed in 1907 was 512 short tons. The average production of bituminous coal for each man employed in 1907 was 769 short tons. In 1908 the corresponding figures were, respectively, 478 short tons and 644 short tons. The average daily production of anthracite per man increased from 2.33 in 1907 to 2.39 in 1908, while the equivalent averages for bituminous coal were 3.29 and 3.34 short tons.

In the following table is presented a statement of the average annual and daily tonnage per man from 1890 to 1908. This table shows that there was a general increasing tendency in the productive capacity per man in the anthracite region up to 1899, when the highest daily average tonnage of 2.5 per man was reached. The productive efficiency of the employees then showed a declining tendency until 1905, when the low record of 2.18 tons was reached. A tendency toward improvement over this has been shown in the figures for 1906, 1907, and 1908. The tendency in the bituminous mines has been fairly regular on the upward scale, and this has been due largely to the introduction of machinery for the undercutting of the coal. In 1890 the use of machines had only started, for in 1891 there were but 545 machines reported as in use in the bituminous coal mines, in that year 6,211,732 tons being mined by the use of machines. In 1908 there were 11,569 machines in use, while the machine-mined tonnage amounted to 123,183,334 short tons, or 37.52 per cent of the total output in the States where machines were employed. The average production per man per day had advanced from 2.56 short tons in 1890 to 3.34 tons in 1908, an advance of 30 per cent in productive efficiency.

Production of coal according to number of persons employed, 1890–1908.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1890	126,000	200	1.85	369	192,204	226	2.56	579
1891	126,350	203	1.98	401	205,803	223	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644

In connection with the statistics of labor employed in the bituminous coal mines of the United States, the Geological Survey has in recent years included in its schedules an inquiry as to the number of hours constituting a day's work. By the terms of the award of the Anthracite Coal Strike Commission, which terminated on March 21, 1906, the anthracite coal mines of Pennsylvania were placed on a nine-hour basis for all company men or those working by the day, with the exception of hoisting engineers, other engineers, and pump men, who were allotted eight hours for a day's work. No length of day was prescribed for the miners themselves, for the reason that practically all of the coal both in the anthracite and bituminous regions is mined by contract, at so much per ton, or per mine car, by yardage, or by other basis of measurement. By an agreement between the operators and the representatives of the miners the award of the Strike Commission was extended without change for a term of three years, or until March 31, 1909, and has again been extended for another three years, or until March 31, 1912.

In addition to the gratifying conditions of peace which have prevailed in the anthracite region since the commission made its awards, there has been a greater regularity of employment throughout the year consequent upon the action of the operators in making a reduction (50 cents per ton in the prepared sizes) from the circular prices, in April of each year, the object being to induce consumers to lay in their supply of coal during the spring and summer months and thus furnish storage facilities otherwise unobtainable. The result of this has been the securing of more steady employment for the miners throughout the year instead of rush work in the fall and winter months, and idleness during the summer. It is to be observed that prior to 1902 the average time worked in the anthracite region ranged from 150 to 203 days, the minimum being in 1897 and the maximum in 1891. There was only one year—1891—when the miners averaged more than 200 days. Since 1902 they have averaged

200 days, or over, in every year but one—1906—and the latter exception was due to the suspension of operations preceding the renewal of the agreement made under the Strike Commission's awards.

The statistics of the labor employed in the bituminous mines show that in the States where the miners are more thoroughly organized the eight-hour day prevails. Throughout the central and western fields, for instance, and in Ohio, Michigan, and Pennsylvania, by far the larger number of miners work eight hours a day. In Tennessee the majority of the mines are operated nine hours a day. In Alabama, Kentucky, Maryland, New Mexico, Virginia, and West Virginia, where the union element is not so strong, the majority of the mines are operated ten hours a day. In Texas the bituminous mines are operated eight hours, and the lignite mines ten hours a day. In Colorado about 40 per cent of the miners work eight hours, and 60 per cent work ten hours a day. In respect to the length of working days, there were no particular changes from 1907 to 1908.

There are so many influences affecting the mining of bituminous coal that it is impossible to draw any reliable conclusions from the statistics presented in these reports as to the effect of the working day upon the productive efficiency of the miners, unless there have been recent changes in individual States. The latest change in this respect was in the State of Wyoming, where, in 1906, the mines were operated upon the basis of a ten-hour day. Through the efforts of the United Mine Workers of America the miners in Wyoming were "organized" in 1907, and in that year and in 1908 the eight-hour day has been the rule. The statistics show that in 1906 the average production per day per man was 3.68 short tons. In 1907 it dropped to 3.42, but increased again in 1908 to 3.66. Whether the increased efficiency in 1908 was due to the shorter working day or to the fewer number of days worked it is impossible to state. There was in 1908 a general increase in the daily production by each man employed, due to the fewer opportunities permitted him to work, which naturally resulted in a larger output per man when the mines were working. Among the influences which make uncertain the drawing of any conclusion is the rapidly increasing use of mining machinery in the bituminous mines and the introduction of other mechanical equipment which has for its objects the cheapening of production and an increase of output without an increase in the number of men employed.

The following tables give the distribution of the employees in the bituminous coal mines, according to the hours worked per day, by States, in 1907 and 1908. Some of the smaller States which have too small a production to have any interest are omitted from this statement.

Number of hours to the working day in 1907, by States and Territories.

State or Territory.	8 hours.		9 hours.		10 hours.		All others.[a]
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	31	1,994	34	2,339	84	13,942	3,113
Arkansas	67	4,970	....	....	....	....	115
Colorado	60	3,420	8	312	54	7,439	3,052
Illinois	457	60,268	8	675	1	4	4,634
Indiana	208	18,323	....	....	....	....	2,699
Iowa	175	15,171	1	10	....	....	404
Kansas	134	10,980	10	156	1	10	1,293
Kentucky	60	4,610	71	4,508	97	6,842	1,011
Maryland	....	....	5	84	57	5,693	103
Michigan	27	3,939	....	....	....	....	43
Missouri	149	8,079	6	54	....	....	315
Montana	29	2,732	1	3	....	....	....
New Mexico	8	79	4	287	14	2,584	20
North Dakota	11	89	6	119	17	304	50
Ohio	490	44,733	4	53	2	31	2,016
Oklahoma (Indian Territory)	83	8,079	....	....	6	194	125
Oregon	3	184	....	....	....	....	....
Pennsylvania	809	96,667	260	24,883	198	35,355	6,390
Tennessee	13	1,561	75	6,968	27	3,379	144
Texas	5	1,453	1	60	16	2,202	512
Utah	16	2,046	....	....	....	....	157
Virginia	....	....	7	849	42	5,791	30
Washington	41	5,594	1	5	....	....	346
West Virginia	35	1,879	156	13,386	322	32,005	11,759
Wyoming	37	6,382	6	197	....	....	66
	2,948	303,232	664	54,948	938	115,775	38,397

[a] Including mines not reporting hours per day.

Number of hours to the working day in 1908, by States and Territories.

State or Territory.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	16	1,205	34	2,358	100	11,969	3,665
Arkansas	67	5,325	....	....	....	....	12
Colorado	79	5,158	3	63	61	8,535	767
Illinois	491	65,289	5	510	....	....	2,236
Indiana	207	18,040	....	....	1	5	335
Iowa	218	14,772	3	28	4	24	1,197
Kansas	138	12,973	11	283	7	363	297
Kentucky	56	4,636	52	2,072	132	9,166	1,122
Maryland	1	80	3	59	49	5,905	35
Michigan	31	4,224	....	....	....	....	23
Missouri	149	8,464	10	83	....	....	441
Montana	36	2,903	1	2	....	....	241
New Mexico	5	30	6	356	14	3,015	47
North Dakota	11	103	5	114	14	275	139
Ohio	510	45,742	8	1,004	3	35	626
Oklahoma	64	8,258	....	....	4	118	275
Oregon	2	69	....	....	....	....	145
Pennsylvania	764	99,406	241	24,828	197	38,125	3,602
Tennessee	5	287	87	8,220	19	1,921	1,384
Texas	16	2,351	1	50	21	1,759	240
Utah	17	2,620	....	....	1	2	42
Virginia	2	112	10	802	32	5,214	80
Washington	39	4,665	1	20	....	....	799
West Virginia	30	1,242	180	14,426	403	39,650	1,643
Wyoming	51	6,802	....	....	2	17	96
	3,005	314,756	661	55,278	1,064	125,998	19,489

In the following table is presented a statement of the average production per man for the day and year in 1906, 1907, and 1908, compared with the number of days worked by each man and the hours per day recorded by the majority of mines in the more important coal-mining States. It is not claimed that this statement indicates with any accuracy the effect which the length of the working day exercises upon the productive efficiency of the men, on account of the wide variance which exists in the mining conditions in the different States. It is noted that the smallest average tonnage per day in 1908 was made in Oklahoma, where the men work eight hours a day, while the largest average tonnage per day was made in West Virginia, where the majority of the mines are operated ten hours a day. On the other hand, in Indiana and Illinois, where the men work eight hours a day, the second and third largest tonnages per man per day are reported.

Average production per man compared with hours worked per day, and average number of days per year in 1906, 1907, and 1908.

State or Territory.	1906.				1907.				1908.			
	Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.	
			Per year.	Per day.			Per year.	Per day.			Per year.	Per day.
Alabama	9 and 10	237	637.7	2.69	9 and 10	242	666.3	2.75	9 and 10	222	604.5	2.72
Arkansas	8	165	433.8	2.63	8	190	525.2	2.76	8	145	389.4	2.68
Colorado	8 and 10	268	*889.4	3.32	8 and 10	258	758.6	2.94	8 and 10	212	663.4	3.13
Illinois	8	192	669.2	3.49	8	218	782.5	3.59	8	185	700.5	3.79
Indiana	8	175	576.7	3.30	8	197	665.3	3.38	8	174	670.0	3.85
Iowa	8	224	476.2	2.13	8	230	486.0	2.11	8	214	447.0	2.09
Kansas	8	165	419.7	2.54	8	225	588.7	2.62	8	181	448.8	2.48
Kentucky	9 and 10	212	632.1	2.98	8, 9, and 10	210	633.6	3.02	8, 9, and 10	186	602.9	3.24
Maryland	10	250	844.3	3.38	10	263	940.9	3.58	10	220	720.0	3.27
Michigan	8	173	339.0	1.96	8	234	511.3	2.19	8	207	432.1	2.09
Missouri	8	185	393.2	2.13	8	214	473.2	2.21	8	169	369.1	2.18
Montana	8	243	764.4	3.15	8	268	737.4	2.75	8	224	610.4	2.73
New Mexico	10	242	949.1	3.92	10	269	885.2	3.29	10	197	715.8	3.63
Ohio	8	167	610.3	3.65	8	199	686.3	3.45	8	161	554.2	3.44
Oklahoma (Indian Territory)	8	166	346.6	2.09	8	216	433.8	2.01	8	172	340.8	1.98
Pennsylvania:												
Anthracite	9	195	439.1	2.25	9	220	511.9	2.33	9	200	478.1	2.39
Bituminous	8	231	850.1	3.68	a 8	255	919.5	3.61	a 8	201	706.1	3.51
Tennessee	9 and 10	229	546.6	2.39	9 and 10	232	565.1	2.44	9 and 10	209	524.8	2.51
Utah	8	288	1,127.6	3.92	8	258	884.1	3.43	8	227	693.2	3.05
Virginia	10	250	829.2	3.32	10	241	706.3	2.93	10	200	686.1	3.43
Washington	8	266	723.4	2.72	8	273	619.1	2.27	8	202	551.6	2.73
West Virginia	9 and 10	220	849.5	3.86	9 and 10	230	814.7	3.54	9 and 10	185	736.8	3.98
Wyoming	10	281	1,033.7	3.68	8	275	941.0	3.42	8	217	793.9	3.66

a Represents 60 per cent of employees; the other 40 per cent about evenly divided between 9 and 10 hours.

LABOR TROUBLES.

More time was lost through labor disaffections in 1908 than in any of the last ten years, except 1902, which was made notable by the great strike in the anthracite region, and in 1906, when in the spring of the year there was a general suspension both among the anthracite and the organized bituminous workers until the miners and operators could come to an agreement on the wage scale. When the controversy in 1906 was settled the contracts made in the bituminous fields were for periods of two years. The trouble in the anthracite region was settled by a renewal of the award of the Anthracite Coal Strike Commission for a second period of three years, or until March 31, 1909, and as both miners and operators have shown faithful endeavor to live up to the terms of the agreement there was no suspension of mining operations in the anthracite region in 1907 and 1908. As, however, the agreements in the bituminous regions were made for only two years, or until March 31, 1908, the spring of last year recorded a renewal of the controversy and the suspension of operations in mines of the organized States until the wage scale had been agreed upon, but while the suspension was fairly general there were not so many men idle as in 1906, nor was the controversy so prolonged. The general depression in business produced an unusual supply of labor and there was not the same temptation to engage in a serious struggle as might have been the case if business were active and labor in great demand. It is a pleasure to record that the period of idleness was for the most part peaceful and there were few instances of disorder. An exception to this condition is to be noted in the strike of the mine workers of Alabama, but the troubles which occurred in that State were not coincident with the general suspension. The strike in Alabama was precipitated by an effort on the part of the United Mine Workers to strengthen the organization in that State, and the strike was called on June 30, 1908, for the purpose of securing recognition of the union, as since the unsuccessful strike of 1904 the mines have been operated practically on the open-shop basis. This strike was ill considered, was attended by considerable rioting and bloodshed, and did not attain the object desired.

The total number of bituminous mine workers idle because of strikes or suspensions in 1908 was 145,145, out of a total of 516,264 men employed. The average time lost was 38 days for each man, and the total working time lost was 5,449,938 days. The time lost was equivalent to 5.47 per cent of the total time made by all of the bituminous workers, but it is doubtful if the suspension had any material effect upon the production. There was not much demand for coal at the time the suspension took place, and the larger consumers had anticipated the period of idleness and had stocked up with sufficient coal to carry them over. One of the unfortunate results of these biyearly suspensions, reported from the operators in the Southwestern States, is the prejudice created against coal as a fuel, causing some of the larger consumers to turn to oil instead, as it is averred that oil consumers are not put to periodical fluctuations in supply and price such as are created by the regularly recurring suspensions among the coal mines.

The statistics of labor troubles in the coal mines of the United States in 1907 and 1908, by States, are presented in the following tables:

Statistics of labor strikes in the coal mines of the United States in 1907 and 1908.

State or Territory.	1907.			1908.		
	Number of men on strike.	Total days lost.	Average number of days lost per man.	Number of men on strike.	Total days lost.	Average number of days lost per man.
Alabama	80	3,600	45	8,397	373,513	44
Arkansas	1,185	35,835	30	4,037	387,841	96
Colorado	215	6,378	30	768	16,646	22
Illinois	5,255	35,191	7	47,456	1,737,611	37
Indiana	3,176	42,842	13	7,076	157,899	22
Iowa	1,621	8,265	5	5,248	121,087	23
Kansas	923	16,957	18	11,155	665,224	60
Kentucky	1,325	53,916	41	1,002	26,941	27
Maryland	510	13,770	27	....	....	....
Michigan	265	1,325	5	300	4,800	16
Missouri	777	8,222	11	6,350	355,138	56
Montana	30	600	20	556	9,201	17
North Dakota	82	736	9	104	1,620	16
Ohio	6,367	110,324	17	21,084	567,450	27
Oklahoma (Indian Territory)	669	17,092	26	6,929	398,251	57
Oregon	25	225	9	....	....	....
Pennsylvania	6,447	59,834	9	18,780	375,569	20
Tennessee	284	4,725	17	349	11,441	33
Texas	270	1,610	6	169	338	2
Utah	148	592	4	....	....	....
Washington	484	8,544	18	226	67,800	300
West Virginia	617	9,749	16	501	71,992	144
Wyoming	1,785	22,060	12	4,658	99,576	21
Total bituminous	32,540	462,392	14	145,145	5,449,938	38

A summary of the statistics of strikes in the coal mines of the United States since 1899 is given in the following table:

Summary of labor strikes in the coal mines of the United States, 1899–1908.

Year.	Number of men on strike.	Total working days lost.	Average number of days lost per man.
1899	45,981	2,124,154	46
1900	131,973	4,878,102	37
1901 [a]	20,593	733,802	35
1902	200,452	16,672,217	83
1903 [a]	47,481	1,341,031	28
1904	77,661	3,382,830	44
1905	37,542	796,735	21
1906	372,343	19,201,348	51.5
1907 [a]	32,540	462,392	14
1908 [a]	145,145	5,449,938	38

[a] Bituminous mines only.

COAL MINED BY MACHINES.

Although, in sympathy with the general decrease in the production of bituminous coal in 1908, there was a decrease also in the quantity of coal mined by the use of machines, the percentage which the machine-mined tonnage bore to the total and the increase in the number of machines employed continued the growing tendency which this feature of the bituminous coal mining industry has shown during the last decade. In spite of the fact that the production of bituminous coal decreased approximately 62,000,000 short tons, as compared with 1907, the number of mining machines in use increased from 11,144 in 1907 to 11,569 in 1908. The quantity of machine-mined coal, however, decreased from 138,547,823 short tons to 123,183,334 tons, a decrease of 15,364,489 short tons, or 11.09 per cent. The percentage of the machine-mined product to the total production of the States in which mining machines were employed increased from 35.71 in 1907 to 37.52 in 1908. The statistics for the three years preceding 1908 show a considerable increase in the production of coal for each machine in use, the average production for each machine having grown from 10,258 short tons in 1904 to 11,258 tons in 1905, 11,638 tons in 1906, and 12,381 tons in 1907. Owing to the decreased production and the fewer number of days the machines were operated in 1908, notwithstanding the increase in the number of machines, the average output for each machine used declined to 10,648 tons. Of the 11,569 machines reported as in use in 1908, 6,380 were pick machines, 4,992 chain-breast, and 197 long-wall. In the number of machines in use and in the quantity of machine-mined tonnage, as in the total production of bituminous coal, Pennsylvania stands at the head with 44.1 per cent of the number of machines and 42.6 per cent of the machine-mined product for 1908. The quantity of coal mined by machines in Pennsylvania in 1907 was 52,447,809 short tons, which represented 44.76 per cent of the total production of bituminous coal in the State. Ohio ranked first in the percentage of coal mined by machinery, with 19,799,140 short tons of machine-mined product in 1908, or 75.37 per cent of the total output. Ohio ranks fourth among the coal-producing States, but second in the quantity of coal mined by machines. West Virginia ranks third among the producing States and third also in the machine-mined tonnage, with a toal of 16,653,174 short tons, or 39.75 per cent of the total output of the State in 1908. Illinois, second in producing importance, is fourth in the quantity of machine-mined coal, having in 1908 a machine-mined output of 15,045,004 short tons, or 31.57 per cent of the total. Kentucky ranks second in the percentage of machine-mined coal to the total product, somewhat over half of the total output of the State being machine-mined.

The statistics in regard to the coal mined by machines during the last five years are shown in the following table, together with the number of machines used in each State, the number of tons mined by machines, the total production of the States in which machines were used, and the percentage of the machine-mined product to the total of those States:

Bituminous coal mined by machines in the United States, 1904–1908, by States and Territories.

State or Territory.	Number of machines in use.					Number of tons mined by machines.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Alabama	141	213	238	197	197	41,170	1,584,942	1,641,476	1,762,948	1,783,516
Colorado	125	121	141	175	211	945,965	1,247,687	1,337,006	1,689,517	1,668,602
Georgia		6					11,684			
Illinois	643	882	1,048	1,080	[illegible]	7,110,902	8,697,547	11,585,419	15,134,401	15,045,004
Indiana	403	506	471	513	[illegible]	3,613,532	4,207,246	4,251,740	5,310,607	5,294,092
Iowa	39	32	34	33	[illegible]	175,742	186,224	193,666	108,022	71,463
Kansas	5	10	6	6	17	10,600	19,101	30,450	35,317	133,248
Kentucky	453	527	600	708	[illegible]	3,595,513	4,409,054	5,175,950	5,504,262	5,252,753
Maryland	38	42	45	43	39	484,373	468,822	427,450	479,110	208,134
Michigan	85	106	110	103	[illegible]	310,007	[illegible]	417,073	606,718	535,543
Missouri	31	30	48	62	[illegible]	376,505	375,194	419,288	486,882	479,850
Montana	57	58	76	86	[illegible]	482,924	752,665	974,306	984,368	713,217
New Mexico	12			3	7	100,000			11,615	30,600
North Dakota	9	9	11	12	11	125,097	97,789	97,035	136,700	104,884
Ohio	865	1,041	1,255	1,328	1,343	13,983,647	16,888,417	20,004,416	24,843,616	19,799,140
Oklahoma (Indian Territory)	18	29	29	11	17	42,594	40,203	33,357	24,331	31,352
Pennsylvania	3,645	4,254	4,515	4,940	5,103	35,174,613	49,335,660	54,146,314	60,771,157	52,447,809
Tennessee	85	89	128	137	122	440,618	479,471	747,500	874,925	787,502
Texas	9	8	12	13	6	33,154	22,400	22,682	36,100	15,000
Utah	9		2	5		34,054		1,000	1,800	
Virginia	18	35	37	77	85	245,536	399,029	424,343	788,793	1,035,832
Washington			1		4			12,521		20,000
West Virginia	901	1,105	1,322	1,533	1,574	9,526,749	12,504,301	15,565,113	17,627,925	16,653,174
Wyoming	72	81	83	79	88	1,053,702	1,236,750	1,339,422	1,328,709	1,072,619
	7,663	9,184	10,212	11,144	11,569	78,606,997	103,396,452	118,847,527	138,547,823	123,183,334

Bituminous coal mined by machines in the United States, 1904–1908, by States and Territories—Continued.

State or Territory.	Total tonnage of States using mining machinery.					Percentage of total product mined by machines.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Alabama	11,262,046	11,866,069	13,107,963	14,250,454	11,604,593	6.58	13.36	12.52	12.37	15.37
Colorado	6,658,355	8,826,429	10,111,218	10,790,236	9,634,973	14.21	14.14	13.22	15.66	17.32
Georgia	....	351,991	....	....	....	....	3.32	....	....	....
Illinois	36,475,060	38,434,363	41,480,104	51,317,146	47,659,690	19.50	22.63	27.93	29.49	31.57
Indiana	10,842,189	11,895,252	12,092,560	13,985,713	12,314,890	33.33	35.37	35.16	37.97	42.99
Iowa	6,519,933	6,798,609	7,266,224	7,574,322	7,161,310	2.70	2.74	2.67	1.43	1.00
Kansas	6,333,307	6,423,979	6,024,775	7,322,449	6,245,508	.17	.30	.51	.48	2.13
Kentucky	7,576,482	8,432,523	9,653,647	10,753,124	10,246,553	47.46	51.44	53.62	51.19	51.27
Maryland	4,813,622	5,108,539	5,435,453	5,532,628	4,377,093	10.06	9.18	7.86	8.66	4.76
Michigan	1,342,840	1,473,211	1,346,338	2,035,858	1,835,019	23.09	29.34	30.98	29.80	29.18
Missouri	4,168,308	3,983,378	3,758,008	3,997,936	3,317,315	9.03	9.42	11.16	12.18	14.47
Montana	1,358,919	1,643,832	1,829,921	2,016,857	1,920,190	35.54	45.79	53.24	48.81	37.14
New Mexico	1,452,325	....	....	2,628,959	2,467,937	6.89	....	....	.44	1.24
North Dakota	271,928	317,542	305,689	347,760	320,742	46.00	30.80	31.74	39.31	32.70
Ohio	24,400,220	25,552,950	27,731,640	32,142,419	26,270,639	57.31	66.10	72.14	77.29	75.37
Oklahoma (Indian Territory)	3,046,539	2,924,427	2,860,200	3,642,658	2,948,116	1.40	1.37	1.17	.67	1.06
Pennsylvania	97,938,287	118,413,637	129,293,206	150,143,177	117,179,527	35.92	41.66	41.88	40.48	44.76
Tennessee	4,782,211	5,766,690	6,259,275	6,810,243	6,199,171	9.21	8.31	11.94	12.85	12.70
Texas	1,195,944	1,200,684	1,312,873	1,648,069	1,895,377	2.77	1.86	1.73	2.19	.79
Utah	1,493,027	....	1,772,551	1,947,607	....	2.28	....	.06	.09	....
Virginia	3,410,914	4,275,271	4,254,879	4,710,895	4,259,042	7.20	9.33	9.97	16.74	24.32
Washington	....	....	3,276,184	....	3,024,943	....	....	.38	....	.66
West Virginia	32,406,752	37,791,580	43,290,350	48,091,583	41,897,843	29.40	33.09	35.96	36.65	39.75
Wyoming	5,178,556	5,602,021	6,133,994	6,252,990	5,489,902	20.35	22.08	21.84	21.25	19.54
	272,927,764	307,082,977	338,597,052	387,943,083	328,270,373	a 28.80	a 33.67	a 35.10	a 35.71	a 37.52

a Average.

In the following table are shown the number and kinds of machines in use in each State in 1907 and 1908:

Number and kinds of machines in use in 1907 and 1908, by States and Territories.

State or Territory.	1907.				1908.			
	Pick.	Chain breast.	Long wall.	Total.	Pick.	Chain breast.	Long wall.	Total.
Alabama	152	42	3	197	142	51	4	197
Colorado	103	58	14	175	137	56	18	211
Illinois	836	243	1	1,080	876	338	3	1,217
Indiana	147	308	58	513	140	332	35	507
Iowa	16	9	8	33	19	9		28
Kansas	3	3		6	10	7		17
Kentucky	475	205	28	708	515	209	35	759
Maryland	43			43	39			39
Michigan	60	42	1	103	85	33	2	120
Missouri	4	4	54	62	5	52		57
Montana	76	10		86	53	4		57
New Mexico	3			3	7			7
North Dakota		12		12		9	2	11
Ohio	109	1,213	6	1,328	135	1,203	5	1,343
Oklahoma (Indian Territory)	7	3	1	11	15	2		17
Pennsylvania	3,372	1,547	21	4,940	3,436	1,659	8	5,103
Tennessee	120	14	3	137	96	18	8	122
Texas	10		3	13	6			6
Utah	3	2		5				
Virginia	26	51		77	14	71		85
Washington					4			4
West Virginia	617	853	63	1,533	599	899	76	1,574
Wyoming	45	33	1	79	47	40	1	88
	6,227	4,652	265	[a]11,144	6,380	4,992	197	[b]11,569

[a] Includes 20 pick and 268 chain shearing machines.
[b] Includes 26 pick and 238 chain shearing machines.

The statistics relating to the use of mining machines were first collected by the Survey for the year 1896. The inquiries at that time asked also for reports on the number of machines in use and the quantity of coal won by them in 1891, five years previous. From the returns to the Survey since 1896, the results of which in detail have been published in the preceding volumes of Mineral Resources, the following table has been prepared, showing the development in the mechanical mining of bituminous coal since 1891:

Production of coal by machines in the United States since 1891, in short tons.

Year.	Number of machines in use.	Total tonnage won by machines.	Average production for each machine.
1891	545	6,211,732	11,398
1896	1,446	16,424,932	11,373
1897	1,956	22,649,220	11,579
1898	2,622	32,413,144	12,362
1899	3,125	43,963,933	14,068
1900	3,907	52,784,523	13,510
1901	4,341	57,843,335	13,325
1902	5,418	69,611,582	12,848
1903	6,658	77,974,894	11,712
1904	7,663	78,606,997	10,258
1905	9,184	103,396,452	11,258
1906	10,212	118,847,527	11,638
1907	11,144	137,973,701	12,381
1908	11,569	123,183,334	10,648

In the following table is presented a statement of the average production per man in the years 1907 and 1908, by States, and the average daily production per man compared with the quantity and percentage of the coal mined by machines in the two years. As a usual thing where there has been an increase in the percentage of machine-mined coal, there has been and should be an increase in the daily production per man employed, but it is not always the case. In Pennsylvania, for instance, the percentage of machine-mined coal to the total increased from 40.48 in 1907 to 44.76 in 1908, while the average daily production per man decreased from 3.61 to 3.51 tons. West Virginia's percentage of machine-mined coal to the total increased from 36.65 to 39.75, and the daily production per man from 3.54 to 3.98 tons. Ohio decreased in the percentage of machine-mined coal and also in the average daily production per man. On account of the diversified character of the mining operations in the different States, it is practically impossible to draw conclusions from these statistics which would in any way indicate the effect upon the productive efficiency of the employees.

Average production per man compared with production by machines in 1907 and 1908, by States and Territories, in short tons.

State or Territory.	Average tonnage.				Production by machines.			
	Per year.		Per day.		Total tonnage by machines.		Per cent of machine coal to state total.	
	1907.	1908.	1907.	1908.	1907.	1908.	1907.	1908.
Alabama	666.3	604.5	2.75	2.72	1,762,948	1,783,516	12.37	15.37
Arkansas	525.2	389.4	2.76	2.68	....	....	....	....
Colorado	758.6	663.4	2.94	3.13	1,689,517	1,668,602	15.66	17.32
Illinois	782.5	700.5	3.59	3.79	15,134,401	15,045,004	29.49	31.57
Indiana	665.3	670.0	3.38	3.85	5,310,607	5,294,092	37.97	42.99
Iowa	486.0	447.0	2.11	2.09	108,022	71,463	1.43	1.00
Kansas	588.7	448.8	2.62	2.48	35,317	133,248	.48	2.13
Kentucky	633.6	602.9	3.02	3.24	5,504,262	5,252,753	51.19	51.27
Maryland	940.9	720.0	3.58	3.27	479,110	208,134	8.66	4.76
Michigan	511.3	432.1	2.19	2.09	606,718	535,543	29.80	29.18
Missouri	473.2	369.1	2.21	2.18	486,882	479,850	12.18	14.47
Montana	737.4	610.4	2.75	2.73	984,368	713,217	48.81	37.14
New Mexico	885.2	715.8	3.29	3.63	11,615	30,600	.44	1.24
North Dakota	618.8	508.3	2.78	2.81	136,700	104,884	39.31	32.70
Ohio	686.3	554.2	3.45	3.44	24,843,616	19,799,140	77.29	75.37
Oklahoma (Indian Territory)	433.8	340.8	2.01	1.98	24,331	31,352	.67	1.06
Pennsylvania:								
Anthracite	511.9	478.1	2.33	2.39	....	....	....	....
Bituminous	919.5	706.1	3.61	3.51	60,771,157	52,447,809	40.48	44.76
Tennessee	565.1	524.8	2.44	2.51	874,925	787,502	12.85	12.70
Texas	389.9	430.8	1.61	1.70	36,100	15,000	2.19	.79
Utah	884.1	693.2	3.43	3.05	1,800	....	.09	....
Virginia	706.3	686.1	2.93	3.43	788,793	1,035,832	16.74	24.32
Washington	619.1	551.6	2.27	2.73	....	20,000	....	.66
West Virginia	814.7	736.8	3.54	3.98	17,627,925	16,653,174	36.65	39.75
Wyoming	941.0	793.9	3.42	3.66	1,328,709	1,072,619	21.25	19.54

COAL-MINING ACCIDENTS.

The death roll in the coal mines of the United States in 1908 was smaller than that of 1907, but with the exception of 1907 it was the largest in the history of the industry, while in the number of men injured the record for 1908 exceeded that of even 1907. The total number of deaths from accidents in the coal mines of the United States in 1908 was 2,450, as compared with 3,125 in 1907, a decrease of 675. The number of nonfatal accidents increased from 5,316 to 6,772.

The statistics relating to accidents in the coal mines are not collected directly by the Geological Survey, and the compilation contained in this report has been prepared from statements received through the courtesy of the state or territory mine inspectors or other officials by whom data concerning accidents and their causes and effects are collected. In a number of States where coal is produced there are no officials charged with these duties, and in a few instances no replies have been received to the inquiries from this office. Among the States where no statistics of mine accidents are collected are California, Georgia, Oregon, Texas, and Virginia, and any statement concerning the accidents in the coal mines of the United States is necessarily incomplete to this extent. The States from which the accidents are reported, however, contribute over 98 per cent of the total production of coal, and it may be considered that the accidents reported are within 3 per cent of the total. The decrease in the number of fatal accidents in 1908 was in those due to gas and dust explosions, and to accidents resulting from powder explosions and windy shots. In the winter of 1907 there was an epidemic of gas and dust explosions in the bituminous coal mines, and of the 947 men killed by this cause, 903 were bituminous mine workers. West Virginia was the chief sufferer, with a total of 484 men killed by dust or gas explosions, and most of these were at the disaster which wrecked the Monongah mines Nos. 6 and 8 of the Fairmont Coal Company. The deaths due to dust and gas explosions in the bituminous coal mines of Pennsylvania in 1907 numbered 276, most of the men killed being victims of two explosions, one at the Naomi mine of the Naomi Coal Company, near Pittsburg, and the other at the Darr mine of the Pittsburg Coal Company, on Jacobs Creek. Alabama contributed 62 victims, of whom 56 were killed in the explosion of mine No. 1 of the Yolande Coal and Coke Company, at Yolande. All of these occurred in December, and while there was a smaller number of explosions in 1908 than in 1907, there were 3 disasters which together caused 75 per cent of the deaths due to mine explosions. The most serious of these was the explosion at the Marianna mine of the Pittsburg-Buffalo Company, in Washington County, Pa., which occurred on November 28, and in which the number of lives lost is said to have been 138. Next to this in the number of victims was the double explosion at the Hanna mine No. 1, of the Union Pacific Coal Company, at Cheyenne, Wyo., the result of which was a total of 59 deaths. The third disaster, according to the number of victims, was at the Lick Branch Colliery of the Pocahontas Consolidated Collieries Company, near Bluefield, W. Va., on March 12. Of the 2,450 men killed in 1908, 678 were in the anthracite mines of Pennsylvania and 1,772 were bituminous mine workers. Of the 6,772 injured, 1,170 were anthracite workers and 5,602 were employed in the bituminous mines.

For the figures from which the statistics of mine accidents have been prepared acknowledgments are due to the following officials: Mr. Edward Flynn, chief mine inspector, Alabama; Mr. R. A. Young, state mine inspector, Arkansas; Mr. John D. Jones, state coal mine inspector, Colorado; Mr. David Ross, secretary of the bureau of labor statistics, Illinois; Mr. James Epperson, state mine inspector, Indiana;

Mr. John Vernon, Mr. R. T. Rhys, and Mr. Edward Sweeney, inspectors of the first, second, and third mining districts of Iowa; Mr. Frank Gilday, state mine inspector, Kansas; Mr. C. J. Norwood, chief inspector of mines, Kentucky; Mr. John H. Donahue, state mine inspector, Maryland; Mr. M. J. McLeod, commissioner of labor, Michigan; Mr. J. W. Marstellar, secretary bureau of mines, Missouri; Mr. J. B. McDermott, state mine inspector, Montana; Mr. J. E. Sheridan, United States mine inspector, New Mexico; Mr. T. R. Atkinson, state mine inspector, North Dakota; Mr. George Harrison, state mine inspector, Ohio; Mr. P. Hanraty, chief inspector of mines, Oklahoma; Mr. James E. Roderick, chief department of mines, Pennsylvania; Mr. R. A. Shiflett, chief bureau of mines, Tennessee; Mr. J. E. Pettit, state coal mine inspector, Utah; Mr. D. C. Botting, state mine inspector, Washington; and Mr. John Laing, chief department of mines, West Virginia.

In the 18 States and Territories from which reports were received in 1907 there were 3,125 men killed and 5,316 injured, the death rate per thousand employees being 4.86 and the number of tons mined for each life lost 145,471. In 1908, with a death roll of 2,450 reported from 22 States and Territories, the death rate per thousand employees was 3.6, and the number of tons mined for each life lost was 167,545. The State in which the lowest death rate per thousand employees was reported in 1907 and 1908 was Missouri, being 0.95 in 1907 and 1.11 in 1908. Michigan ranks second on the roll of honor in both years, with 1.76 men killed per thousand of employees in 1907 and 1.18 in 1908. Michigan ranks first in the number of tons mined for each life lost, with a total of 367,004; Maryland second, with 347,019; and Missouri third, with 331,732. Iowa and Kansas were close rivals for third place per thousand of employees, the former having 1.93 and the latter 1.94. Wyoming reported the largest death rate in 1908—11.71 per thousand—while Oklahoma reported the fewest number of tons mined for each life lost. New Mexico came second in the death rate per thousand, with 6.67; Montana third, with 6.36; North Dakota fourth, with 6.34; and Oklahoma fifth, with 6.04; and it will be noted that four of these are in the Rocky Mountain region, the fifth, Oklahoma, being also west of the Mississippi River. The two States east of the Mississippi which showed the largest death rate were Alabama, with 5.63, and West Virginia, with 5.5.

Attention has been called in previous reports to the popular error that most of the deaths in coal mines are caused by explosions. This impression is due to the prominence given by the press to such disasters, and yet notwithstanding the large number of fatalities from this cause in 1907, the number of deaths from falls of roof or of coal was greater than from any other cause. In 1907 there were 947 men killed and 343 injured by explosions of gas or dust, while 1,122 were killed and 2,141 injured by falls of roof or coal. In 1908 there were 396 fatalities due to gas and dust explosions, while 326 men were injured through such accidents. There were 1,080 men killed and 2,591 injured by falls of roof. Humanity, however, is not shocked by the number of deaths and injuries due to the coal and rock falls in the mine. These usually occur singly and are not included in the press dispatches, not being known outside of the immediate locality in which the accident occurs, and while more deaths or injuries are due to this one cause than to any other, it must also be stated that in the majority of cases the accidents could have been prevented if the mine workers had been careful of their safety. In most cases the falls are due to the failure to timber the working places or to the improper setting of the timbers.

The number of men killed and injured, the death rate per thousand of employees, and the number of tons of coal mined for each life lost in the several States and Territories from which reports were received in 1907 and 1908 are shown in the following tables:

Fatal and nonfatal accidents in coal mines of the United States in 1907, by States and Territories.

State or Territory.	Number of men killed.	Number of men injured.	Death rate per 1,000 employees.	Number of tons mined for each life lost.
				Short tons.
Alabama	154	85	7.20	92,535
Arkansas	[a] 10	[a] 6	1.97	133,522
Colorado	99	138	6.96	108,992
Illinois	172	596	2.62	298,356
Indiana	53	451	2.52	263,881
Iowa	41	68	2.63	184,740
Kansas	32	48	2.57	228,827
Kentucky	32	86	1.89	336,035
Michigan	7	47	1.76	290,837
Missouri	8	23	.95	499,742
Montana	12	52	4.39	168,071
New Mexico	34	....	11.45	77,322
Ohio	153	662	3.27	210,081
Oklahoma (Indian Territory)	33	56	3.93	110,384
Pennsylvania:				
Anthracite	708	1,369	4.23	120,910
Bituminous	806	1,207	4.94	186,281
Utah	6	82	2.72	324,601
Washington	36	95	6.06	102,237
West Virginia	729	245	12.35	65,969
	3,125	5,316	4.86	145,471

[a] For 6 months only.

Fatal and nonfatal accidents in coal mines of the United States in 1908, by States and Territories.

State or Territory.	Number of men killed.	Number of men injured.	Death rate per 1,000 employees.	Number of tons mined for each life lost.
				Short tons.
Alabama	108	58	5.63	107,450
Arkansas	14	43	2.62	148,454
Colorado	61	115	4.20	157,950
Illinois [a]	183	819	2.58	269,248
Indiana	45	830	2.45	273,664
Iowa	31	90	1.93	231,010
Kansas [a]	27	70	1.94	231,315
Kentucky	39	127	2.29	262,732
Maryland [a]	12	96	2.00	347,019
Michigan	5	101	1.18	367,004
Missouri	10	36	1.11	331,732
Montana	20	58	6.36	96,010
New Mexico	23	([b])	6.67	107,302
North Dakota	4	4	6.34	80,186
Ohio	113	598	2.38	232,484
Oklahoma [a]	44	128	6.04	61,928
Pennsylvania:				
Anthracite	678	1,170	3.89	122,815
Bituminous	572	1,019	3.45	204,859
Tennessee	34	195	2.88	182,329
Utah	8	128	3.00	230,849
Washington	25	79	4.56	120,998
West Virginia	313	942	5.50	133,859
Wyoming [a]	81	66	11.71	67,777
	2,450	6,772	3.60	167,545

[a] Fiscal year. [b] Not reported.

In the following tables the fatal and nonfatal accidents are segregated according to the causes, whether by explosions of gas or dust, explosions of powder or windy shots, falls of roof or coal, or miscellaneous causes. In the fatalities due to "Other causes" reported from Oklahoma in 1908 there were 29 men who were suffocated as the result of a fire caused by the ignition of a barrel of oil through the carelessness of a mine worker.

Causes of fatal and nonfatal accidents in coal mines in 1907.

State or Territory.	Gas and dust explosions.		Powder explosions and windy shots.		Falls of roof or coal.		Other causes.		Total.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Alabama	62	7	5	13	24	22	63	43	154	85
Arkansas [a]	5	4	1	....	1	2	3	....	10	6
Colorado	25	5	3	6	52	80	19	47	99	138
Illinois	7	23	26	38	92	301	47	234	172	596
Indiana	2	16	18	33	16	153	17	249	53	451
Iowa	1	....	3	4	29	30	8	34	41	68
Kansas	9	5	1	9	17	22	5	12	32	48
Kentucky	....	8	2	12	12	19	18	47	32	86
Maryland	....	....	....	....	....	....	....	....	....	....
Michigan	1	....	2	....	4	26	....	21	7	47
Missouri	....	....	1	1	6	19	1	3	8	23
Montana	....	3	....	1	7	33	5	15	12	52
New Mexico [b]	11	....	....	....	13	....	10	....	34	....
North Dakota	....	....	....	....	....	....	....	....	....	....
Ohio	3	7	2	34	97	307	51	314	153	662
Oklahoma (Ind. T.)	6	23	11	8	11	15	5	10	33	56
Pennsylvania:										
Anthracite	44	191	87	150	279	357	298	671	708	1,369
Bituminous	276	27	15	69	307	593	208	518	806	1,207
Tennessee	....	....	....	....	....	....	....	....	....	....
Utah	1	4	....	....	3	26	2	52	6	82
Washington	10	20	1	4	8	32	17	39	36	95
West Virginia	484	....	23	34	144	104	78	107	729	245
Wyoming	....	....	....	....	....	....	....	....	....	....
	947	343	201	416	1,122	2,141	855	2,416	3,125	5,316

[a] For 6 months only. [b] Fatal accidents only reported.

Causes of fatal and nonfatal accidents in coal mines in 1908.

State or Territory.	Gas and dust explosions.		Powder explosions and windy shots.		Falls of roof or coal.		Other causes.		Total.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Alabama	9	12	2	1	39	14	58	31	108	58
Arkansas	1	8	1	1	8	10	4	24	14	43
Colorado	5	8	2	1	39	57	15	49	61	115
Illinois [a]	9	33	25	39	93	404	56	343	183	819
Indiana	5	33	0	3	20	212	20	582	45	830
Iowa	1	0	2	6	19	49	9	35	31	90
Kansas [a]	7	20	0	0	14	15	6	35	27	70
Kentucky	9	1	3	4	17	42	10	80	39	127
Maryland [a]	0	0	0	2	4	55	8	39	12	96
Michigan	0	0	1	10	4	45	0	46	5	101
Missouri	0	0	0	0	9	24	1	12	10	36
Montana	0	6	1	5	7	25	12	22	20	58
New Mexico	0	([b])	1	([b])	15	([b])	7	([b])	23	([b])
North Dakota	0	0	0	2	2	1	2	1	4	4
Ohio	2	9	4	24	72	273	35	292	113	598
Oklahoma [a]	3	21	3	4	2	19	36	84	44	128
Pennsylvania:										
Anthracite	57	130	23	46	284	328	314	666	678	1,170
Bituminous	162	20	1	21	263	557	146	421	572	1,019
Tennessee	([b])	([b])	([b])	([b])	([b])	([b])	34	195	34	195
Utah	2	2	0	2	2	10	4	114	8	128
Washington	1	14	0	2	12	19	12	44	25	79
West Virginia	63	9	4	6	153	431	93	496	313	942
Wyoming	60	....	....	....	2	1	19	65	81	66
	393	326	73	179	1,080	2,591	901	3,676	2,450	6,772

[a] Fiscal year. [b] Not reported.

Fatal accidents in coal mines in the United States from 1896 to 1908.

State or Territory.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Alabama	28	38	45	40	37	41	50	57	84	185	96	154	108
Arkansas	......	......	......	......	......	18	13	......	......	8	13	10	14
Colorado	68	35	24	41	29	55	73	40	89	59	88	99	61
Illinois	77	69	72	84	94	99	99	156	157	199	155	172	[b] 183
Indiana	28	16	22	16	18	24	24	55	34	47	31	53	45
Iowa	22	21	26	20	29	26	55	21	31	24	37	41	31
Kansas	12	6	17	16	22	26	27	36	[a] 16	36	31	32	[b] 27
Kentucky	6	12	6	7	17	21	19	25	19	31	40	32	39
Maryland	6	5	4	5	7	12	11	13	12	13	7	......	[b] 12
Michigan	......	......	......	[a] 4	10	6	6	8	7	8	6	7	5
Missouri	16	8	9	14	10	15	10	17	11	11	16	8	10
Montana	......	......	......	......	......	......	12	......	......	......	13	12	20
New Mexico	7	7	7	15	15	9	17	17	15	5	9	34	23
North Dakota	......	......	......	......	......	......	......	......	......	......	......	......	4
Ohio	41	40	52	57	68	72	81	114	118	131	127	153	113
Oklahoma (Indian Territory)	12	22	17	25	40	44	60	33	30	40	44	33	[b] 44
Pennsylvania:													
Anthracite	502	423	411	461	411	513	300	518	595	644	557	708	678
Bituminous	180	150	199	258	265	301	456	402	536	479	477	806	572
Tennessee	22	10	19	20	10	53	226	26	28	29	33	......	34
Utah	3	3	3	......	209	10	8	7	9	7	7	6	8
Washington	8	7	9	45	33	27	34	25	31	13	22	36	25
West Virginia	65	62	90	89	141	130	120	159	140	194	268	729	313
Wyoming	......	......	......	......	......	41	190	......	......	12	15	......	81
	1,103	934	1,032	1,217	1,465	1,543	1,891	1,729	1,962	2,175	2,092	3,125	2,450

[a] Six months only. [b] Fiscal year.

QUANTITY OF COAL WASHED AT THE MINES IN 1908.

In 1908, as in 1906 and 1907, the schedules used in the collection of statistics of the production of coal in the United States have included inquiries concerning the quantity of bituminous coal washed at the mines, either before shipment or before being charged into the ovens for coking. The returns for 1908 show that during that year 13,660,478 short tons of coal were washed, from which were obtained 11,870,438 short tons of cleaned coal and 1,790,040 tons of refuse. In 1907 the quantity of coal washed at the mines was 12,981,514 short tons, yielding 11,269,518 tons of cleaned coal, and 1,711,996 tons of refuse, while in 1906, 10,425,455 tons were washed, the cleaned product amounting to 9,251,946, and the refuse to 1,173,509 tons. In Alabama, Georgia, Kentucky, Pennsylvania, Tennessee, West Virginia, and other coal-producing States a large portion of the coal washed was slack used in the manufacture of coke, the returns from the coking plants in those States showing that in 1908, 5,378,035 tons of slack coal were washed before being charged into the ovens, and the total amount of coal washed before coking, in 1908, having been reported at 9,208,914 tons. The statistics of washed coal presented in this report include only the coal washed at the mines. A considerable portion of the coal used in coke making was washed at points distant from the mines. In Colorado, for instance, the statistics relating to the production of coke show that 1,138,511 tons of coal were washed for coke making, while only 449,320 tons were reported from that State as having been washed at the mines.

In his report on the production of Pennsylvania anthracite, which will be found in the discussion of the production of coal, by States, William W. Ruley states that 3,646,250 long tons, equivalent to

4,083,800 short tons, were recovered by the washing of culm, against 4,301,082 long tons, or 4,817,212 short tons, in 1907. The quantity of coal recovered by the anthracite washeries is not included in the following table, which shows the quantity of bituminous coal washed at the mines in 1907 and 1908:

Bituminous coal washed at the mines in 1907, with quantity of washed coal and of refuse obtained from it, by States and Territories, in short tons.

1907.

State or Territory.	Number of jigs or washers.	Quantity of coal washed.	Quantity of coal obtained.	Quantity of refuse.
Alabama	82	4,193,545	3,750,418	443,127
Arkansas	4	92,848	69,636	23,212
Colorado	4	39,655	26,372	13,283
Georgia	6	147,683	136,031	11,652
Illinois	181	2,988,386	2,465,767	522,619
Indiana	4	23,825	21,659	2,166
Kentucky	6	99,763	88,678	11,085
Maryland	1	10,640	9,856	784
Missouri	4	103,181	72,227	30,954
Montana	31	338,869	253,060	85,809
New Mexico	3	306,292	287,785	18,507
Ohio	17	140,460	107,246	33,214
Oklahoma (Indian Territory)	14	92,710	80,871	11,839
Oregon	1	36,936	18,928	18,008
Pennsylvania	289	2,705,519	2,475,956	229,563
Tennessee	10	604,557	543,333	61,224
Virginia	7	33,886	29,386	4,500
Washington	40	799,015	644,501	154,514
West Virginia	8	223,744	187,808	35,936
	712	12,981,514	11,269,518	1,711,996

1908.

State or Territory.	Number of jigs or washers.	Quantity of coal washed.	Quantity of coal obtained.	Quantity of refuse.
Alabama	51	2,902,815	2,614,954	287,861
Arkansas	4	57,450	43,670	13,780
Colorado	4	449,320	336,123	113,197
Georgia	3	79,000	71,452	7,548
Illinois	201	3,768,112	3,202,264	565,848
Indiana	4	29,120	26,473	2,647
Kentucky	6	81,897	72,798	9,099
Maryland				
Missouri	4	74,104	55,576	18,528
Montana	35	286,517	214,729	71,788
New Mexico	12	450,114	384,778	65,336
Ohio	16	205,588	180,890	24,698
Oklahoma	6	64,812	58,252	6,560
Oregon	1	50,400	35,413	14,987
Pennsylvania	275	3,561,222	3,254,661	306,561
Tennessee	8	278,928	258,477	20,451
Virginia	4	30,872	29,745	1,127
Washington	41	1,098,879	859,942	238,937
West Virginia	7	191,328	170,241	21,087
	682	13,660,478	11,870,438	1,790,040

PRICES.

The following tables show the fluctuations in the average prices prevailing in each State since 1904 and also the average prices for the total production of anthracite and bituminous coal in the United States since 1880. These averages are obtained by dividing the total product, including colliery consumption, into the total value. From these tables it appears that the highest average prices for both anthracite and bituminous coal were in 1903 the highest in any year since 1880. There was a general increase in prices in 1907, that year recording the highest averages subsequent to 1903, when values were abnormally high as a result of the long strike in the anthracite region. Considering the depressed conditions and the decreased production in the bituminous regions in 1908, the values were surprisingly well maintained, the average price for bituminous coal in 1908 being $1.12, against $1.14 in 1907. In some of the Western States, notably Utah, Washington, and Wyoming, higher prices prevailed in 1908 than in 1907.

Average price per short ton for coal at the mines since 1904, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	$1.20	$1.21	$1.34	$1.29	$1.26
Arkansas	1.54	1.49	1.61	1.68	1.68
California	[a] 4.74	[a] 4.97	[a] 2.55	[a] 3.81	[a] 3.19
Colorado	1.31	1.22	1.26	1.40	1.41
Georgia	[b] 1.22	[b] 1.29	1.28	1.38	1.38
Idaho	[c] 3.95	[c] 3.03	[c] 3.93	[d] 4.10	4.02
Illinois	1.10	1.06	1.08	1.07	1.05
Indiana	1.11	1.05	1.08	1.08	1.06
Iowa	1.61	1.56	1.60	1.62	1.63
Kansas	1.52	1.46	1.49	1.52	1.49
Kentucky	1.04	.99	1.02	1.06	1.01
Maryland	1.19	1.14	1.19	1.20	1.17
Michigan	1.81	1.71	1.80	1.80	1.81
Missouri	1.63	1.58	1.63	1.64	1.64
Montana	1.61	1.72	1.77	1.94	1.96
New Mexico	1.31	1.33	1.34	1.46	1.37
North Carolina	([e])	([e])	....	....	....
North Dakota	1.43	1.34	1.54	1.61	1.63
Ohio	1.09	1.04	1.09	1.10	1.06
Oklahoma (Indian Territory)	1.82	1.76	1.92	2.04	2.03
Oregon	2.18	2.58	2.66	2.34	2.74
Pennsylvania bituminous	.96	.96	1.00	1.04	1.01
Tennessee	1.18	1.14	1.22	1.25	1.15
Texas	1.66	1.64	1.66	1.69	1.80
Utah	1.30	1.35	1.36	1.52	1.69
Virginia	.86	.88	.98	1.02	.91
Washington	1.63	1.79	1.80	2.09	2.21
West Virginia	.88	.86	.95	.99	.95
Wyoming	1.30	1.31	1.31	1.56	1.62
Total bituminous	1.10	1.06	1.11	1.14	1.12
Pennsylvania anthracite	1.90	1.83	1.85	1.91	1.90
General average	1.26	1.21	1.24	1.28	1.28

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nebraska.
[d] Includes Nebraska and Nevada.
[e] Included in Georgia.

Average price per short ton of coal in the United States for 29 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1895	$1.41	$0.86
1881	2.01	1.12	1896	1.50	.83
1882	2.01	1.12	1897	1.51	.81
1883	2.01	1.07	1898	1.41	.80
1884	1.79	.94	1899	1.46	.87
1885	2.00	1.13	1900	1.49	1.04
1886	1.95	1.05	1901	1.67	1.05
1887	2.01	1.11	1902	1.84	1.12
1888	1.91	1.00	1903	2.04	1.24
1889	1.44	.99	1904	1.90	1.10
1890	1.43	.99	1905	1.83	1.06
1891	1.46	.99	1906	1.85	1.11
1892	1.57	.99	1907	1.91	1.14
1893	1.59	.96	1908	1.90	1.12
1894	1.51	.91			

IMPORTS AND EXPORTS.

The following tables have been compiled from official returns to the Bureau of Statistics of the Department of Commerce and Labor, and show the imports and exports of coal from 1904 to 1908, inclusive. The values given in both cases are considerably higher than the average "spot" rates by which the values of the domestic production have been computed.

The tariff from 1824 to 1843 was 6 cents per bushel, or $1.68 per long ton; from 1843 to 1846, $1.75 per ton; 1846 to 1857, 30 per cent ad valorem; 1857 to 1861, 24 per cent ad valorem; 1861, bituminous and shale, $1 per ton; all other, 50 cents per ton; 1862 to 1864, bituminous and shale, $1.10 per ton; all other, 60 cents per ton; 1864 to 1872, bituminous and shale, $1.25 per ton; all other, 40 cents per ton. By the act of 1872 the tariff on bituminous coal and shale was made 75 cents per ton, and so continued until the act of August, 1894, changed it to 40 cents per ton. On slack or culm the tariff was made 40 cents per ton by the act of 1872; was changed to 30 cents per ton by the act of March, 1883, and so continued until the act of August, 1894, changed it to 15 cents per ton. The tariff act of 1897 provided that all coals which contain less than 92 per cent fixed carbon, and which will pass over a half-inch screen, shall pay a duty of 67 cents per ton. Slack or culm was not changed by the act of 1897. Tons are all 2,240 pounds. Anthracite coal has been free of duty since 1870. During the period from June, 1854, to March, 1866, the reciprocity treaty was in force, and coal from the British possessions in North America was admitted into the United States duty free. A special act of Congress placed all the coal on the free list for one year from January 1, 1903, in order to relieve the shortage caused by the anthracite strike of 1902.

The exports consist of anthracite and bituminous coal, the quantity of bituminous being the greater in the last few years. They are made principally by rail over the international bridges and by lake and sea to the Canadian provinces. Exports are also made by sea to the West Indies, to Central and South America, and elsewhere.

The imports are principally from Australia and British Columbia to San Francisco, from Great Britain to the Atlantic and Pacific coasts, and from Nova Scotia to Atlantic coast points.

The total exports of coal from the United States during 1908 were 11,853,177 long tons, valued at $36,886,509, of which 2,752,358 long tons, valued at $13,524,595, were anthracite, and 9,100,819 long tons, valued at $23,361,914, were bituminous coal. The imports of anthracite amounted in 1908 to 16,484 long tons, valued at $73,778, and those of bituminous coal to 1,452,662 long tons, valued at $3,964,843. From this it can be seen that the imports of anthracite coal into the United States are relatively of no importance. Most of the anthracite imported is to San Francisco and other points on the Pacific coast, being brought in principally as ballast in vessels coming for outgoing cargoes. The principal increase has been in imports of bituminous coal during the last five or six years. This has been due to the receipts of Nova Scotian coal at Everett, Mass., that fuel being used in the manufacture of coke in the retort-oven plant of the New England Gas and Coke Company at that place. Compared with the domestic production, the total quantity of coal imported into the United States is of little consequence, having for years averaged less than 1 per cent of the production.

Coal of domestic production exported from the United States, 1904–1908, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1904	2,228,392	$11,077,470	6,345,126	$17,160,538
1905	2,229,983	11,104,654	6,959,265	17,867,964
1906	2,216,969	10,896,200	7,704,850	19,787,459
1907	2,698,072	13,217,985	10,448,676	26,972,908
1908	2,752,358	13,524,595	9,100,819	23,361,914

Coal imported and entered for consumption in the United States, 1904–1908, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1904	72,529	$220,664	[a] 1,550,751	$3,895,469
1905	34,241	107,314	[a] 1,611,002	3,903,765
1906	32,354	105,161	[a] 1,702,799	4,102,355
1907	9,897	40,971	2,103,711	5,397,222
1908	16,484	73,778	1,452,662	3,964,843

[a] Includes 579,204 tons of slack or culm passing ½-inch screen imported in 1904, 611,053 tons imported in 1905, and 659,486 tons imported in 1906.

WORLD'S PRODUCTION OF COAL.

According to the record made in coal production by the several countries of the world, the business depression of 1908 was felt more severely in the United States than elsewhere. Production fell off in Great Britain, but not to such an extent as in the United States; declined slightly in Belgium; increased in Germany, France, India, Canada, and New South Wales. The statistics of coal production in Russia and Austria-Hungary in 1908 were not available at the time of writing this report. Because of the more serious effects of the depression in the United States the percentage of the world's supply produced by this country decreased from 39.4 in 1907 to 35.6 in 1908. In the following table is presented a statement of the coal production in the principal countries of the world in the years nearest to that under review for which figures are obtainable. For the sake of convenience, the quantities are expressed in the measurement customary in each country and are reduced for comparison to short tons of 2,000 pounds. In each case the year is named for which the production is given. The production of the United States decreased from 480,363,424 short tons in 1907 to 415,842,698 short tons in 1908. The output of Great Britain decreased from 299,970,677 short tons in 1907 to 292,887,144 tons in 1908. In 1907 the production of the United States exceeded that of Great Britain by 180,392,747 short tons, or 60 per cent. In 1908 the production of this country exceeded that of Great Britain by 122,955,554 short tons, or 42 per cent. In 1907 the coal production of the United States exceeded that of Germany by 253,589,819 short tons, or over 100 per cent, while in 1908 the excess of the United States' production over that of Germany was 178,535,725 short tons, or 75 per cent.

Attention is called to the fact that 98 per cent of the total world's production of coal comes from countries lying north of the equator, the countries south of the equator producing less than 20,000,000 tons annually.

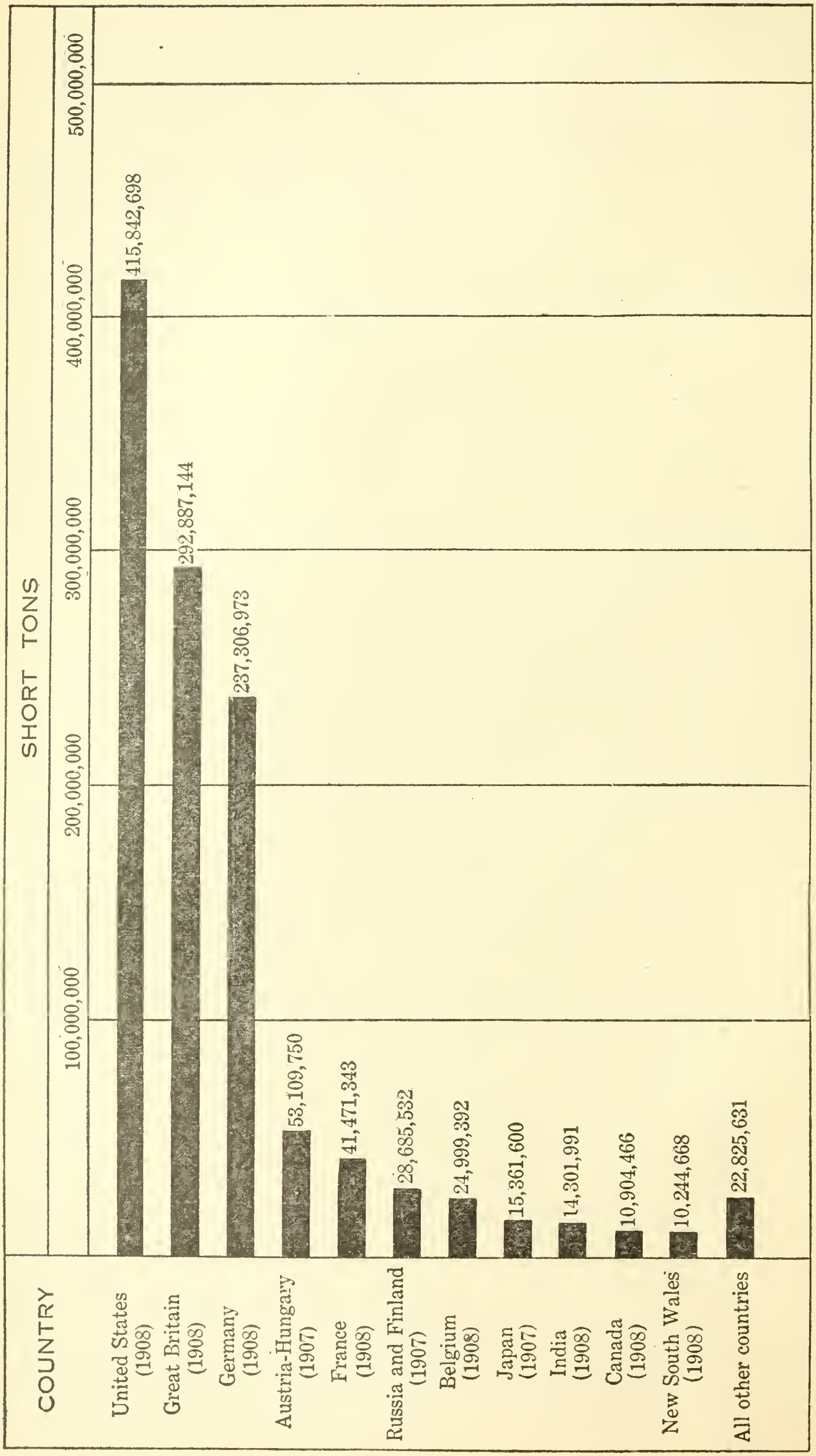

FIGURE 4.—World's production of coal.

The world's production of coal.

Country.		Usual unit in producing country.	Equivalent in short tons.
United States (1908)	long tons	371,288,123	415,842,698
Great Britain (1908)	do	261,506,379	292,887,144
Germany (1908)	metric tons	215,283,474	237,306,973
Austria-Hungary (1907)	do	48,180,849	53,109,750
France (1908)	do	37,622,556	41,471,343
Russia and Finland (1907)	do	26,023,344	28,685,532
Belgium (1908)	do	22,679,300	24,999,392
Japan (1907)	do	13,935,952	15,361,600
India (1908)	long tons	12,769,635	14,301,991
Canada (1908)	short tons	10,904,466	10,904,466
New South Wales (1908)	long tons	9,147,025	10,244,668
Spain (1907)	metric tons	3,887,236	4,284,900
Transvaal (1908)	long tons	3,012,692	3,374,215
New Zealand (1907)	do	1,831,009	2,050,730
Natal (1907)	do	1,530,043	1,713,648
Queensland and Victoria (1907)	do	964,229	1,079,936
Mexico (1906)	metric tons	767,864	846,416
Holland (1906)	do	532,780	587,283
Italy (1907)	do	453,137	499,493
Sweden (1907)	do	305,338	336,574
Cape Colony (1907)	long tons	128,607	144,040
Tasmania (1908)	do	61,068	68,396
Other countries [a]	do	7,000,000	7,840,000
Total			1,167,941,188
Percentage of the United States			35.6

[a] Includes China, Turkey, Servia, Portugal, United States of Colombia, Chile, Borneo and Labuan, Peru, Greece, etc.

As a matter of historical interest the following table giving the statistics of the production of coal in the more important countries of the world since 1868, is presented. In the forty-one years covered by this table the percentage of the total contributed by the United States increased from less than 15 per cent in 1868 to nearly 40 per cent in 1907, but decreased to 35.6 per cent in 1908.

World's production of coal, by countries, 1868–1908.

Year.	United States.		Great Britain.		Germany.	
	Long tons.	Short tons.	Long tons.	Short tons.	Metric tons.	Short tons.
1868	29,341,036	32,861,960	103,141,157	115,518,096	32,879,123	36,249,233
1869	29,378,893	32,904,360	107,427,557	120,318,864	34,343,913	37,864,164
1870	29,496,054	33,035,580	110,431,192	123,682,935	34,003,004	37,488,312
1871	41,861,679	46,885,080	117,352,028	131,434,271	37,856,110	41,736,361
1872	45,940,535	51,453,399	123,497,316	138,316,994	42,324,467	46,662,725
1873	51,430,786	57,602,480	128,680,131	144,121,747	46,145,194	50,875,076
1874	46,969,571	52,605,920	126,590,108	141,780,921	46,658,145	51,440,605
1875	46,739,571	52,348,320	133,306,485	149,303,263	47,804,054	52,703,970
1876	47,571,429	53,280,000	134,125,166	150,220,186	49,550,461	54,629,383
1877	54,019,429	60,501,760	134,179,968	150,281,564	48,229,882	53,173,445
1878	51,728,214	57,935,600	132,612,063	148,525,511	50,519,899	55,698,188
1879	60,808,749	68,105,799	133,720,393	149,766,840	53,470,716	58,951,464
1880	63,822,830	71,481,570	146,969,409	164,605,738	59,118,035	65,177,634
1881	76,679,491	85,881,030	154,184,300	172,686,416	61,540,485	67,848,385
1882	92,456,419	103,551,189	156,499,977	175,279,974	65,378,211	72,079,478
1883	103,310,290	115,707,525	163,737,327	183,385,806	70,442,648	77,663,019
1884	107,281,742	120,155,551	160,757,779	180,048,712	72,113,820	79,505,487
1885	99,250,263	111,160,295	159,351,418	178,473,588	73,675,515	81,227,255
1886	101,500,381	113,680,427	157,518,482	176,420,700	73,682,584	81,235,049
1887	116,652,242	130,650,511	162,119,812	181,574,189	76,232,618	84,046,461
1888	132,731,837	148,659,657	169,935,219	190,327,445	81,960,083	90,360,992
1889	126,097,779	141,229,513	176,916,724	198,146,731	84,973,230	93,640,500
1890	140,866,931	157,770,963	181,614,288	203,408,003	89,290,834	98,398,500
1891	150,505,954	168,566,669	185,479,126	207,736,621	94,252,278	103,913,136
1892	160,115,242	179,329,071	181,786,871	203,601,296	92,544,050	102,029,815
1893	162,814,977	182,352,774	167,325,795	184,044,890	95,426,153	105,207,334
1894	152,447,791	170,741,526	188,277,525	210,870,828	98,805,702	108,883,884
1895	172,426,366	193,117,530	189,661,362	212,320,725	103,957,639	114,561,318
1896	171,416,390	191,986,357	195,361,260	218,804,611	112,471,106	123,943,159
1897	178,776,070	200,229,199	202,129,931	226,385,523	120,474,485	132,762,882
1898	196,407,382	219,976,267	202,054,516	226,301,058	130,928,490	144,283,196
1899	226,554,635	253,741,192	220,094,781	246,506,155	135,824,427	149,719,766
1900	240,789,310	269,684,027	225,181,300	252,203,056	149,551,000	164,805,202
1901	261,874,836	293,299,816	219,046,945	245,332,578	152,628,931	168,217,082
1902	269,277,178	301,590,439	227,095,042	254,346,447	150,436,810	165,826,496
1903	319,068,229	357,356,416	230,334,469	257,974,605	162,457,253	179,076,630
1904	314,121,784	351,816,398	232,428,272	260,319,665	169,450,583	186,785,378
1905	350,645,210	392,722,635	236,128,936	264,464,408	173,796,674	191,576,074
1906	369,783,284	414,157,278	251,067,628	281,195,743	201,715 074	222,350,526
1907	428,895,914	480,363,424	267,830,962	299,970,677	205,727,665	226,773,605
1908	371,288,123	415,842,698	261,506,379	292,887,144	215,283,474	237,306,973

World's production of coal, by countries, 1868–1908—Continued.

Year.	Austria-Hungary.		France.		Belgium.	
	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.
1868	7,021,756	7,741,486	13,330,826	14,697,236	12,298,589	13,559,194
1869	7,663,043	8,448,505	13,509,745	14,894,494	12,943,994	14,270,753
1870	8,355,945	9,212,429	13,179,788	14,530,716	13,697,118	15,101,073
1871	8,437,401	9,302,235	13,240,135	14,597,249	13,733,176	15,140,827
1872	8,825,896	9,730,550	16,100,773	17,751,102	15,658,948	17,263,990
1873	10,104,769	11,140,508	17,479,341	19,270,973	15,778,401	17,395,687
1874	12,631,364	13,926,079	16,907,913	18,640,974	14,669,029	16,172,604
1875	13,062,738	14,395,137	16,956,840	18,694,916	15,011,331	16,549,992
1876	13,000,000	14,327,300	17,101,448	18,854,346	14,329,578	15,798,360
1877	13,500,000	14,883,750	16,804,529	18,526,993	13,669,077	15,070,157
1878	13,900,000	15,324,750	16,960,916	18,699,410	14,899,175	16,426,340
1879	14,500,000	15,986,250	17,110,979	18,864,854	15,447,292	17,030,640
1880	14,800,000	16,317,000	19,361,564	21,346,124	16,886,698	18,617,585
1881	15,304,813	16,873,556	19,765,983	21,791,996	16,873,951	18,603,531
1882	15,555,292	17,149,709	20,603,704	22,715,584	17,590,989	19,394,065
1883	17,047,961	18,795,377	21,333,884	23,520,607	18,177,754	20,040,974
1884	18,000,000	19,845,000	20,023,514	22,075,924	18,051,499	19,901,778
1885	20,435,463	22,530,098	19,510,530	21,510,359	17,437,603	19,224,957
1886	20,779,441	22,909,334	19,909,894	21,950,658	17,285,543	19,057,311
1887	21,879,172	24,121,787	21,287,589	23,469,567	18,378,624	20,262,433
1888	23,859,608	26,305,218	22,602,894	24,919,691	19,218,481	21,188,375
1889	25,328,417	27,924,580	24,303,509	26,794,619	19,869,980	21,906,653
1890	27,504,032	30,323,195	26,083,118	28,756,638	20,365,960	22,453,471
1891	28,823,240	31,777,622	26,024,893	28,692,444	19,675,644	21,692,398
1892	29,037,978	32,014,371	26,178,701	28,862,018	19,583,173	21,590,448
1893	30,449,304	33,570,358	25,650,981	28,280,207	19,410,519	21,400,097
1894	31,492,000	34,704,184	27,459,137	30,273,699	20,458,827	22,555,857
1895	32,654,777	35,985,564	28,019,893	30,877,922	20,450,604	22,536,566
1896	33,676,411	37,111,405	29,189,900	32,167,270	21,252,370	23,420,112
1897	35,858,000	39,515,516	30,797,629	33,938,987	21,534,629	23,731,161
1898	37,786,963	41,652,569	32,356,104	35,656,426	22,075,093	24,326,752
1899	38,739,000	42,690,378	32,863,000	36,215,026	21,917,740	24,159,925
1900	39,029,729	43,010,761	33,404,298	36,811,536	23,462,817	25,856,024
1901	41,202,902	45,417,959	32,301,757	35,596,536	22,213,410	24,485,842
1902	39,479,560	43,518,319	30,196,994	33,286,146	22,877,470	25,217,835
1903	40,628,785	44,772,921	34,906,418	38,466,873	23,796,680	26,223,941
1904	41,014,182	45,209,933	34,167,966	37,663,349	22,761,430	25,089,924
1905	42,994,240	47,392,551	35,336,442	38,951,360	21,844,200	24,078,862
1906	45,568,434	50,230,085	34,313,645	37,823,931	23,610,740	26,026,119
1907	48,180,849	53,109,750	36,930,250	40,708,215	23,824,499	26,261,745
1908	....	....	37,622,556	41,471,343	22,679,300	24,999,392

World's production of coal, by countries, 1868–1908—Continued.

Year.	Russia.		Japan.		Other countries.	Total.	Per cent of United States.
	Metric tons.	Short tons.	Metric tons.	Short tons.	Short tons.	Short tons.	
1868	430,032	473,895			1,147,330	222,248,430	14.79
1869	579,419	638,510			1,104,563	230,444,213	14.28
1870	667,806	735,922			1,063,121	234,850,088	14.07
1871	772,371	851,153			1,114,248	261,061,424	17.96
1872	1,037,611	1,143,447			1,268,115	283,590,322	18.14
1873	1,154,618	1,272,389			1,502,516	303,181,376	19.00
1874	1,270,889	1,400,520			2,708,756	298,676,379	17.61
1875	1,673,753	1,844,475			2,639,104	308,479,177	16.97
1876	1,795,146	1,968,251			2,597,143	311,674,969	17.09
1877	1,760,276	1,939,824			2,821,155	317,198,648	19.07
1878	2,483,575	2,738,141			3,176,050	318,523,990	18.19
1879	2,874,790	3,169,456			3,362,605	335,237,908	20.32
1880	3,238,470	3,570,413			3,621,342	369,413,780	20.62
1881	3,439,787	3,792,365			5,185,974	392,663,253	21.87
1882	3,672,782	4,049,242			6,128,631	420,082,472	24.58
1883	3,916,105	4,317,506	1,021,000	1,125,142	6,929,841	450,990,397	25.55
1884	3,869,689	4,266,332	1,159,000	1,277,218	7,367,309	454,022,811	26.37
1885	4,207,905	4,639,215	1,314,000	1,448,028	7,570,507	447,783,802	24.82
1886	4,506,027	4,967,895	1,402,000	1,545,004	9,082,815	450,848,793	25.22
1887	4,464,174	4,921,752	1,785,000	1,967,070	10,399,273	481,412,743	27.14
1888	5,187,312	5,719,011	2,044,000	2,252,488	11,493,176	521,225,803	28.52
1889	6,215,577	6,852,674	2,435,000	2,683,370	12,618,299	531,797,039	26.56
1890	6,016,525	6,633,219	2,653,000	2,923,606	13,025,637	563,693,232	27.99
1891	6,233,020	6,871,905	3,230,000	3,559,460	14,744,329	587,554,583	28.69
1892	6,816,323	7,514,996	3,228,000	3,557,256	14,998,633	593,497,904	30.22
1893	7,535,000	8,307,337	3,350,000	3,691,700	15,783,599	582,638,296	31.30
1894	8,629,000	9,509,158	4,311,000	4,750,722	18,197,510	610,487,368	27.97
1895	9,079,138	10,005,210	4,849,000	5,343,598	19,428,643	644,177,076	29.98
1896	9,229,000	10,170,358	5,019,690	5,531,698	20,866,748	664,001,718	28.92
1897	11,207,475	12,350,638	5,647,751	6,225,516	22,074,093	697,216,515	28.72
1898	12,307,450	13,562,810	6,761,301	7,572,657	24,797,873	738,129,608	29.80
1899	13,562,810	15,730,346	6,716,831	7,401,948	25,811,285	801,076,021	31.63
1900	16,151,557	17,799,016	7,429,457	8,187,262	27,684,964	846,041,848	31.88
1901	16,269,800	17,934,201	8,945,938	9,861,107	30,565,923	870,711,044	33.69
1902	15,259,674	17,090,835	9,701,682	10,691,254	37,907,163	888,453,950	33.95
1903	17,818,000	19,640,781	10,088,845	11,120,934	37,562,430	972,195,531	36.76
1904	[a] 19,318,370	21,294,639	10,772,240	11,874,240	43,332,409	983,527,562	35.78
1905	[a] 17,233,871	18,996,896	11,630,000	12,819,749	45,478,314	1,034,156,604	37.98
1906	21,613,800	23,857,961	12,980,103	14,307,968	47,898,532	1,117,848,143	37.05
1907	[a] 26,023,344	28,685,532	13,935,952	15,361,600	51,930,700	1,218,337,677	39.43
1908					[b] 58,276,756	[c] 1,167,941,188	35.60

[a] These figures also include the production of Finland.

[b] This includes the output of Canada (1908, 10,904,466 short tons); India (1908, 14,301,991 short tons); New South Wales (1908, 10,244,668 short tons); Spain (1907, 4,284,900 short tons); South African Republic (1908, 3,374,215 short tons); New Zealand (1907, 2,050,730 tons); Sweden (1907, 336,574 tons); Italy (1907, 499,493 tons); Queensland (1907, 1,079,936 tons); also that of Holland, Natal, Cape Colony, Tasmania, Mexico, and Victoria; and of China, Turkey, Servia, Portugal, etc., (estimated), 7,840,000 tons.

[c] Latest available figures are used in making up totals for 1908.

COAL TRADE REVIEW.

It has been the practice in the preparation of the annual report on the production of coal to include reviews of the coal trade in some of the principal cities, and this custom has been followed in the present chapter. These reviews have been contributed, in whole or in part, by secretaries of chambers of commerce or other local authorities familiar with the coal trade of their respective communities. They will be found of interest as reflecting the conditions which have influenced the markets and the bearing they have had upon production. Acknowledgment for the services rendered is gratefully made and recognition by name is given for each contribution.

NEW YORK CITY.

The following review of the coal trade of New York City has been prepared by Mr. Frederick Hobart, associate editor of the Engineering and Mining Journal:

As was the case all over the country, the coal trade in New York suffered from depression during the year 1908. It is impossible to secure any complete record of sales and deliveries, but from such data as are available it is estimated that the decrease in the anthracite trade of the city and the district which draws its supplies from New York Harbor was between 5 and 10 per cent, as compared with 1907. In the bituminous trade it was greater, estimates of the decrease varying from 15 to 20 per cent. The lower figure is probably nearer the actual fact. Such decreases, while they still left a great volume of trade, were sufficient to cause low prices and a general feeling of depression and uncertainty.

There was little or no change in the general conditions under which trade was done. Locally little was done on the improvements looking to better and more economical handling of coal supplies, which were referred to a year ago. The greatest progress made was on the great yards of the Pennsylvania Railroad on Long Island. When completed, these will facilitate the deliveries of coal to the boroughs of Brooklyn and Queens. Other improvements, in progress and projected, were delayed by financial troubles.

Toward the close of the year there was much discussion on the possible effect of the Virginian Railway on the local trade. It is understood that the plans of this road include a system for the prompt and extensive delivery of West Virginia coal in eastern territory. This would bring in a new and aggressive element in the market, which may have important results. It is doubtful, however, whether these plans can be carried out in less than a year; and the discussion is rather of prospective than of current interest.

One source of complaint and disturbance in the trade, of which a great deal was heard in 1907, was entirely absent in 1908. The car supply throughout the year was abundant, and transportation from mines to tide was regular and more prompt than has been the case for several years.

Anthracite.—Fluctuations in the anthracite trade in New York are comparatively insignificant. The demand for prepared sizes for household use does not vary largely, even in a mild winter. The steam sizes show greater changes, as they are used by factories and mills and their consumption will show greater differences from year to year. A large proportion of these sizes is now used in office buildings and large apartment houses having central heating and steam plants, and for the public utilities such as electric lighting, electric railroad power plants, etc. The steam sizes are not sold extensively in the region outside of New York, which is supplied from the harbor points. This territory takes chiefly bituminous coal for steam purposes, and its interest is therefore chiefly in the bituminous market.

The chief variations in the anthracite trade, therefore, were found in the facts that the early winter months were not severe and that the fall weather also was mild, only one or two really cold spells coming in to stimulate demand. Supply was generally good and even, nothing occurring to prevent the delivery of coal as required. Even locally there were no heavy snowstorms to interfere with the street delivery to consumers. The trade, therefore, had an uneventful year, with no such periods of dullness and slack demand as that with which the bituminous coal trade had to contend.

The list prices of the large or prepared sizes remained unchanged throughout the year: $4.75 for lump and $5 for egg, stove, and chestnut, all f. o. b. tide water. The usual spring and summer graduated discounts from these prices were allowed: 50 cents in the month of April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August; returning to full list prices in September. This system of discounts has been found to work well, inducing buyers to put in stocks in the summer when work at the collieries would otherwise be slack.

The prices of steam sizes did not vary to any degree. A fair average for the year is $3.25 to $3.30 for pea; $2.35 to $2.50 for buckwheat; $1.60 to $2 for buckwheat No. 2 or rice; $1.35 to $1.50 for barley, all f. o. b. tide water. At several times during the year individual mine and washery pea sold at from 5 to 15 cents below these prices; and once or twice 5 or 10 cents more was obtained for special sizes which were temporarily scarce.

Toward the close of the year there was talk of labor troubles in the anthracite region. The action of the companies in gradually accumulating stocks as a provision against any stoppage at the mines, and the general belief that any differences could be adjusted, prevented any feeling of disturbance in the trade.

The use of anthracite in the eastern cities is so established that it is a necessity of life, the demand for which can not vary greatly. The only reduction in prospect comes from the increasing use of gas and coke for cooking and heating; possibly in the future from the application of electricity to the same purposes.

Bituminous.—The year 1908 opened with unfavorable prospects. The demand for steam coal throughout New England and all the territory supplied from New York Harbor was lighter than at any time for three years, while at the same time large stocks had accumulated at tide water. These stocks were so heavy that several of the railroads declared an embargo and refused to receive any coal for tidewater delivery, unless they had proof that immediate unloading could be secured. There was no prospect that the stocks could be quickly worked off. Prices were affected accordingly, and while good grades of steam coal were held at $2.50, f. o. b. New York Harbor, there was plenty of coal to be had down to $2.20, offers of low prices being made to stop demurrage charges. Factories in New England and along the Hudson were running very slack, and most of them were carrying stocks of coal enough to last them for some time. In addition to the local stocks, it was reported at one time that some 80,000 tons of West Virginia coal were at Newport News and Norfolk, waiting shipping orders. On contracts deliveries were slow, and the trade seemed almost dead for the time being.

Through January and February trade continued uncertain. While the nominal asking price for good grades of Clearfield remained at $2.50, plenty of coal was offered at $2.30 and $2.20, which was practically the market price. As March approached, however, the stocks were gradually worked off. There was less coal offered at low prices and quotations gradually worked up to $2.40 or $2.45, f. o. b. harbor shipping ports, with $2.50 to $2.60 for the higher special grades. Shippers began generally to adopt the plan—which was adhered to more or less closely through the year—of shipping from the mines only on orders, keeping small stocks, or none at all, at tide water.

March brought about discussion on yearly contracts, which are generally made about this season. These came in slowly, partly for the reason that users of coal had little confidence in the future and were uncertain about their wants, and partly because there were current reports of changes in railroad rates. Some yearly contracts were taken at mine prices, subject to change in rates. The change did not materialize, however, rates remaining the same as in the preceding season. Prices on current trade remained through March at about $2.50 New York Harbor for good grades, with up to $2.65 for specials. At the close of the month a possible source of disturbance to the trade was removed, the mines of the Central Pennsylvania district—including the Clearfield region—agreeing to extend the old wage scale for another year.

The bids for shipping 360,000 tons of coal for the Panama Canal Zone, during the year beginning April 1, showed a range of $2.60 to $2.80 f. o. b. tide water, for New River coal; $2.65 to $2.80 for Pocahontas; $2.30 to $2.80 for Georges Creek; $2.50 to $2.60 for Clearfield; $2.60 for Alabama coal delivered at Pensacola.

In April contracts were closed freely and most of this class of business was settled. Prices were generally lower than in the preceding year, and quantities specified smaller. Current sales remained comparatively small, and with no advance in prices. It was noticed that a few large consumers held back on contracts, probably believing that they would do better on the open market. These were the exceptions. The first orders on the new contracts came in slowly, and were rather disappointing in quantity, as a rule; indicating a low rate of consumption.

In May trade began to show some signs of improvement, but they did not last. Prices at tide water remained fairly steady at $2.50 f. o. b. for good steam grades. A feature which developed in May and at several times later in the year was a demand for slack, especially gas slack. Users of this grade could not always get it when wanted, and several times sales were made at prices on a parity with run of mine. This was due to the light demand for lump coal, and the short running time in vogue at many mines, which cut down the quantity of slack made. The largest consumers of slack are the cement makers, and some of them had, at times, trouble in securing what they needed.

As June went on the tide-water market settled down to slow but fairly steady trade, with prices on a basis of \$2.40 to \$2.50 f. o. b. harbor ports for good grades of Clearfield. The competition of West Virginia coals was not aggressive on the whole, though at several times during the year those coals were offered at prices 15 or 20 cents under Clearfield. Consumers did not seem to be attracted by low prices, preferring to run chances of paying more, rather than the risk of carrying stocks which they could not use.

In July some improvement began to be manifest in the all-rail trade—that is, in the trade to interior towns in the East, between the mines and tide water. It may be added that all through the remainder of the year this all-rail business continued to make a better showing than the tide-water trade.

Gas coal was in steady but not large demand throughout. In July the current quotations—all at mines—were 65 cents for run of mine, 90 cents for $\frac{3}{4}$-inch lump, and 50 cents for slack. These may be taken as a pretty fair average of the prices for the year.

In August prices on steam coal dropped a little, good Clearfield being offered at \$2.35 f. o. b. tide water, and Somerset at \$2.25. Even these prices did not seem to attract business. In September a slight improvement set in, and prices went back to \$2.40 for good Clearfield as a standard.

About September 1, the Interstate Commerce Commission having upheld the claims of the producers, the Baltimore and Ohio issued a new tariff, reducing the rate on "small-vein" Cumberland and Georges Creek coal to tide water 15 cents below that charged on "big-vein" coal. This point had been in controversy some time. The reduction made the rate on small-vein coal about the same as that on Clearfield to tide water.

As October opened there was some inquiry from the shoal-water ports for winter supplies. It was not active enough to cause any excitement and those ports secured their supplies—smaller than usual—without disturbing the market to any degree. Prices worked up a little, \$2.50 to \$2.65 being paid for fair grades, with \$2.40 for lower grades only. Business began to pick up in the East, orders coming in a little more freely. The New York Harbor trade, however, remained dull. Through November trade continued to improve. While it could not be called brisk at any time, it was better than it had been all through the earlier part of the year.

In December business fell off again. The ice-bound ports in the East had been supplied and consumers seemed to have lost interest in the market. Prices remained steady at \$2.35 to \$2.60 f. o. b. tide water, according to grade. The year closed quietly, with a dull market, and the coal trade generally pleased that it was at an end.

The coastwise market.—Naturally with a dull market, such as prevailed in 1908, the demand for vessels in the coastwise trade was not active. January opened with rates nominally at about 75 cents to Boston and Portland; but there was some skirmishing for cargoes, and coal was taken at lower rates. To Long Island Sound ports coal was taken very low, small vessels making a figure of 30 cents to New Haven and New London. Later in the month this was cut further, 20 cents being accepted in some cases. This state of affairs continued through February, and though an attempt was made to peg rates at 65 or 70 cents from New York to points around Cape Cod shippers could secure vessels at practically their own terms. Such boats as kept in the trade were begging for business, and instances were not unknown where they were willing to take half cargoes rather than stay idle.

In March there was only a slight improvement, and sailing vessels were quite willing to take such trade as was going at 60 cents to points around Cape Cod, and 30 or 35 cents to Providence and the Sound ports. The barge lines owned by the large companies took the cream of the business and sailing vessels had to work to get charters. Some stormy weather, however, caused the loss of several barges, and this was some help to the schooners. Many owners, however, decided that it was cheaper to tie up, or to go into the southern lumber trade if they could. The result of this was felt in late April, when the ice-making ports in the East began to call for their spring supplies. A temporary scarcity developed, especially for small vessels, and rates were a little firmer, though there was no material increase. The spring rates were 60 to 65 cents to Boston and Portland; 75 to 80 cents to Bath and Bangor; 50 cents to Sound ports. The spring trade was disappointing in volume; chartering was light, and rates weakened again in May, the April figures being shaded 5 cents to around Cape Cod and 10 cents to Providence, New Bedford, and the Sound.

In June the low rates attracted some attention and there was a little spurt which stopped rate cuts for a while. It was soon over, since eastern buyers hesitated about putting in large stocks. By the end of June charters were accepted at 50 cents to Boston and Portland; 65 to 70 cents to Bath and Bangor; 40 to 45 cents to Long Island Sound ports. These prices continued well through July. Even in August, when rates are usually at the best, there was little improvement, a stiffening of 5 cents for small vessels being the greatest change.

Early in September buyers from the shoal-water or ice-making ports began to take stocks. This and the fact that many schooners had gone into the lumber trade caused a slight improvement and put a stop for the time to offers of cut rates. The quoted rates, however, remained about the same until nearly the end of October, when there was a 5-cent advance, quotations to Boston and Portland being 55 cents; Bath and Bangor, 70 to 75 cents; Providence and the Sound, 45 to 50 cents. The usual fall rush to get coal to the shoal-water ports was conspicuously absent. Some stocks had been laid in early, and in other cases the buyers did not seem to care much about stocks anyhow.

Toward the middle of November eastern buyers began to feel an improvement in business and to realize that their winter stocks were low. This brought more business for vessels, and there was a general advance. It was realized that the supply of boats was not large, and the quotations went up to 70 cents to Boston and Portland; 80 cents to Newburyport and Bath; 60 cents to the Sound. The reluctance of owners to run too much risk of storms brought about a shorter supply, and by December there was another advance of 5 cents all around, which held through the month. Closing rates were 75 cents to Boston and Portland; 80 cents to Portsmouth; 65 to 70 cents to Long Island Sound.

One accompaniment of the light trade was that there was comparatively little complaint of delays in unloading at the eastern ports. Even at the Sound ports, where coal often accumulates to an exasperating degree, there was little trouble, and there were few instances of insistence on the loading and discharging clause in charters.

The coastwise shipments from New York Harbor ports are reported as below:

Coastwise shipments from New York Harbor ports, 1907–1908 in long tons.

	1907.	1908.	Decrease.
Anthracite	16,753,914	15,069,981	1,683,933
Bituminous	11,691,101	10,247,014	1,444,087
	28,445,015	25,316,995	3,128,020

The decrease was only 11 per cent. A considerable part of these shipments, however, go to the docks in the immediate vicinity. The decrease in the actual coastwise trade—that is, the trade which goes beyond the harbor limits—was much greater in proportion. The coastwise trade had the leanest year it has seen for years.

BOSTON, MASS.

Mr. Daniel D. Morss, secretary of the Boston Chamber of Commerce, has furnished the statistics for the following statement of the receipts and shipments of coal at the port of Boston during 1908.

The total quantity of coal received at Boston from all points in 1908 amounted to 5,450,039 long tons, which, as compared with the record year of 1907, when the receipts amounted to 5,884,924 long tons, was a decrease of 434,885 tons, or 8 per cent. Of the total receipts in 1908, 1,776,401 long tons were anthracite, and 3,673,638 long tons were bituminous coal. In 1907 the receipts of anthracite were 2,053,288 long tons, while the arrivals of bituminous coal were 3,831,636 tons. The anthracite receipts, therefore, in 1908 fell off 276,887 long tons, while those of bituminous coal decreased 157,998 long tons. The quantity of anthracite forwarded to interior points decreased from 281,633 long tons in 1907 to 255,984 tons in 1908, but bituminous coal forwarded increased from 854,347 long tons to 1,130,674 tons. This is the only case where an increase in business was shown. Net receipts of anthracite for local consumption decreased from 1,771,655 tons to 1,520,417 tons, and bituminous from 2,977,289 tons to 2,542,964 tons. It is significant, as showing the effect of the policy of making the summer reductions in the price of anthracite, that almost exactly 50 per cent of the receipts of anthracite and something more than 50 per cent of the quantities forwarded to interior points were made in the six months from April to September. The receipts of bituminous coal in the summer months were about 200,000 tons less than in the winter months.

The following table shows the receipts of both anthracite and bituminous coal, by months, in 1908, the quantities forwarded to interior points, the net receipts for local consumption, and the totals for 1908 compared with those for the three preceding years:

Monthly receipts of coal at Boston, Mass., for 1908, with comparisons, in long tons.

Month.	Receipts from all points.		Quantities forwarded to New England points.		Net receipts (for local consumption).	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.
January	141,579	289,718	14,344	142,322	127,235	147,396
February	100,176	301,387	16,161	57,418	84,015	243,969
March	148,149	375,245	11,237	32,602	136,912	342,643
April	150,276	248,036	30,544	105,847	119,732	142,189
May	178,638	243,731	22,568	60,323	156,070	183,408
June	163,240	288,713	19,964	78,402	143,276	210,311
July	143,221	339,511	24,888	127,029	118,333	212,482
August	123,597	304,876	21,288	104,612	102,309	200,264
September	125,268	323,969	18,968	111,512	106,300	212,457
October	189,979	249,803	37,269	86,258	152,710	163,545
November	155,677	345,787	19,485	101,663	136,192	244,124
December	156,601	362,862	19,268	122,686	137,333	240,176
Total, 1908	1,776,401	3,673,638	255,984	1,130,674	1,520,417	2,542,964
1907	2,053,288	3,831,636	281,633	854,347	1,771,655	2,977,289
1906	1,659,679	3,517,916	197,690	1,370,477	1,461,989	2,147,439
1905	1,977,398	3,406,761	254,565	1,093,879	1,722,833	2,312,882

The following table shows the receipts of domestic and foreign coals at the port of Boston for a series of five years. The receipts of foreign coals are almost exclusively those of bituminous coal from Nova Scotia delivered to the by-product coking plant at Everett, a suburb of Boston. These, in 1907, when all other business showed an increase, decreased over 100,000 tons as compared with 1906, and this decrease is said to have been due to larger quantities of West Virginia coal used at the coking plant. A further decrease of over 170,000 tons (more than the total decrease in bituminous receipts) is exhibited in the arrivals of Nova Scotian coal in 1908.

Receipts of coal at Boston, Mass., for six years, in long tons.

Year.	Domestic.				Foreign.		Total.
	By water.		By rail.				
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.	
1903	2,042,512	2,078,499	109,033	185,330	22,432	1,226,134	5,663,940
1904	1,961,785	2,397,885	40,994	117,605		550,383	5,068,652
1905	1,941,478	2,757,186	35,920	41,104		608,471	5,384,159
1906	1,630,674	2,772,593	29,005	87,251		658,072	5,177,595
1907	2,016,252	3,196,057	37,036	89,927		545,652	5,884,924
1908	1,733,112	3,240,562	43,289	62,367		370,709	5,450,039

Coastwise freight rates in 1908 were notably lower than in either 1906 or 1907, except from New York Harbor ports. From Norfolk and Newport News the minimum rate in 1908 was 50 cents, against 75 cents in 1907; the maximum was 80 cents in 1908 and $1.25 in

1907. The range from Baltimore in 1908 was from 50 cents to 85 cents, against a range of 75 cents to $1.30 in 1907. Rates from Philadelphia ranged from 50 cents to $1 in 1908, and from 65 cents to $1.35 in 1907.

The following tables show the minimum and maximum freight rates from coal-shipping ports to Boston during 1907 and 1908:

Coal freights to Boston during 1907.

From—	Minimum.		Maximum.	
	Rate.	Date.	Rate.	Date.
New York	[a] $0.50–$0.55		$0.85	March 30.
Philadelphia	.65	December 10	1.35	March 25–April 1.
Baltimore	.75	December 20	1.30	March 15–April 1.
Norfolk and Newport News	.75	December 9	1.25	March 18.

[a] 50 to 55 cents is season rate on coal-carrying railroad transportation. 60 cents was the minimum rate on sail tonnage from New York to Boston.

Coal freights to Boston during 1908.

From—	Minimum.		Maximum.	
	Rate.	Date.	Rate.	Date.
New York	[a] $0.50–$0.55		$0.85	February 15.
Philadelphia	.50	July 1–October 30	1.00	January 1–31.
Baltimore	.50	August 10–November 15	.85	January 15.
Norfolk and Newport News	.50	June 15–December 15	.80	January 25.

[a] 50 to 55 cents is season rate on anthracite coal-carrying railroad transportation from New York and 75 cents from Philadelphia. 60 cents was the minimum rate on sail (i. e., sailing vessels) tonnage from New York to Boston.

PHILADELPHIA, PA.

The following review of the coal trade of Philadelphia has been prepared for this report by Mr. Samuel R. Kirkpatrick:

While the mining of anthracite and bituminous coal in Pennsylvania in 1908 was not as great as in the previous year, it was nevertheless large, and if it had not been for the scarcity of water in the anthracite region the production of hard coal would probably have been nearly equal to that of 1907, the year in which the maximum output was obtained. Owing to that scarcity, the Philadelphia and Reading Coal and Iron Company was compelled to haul large quantities of water to many of its mines, while other companies, unable to secure sufficient water, had to shut down. There were few interruptions because of labor troubles, although there were some petty annoyances, most of which were caused by a misunderstanding of the rules laid down by the strike commission or were due to efforts on the part of the miners to bring about a change in mining conditions. During the latter part of the year there was some apprehension of trouble on the termination of the wage agreement (March 31, 1909), so in order to be ready for emergencies the mines were worked to their full capacity during the latter part of 1908. Despite the fact that the demand for hard coal was light, the companies continued mining and storing large quantities so that at the close of the year there were many millions of tons of anthracite in the yards of the large coal-producing companies.

The total shipments from the anthracite mines during the year amounted to 64,665,014 tons, against 67,109,393 tons in 1907. This is exclusive of the coal used at and around the mines. It was only during the months of February, March, July, and August that the shipments amounted to less than 5,000,000 tons a month. The scarcity of water hampered mining in July and August. In May 6,088,116 tons of anthracite were shipped. This is the largest tonnage made in any one month. The falling off in business caused a curtailment of orders, and while the more important producing companies maintained prices the individual operators who had no storage yards were forced to get rid of their production. This caused some cutting of prices, and at times prepared sizes were sold at from 25 to 50 cents below the circular prices.

The early months of 1908 were of a character to create a great demand for prepared sizes, but during the latter part of the year the weather was mild and the retail dealers did a small business as compared with the same period in the previous year. There was a general falling off in the shipments of all kinds of coal. The consumption of bituminous coal was considerably less, and the shipments by "coastwise and harbor" and for "local" trade were also below those of 1907. The decrease in the shipments of bituminous coal was due to the shutting down of many manufacturing plants, and the depression in the iron trade put many coke ovens out of service. Notwithstanding the stagnation of business the mining of hard coal was kept well up to capacity. All the large coal companies, as well as the railroads, have so greatly improved their facilities that it is now possible to handle over 5,500,000 tons of anthracite monthly. A few years ago this would have been impossible, as the railroads could not have supplied the rolling equipment nor could they have handled such a large output without a congestion at tide-water ports.

The stock or coal on hand in the yards of the coal-producing companies at the beginning of 1908 was comparatively small, but at the close of the year there was a large surplus. On April 1 the usual 50-cents-a-ton reduction was made, and each month thereafter the price advanced 10 cents a ton until September, when the full circular prices were restored. The retailers took advantage of this reduction and lowered the price to the consumer. The decreased consumption of anthracite was due largely to the drop in business and to the open winter of 1908. During the summer months all the more important coal companies shipped large quantities of hard coal to their yards on the Great Lakes and to the principal cities of the Middle West. The shipments of anthracite for export showed a slight increase, while those for coast and harbor trade decreased 135,790 tons and for local uses there was a decrease of 635,077 tons. The shipments for the coast and harbor trade were at one time at a standstill, many of the seagoing tugs and coal barges being put out of commission. The falling off in the shipments of bituminous coal was also large. In the coast and harbor trade alone there was a decrease of 867,408 tons; in the local trade

274,605 tons, and in the quantity of coal exported there was a decrease of 137,286 tons. Although the trade became very dull and competition was quite keen among the retailers, prices were fairly well maintained. In some instances an inferior quality of bituminous coal was freely sold below the market price. The following table shows the average range of retail prices of anthracite and bituminous during 1908, by months:

Average prices for anthracite and bituminous coal at Philadelphia in 1908, by months.

Month.	Prepared sizes.	Pea.	Buckwheat.	Rice.	Bituminous.
January	$7.00	$4.75	$3.35-$3.75	$2.75-$3.10	$3.75-$4.00
February	7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
March	7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
April	6.50	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
May	6.60	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
June	6.70	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
July	6.80	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
August	6.90	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
September	7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
October	7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
November	7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
December	7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00

The production of anthracite coal during 1908 was to a great measure uninterrupted, each company mining its full quota, except when forced to suspend operations by the scarcity of water. The following table shows the shipments during each month of 1908 as compared with 1907:

Anthracite shipments in 1907 and 1908, by months, in long tons.

Month.	1907.	1908.	Month.	1907.	1908.
January	5,249,946	5,618,339	August	5,716,252	4,599,093
February	4,563,720	4,503,756	September	5,442,234	5,211,047
March	5,235,814	4,766,158	October	6,015,851	5,977,497
April	5,916,583	5,987,221	November	5,666,205	5,839,491
May	5,994,272	6,088,116	December	5,343,477	5,827,938
June	5,924,260	5,704,952			
July	5,602,435	4,541,506	Total	67,109,393	64,665,014

As has been the custom for several years, in September the retail dealers advanced the price of egg, stove, and chestnut sizes in keeping with the advance made by the operators, but as most of the independent operators were offering their output at from 25 to 50 cents a ton below circular, the advance in retail prices was not general. The prices for steam sizes were firm throughout the year. Pea coal is now used exclusively in many dwellings, especially as nearly all modern homes are equipped with either hot water or steam heaters, which consume the smaller sizes to advantage.

The demand for bituminous coal in 1908 was considerably less than in 1907. Even the Government did not purchase as much as it did in 1907. This falling off in the demand caused an unsettled market in the soft-coal trade.

The following table shows the prices of the various sizes of anthracite at the mines during the year 1908, by months:

Prices of anthracite at the mines for Philadelphia delivery in 1908, per long ton.

Month.	Broken.	Egg.	Stove and chestnut.	Pea.	Buckwheat.
January	$3.00-$3.25	$3.50-$3.75	$3.75	$2.00	$1.25-$1.50
February	3.00- 3.25	3.50- 3.75	3.75	2.00	1.25- 1.50
March	3.00- 3.25	3.35- 3.75	$3.50- 3.75	2.00	1.25- 1.50
April	3.00- 3.15	3.25	3.25	2.00	1.25
May	3.00- 3.15	3.25- 3.35	3.35	2.00	1.25
June	3.00- 3.10	3.35- 3.45	3.45	$1.75- 2.00	1.25
July	3.00- 3.20	3.35- 3.55	3.35- 3.55	1.75- 2.00	1.15- 1.25
August	3.00- 3.30	3.35- 3.65	3.50- 3.65	1.75- 2.00	1.15- 1.25
September	3.00- 3.40	3.35- 3.75	3.75	2.00- 2.25	1.15- 1.25
October	3.00- 3.50	3.35- 3.75	3.75	2.00- 2.25	1.25
November	3.00- 3.50	3.35- 3.75	3.75	2.00- 2.25	1.25- 1.40
December	3.00- 3.50	3.35- 3.75	3.75	2.00- 2.25	1.25- 1.40

The one item to show an increase was the export of anthracite, this being 55,823 tons as against 48,541 tons in 1907, an increase of 7,282 tons. The largest quantity of hard coal exported from Philadelphia in 1908 (23,845 tons) was sent to Cuba. Canada received 19,806 tons, Mexico 1,599 tons, Newfoundland 8,103 tons, Bermuda 1,732 tons, and the British West Indies 162 tons. France received 26 tons and Santo Domingo 550 tons. The anthracite exported was valued at $242,297.

The export shipments of bituminous coal in 1908 showed a decrease of 137,286 tons over those of 1907, the total shipments amounting to 741,891 tons. Cuba continued to take the largest amount, 375,205 tons being sent to that country; Italy received 158,182 tons, a large increase over 1907, when only 22,708 tons were shipped to that country; Mexico received 95,729 tons as against 213,177 in the previous year, and 16,744 tons were shipped to Panama. The French West Indies took 45,689 tons and France 9,955 tons. No coal was shipped from Philadelphia in 1908 to the Philippine Islands. The total value of the bituminous coal exported from Philadelphia in 1908 was $2,066,573 as against $2,433,051 in 1907 and $1,647,119 in 1906.

There was no change in freight rates for local delivery during the year. The charges per ton, which vary according to the region from which the shipment is made and according to size of coal, were as follows:

Freight rates per long ton on anthracite from coal regions to Philadelphia, Pa.

Region.	Prepared sizes.	Pea.	Buckwheat.
Schuylkill	$1.70	$1.40	$1.25
Lehigh	1.75	1.45	1.30
Wyoming	1.80	1.50	1.35

Through the courtesy of the officers of the Pennsylvania Railroad Company, the Philadelphia and Reading Railway Company, the Lehigh Coal and Navigation Company, and the Baltimore and Ohio

Railroad Company, data have been furnished from which the following table has been compiled. It shows the distribution of coal at Philadelphia for the export trade, the coastwise and harbor trade, and the Philadelphia local trade.

Distribution of coal at Philadelphia, Pa., in 1907 and 1908, in long tons.

Destination.	1907.		1908.	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.
Export	48,541	879,177	55,823	741,891
Coastwise and harbor	2,173,901	5,124,579	2,038,111	4,257,171
Local	4,742,062	2,208,712	4,106,985	1,934,107
	6,964,504	8,212,468	6,200,919	6,933,169

The price circular of the Philadelphia and Reading Coal and Iron Company, which is the same as that of other companies, is as follows:

Circular prices for anthracite coal at the mines in 1906, 1907, and 1908.

Size.	1906.		1907.			1908.	
	April.	September.	January.	April.	September.	April.	September.
Lump	$3.00	$3.00	$3.50	$3.25	$3.50	$3.50	$3.50
Steamboat	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Broken	3.50	3.50	3.50	3.00	3.50	3.00	3.50
Egg	3.75	3.75	3.75	3.25	3.75	3.25	3.75
Stove	3.75	3.75	3.75	3.25	3.75	3.25	3.75
Chestnut	3.75	3.75	3.75	3.25	3.75	3.25	3.75
Pea	3.00	1.75	1.75	1.75	2.00	2.00	2.00
Buckwheat	2.00	1.25	1.25	1.25	1.50	1.50	1.50

BALTIMORE, MD.

The following review of the coal trade of Baltimore has been contributed by Mr. Maurice J. Lunn, editor of Coal and Coke:

As shown in the following statistics, the coal trade of Baltimore suffered from the general depression in business during the year 1908, the receipts of coal for the year amounting to 5,433,846 long tons, a decrease of over 500,000 tons as compared with the preceding year. The coastwise coal shipments held up fairly well, showing a decrease of only a little over 100,000 tons, while the exports amounted to but 348,714 tons of coal, a decrease of over 200,000 tons as compared with 1907.

The bituminous coal trade was unsatisfactory throughout the year, and the receipts of this kind of coal at Baltimore showed a decrease of over 500,000 tons as compared with the previous year. Anthracite receipts showed only a slight decrease, due largely to the mild weather, otherwise they would have doubtless shown an increase on account of the natural increase in population from year to year.

The following table gives the coastwise coal shipments from Baltimore for the past six years, and those in 1908, instead of showing a material increase as has been the case during the other portions of the period covered, show a decrease of over 100,000 tons:

Coastwise coal shipments from Baltimore, 1903–1908, in long tons.

Year.	Anthracite.	Bituminous.	Total.
1903	....	....	1,731,896
1904	238,728	2,064,060	2,302,788
1905	252,568	2,832,321	3,084,889
1906	238,162	3,176,710	3,414,872
1907	266,062	3,804,066	4,070,128
1908	251,739	3,704,851	3,956,590

The exports of bituminous coal and coke from Baltimore, by months, for the year 1908, and the totals for the five previous years, are shown in the following table, from which it will be observed that the aggregate has fallen back to about the figures of the year 1905:

Exports of bituminous coal and coke from Baltimore, Md., in 1908, in long tons.

Month.	Bituminous coal.	Coke.
January	72,318	17,028
February	34,887	15,026
March	27,262	11,203
April	38,454	8,139
May	24,094	9,279
June	21,069	2,383
July	23,915	12,422
August	31,548	5,469
September	16,352	5,418
October	20,398	4,088
November	15,683	3,324
December	21,509	11,538
Total	347,489	105,317
Total, 1907	559,880	77,822
1906	458,203	69,230
1905	341,107	32,954
1904	150,912	....
1903	116,294	....

There were also 1,225 tons of anthracite coal exported during 1908.

The following tables give the receipts and shipments of anthracite and bituminous coal at Baltimore in 1907 and 1908:

Receipts and shipments of coal at Baltimore, 1907, in long tons.

	Receipts.	Tide-water shipments.	
		Coastwise.	Exports.
Bituminous	5,154,526	3,804,066	559,880
Anthracite	803,031	266,062	....
Total	5,957,557	4,070,128	559,880
Coke	215,045	....	....

Receipts and shipments of coal at Baltimore, 1908, in long tons.

	Receipts.	Tide-water shipments.	
		Coastwise.	Exports.
Bituminous	4,641,277	3,704,851	347,489
Anthracite	792,569	251,739	1,225
Total	5,433,846	3,956,590	348,714
Coke	137,167		

As stated in previous reports, in compiling the coal tonnage of the port of Baltimore, the receipts of coal at the plants of the Maryland Steel Company, at Sparrow's Point, about 9 miles from the city, and of the Central Foundry Company, located at Dundalk, about 6 miles out of the city, are not included, although possibly they should be. These figures, which are not included in the above table, are as follows:

Mr. R. K. Wood, general agent of the Maryland Steel Company, states that the consumption of bituminous coal amounted to 414,279 long tons in 1908, as compared with 517,139 long tons in 1907, and that the works consumed 10,064 long tons of coke, purchased from outside sources, in addition to the coke manufactured at its own ovens at the plant, which compares with 182,928 long tons of coke from the same source in the previous year.

Mr. D. Keller, manager of the Central Foundry Company, states that 1,754 long tons of coal and 2,298 long tons of coke were consumed at its plant during 1908, as compared with 2,755 long tons of coal and 3,369 long tons of coke in the preceding year.

PITTSBURG, PA.

In the following tables is presented a statement showing the quantity of coal received in Pittsburg and vicinity, by both rail and water, and the shipments of coal through and from the Pittsburg district to the West during the last five years. This statement has been compiled from reports made to the Geological Survey by officials of the railroads entering Pittsburg and by the United States army officer in charge of the slack-water navigation on Monongahela River and of the improvements at Davis Island dam, in Ohio River below Pittsburg. The railroad officials furnishing the information in the report to whom special acknowledgment is due are Messrs. R. H. Large, coal freight agent of the Pennsylvania Railroad at Philadelphia; W. L. Cromlish, coal and coke agent of the Baltimore and Ohio Railroad at Pittsburg; W. A. Terry, general freight agent of the Pittsburg and Lake Erie Railroad at Pittsburg; J. B. Safford, superintendent of the Pittsburg, Chartiers and Youghiogheny Railroad at Pittsburg; H. J. Booth, general coal and coke agent of the Wheeling and Lake Erie Railroad at Cleveland; and S. P. Woodside, general freight agent of the Wabash Pittsburg Terminal Railway and West Side Belt Railroad. The statistics of the movement of coal through the Monongahela River locks and at the Davis Island dam have been furnished by Maj. H. C. Newcomer, Corps of Engineers, U. S. Army.

In the movement of coal to Pittsburg and points west thereof the record of 1908 shows a decrease of one-third from that of 1907. The aggregate of business in 1908 was less than in any of the five preceding years. The railroad shipments to the Pittsburg district decreased from 4,774,977 short tons in 1907 to 3,494,905 tons in 1908; the shipments through Pittsburg to western points decreased from 20,817,263 tons to 12,545,081 tons, and the aggregate rail shipments to Pittsburg and the west decreased from 25,592,240 tons to 16,039,986 tons. Shipments to Pittsburg by water decreased from 7,611,680 short tons in 1907 to 6,435,851 tons in 1908; to points west of Pittsburg the shipments decreased from 3,204,129 tons to 1,742,339 tons, and the total water shipments in 1908 were 2,637,619 tons less than in 1907.

The greatest decreases were shown in the movement of coal to western points, the aggregate by rail and water in 1908 being 14,287,420 short tons, against 24,021,392 tons in 1907. The total shipments to the Pittsburg district for local consumption decreased from 12,386,657 short tons in 1907 to 9,930,756 tons in 1908. In all, the shipments to Pittsburg and the West in 1908 amounted to 24,218,176 short tons, against 36,408,049 tons in 1907.

The shipments of Pittsburg coal to eastern points did not exhibit as great a decrease as did those for local consumption and western destinations. The quantity of coal shipped east, all of it going by rail, amounted in 1908 to 11,666,160 short tons, against 12,202,530 tons in 1907.

Rail and water shipments to Pittsburg and vicinity and through Pittsburg to western points during the last five years have been as follows:

Movement of coal to and through Pittsburg, 1904–1908, in short tons, showing totals by rail and water.

	1904.	1905.	1906.	1907.	1908.
By rail:					
To Pittsburg district	5,083,535	5,463,012	5,107,413	4,774,977	3,494,905
To west of Pittsburg	16,017,327	18,370,368	22,419,496	20,817,263	12,545,081
Total by rail	21,100,862	23,833,380	27,526,909	25,592,240	16,039,986
By Monongahela River locks:[a]					
To Pittsburg district	4,173,992	5,558,541	6,840,816	7,611,680	6,435,851
To west of Pittsburg	2,811,584	3,926,319	2,883,965	3,204,129	1,742,339
Total by water	6,985,576	9,484,860	9,724,781	10,815,809	8,178,190
Total shipments	28,086,438	33,318,240	37,251,690	36,408,049	24,218,176

[a] The coal traffic on the Monongahela is obtained by adding to that which passes Lock No. 3 the coal mined and shipped in pools Nos. 1 and 2. In 1908 there were consumed in pools Nos. 1 and 2, 4,722,390 tons river coal, and in the harbor below No. 1, including the lower Allegheny River, 1,713,461 tons of Monongahela River coal, a total of 6,435,851 tons locally consumed.

Movement of coal to and through Pittsburg, 1904–1908, in short tons, showing totals to Pittsburg district and west of Pittsburg.

	1904.	1905.	1906.	1907.	1908.
To Pittsburg district:					
By rail	5,083,535	5,463,012	5,107,413	4,774,977	3,494,905
By water	4,173,992	5,558,541	6,840,816	7,611,680	6,435,851
Total to Pittsburg district	9,257,527	11,021,553	11,948,229	12,386,657	9,930,756
To west of Pittsburg:					
By rail	16,017,327	18,370,368	22,419,496	20,817,263	12,545,081
By water	2,811,584	3,926,319	2,883,965	3,204,129	1,742,339
Total to west of Pittsburg	18,828,911	22,296,687	25,303,461	24,021,392	14,287,420
Total shipments	28,086,438	33,318,240	37,251,690	36,408,049	24,218,176

CLEVELAND, OHIO.

The total receipts of coal and coke at Cleveland, as reported by Mr. Munson A. Havens, secretary of the chamber of commerce, amounted in 1908 to 6,922,240 short tons. This was nearly equal to the record for 1907 and was larger than for any year previous to 1907. As compared with the preceding year, the receipts in 1908 showed a decrease of 75,884 short tons, or only a little more than 1 per cent. The decreases were altogether in the receipts of bituminous coal and coke, the former showing a falling off of 279,416 short tons, and the latter of 159,108 short tons. The receipts of anthracite showed an exceptional increase—362,640 short tons, from 153,077 tons in 1907 to 515,717 tons in 1908.

The following tables show the quantities of anthracite and of bituminous coal and coke received at and shipped from Cleveland during the last five years:

Coal and coke receipts and shipments at Cleveland, Ohio, 1904–1908, in short tons.

RECEIPTS.

Kind.	1904.	1905.	1906.	1907.	1908.
Bituminous	5,347,476	4,846,162	6,021,958	5,995,197	5,715,781
Anthracite	199,907	295,423	145,822	153,077	515,717
Coke	594,101	583,053	659,307	849,850	690,742
	6,141,484	5,724,638	6,827,087	6,998,124	6,922,240

SHIPMENTS.

Kind.	1904.	1905.	1906.	1907.	1908.
Anthracite by rail	27	74	10,138	7,553	41,428
Bituminous by rail	61,047	50,575	45,687	112,500	82,542
Bituminous by lake	3,052,819	2,567,916	2,926,279	3,264,875	3,350,830
Coke by rail	21,655	45,527	117,718	56,738	75,559
	3,135,548	2,664,092	3,099,822	3,441,666	3,550,359

Total coal receipts and shipments, with local consumption, at Cleveland, Ohio, 1904–1908, in short tons.

Year.	Receipts.	Shipments.	Local consumption.
1904	6,141,484	3,135,548	3,005,936
1905	5,724,638	2,664,092	3,060,546
1906	6,827,087	3,099,822	3,727,265
1907	6,998,124	3,441,666	3,556,458
1908	6,922,240	3,550,359	3,371,881

CINCINNATI, OHIO.

Mr. Charles B. Murray, superintendent of the Chamber of Commerce, has furnished the following extract from his report in advance of its publication:

The supply of coal in the Cincinnati market was reduced in 1908 in comparison with the preceding year, which was also below the high record of 1906. There was no stringency during the year, the trade being dull much of the time, due at least partly to the slackened operations of industrial plants.

The aggregate receipts of coal at Cincinnati in 1908 were 120,637,000 bushels, compared with 149,980,000 bushels for 1907, and an annual average of 143,000,000 for five years prior to 1908. The year's aggregate shipments were 64,234,000 bushels against 71,414,000 for 1907, and an annual average of 63,706,000 bushels for five years prior to 1908.

There was a considerable period of low stages of water in Ohio and Kanawha rivers in 1908, serving to curtail the movement of coal by river. The arrivals by railroads were about the same as for the preceding year.

The receipts of coal in 1908 by river were 35,765,000 bushels, compared with 64,647,000 for 1907, and an annual average of 58,714,000 bushels for five years prior to 1908. Of these receipts for the past year about 38 per cent represented product from the Pittsburg district and 61 per cent from the Kanawha district.

Receipts of coal by railroad in 1908 were 84,872,000 bushels, compared with 85,333,000 bushels for 1907, and an annual average of 84,344,000 bushels for five years. It is estimated that about 55 per cent of the arrivals by railroad represented product from the Kanawha district and 45 per cent from other sources, mainly in Ohio. Shipments of coal by river are usually not large, showing 3,380,000 bushels for 1908, compared with 5,006,000 bushels for 1907, and an annual average of 4,701,000 bushels for five years.

Shipments of coal by railroad as reported include a quantity that can not be stated representing through movement, while appearing on the waybills of local offices. The total for 1908 was 60,854,000 bushels, against 66,408,000 bushels for 1907, and an annual average of 59,005,000 bushels for five years.

For coal afloat from the Pittsburg district the price was practically at the uniform figure of 8½ cents per bushel for the year—which applies also to coal from the Kanawha district for most of the year, there being some exceptions on a fractionally lower basis. Run of mine coal was quoted at 7¾ cents and nut and slack at 6½ cents until August, followed by 6 cents to the close of the year.

The price of lump coal delivered to local consumers, for both Pittsburg and Kanawha, for the first three months of the year was $3.75 per short ton until near the close of the period, and subsequently $3.25 per short ton until October, when an advance to $3.50 was established. The general average for the year was $3.40 per short ton, or about 12.25 cents per bushel, compared with 12.45 cents for 1907, and an annual average of 12.20 cents for five years. For nut and slack coal the range was mainly $2 to $2.25 per ton for deliveries to consumers.

Anthracite coal is but moderately consumed in this market, the total receipts in 1908 being 855,000 bushels, compared with 654,000 bushels for 1907, and an annual average of 650,000 bushels for five years prior to 1908. The price for lots delivered to consumers was $7 to $7.50 per short ton, the lower rate for about four months of the period.

The local consumption of coal, as near as can be estimated upon statements of dealers, has been pretty evenly divided between industrial and household requirements, with a tendency of enlargement of the industrial proportion in late years, so that probably 55 per cent is not too high to estimate such consumption at this time.

For the year 1908 the local gas works consumed coal to the extent of 199,142 short tons, or 5,500,000 bushels. There were sent out from the works during the year 1,904,112,000 cubic feet of manufactured gas, and the product of electric current represented 43,700,000 kilowatts. Compared with the preceding year there was a decrease of about 22 per cent in coal consumed, about the same percentage decrease in quantity of manufactured gas sent out, and 6¾ per cent increase in product of electric current. There was additionally sent out 1,116,342,000 feet of natural gas, against 164,568,000 feet the preceding year.

The yearly range and average prices of Pittsburg coal, afloat and delivered, per bushel, based on weekly records, compare for a series of years as shown in the following compilation:

Prices of Pittsburg coal at Cincinnati, 1897–1908, in cents per bushel.

Year.	Afloat.			Delivered.		
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.
1897	5½	5¾	5.70	5¾	10¾	8.40
1898	5	6	5.66	7¼	9	8.10
1899	4½	7½	5.30	8⅛	11¾	8.05
1900	7½	8	7.50	10¾	11¾	9.50
1901	6½	8	7.50	9	10¾	10.90
1902	6½	10	7.92	10	14½	10.55
1903	9	10	9.25	12⅝	14½	11.75
1904	8	9	8.50	10¾	13½	13.18
1905	8	8	8.00	11¾	12⅝	11.50
1906	7½	8½	7.80	11¾	12⅝	12.20
1907	8	9	8.20	11¾	14⅜	12.45
1908	8½	8½	8.50	11¾	13½	12.25

Coal from the Kanawha, Virginia, and West Virginia regions sells at the same, or about the same, prices as are obtained for the product from the Pittsburg district. Sales afloat are on the bushel basis, 72 pounds; sales delivered are on the ton basis, 2,000 pounds, and represent screened or lump grade.

The receipts of coke for the year were 2,428,000 bushels, and the quantity locally manufactured was 7,260,000 bushels, making a total of 9,688,000 bushels, compared with 13,810,000 bushels the preceding year. For city manufacture the average price for the year was 11½ cents per bushel; of gas house, 10 cents; of Connellsville, $5.40 per ton.

Summary of coal movements at Cincinnati, Ohio, in 1907 and 1908, in bushels.

Details.	1907.	1908.	Details.	1907.	1908.
Total received	149,980,000	120,637,000	Anthracite	654,000	855,000
Pittsburg	30,726,000	13,397,000	Total:		
Ohio River	426,000	679,000	By river	64,647,000	35,765,000
Kanawha:			By rail	85,333,000	84,872,000
By river	33,495,000	21,689,000	Shipped:		
By rail	46,573,000	46,209,000	By river	5,006,000	3,380,000
Total Kanawha	80,068,000	67,898,000	By rail	66,408,000	60,854,000
Other kinds by rail	38,106,000	37,808,000	Total shipped	71,414,000	64,234,000

ST. LOUIS, MO.

Mr. O. L. Whitelaw, acting president of the Business Men's League of St. Louis, has furnished a statement of the coal and coke receipts at that city, and of the prices prevailing during 1908.

Decreases were shown in the receipts of all three kinds of fuel, anthracite, bituminous coal, and coke, the greatest decrease being in coke, which fell off nearly 60 per cent, from 20,660,000 bushels in 1907 to 8,925,400 bushels in 1908. Bituminous receipts decreased from 211,936,900 bushels to 184,127,275 bushels, and anthracite from 265,571 short tons to 236,036 short tons.

Prices generally were considerably lower in 1908 than in 1907. Anthracite prices, because of the close control exercised over the trade by the producing interests, and because it is, in this community, a fancy fuel, were fairly well maintained, but for bituminous coal and coke prices in 1908 ruled about 10 per cent lower than in 1907.

The receipts of coal and coke at St. Louis for the last five years, and the high, low, and closing prices in 1907 and 1908, are shown in the following tables:

Coal and coke receipts at St. Louis, Mo., 1904-1908.

Year.	Soft coal.	Hard coal.	Coke.	Year.	Soft coal.	Hard coal.	Coke.
	Bushels.	*Tons.*	*Bushels.*		*Bushels.*	*Tons.*	*Bushels.*
1904	170,970,875	155,097	8,558,100	1907	211,936,900	265,571	20,660,000
1905	171,727,675	158,843	12,350,278	1908	184,127,275	236,036	8,925,400
1906	190,540,325	174,226	18,244,444				

Coal prices at St. Louis, Mo., during 1907 and 1908, per short ton.

Kind.	1907.			1908.		
	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.
Standard Illinois lump coal	$2.07	$1.47	$1.65	$1.80	$1.47	$1.52
High-grade Illinois lump coal	3.12	2.12	2.62	2.62	2.02	2.32
Anthracite, large	6.85	6.35	6.85	6.70	6.20	6.70
Anthracite, small	7.10	6.60	7.10	6.95	6.45	6.95
Connellsville coke	6.75	5.25	6.75	5.25	5.00	5.25
New River coke				5.40	5.25	5.40
Kentucky coke	4.15	3.75	4.15	3.60	3.50	3.60
Gas coke	5.25	3.85	5.25	4.75	4.00	4.25

MILWAUKEE, WIS.

Mr. H. A. Plumb, who succeeded W. J. Langson, deceased, as secretary of the chamber of commerce, has furnished the following statement regarding the coal trade of Milwaukee.

The total receipts by rail and lake were somewhat less in 1908 than in 1907, the exact decrease being 307,581 short tons. The receipts by lake were the more seriously affected, these showing a falling off of 378,345 tons, which was partly offset by an increase of 70,764 tons in the receipts by rail. In the receipts by lake anthracite showed an increase of 205,477 short tons, while bituminous coal decreased 583,822 tons. With the single exception of 1907, the receipts of coal at this port in 1908 were larger than in any other preceding year.

There are 30 docks located at Milwaukee, 13 of which are operated by coal companies, and 17 by private industries, and these, with the excellent harbor facilities, make Milwaukee an important coal-distributing point. Of the large quantity that came to Milwaukee in 1908 approximately only 800,000 or 900,000 tons went into local consumption, the balance being distributed to dealers in the Northwest. It was estimated by one of the leading dealers that stocks amounted to about 2,350,000 tons at the end of the year.

The receipts at and shipments from Milwaukee during the last five years, and the total receipts for a series of years since 1865, are shown in the following tables:

Receipts of coal at Milwaukee, Wis., 1904–1908, in short tons.

Source.	1904.	1905.	1906.	1907.	1908.
By lake from—					
Buffalo	809,471	800,814	748,644	813,904	1,005,594
Erie	91,310	60,641	66,964	140,313	17,359
Oswego	22,000	4,369	8,002	28,428	58,285
Cleveland	341,658	247,878	560,475	740,785	520,244
Ashtabula	187,772	245,455	263,527	318,046	167,851
Lorain	194,361	159,788	157,515	204,873	337,465
Sandusky	254,014	359,427	362,408	457,582	451,807
Toledo	689,641	770,962	851,521	1,064,666	891,626
Fairport	22,800	23,051	25,627	50,041	77,001
Ogdensburg	3,972	....	....	....	....
Huron, Ohio	38,012	87,008	160,274	134,508	22,425
Other ports	41,323	75,739	149,115	88,366	111,510
Total, lake	2,696,334	2,835,132	3,354,072	4,039,512	3,661,167
By railroad	248,105	[a] 322,332	[b] 461,203	[c] 309,995	[d] 380,759
Receipts	2,944,439	3,157,464	3,815,275	4,349,507	4,041,926

[a] Including 241,606 tons by car-ferry lines.
[b] Including 319,935 tons by car ferry.
[c] Including 132,516 tons by car ferry.
[d] Including 168,205 tons by car ferry.

Shipments of coal from Milwaukee, Wis., 1904–1908, in short tons.

Shipped by—	1904.	1905.	1906.	1907.	1908.
Chicago, Milwaukee and St. Paul Ry	569,330	668,509	631,205	698,040	632,184
Chicago and Northwestern Ry	361,824	512,536	459,333	509,271	471,101
Wisconsin Central R. R	55,368	87,105	93,766	103,551	99,411
Lake	6,040	9,460	4,138	....	....
	992,562	1,277,610	1,188,442	1,310,862	1,202,696

Total receipts of coal by lake from lower lake ports at Milwaukee, Wis., 1904–1908, by kinds, in short tons.

Kind.	1904.	1905.	1906.	1907.	1908.
Anthracite	876,169	802,083	756,646	858,402	1,063,879
Bituminous	1,820,165	2,033,049	2,597,426	3,181,110	2,597,288
	2,696,334	2,835,132	3,354,072	4,039,512	3,661,167

Receipts of coal at Milwaukee, Wis., by lake and rail in 1865, 1870, 1880, 1890, and annually from 1900 to 1908, in short tons.

1865	36,369	1903	3,023,977
1870	122,865	1904	2,944,439
1880	368,568	1905	3,157,464
1890	999,657	1906	3,815,275
1900	1,808,593	1907	4,349,507
1901	1,953,489	1908	4,041,926
1902	1,641,095		

The prices of coal at Milwaukee f. o. b. cars in 1908, by months, as reported by the Pennsylvania Coal and Supply Company, were as follows:

Price of coal at Milwaukee during 1908, per short ton.

Month.	Pittston—anthracite.	Egg—Pocahontas.	Cannel—Kentucky.	Steam coal—screened. Hocking.	Steam coal—screened. Pittsburg.	Mine run—Pocahontas.
January	$6.50	$5.00	$6.50	$3.50	$3.50	$3.50
February	6.50	5.00	6.50	3.50	3.50	3.50
March	6.50	5.00	6.50	3.50	3.50	3.50
April	6.00	5.00	6.50	3.50	3.50	3.50
May	6.10	5.00	6.50	3.50	3.50	3.50
June	6.20	5.00	6.50	3.50	3.50	3.50
July	6.30	5.00	6.50	3.50	3.50	3.50
August	6.40	5.00	6.50	3.50	3.50	3.50
September	6.50	5.00	6.50	3.50	3.50	3.50
October	6.50	5.00	6.50	3.50	3.50	3.50
November	6.50	5.00	6.50	3.50	3.50	3.50
December	6.50	5.00	6.50	3.50	3.50	3.50

Lake freights on coal from Buffalo to principal upper lake ports during the season of 1908, as compared with those of 1907, were as follows:

Freight rates per ton on coal from Buffalo to principal upper lake ports, 1907 and 1908.

Month.	To Milwaukee.		To Chicago. North Branch.		To Chicago. South Branch.		To Duluth.	
	1908.	1907.	1908.	1907.	1908.	1907.	1908.	1907.
March	$0.40	$0.40	$0.40	$0.40	$0.50	$0.50	$0.30	$0.30
April	.40	.40	.40	.40	.50	.50	.30	.30
May	.40	.40	.40	.40	.50	.50	.30	.30
June	.40	.40	.40	.40	.50	.50	.30	.30
July	.40	.40	.40	.40	.50	.50	.30	.30
August	.40	.40	.40	.40	.50	.50	.30	.30
September	.40	.40	.40	.40	.50	.50	.30	.30
October	.40	.40	.40	.40	.50	.50	.30	.30
November	.40	.40	.40	.40	.50	.50	.30	.30
December	.50	.60	.50	.60	.55	.70	.50	.50

PRODUCTION OF COAL BY STATES AND TERRITORIES.

There were two States in which a small amount of coal was produced in 1907 which did not report any output in 1908, and Massachusetts has been for the first time added to the list of coal-producing States. This made a net decrease of 1, or from 31 to 30, in the coal-producing States and Territories in 1908 as compared with 1907. North Carolina, whose production had decreased steadily since 1902, has shown no production during the last three years. Of the 30 States and Territories which produced coal in 1908, 13 are east of Mississippi River and 17 west of it. In 1907 there were 12 States east of Mississippi River, and these produced 425,739,953 short tons, or 88.6 per cent of the total. In 1908 the 13 States east of Mississippi River produced 367,377,636 short tons, or 88.3 per cent of the total. The 19 States west of Mississippi River produced 54,623,471 short tons, or 11.4 per cent in 1907, and in 1908 the 17 States produced

48,465,012, or 11.7 per cent of the total. Excluding Massachusetts with its small production of 50 tons in 1908, there were out of the 12 States east of Mississippi River 6 situated north of the dividing line formed by Ohio and Potomac rivers and 6 south of that boundary which produced coal in that year. The 6 Northern States produced in 1908 292,905,612 short tons, or 70.4 per cent of the total output, while the Southern States produced 74,472,024 short tons, or 17.9 per cent of the total. Although the States north of Potomac and Ohio rivers have excelled by several fold the production of the Southern States, the ratio of increase has been decidedly in the favor of the latter. In 1880 the Northern States produced 63,044,558 short tons and the Southern States 3,793,308 tons, the former being about 17 times the latter. In 1890 the Northern States produced 122,296,267 short tons, which was about seven times the 17,378,754 short tons produced in the Southern States. In 1900 the Southern States produced 42,607,053 short tons and the Northern States 193,324,621, less than five times that of the Southern States. In 1906, 1907, and 1908 the output from the Northern States has been about four times that of the southern competitors. The States west of Mississippi River increased from 4,705,271 short tons in 1880 to 54,623,471 short tons in 1907, and decreased to 48,465,012 tons in 1908.

In the following table is given the production of the various States, grouped according to the geographic divisions made by Mississippi, Ohio, and Potomac rivers, for the years 1880, 1890, 1900, 1906, 1907, and 1908, in order that the development of the different sections may be observed:

Coal production in States north of Ohio and Potomac rivers in 1880, 1890, 1900, 1907 and 1908, in short tons.

State.	1880.		1890.		1900.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Illinois	6,115,377	$8,779,832	15,292,420	$14,171,230	25,767,981	$26,927,185
Indiana	1,454,327	2,150,258	3,305,737	3,259,233	6,484,086	6,687,137
Maryland	2,228,917	2,585,537	3,357,813	2,899,572	4,024,688	3,927,381
Michigan	100,800	224,500	74,977	149,195	849,475	1,259,683
Ohio	6,008,595	7,719,667	11,494,506	10,783,171	18,988,150	19,292,246
Pennsylvania:						
Anthracite	28,711,379	42,282,948	46,468,641	66,383,772	57,367,915	85,757,851
Bituminous	18,425,163	18,567,129	42,302,173	35,376,916	79,842,326	77,438,545
	63,044,558	82,309,871	122,296,267	133,023,089	193,324,621	221,290,028

State.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Illinois	51,317,146	$54,687,382	47,659,690	$49,978,247
Indiana	13,985,713	15,114,300	12,314,890	13,084,297
Maryland	5,532,628	6,623,697	4,377,093	5,116,753
Michigan	2,035,858	3,660,833	1,835,019	3,322,904
Ohio	32,142,419	35,324,746	26,270,639	27,897,704
Pennsylvania:				
Anthracite	85,604,312	163,584,056	83,268,754	158,178,849
Bituminous	150,143,177	155,664,026	117,179,527	118,816,303
	340,761,253	434,659,040	[a] 292,905,612	376,395,057

[a] Exclusive of Massachusetts.

Coal production in States south of Ohio and Potomac rivers in 1880, 1890, 1900, 1907, and 1908, in short tons.

State.	1880.		1890.		1900.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	323,972	$476,911	4,090,409	$4,202,469	8,394,275	$9,793,785
Georgia	154,644	231,605	228,337	238,315	315,557	370,022
Kentucky	946,288	1,134,960	2,701,496	2,472,119	5,328,964	4,881,577
North Carolina	350	400	10,262	17,864	17,734	23,447
Tennessee	495,131	629,724	2,169,585	2,395,746	3,509,562	4,003,082
Virginia	43,079	99,802	784,011	589,925	2,393,754	2,123,222
West Virginia	1,829,844	2,013,671	7,394,654	6,208,128	22,647,207	18,416,871
	3,793,308	4,587,073	17,378,754	16,124,566	42,607,053	39,612,006

State.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Alabama	14,250,454	$18,405,468	11,604,593	$14,647,891
Georgia	362,401	499,686	264,822	364,279
Kentucky	10,753,124	11,405,038	10,246,553	10,317,162
North Carolina				
Tennessee	6,810,243	8,490,334	6,199,171	7,118,499
Virginia	4,710,895	4,807,533	4,259,042	3,868,524
West Virginia	48,091,583	47,846,630	41,897,843	40,009,054
	84,978,700	91,454,689	74,472,024	76,325,409

Coal production in States and Territories west of Mississippi River in 1880, 1890, 1900, 1907, and 1908, in short tons.

State or Territory.	1880.		1890.		1900.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arkansas	14,778	$33,535	399,888	$514,595	1,447,945	$1,653,618
California	236,950	663,013	110,711	283,019	172,908	540,031
Colorado	462,747	1,041,350	3,094,003	4,344,196	5,244,364	5,858,036
Idaho					10	50
Indian Territory	120,947	274,550	869,229	1,579,188	1,922,298	2,788,124
Iowa	1,461,116	2,507,453	4,021,739	4,995,739	5,202,939	7,155,341
Kansas	771,442	1,517,444	2,259,922	2,947,517	4,467,870	5,454,691
Missouri	844,304	1,464,425	2,735,221	3,382,858	3,540,103	4,280,328
Montana	224	800	517,477	1,252,492	1,661,775	2,713,707
Nebraska	200	750	1,500	4,500		
New Mexico			375,777	504,390	1,299,299	1,776,170
North Dakota			30,000	42,000	129,883	158,348
Oregon	43,205	97,810	61,514	177,875	58,864	220,001
Texas			184,440	465,900	968,373	1,581,914
Utah	14,748	33,645	318,159	552,390	1,147,027	1,447,750
Washington	145,015	389,046	1,263,689	3,426,590	2,474,093	4,700,068
Wyoming	589,595	1,080,451	1,870,366	3,183,669	4,014,602	5,457,953
	4,705,271	9,104,272	18,113,635	27,656,918	33,752,353	45,786,130

Coal production in States and Territories west of Mississippi River in 1880, 1890, 1900, 1907, and 1908, in short tons—Continued.

State or Territory.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Arkansas	2,670,438	$4,473,693	2,078,357	$3,499,470
California	[a] 24,089	91,813	[a] 21,862	69,650
Colorado	10,790,236	15,079,449	9,634,973	13,586,988
Idaho	[b] 7,588	31,119	5,429	21,832
Iowa	7,574,322	12,258,012	7,161,310	11,706,402
Kansas	7,322,449	11,159,698	6,245,508	9,292,222
Missouri	3,997,936	6,540,709	3,317,315	5,444,907
Montana	2,016,857	3,907,082	1,920,190	3,771,248
Nebraska	(c)	(c)		
New Mexico	2,628,959	3,832,128	2,467,937	3,368,753
North Dakota	347,760	560,199	320,742	522,116
Oklahoma (Indian Territory)	3,642,658	7,433,914	2,948,116	5,976,504
Oregon	70,981	166,304	86,259	236,021
Texas	1,648,069	2,778,811	1,895,377	3,419,481
Utah	1,947,607	2,959,769	1,846,792	3,119,338
Washington	3,680,532	7,679,801	3,024,943	6,690,412
Wyoming	6,252,990	9,732,668	5,489,902	8,868,157
	54,623,471	88,685,169	48,465,012	79,593,501

[a] Includes Alaska. [b] Includes Nebraska and Nevada. [c] Included in Idaho.

The production of coal in the several States and Territories in 1908 and preceding years is discussed more in detail in the following pages:

ALABAMA.

Total production in 1908, 11,604,593 short tons; spot value, $14,647,891.

The effect of the business depression prevailed throughout practically the whole of 1908 and was exhibited in the coal production of Alabama by a decrease of 2,645,861 short tons, as compared with the output of 1907, while the value of the product showed a decline of $3,757,577. The quantity of the production decreased from 14,250,454 short tons in 1907 to 11,604,593 tons in 1908, with a decrease in value from $18,405,468 to $14,647,891. The percentage of decrease in quantity was 18.57 and in value, 20.42. Nearly one-half of the decrease in production was in the quantity of coal made into coke, this factor having decreased from 4,973,296 short tons in 1907 to 3,875,791 short tons in 1908. It should be stated that only from one-half to two-thirds of the coal coked in Alabama is made into coke at the mines. In 1908 the quantity of coal made into coke at the mines was 2,604,320 short tons, while the total quantity of coal coked was 3,875,791 short tons. The difference is the quantity of coal shipped from the mines to distant ovens, and this coal is included among the shipments.

Alabama is peculiarly favored in its ability to manufacture cheap iron, although the ores are not of as high a grade as those from Lake Superior, which feed the furnaces of the more northern States. Because of these conditions Alabama's proportion of iron production is usually larger in years of depression than in flush times. This is illustrated by the statistics of pig-iron production in 1908, which show that Alabama's output was 17 per cent less than in 1907, while in Illinois the percentage of decrease was 31 per cent; in Virginia it was 33 per cent; in Pennsylvania, 38 per cent; in Ohio, 45 per cent;

Maryland and West Virginia, 65 per cent; and the average decrease in pig-iron production for the entire United States in 1908 was 38.2, as compared with 1907. Had the production of pig iron in Alabama shown the same decreases as in other States the falling off in coal and coke production would have been materially larger.

Considering the depressed condition of the iron trade and the general falling off in business during 1908, the prices of coal in Alabama were fairly well maintained, the average price per ton showing a decrease of only 3 cents, from $1.29 in 1907 to $1.26 in 1908.

The total number of men employed in the coal mines of Alabama in 1908 was 19,197, and the average number of working days reported was 222, against 21,388 men for an average of 242 days in 1907, and 20,555 men for 237 days in 1906. There was a slight falling off in the efficiency records of the mine workers, the statistics of 1908 showing the average production per man each day to have been 2.72 tons, as against 2.75 tons in 1907, and 2.69 tons in 1906. The average production of each man during the entire year, in 1908, was 605 short tons, against 666 tons in 1907 and 637.7 tons in 1906.

The number of mining machines reported as in operation in 1908 was the same as in 1907—197 machines having been used in both years. The quantity of coal undercut by the use of machines increased slightly, from 1,762,948 short tons in 1907 to 1,783,516 tons in 1908. The percentage of machine-mined coal to the total production increased from 12.37 in 1907 to 15.37 in 1908. Of the 197 machines in use, 142 were of the pick or puncher type, 51 were chain, and 4 were long-wall machines.

Since the general strike among the coal mines of Alabama in 1904, many of the larger mines, particularly those operated by companies engaged in the iron industry, have been operated on the open-shop basis. In an attempt to strengthen the mine workers' organization in Alabama the president of the United Mine Workers of America on June 30, 1908, called a strike of all the union mine workers in the State, to take effect July 6, following. The calling of this strike does not seem to have been well considered, nor was it in any way successful, from the miners' standpoint. It was attended with some bloodshed, and lacked what is largely essential in the successful conduct of a strike—the sympathy of the general public. The action of the State authorities in prohibiting the idle men from living in tents and of holding meetings in the mining regions was given as one of the reasons for the unsuccessful termination of the strike. On August 31 it was officially called off. The returns to the Geological Survey show that there were 83 mines where the men quit work. The total number of men on strike during the year was 8,397. The average number of days each was idle was 44, and the total number of days' work lost was 373,513, equal to about 9 per cent of the total time made during the year.

Most of the coal mines of Alabama are operated on the basis of a ten-hour day, 100 mines employing a total of 11,969 men having reported ten hours as the length of the working day in 1908. In 1907 there were 84 mines, employing 13,942 men, that worked ten hours. In 1908 there were 34 mines, employing 2,358 men, that reported nine hours as the length of the working day, and 16 mines, employing 1.205 men, worked eight hours.

In 1908, out of the total quantity of coal produced in Alabama, 2,902,815 short tons were washed at the mines. The washing operations resulted in the production of 2,614,954 short tons of cleaned coal, and 287,861 tons of refuse. There are also some washeries which are operated in connection with coking plants at distant points from the mines. The coal washed at these plants is not included in this statement.

The following information regarding the number and character of the coal-mine accidents in Alabama is taken from the annual report of Mr. Edward Flynn, the chief mine inspector, Mr. Flynn having succeeded Mr. J. M. Gray during 1908:

According to Mr. Flynn's report there were 108 fatal and 58 nonfatal accidents in the coal mines of Alabama during 1908. Mr. Flynn states that the fewer number of nonfatal accidents reported is due to the fact that there are a number of mining companies which do not report the nonfatal accidents. The casualty record of 1908 was favorable when compared with that of 1907, when 154 men were killed and 85 injured in the coal mines of Alabama. In 1907 one disaster alone, an explosion in the mines of the Yolande Coal and Coke Company, at Yolande, resulted in the death of 56 men. In 1908 gas explosions are charged with but 9 deaths and 12 injuries. The largest number of deaths were due to falls of rock, 36 men having died from accidents of that character. Falls of coal killed 3 men, and tramway accidents killed 16. Ten men were electrocuted, 10 were killed by blown-out shots, 8 were suffocated by smoke, and 2 were killed by powder explosions. There were 14 deaths the causes of which were not given. Of the 108 men killed, 55 left widows and a total of 97 orphans.

The total death rate per thousand men employed in 1908 was 5.6, as against 7.2 in 1907, and 4.67 in 1906. The number of tons mined for each life lost was 107,450, against 92,535 in 1907 and 136,541 in 1906.

The statistics of coal production in Alabama in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Alabama in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bibb	1,201,181	4,737	88,079	3,161	1,297,158	$1,958,861	$1.52	247	1,885
Etowah	194,340	5,100	5,575		205,015	306,151	1.49	243	312
Jefferson	5,415,913	138,866	278,038	1,693,458	7,526,275	9,517,837	1.26	249	11,001
St. Clair	267,171	1,701	14,934		283,806	402,276	1.42	231	502
Shelby	225,329	1,100	18,658		245,087	346,424	1.41	244	600
Tuscaloosa	550,429	4,394	40,314	452,227	1,047,364	1,435,161	1.37	254	1,267
Walker	2,920,081	50,255	66,767	217,816	3,254,919	3,873,414	1.19	224	4,945
Winston	35,058	230	45		35,333	61,163	1.73	178	109
Other counties [a]	334,950	9,682	10,383		355,015	503,487	1.42	236	767
Small mines		482			482	694			
	11,144,452	216,547	522,793	2,366,662	14,250,454	18,405,468	1.29	242	21,388

[a] Blount, Cullman, Dekalb, Jackson, and Marion.

Coal production of Alabama in 1907 and 1908, by counties, in short tons—Continued.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bibb	1,080,432	12,409	73,707	....	1,166,548	$1,778,008	$1.52	224	2,187
Etowah	7,880	1,000	....	....	8,880	11,090	1.25	211	30
Jefferson	3,664,375	54,607	204,799	1,990,348	5,914,129	7,089,173	1.20	239	8,780
St. Clair	179,920	1,261	12,253	....	193,434	288,737	1.49	156	450
Shelby	382,280	1,938	23,329	....	407,547	737,714	1.81	201	827
Tuscaloosa	301,080	8,282	25,126	377,613	712,101	966,804	1.36	220	1,288
Walker	2,599,158	53,665	52,654	236,359	2,941,836	3,386,159	1.15	205	4,970
Winston	28,388	20	....	....	28,408	49,769	1.75	222	85
Other counties [a]	222,051	2,536	6,473	....	231,060	339,387	1.47	204	580
Small mines	....	650	....	....	650	1,050	1.62	....	....
	8,465,564	136,368	398,341	2,604,320	11,604,593	14,647,891	1.26	222	19,197

[a] Blount, Cullman, Dekalb, Jackson, and Marion.

In the following table is presented a statement of the production of coal in Alabama, by counties, during the last five years, with the increases in 1908 as compared with 1907:

Coal production of Alabama, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Bibb	1,386,079	1,335,923	1,324,656	1,297,158	1,166,548	− 130,610
Blount Cullman	[a] 279,070	[a] 294,550	337,848	336,308	181,062	− 155,246
Etowah	128,989	170,484	133,660	205,015	8,880	− 196,135
Jefferson	5,821,663	5,873,268	6,623,115	7,526,275	5,914,129	− 1,612,146
St. Clair	144,223	186,595	256,227	283,806	193,434	− 90,372
Shelby	128,307	157,569	225,087	245,087	407,547	+ 162,460
Tuscaloosa	663,412	885,361	1,050,792	1,047,364	712,101	− 335,263
Walker	2,583,473	2,845,617	3,062,518	3,254,919	2,941,836	− 313,083
Winston	40,356	40,109	27,076	35,333	28,408	− 6,925
Other counties and small mines	[b] 86,474	76,593	[b] 66,984	19,189	50,648	+ 31,459
Total	11,262,046	11,866,069	13,107,963	14,250,454	11,604,593	− 2,645,861
Total value	$13,480,111	$14,387,721	$17,514,786	$18,405,468	$14,647,891	−$3,757,577

[a] Includes production of Marion County. [b] Includes Dekalb and Jackson counties.

So far as known the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given as 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the civil war, but there are no records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham, and thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted for two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of over 10,000,000 tons, and reached the maximum of 14,250,454 tons in 1907.

The statistics of coal production in Alabama from 1840 to the close of 1908 are found in the following table:

Production of coal in Alabama from 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	946	1858	8,500	1876	112,000	1894	4,397,178
1841	1,000	1859	9,000	1877	196,000	1895	5,693,775
1842	1,000	1860	10,200	1878	224,000	1896	5,748,697
1843	1,200	1861	10,000	1879	280,000	1897	5,893,770
1844	1,200	1862	12,500	1880	323,972	1898	6,535,283
1845	1,500	1863	15,000	1881	420,000	1899	7,593,416
1846	1,500	1864	15,000	1882	896,000	1900	8,394,275
1847	2,000	1865	12,000	1883	1,568,000	1901	9,099,052
1848	2,000	1866	12,000	1884	2,240,000	1902	10,354,570
1849	2,500	1867	10,000	1885	2,492,000	1903	11,654,324
1850	2,500	1868	10,000	1886	1,800,000	1904	11,262,046
1851	3,000	1869	10,000	1887	1,950,000	1905	11,866,069
1852	3,000	1870	11,000	1888	2,900,000	1906	13,107,963
1853	4,000	1871	15,000	1889	3,572,983	1907	14,250,454
1854	4,500	1872	16,800	1890	4,090,409	1908	11,604,593
1855	6,000	1873	44,800	1891	4,759,781		
1856	6,800	1874	50,400	1892	5,529,312		176,338,903
1857	8,000	1875	67,200	1893	5,136,935		

According to the estimates prepared by M. R. Campbell, of the United States Geological Survey, the original coal supply of Alabama when mining began was 68,903,000,000 short tons, of which 63,513,000,000 tons were in the Warrior and Plateau fields, 2,994,000,000 tons were in the Cahaba field, and 2,396,000,000 tons in the Coosa field. From this total supply of approximately 69,000,000,000 tons there had been mined, at the close of 1908, 176,338,903 tons, representing an exhaustion, including waste in mining, of 264,000,000 tons, or nearly 0.4 of 1 per cent of the total estimated supply.

The production of coal in Alabama in 1908 was more than 6 per cent of the total production up to the close of the year, and a little less than 0.02 per cent of the estimated original supply.

ALASKA.

By Alfred H. Brooks.

The coal production for 1908 was 3,107 tons, with a value of $14,810, as compared with an output of 10,139 tons in 1907, valued at $53,600. While four mines were operated in 1907 only three were productive in 1908. Of these, one was at Port Graham, Kenai Peninsula (lignite), one at Chignik, Alaska Peninsula (bituminous), and one at Chicago Creek, Seward Peninsula (lignite). In addition to these there were a few tons of coal mined for domestic use at Tyonok, at several points on the Yukon, at Cape Lisburne, and at Wainright Inlet in northern Alaska where the Eskimos are utilizing a lignitic coal for fuel in lieu of the fast disappearing driftwood.

Production of coal in Alaska, 1888–1908.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1888–1896 [a]	6,000	$84,000	1904	1,694	$7,225
1897	2,000	28,000	1905	3,774	13,250
1898	1,000	14,000	1906	5,541	17,974
1899	1,200	16,800	1907	10,139	53,600
1900	1,200	16,800	1908	3,107	14,810
1901	1,300	15,600			
1902	2,212	19,048	Total	40,614	310,889
1903	1,447	9,782			

[a] The production for 1888–1896 is estimated on the best data obtainable. That for the later years subsequent to 1896 is based for the most part on data supplied by operators.

Though the developments are insignificant, Alaska's coal resources are large, and, because of the higher quality of the coal, very important. The quantitative data bearing on the coal reserves have been recently summarized by G. C. Martin in a report to the National Conservation Commission from which the following table is extracted:

Estimate of tonnage and areas, Alaska coal fields.

	Tonnage.	Areas believed to be underlain by coal.	Supposed areas of coal fields.
	Short tons.	*Sq. miles.*	*Sq. miles.*
Anthracite, Pacific coast	1,611,700,000	25.8	
Semianthracite, Pacific coast	517,100,000	7.2	
Semibituminous:			
Pacific coast	1,425,800,000	35.8	
Arctic slope	66,800,000	14.2	
Total semibituminous	1,492,600,000	50.0	
Total high-grade	3,621,400,000	83.0	620
Bituminous:			
Pacific coast	2,600,000	2.0	900
Interior region	15,900,000	162.0	2,475
Total bituminous	18,500,000	164.0	3,375
Subbituminous:			
Pacific coast	535,500,000	49.7	657
Interior region	59,200,000	6.0	15
Arctic slope	3,465,600,000	205.0	1,323
Total subbituminous	4,060,300,000	260.7	1,995
Lignite:			
Pacific coast	2,173,100,000	337.0	2,938
Interior region	4,228,000,000	264.5	2,003
Arctic slope	1,003,200,000	93.0	1,736
Total lignite	7,404,300,000	694.5	6,677
Summary by provinces:			
Pacific coast	6,265,800,000	457.5	5,115
Interior region	4,303,100,000	432.5	4,493
Arctic slope	4,535,600,000	312.2	3,059
Grand total	15,104,500,000	1,202.2	12,667

Even where a coal field has been both developed and surveyed in detail there is a large amount of uncertainty in all tonnage estimates. Moreover, the Bering and Matanuska fields, which contain the most valuable coals, are regions of great structural complexity, which introduces another factor of error. In Alaska only between 300 and 400 square miles of coal-bearing rocks have been surveyed in any detail, and of the remaining 800 believed to be underlain by coal there are only very meager data. Of the remaining estimated 12,000 square miles of coal fields, only the general outline is known, and it will remain for further surveys to determine how much of it is underlain by workable coal beds. It should be remembered also that upward of a third of Alaska is almost unexplored.

These estimates, while they have little quantitative value, indicate a probable minimum. In view of the incompleteness of the data it will probably be conservative to multiply the above figures, at least those referring to lignite, by 10 or even by 100.

These facts clearly show that the present low status of coal mining in Alaska is no criterion of the future importance of this industry. Up to the present time coal has been mined only for very local markets and the high-grade fuels of Bering River and the Matanuska field are practically untouched. These two fields can ship coal only when railway connection with tide water has been established. Some progress was made on such railways during 1908, but it will probably be two years before any considerable shipments are made. In both fields the activities in 1908 were largely confined to surveys for patents, assessment work, and the building of trails and roads. Up to the close of 1908 no patents for coal lands had been issued, and this tended to discourage development.

Coal consumption in Alaska also decreased in 1908, compared with 1907, as shown in the accompanying table. This is largely due to the decreased industrial activities brought about by the financial depression. Very little coke was used, as the copper smelter at Hadley was in blast only a part of the year. A more important cause for decrease in coal consumption was the large use made of petroleum as fuel. At the Treadwell group of mines petroleum was substituted for coal, and there was also an increase of petroleum-burning engines on Yukon River boats. These facts were reflected in the increased shipments of petroleum to Alaska, which in the year ending June 30, 1907, amounted to 117,696 barrels and in the succeeding twelve months increased to 285,642 barrels.

Shipments of coal to Alaska, 1904–1908, in short tons.

	12 months ending June 30, 1904.		12 months ending June 30, 1905.		12 months ending June 30, 1906.		12 months ending June 30, 1907.		12 months ending June 30, 1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Domestic anthracite	....	....	6	$85	....	....	533	$7,090	1,388	$17,087
Domestic bituminous	46,709	$193,740	47,314	187,352	75,368	$265,047	54,189	270,651	27,306	154,841
Domestic coke	439	2,251	535	4,281	389	3,676	3,481	25,629	2,052	11,014
Canadian bituminous	71,290	261,987	[a]66,397	260,266	[b]46,463	187,348	[c]71,740	288,164	63,485	299,861
Australian bituminous	1,802	4,303	....	....	....	....	3,952	8,587	4,664	10,132
Japanese bituminous	....	....	....	....	....	....	12,932	33,789	4,683	15,616
Foreign bituminous, shipped via United States	3,723	23,904	6,216	29,673	791	4,838	4,638	28,679	13,573	91,049
Canadian coke	....	....	....	....	8,543	38,139	3,314	14,795	31	168
	123,963	486,185	120,468	481,657	131,554	499,048	154,779	677,384	117,182	599,768

[a] Includes 11 tons of Canadian anthracite.
[b] Includes 4 tons of Canadian anthracite.
[c] Includes 28 tons of Canadian anthracite.

ARKANSAS.

Total production in 1908, 2,078,357 short tons; spot value, $3,499,470.

Arkansas suffered more from the untoward conditions which existed during 1908 than did any of the States of the southwestern region, having in 1908 shown a decrease in production of 22.17 per cent, as compared with 14.7 per cent decrease in Kansas, 17 per cent decrease in Missouri, and 19 per cent decrease in Oklahoma. The loss in tonnage in Arkansas amounted to 592,081 short tons, a decrease from 2,670,438 short tons in 1907 to 2,078,357 tons in 1908. The value declined from $4,473,693 to $3,499,470, a loss of $974,223, or 21.78 per cent. The average price obtained during 1908 was only a fraction of a cent less than in 1907, the principal reason for this being that on account of the conditions which prevailed during the year there was little or no demand for the slack or small sizes of coal produced in mining operations, and these were to a considerable extent wasted. The prices obtained for the higher grades averaged about the same as prevailed for the total output in 1907.

The factors which contributed to the decreased production were (1) the financial depression, (2) the exceptionally warm weather during the winter months, (3) labor disaffections, and (4) increased production and consumption of petroleum and natural gas in the Louisiana and Mid-Continent fields. The last factor was probably as much responsible for the decrease as all the others put together. The labor disaffection was the usual biennial suspension of operations on April 1 pending the settlement of the wage scale.

Of the 5,337 men employed in the coal mines of the State, 4,037 went on strike and these were idle for an average of 96 days each. The total number of days lost was 387,841, or almost exactly half of the total time made. Because of the slight demand and also because the large consumers in anticipation of a suspension had well stocked with coal, this did not have as much effect upon the production as might be supposed. During 1908 the 5,337 men employed in the coal mines of Arkansas averaged 145 working days. In 1907 the 5,085 men employed worked an average of 190 days. It is to be noted in Arkansas, as in a number of other coal-producing States, that notwithstanding the depression and decreased production in 1908, there was a larger number of men employed. This is attributed to the fact that on account of the slight demand for labor in other branches of industry there was a greater supply for the coal mines. The average production per man for each working day in 1908 was 2.68 short tons, and the average production per man for the year was 389 tons. In 1907 the average daily production per man was 2.76 short tons, and for the year 525 tons. Since the coal miners of Arkansas have been unionized practically all of the coal mines of the State have been operated on the basis of an eight-hour day.

No machines have been in use in the production of coal in Arkansas during the last six years.

There was only one company in Arkansas which made any effort to improve the quality of the coal by washing. This company installed 4 Stewart jigs, by which there were washed, in 1908, 57,450 short tons of coal, yielding 43,670 tons of cleaned coal and 13,708 tons of refuse. In 1907 the same company washed 92,848 short tons of coal, obtaining 69,636 tons of cleaned coal and 23,212 tons of refuse.

Mr. R. A. Young, the state mine inspector of Arkansas, reports that during 1908 there were 14 men killed, 17 seriously injured, and 26 slightly injured in the coal mines of the State. Of the total number of men killed, 6 were married, and 7 children were left fatherless. The causes of the accidents were as follows: From falls of rock or coal in the gangways, 6 men were killed and 8 injured; from falls of roof in rooms, 2 were killed and 2 injured; from gas explosions, 1 was killed and 7 were injured. Two men were killed and 13 injured by being crushed by trip cars. Shaft accidents killed one and injured one. One man was injured by a dust explosion. One death and 10 injuries were the result of "other causes."

The statistics of production, by counties, for the last two years, with the distribution of the product for consumption, are shown in the following table:

Coal production of Arkansas in 1907 and 1908, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1907.								
Franklin	403,128	3,534	16,790	423,452	$647,615	$1.53	214	774
Johnson	235,555	2,648	5,080	243,283	512,477	2.11	149	772
Logan	27,683	1,603	684	29,970	73,767	2.46	201	89
Pope	38,389	404	8,960	47,753	163,267	3.42	165	237
Sebastian	1,806,737	9,972	58,677	1,875,386	3,009,026	1.60	197	3,111
Scott and Washington	44,734	4,554	1,306	50,594	67,541	1.33	133	102
	2,556,226	22,715	91,497	2,670,438	4,473,693	1.68	190	5,085
1908.								
Franklin	196,334	875	6,103	203,312	$316,140	$1.55	87	781
Johnson	191,038	2,345	4,300	197,683	407,874	2.06	97	738
Logan	27,754	1,822	1,147	30,723	72,844	2.37	124	171
Sebastian	1,524,610	7,121	49,047	1,580,778	2,520,225	1.59	171	3,280
Other counties[a] and small mines	51,452	2,630	11,779	65,861	182,387	2.77	149	367
	1,991,188	14,793	72,376	2,078,357	3,499.470	1.68	145	5,337

[a] Pope, Scott, and Washington.

A statement of the production of coal in Arkansas, by counties, for the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Arkansas, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Franklin	408,494	[a] 634,618	[a] 489,434	[a] 666,735	[a] 400,995	− 265.740
Johnson	217,667					
Logan	35,300	26,090	26,647	29,970	30,723	+ 753
Pope	51,488	39,685	34,776	47,753	35,481	− 12,272
Sebastian	1,234,794	1,189,455	1,278,497	1,875,386	1,580,778	− 294,608
Other counties and small mines	61,708	44,825	34,914	50,594	30,380	− 20,214
Total	2,009,451	1,934,673	1,864,268	2,670,438	2,078,357	− 592,081
Total value	$3,102,660	$2,880,738	$3,000,339	$4,473,693	$3,499,470	−$974,223

[a] Includes Johnson County.

According to the United States census for 1840, a small quantity of coal (220 short tons) was mined in Arkansas during that year. With the exception of 9,972 short tons mined in Missouri and 400 tons from Iowa mines, this was the only coal produced west of Mississippi River in that year, and for the next twenty years these were the only States west of the Mississippi from which any coal production was reported. The industry in Arkansas did not develop rapidly during the earlier years, as the census of 1860 shows a production of only 200 tons, and that of 1880 a total of 14,778 short tons. During the last twenty years, with the exception of 1904, 1905, 1906, and 1908 the production has increased quite rapidly, reaching a maximum of 2,670,438 short tons in 1907.

A statement of the annual production of coal in Arkansas from 1840 to the close of 1908 will be found in the following table:

Production of coal in Arkansas from 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	220	1887	129,600	1896	675,374	1905	1,934,673
1860	200	1888	276,871	1897	856,190	1906	1,864,268
1880	14,778	1889	279,584	1898	1,205,479	1907	2,670,438
1881	20,000	1890	399,888	1899	843,554	1908	2,078,357
1882	25,000	1891	542,379	1900	1,447,945		
1883	50,000	1892	535,558	1901	1,816,136		25,834,758
1884	75,000	1893	574,763	1902	1,943,932		
1885	100,000	1894	512,626	1903	2,229,172		
1886	125,000	1895	598,322	1904	2,009,451		

The total original supply of coal in Arkansas was 1,887,000,000 short tons,[a] of which 1,797,000,000 were bituminous and semianthracite and 90,000,000 tons were lignite. The lignite areas have not been developed and no production has been reported from them. From the bituminous and semianthracite areas there have been mined, to the close of 1908, 25,834,758 short tons, representing an exhaustion, including waste, of approximately 39,000,000 tons, or a little more than 2 per cent of the estimated original contents of the Arkansas fields. Of the total amount of coal produced in Arkansas from the time when mining began, 8 per cent was mined in 1908, in which year the output also represented about 0.11 per cent of the estimated original supply.[b]

CALIFORNIA.

Total production in 1908, 18,755 short tons; spot value, $54,840.

California does not possess much importance as a coal-producing State, but it is one of the few in which the output in 1908 showed an increase over that of the preceding year. All of the production was the result of recent developments in new territory. The old mines at Tesla, in Alameda County, and at Black Diamond, in Contra Costa County, were idle throughout the year. The recent developments have been at Ione, in Amador County, and at Stone Canyon, in Monterey County, and the production in those two counties in 1908 exceeded that of the entire State in 1907 by 4,805 tons, while the increase in value amounted to $16,627.

[a] Coal fields of the United States, by Marius R. Campbell, U. S. Geol. Survey, 1908.

[b] For detailed description of the Arkansas coal fields, see Contributions to Economic Geology: Bull. U. S. Geol. Survey, No. 316, 1906, p. 137.

The coal-mining industry of California has been adversely affected, first by the importation of foreign and better-grade coals, brought largely as ballast, and second, by the increased production of petroleum and its use for fuel purposes in manufacturing establishments. As a result of these conditions the production of coal in the State had decreased from over 170,000 tons in 1900 to 77,050 tons in 1905; to 25,290 tons in 1906, and to 13,950 tons in 1907. Up to the close of 1908 the entire production of coal in the State had been of the lignite or subbituminous variety. During the past year, however, the development of the mines in Stone Canyon, Monterey County, has placed upon the market a bituminous coal of a quality to compete with the foreign coals brought into the San Francisco market, and it is believed that this will result, to some extent, in the rehabilitation of the coal-mining industry of the State. It is understood to be the intention of the promoters of this enterprise to cater to the domestic trade in which fuel petroleum does not figure as a competitor.

The production of petroleum in California increased from 33,098,598 barrels in 1906 to 39,748,375 barrels in 1907, and to 44,861,742 barrels in 1908. This enormous output of crude petroleum has almost eliminated coal as a fuel for railroad and manufacturing purposes in California, and has confined its use almost entirely to domestic purposes. There is promise of additional coal supplies from Monterey and San Benito counties, if transportation facilities are secured.

The statistics of coal production in California during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of California, 1904–1908, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1904	74,656	3,840	392	78,888	$375,581	$4.76	282	168
1905	74,000	550	2,500	77,050	382,725	4.97	294	135
1906	7,040	15,250	3,000	[a] 25,290	60,710	2.40	284	41
1907	7,910	2,680	3,360	13,950	38,213	2.74	258	32
1908	12,400	1,955	4,400	18,755	54,840	2.93	250	34

[a] In addition to this total there were 6,910 tons of bituminous coal mined in Monterey County, but not shipped during the year.

The records of the State Mining Bureau of California show a production of coal in that State as early as 1861. It was at that time one of the 16 coal-producing States. During the latter part of that decade and throughout the one following the production of California exceeded 100,000 tons annually and reached a maximum of 237,000 tons in 1880. Since 1881 the production has been irregular, having been largely influenced by the imports of Australian and British Columbia coals. The receipts of Australian coal have depended principally upon the wheat production and shipments from the Pacific coast. Vessels bringing Australian coal as return cargoes have had very low freight rates.

The history of the coal-mining industry in California from 1861 to the close of 1908 is exhibited in the following table:

Production of coal in California from 1861 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1861	6,620	1874	215,352	1887	50,000	1900	171,708
1862	23,400	1875	166,638	1888	95,000	1901	151,079
1863	43,200	1876	128,049	1889	119,820	1902	84,984
1864	50,700	1877	107,789	1890	110,711	1903	104,673
1865	60,530	1878	134,237	1891	93,301	1904	78,888
1866	84,020	1879	147,879	1892	85,178	1905	77,050
1867	124,690	1880	236,950	1893	72,603	1906	25,290
1868	143,676	1881	140,000	1894	67,247	1907	13,950
1869	157,234	1882	112,592	1895	75,453	1908	18,755
1870	141,890	1883	76,162	1896	78,544		
1871	152,493	1884	77,485	1897	87,992		5,049,700
1872	190,859	1885	71,615	1898	145,888		
1873	186,611	1886	100,000	1899	160,915		

COLORADO.

Total production in 1908, 9,634,973 short tons; spot value, $13,586,988.

For the second time in a period of fifteen years the coal production of Colorado has shown a decrease as compared with the output of the preceding year. In 1904 the coal-mining industry of the State was seriously affected by labor disturbances, and the production decreased from 7,423,602 short tons in 1903 to 6,658,355 tons in 1904. The trade depression and the stringency in the money market during 1908 were manifested in Colorado by a decrease in the coal production which amounted to 1,155,263 short tons, or 10.71 per cent, as compared with the production of 1907. The value of the product decreased slightly less in proportion—from $15,079,449 in 1907 to $13,586,988 in 1908, a decline of $1,492,461, or 9.9 per cent.

The condition of the money market was most severely felt in the early part of the year, and resulted in the shutting down of many fuel-consuming industries in Colorado and adjoining States. The plants of many metalliferous mines either closed down entirely or materially reduced their output, and this decline in production in turn curtailed freight traffic and consequently lessened the demand of the railroads for fuel. In addition to this, the winter of 1907–8 was exceptionally mild, and, as the result of these several untoward conditions, many of the coal mines in Colorado suspended operations, and some did not resume business until late in the fall of 1908. It is to be noted, however, that in spite of these conditions there was a slight increase in the average price per ton, and, as already observed, the decline in value was less in proportion than the decrease in production. This may be attributed in part to the fact that the miners' wages were not reduced, and with shortened production the mining expenses were naturally slightly increased, necessitating an advance in price. It may also be assumed that the closing down of the metal mining and smelting operations cut off the market for the lower grades of coal used for steaming purposes, and that the coal sold during the year consisted largely of screened sizes, which command higher prices.

The relations between the operators and the miners during 1908 were in general harmonious, such disaffections as occurred being of insufficient importance to affect production. Most of the labor troubles occurred in the Denver subbituminous or black lignite region and were generally of short duration. Out of 14,523 men, 768 were on strike for an average of 22 days. The most serious difficulty occurred at the mines of the Leyden Coal Company, in Jefferson County, where 130 men were idle for a period of 60 days. The total amount of time lost was a little more than one-half of 1 per cent of the total time worked.

The supply of railroad cars was unusually regular, although at times there were shortages, not because of the lack of cars, but by reason of the inability of the transportation companies to furnish motive power.

At the beginning of 1909 the outlook for the year was encouraging. It is believed that the tonnage of the current year will exceed that of 1907, which was the largest in the history of the State.

The total number of men employed in the coal mines of Colorado in 1908 was 14,523, working an average of 212 days, as compared with 14,223 men for a period of 258 days in 1907, indicating that the supply of labor was greater in 1908 than in the previous year, but that the working time was materially reduced. There was also a reduction in the average production per man for the year, although the daily output for each man employed increased. In 1907 the average production for each man employed was 759 tons. In 1908 it was 663 tons. The average production per day per man was 3.13 tons in 1908, as compared with 2.94 tons in 1907. In 1906 the average production per man for the year was 889.4 tons, and per day 3.32 tons. Most of the larger mines of the State are operated upon the basis of the ten-hour day, there being 61 mines in 1908, employing 8,535 men, that worked ten hours; 79 mines, employing 5,158 men, reporting eight hours as the working day in 1908, as compared with 60 mines, employing 3,420 men in 1907. Three mines, employing 63 men, reported nine hours as the working day in 1908.

The increase in the use of mining machines in the coal mines of Colorado, which was reported in 1907, continued in 1908, as far as is indicated by the number of machines in use, but sympathizing with the slight decrease in production, there was a corresponding decrease in tonnage won by the use of machines. Returns for 1908 show that there were 211 machines in use, as compared with 175 in 1907. The machine-mined product, however, decreased from 1,689,517 tons in 1907 to 1,668,602 tons in 1908. The percentage of the machine-mined product to the total increased, however, from 15.66 to 17.32. Of the 211 machines in use in 1908, 205 were undercutting and 6 were shearing machines. The undercutting machines consisted of 134 pick machines, 53 chain breast, and 18 long-wall machines. The shearing machines consisted of 3 pick and 3 chain machines. There are two plants in the State at which washing machinery has been installed. The total quantity of raw coal washed in 1908 was 449,320 tons, yielding 336,123 tons of cleaned coal and 113,197 tons of refuse. All of this washed coal was used for coking.

Mr. John D. Jones, the state coal-mine inspector, reports that in 1908 there were 61 men killed and 115 injured in the coal mines of Colorado, this being a decided improvement over the preceding year, when 99 men were killed and 138 injured. Of the 61 men killed last year 27 were married, and there were 51 children left fatherless. Of the nonfatal accidents 29 were of a serious character, and in 86 the injuries received were of minor importance. By far the larger number both of deaths and injuries were due to falls of roof in rooms, this character of accident claiming a total of 91 victims, 34 of whose injuries resulted fatally and 57 of whom recovered. The injuries resulting from accidents on "trips" of mine cars claimed the second largest number of victims, 10 men having been killed and 35 injured from that cause. Gas and dust explosions killed 5 and injured 8. Falls of rock in gangways killed 5, powder explosions killed 2 and injured 1, shaft accidents resulted in 1 death, while 4 deaths and 14 injuries were due to other causes. The death rate per 1,000 employees was 4.2 in 1908 against 6.96 in 1907, and the number of tons mined for each life lost was 157,950 in 1908 as against 108,992 tons in 1907.

On account of the unfavorable trade conditions, little work in the way of new development in the Colorado coal fields was done in 1908, except the continuation of construction of the Denver, Northwestern and Pacific Railroad, "the Moffat road," from Denver into Routt County, where large quantities of high-grade coal are known to exist. With the transportation facilities thus afforded (Routt County having been hitherto without railroad connections) this will probably become one of the important coal-producing districts of the State.

The statistics of production in Colorado in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Colorado in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	1,240,935	11,641	44,153		1,296,729	$1,976,064	$1.52	212	1,472
Delta	14,366	7,591	130		22,087	35,447	1.60	155	87
El Paso	150,110	112,690	6,995		269,795	394,402	1.46	209	277
Fremont	715,593	25,262	32,094		772,949	1,655,280	2.14	259	1,535
Garfield	211,930	2,764	5,346		220,040	282,091	1.28	208	288
Gunnison	495,166	6,744	12,769	74,180	588,859	885,015	1.50	228	697
Huerfano	1,742,418	8,458	46,914		1,797,790	2,799,133	1.56	251	2,511
La Plata	177,698	1,179	2,185	2,956	184,018	324,239	1.76	260	283
Las Animas	3,184,766	37,189	115,302	1,547,848	4,885,105	5,658,606	1.16	281	6,186
Mesa	40,148	4,030	352		44,530	85,233	1.91	200	62
Routt		5,690			5,690	10,530	1.85	218	10
Weld	109,971	20,817	5,286		136,074	222,269	1.63	226	198
Other counties[a]	326,523	11,824	24,753	201,280	564,380	747,405	1.32	281	617
Small mines		2,190			2,190	3,735	1.71		
	8,409,624	258,069	296,279	1,826,264	10,790,236	15,079,449	1.40	258	14,223

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	1,007,230	14,766	45,952		1,067,948	$1,535,810	$1.44	162	1,337
Delta	31,842	5,737	110		37,689	66,421	1.76	191	69
El Paso	221,451	86,250	10,062		317,763	427,502	1.35	241	364
Fremont	622,484	15,483	31,307		669,274	1,471,164	2.20	206	1,416
Garfield	215,412	2,881	1,776	30	220,099	274,633	1.25	184	332
Gunnison	462,103	1,745	14,524	24,768	503,140	801,661	1.59	215	697
Huerfano	1,568,469	7,566	68,033		1,644,068	2,644,508	1.61	210	2,808
La Plata	154,170	10,864	1,056		166,090	300,317	1.81	196	312
Las Animas	2,922,135	33,658	121,558	1,113,450	4,190,801	4,854,651	1.16	227	6,047
Mesa	42,900	15,350	1,000		59,250	99,275	1.68	171	99
Routt	10,180	2,825			13,005	20,595	1.58	180	8
Weld	296,463	35,066	11,885		343,414	535,958	1.56	204	494
Other counties[b]	231,583	10,322	23,841	133,706	399,452	548,452	1.37	218	540
Small mines		2,980			2,980	6,041	2.02		
	7,786,422	245,493	331,104	1,271,954	9,634,973	13,586,988	1.41	212	14,523

[a] Adams, Archuleta, Jefferson, Larimer, Montezuma, Pitkin, and Rio Blanco.
[b] Archuleta, Douglas, Jefferson, Larimer, Montezuma, Pitkin, and Rio Blanco.

The following table shows the total production of the State, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907:

Coal production of Colorado, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Boulder	736,824	839,804	1,022,096	1,296,729	1,067,948	− 228,781
Delta	21,683	9,497	6,812	22,087	37,689	+ 15,602
El Paso	248,013	188,775	210,793	269,795	317,763	+ 47,968
Fremont	256,200	512,002	666,034	784,949	669,274	− 115,675
Garfield	198,545	172,563	193,063	220,040	220,099	+ 59
Gunnison	494,545	513,317	583,175	576,859	503,140	− 73,719
Huerfano	1,187,905	1,426,640	1,803,791	1,797,790	1,644,068	− 153,722
Jefferson	129,168	189,235	212,037	193,814	163,624	− 30,190
La Plata	146,080	168,669	173,720	184,018	166,090	− 17,928
Las Animas	2,808,953	4,297,599	4,768,882	4,885,105	4,190,801	− 694,304
Pitkin	269,006	342,804	319,529	313,866	228,828	− 85,038
Routt	5,568	3,643	5,297	5,690	13,005	+ 7,315
Weld	118,862	101,812	95,420	136,074	343,414	+ 207,340
Other counties	37,003	60,069	50,569	103,420	69,230	− 34,190
Total	6,658,355	8,826,429	10,111,218	10,790,236	9,634,973	− 1,155,263
Total value	$8,751,821	$10,810,978	$12,735,616	$15,079,449	$13,586,988	−$1,492,461

It is noted in the above table that the greatest decrease occurred in Las Animas County, where the production in 1908 was 694,304 short tons less than in 1907. This is the principal coke-producing county in the State, and the greater part of the decrease was due to the falling off in the manufacture of coke. The coal made into coke in Las Animas County in 1908 was 434,398 tons less than in 1907. The cause of this decrease was the lessened demand by the smelters. The next largest decrease was in Boulder County, where the production in 1908 was 228,781 short tons less than in 1907. This was offset in part, however, by the increased production in Weld County, both of these counties being in the Denver subbituminous region. The increase in Weld County amounted to 207,340 short tons and was due principally to the operations of the Parkdale Fuel Company, which began its coal-mining operations in 1906. Huerfano County, second in producing importance, was third in the amount of decrease in 1908. The production in that county decreased 153,722 short tons. Fremont County showed a decrease of 115,675 tons. Of the counties having an output exceeding 5,000 tons, there were eight in which the production decreased in 1908 and five which showed increases.

Coal mining as an industry in Colorado began in 1864, a production of 500 short tons being recorded for that year. In 1876 the production reached for the first time a total exceeding 100,000 tons, and six years later, in 1882, had reached the million-ton mark. Since that date the increase has been almost uninterrupted, there being only three instances, ten years apart (in 1884, 1894, and 1904), when the production showed a decrease of any importance, and only four altogether in thirty-six years. The largest decrease was made in the "hard-times" year, 1894. The coal production of the State exceeded 3,000,000 tons in 1890; ten years later it had grown to over 5,000,000 tons, and it amounted to nearly 11,000,000 tons in 1907.

The record by years since 1864 is shown in the following table:

Production of coal in Colorado from 1864 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1864	500	1876	117,666	1888	2,185,477	1900	5,244,364
1865	1,200	1877	160,000	1889	2,597,181	1901	5,700,015
1866	6,400	1878	200,630	1890	3,077,003	1902	7,401,343
1867	17,000	1879	322,732	1891	3,512,632	1903	7,423,602
1868	10,500	1880	462,747	1892	3,510,830	1904	6,658,355
1869	8,000	1881	706,744	1893	4,102,389	1905	8,826,429
1870	4,500	1882	1,061,479	1894	2,831,409	1906	10,111,218
1871	15,600	1883	1,229,593	1895	3,082,982	1907	10,790,236
1872	68,540	1884	1,130,024	1896	3,112,400	1908	9,634,973
1873	69,997	1885	1,356,062	1897	3,361,703		
1874	77,372	1886	1,368,338	1898	4,076,347		122,303,309
1875	98,838	1887	1,791,735	1899	4,776,224		

Mr. Campbell's estimate [a] of the coal fields of Colorado shows that the area containing, or which may contain, workable coal beds amounts to 17,130 square miles, of which 10,130 square miles are estimated to contain workable coal; 4,180 square miles may contain workable coal, but the information about this area is uncertain; and 2,820 square miles contain coal under heavy cover. The original contents of these areas is estimated to have been 371,770,000,000 short tons.

The production of coal in Colorado up to the close of 1908 aggregated 122,303,309 short tons, and assuming that for each 2 tons of coal mined 1 ton was wasted, this production represents an exhaustion of 183,000,000 tons, or about 0.05 per cent of the estimated original supply.

GEORGIA.

Total production in 1908, 264,822 short tons; spot value, $364,279.

There were few States which suffered more acutely from the financial depression of 1908, as far as coal production is concerned, than did Georgia, the output of the State decreasing from 362,401 short tons in 1907 to 264,822 tons in 1908, a decline of 97,579 short tons, or 26.93 per cent, while the value fell off from $499,686 to $364,279, a decrease of $135,407, or 27.1 per cent. The production in 1908 was less than in any year since 1899, and can be attributed almost entirely to the depression in the iron trade, which particularly affected the production of high-grade coals and the manufacture of coke. In Georgia the quantity of coal made into coke decreased from 141,031 short tons in 1907 to 71,452 tons in 1908—almost exactly 50 per cent. Of the total decrease in Georgia's coal production in 1908, 71 per cent was in the quantity of coal charged into the ovens for the manufacture of coke.

The number of men employed in the coal mines of Georgia in 1908 was 670, who worked an average of 261 days, compared with 808 men for an average of 262 days, in 1907, and 737 men for 279 days, in 1906. The efficiency record of the laborers in the coal mines of Georgia can not properly be compared with that of other States, however, as a great number—considerably more than half of the mine

[a] Campbell, Marius R., Coal Fields of the United States, U. S. Geol. Survey, 1908.

workers—are convicts leased by the State to the mining companies. Most of the men worked nine hours a day, but the statistics of production show that the average output per man each day during 1908 was only 1.51 tons, compared with 1.71 in 1907, and 1.62 in 1906. The average production per man for the year was 395 tons, compared with 449 tons in 1907, and 450.6 tons in 1906. This low efficiency is explained by the fact that the convicts employed in the mines have for experience as coal miners only the periods of their incarceration.

There are no undercutting machines in use in the mines of Georgia. At one plant washing machinery is employed, and in 1908, 79,000 tons of coal were washed, yielding 71,452 tons of cleaned coal and 7,548 tons of refuse. As comparatively little free labor is employed in the mines, the operations are not subject to much interference by labor troubles.

The statistics of the production of coal for the last five years, with the distribution of the product for consumption, are shown in the following table:

Coal production of Georgia, 1904-1908, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1904	243,244	1,000	6,677	132,270	383,191	$466,496	$1.22	222	881
1905	224,695	1,148	7,113	119,035	351,991	453,848	1.29	270	801
1906	194,881	850	8,324	128,052	332,107	424,004	1.28	279	737
1907	204,890	5,780	10,700	141,031	362,401	499,686	1.38	262	808
1908	184,040	930	8,400	71,452	264,822	364,279	1.38	261	670

Portions of two counties in the extreme northwestern corner of Georgia are underlain by the coal measures of the southern Appalachian coal fields. The Walden basin of Tennessee crosses Dade County in Georgia, and extending southwesterly becomes the Blount Mountain and Warrior basins in Alabama. The Lookout basin, a narrow outlying area, extends from Etowah County in Alabama in a northeasterly direction into Walker County, Ga. The total area of the coal fields in Georgia is estimated at 167 square miles, the smallest of all the state coal fields, not all of it being workable. Extensive operations are carried on in both counties, however, some of this coal being highly prized as a steam fuel and finding a ready market for bunker coal at Brunswick and other coast cities. It also makes an excellent coke, and about 30 per cent of the output each year is made into coke, which is sold to the furnaces at Chattanooga and other points in Tennessee and Georgia.

The Eighth United States Census contains the first authentic statement of production of coal in Georgia. This report, which is for 1860, gives the production in that year as 1,900 short tons. The census for 1870 does not mention any production in Georgia for that year. The Tenth Census (1880) reports an output of coal for the State of 154,644 short tons, since which time the production has been reported in the annual report, Mineral Resources of the United States. The annual production since 1860 is shown in the following table:

Annual production of coal in Georgia, 1860–1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	1,900	1873	40,000	1886	223,000	1899	233,111
1861	2,500	1874	60,000	1887	313,715	1900	315,557
1862	3,500	1875	80,000	1888	180,000	1901	342,825
1863	6,000	1876	110,000	1889	225,934	1902	414,083
1864	10,000	1877	120,000	1890	228,337	1903	416,951
1865	10,000	1878	128,000	1891	171,000	1904	383,191
1866	8,000	1879	140,000	1892	215,498	1905	351,991
1867	8,000	1880	154,644	1893	372,740	1906	332,107
1868	10,000	1881	168,000	1894	354,111	1907	362,401
1869	12,000	1882	160,000	1895	260,998	1908	264,822
1870	15,000	1883	155,000	1896	238,546		
1871	20,000	1884	150,000	1897	195,869		8,388,518
1872	25,000	1885	150,000	1898	244,187		

According to the estimates of M. R. Campbell, the total original coal supply of Georgia was 933,000,000 tons, from which there had been mined to the close of 1908, 8,388,518 short tons, representing (including loss in mining) an exhaustion of about 12,500,000 tons. This would leave still in the ground a total of 920,500,000 tons, of which from 600,000,000 to 650,000,000 tons would probably be considered as recoverable.

IDAHO.

Total production in 1908, 5,429 short tons; spot value, $21,832.

There are several somewhat restricted and widely separated areas in Idaho in which beds of subbituminous coal and lignite occur, and the coal mining industry has been confined to comparatively small operations for local consumption. The output in 1908 was 1,079 short tons, or 16.58 per cent less than in 1907, and the value decreased $4,662, or 17.6 per cent. Most of the production in 1908, as in the three preceding years, was from the Salmon district in Lemhi County, with smaller quantities from Bingham and Fremont counties.

The production of coal in Idaho during the last five years is shown in the following table:

Coal production of Idaho, 1904–1908, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1904	3,330	$12,230	1907	6,508	$26,494
1905	5,782	16,346	1908	5,429	21,832
1906	5,365	18,538			

ILLINOIS.

Total production in 1908, 47,659,690 short tons; spot value, $49,978,247.

In Illinois, the second among the coal-producing States, the effects of the monetary disturbances do not seem to have been as seriously felt as in some of the other States. The statistics for the fiscal year ended June 30, 1908, compiled by Mr. David Ross, secretary of the bureau of labor statistics, show that the coal production of Illinois during that period amounted to 49,272,452 short tons, as compared with 47,798,621 tons in the fiscal year ended June 30, 1907, and

51,317,146 tons during the calendar year 1907. From this it appears that the production during the fiscal year ended June 30, 1908, showed an increase of nearly 1,500,000 tons over the preceding fiscal year and a decrease of about 2,000,000 tons from the output reported for the calendar year 1907. The production reported to the United States Geological Survey for the calendar year 1908 was 47,659,690 short tons, a decrease, compared with the calendar year 1907, of 3,657,456 short tons, and of 1,612,762 short tons, compared with Mr. Ross's figures for the fiscal year 1908. The percentage of decrease in the production of Illinois in the calendar year from 1907 to 1908 was 7.13, which is considerably less than the percentage of decrease in any of the other important coal-producing States. The bituminous coal production of Pennsylvania showed a decrease of 22 per cent; that of West Virginia, 13 per cent; Ohio, 18.3 per cent; Alabama, 18.6 per cent; and Indiana, 12 per cent. The value of the coal production of Illinois in 1908 was $49,978,247, against $54,687,382 in 1907, a decrease of $4,709,135, or 8.61 per cent, compared with the percentages of decrease in Pennsylvania (23.7), West Virginia (16.4), Ohio (21), Alabama (20), and Indiana (13). The reason for the comparatively small percentage of decrease in Illinois's production, both in quantity and value, may be attributed to the fact that relatively small quantities of Illinois coal are used in the iron and steel trade, where most of the effects of the depression were felt. The manufacturing industries depend upon Illinois coals for fuel, and these industries were not so adversely influenced by the panic as was the iron trade, while there was little or no falling off in the demand for coal for domestic consumption. The most unsatisfactory feature of the year's business in Illinois was the great difficulty experienced in getting rid of screenings, and the comparatively insignificant decline in the average price per ton—from $1.07 in 1907 to $1.05 in 1908—was due principally to the more exacting demands of consumers, which were for larger proportions of screened coal, leaving unusually large quantities of slack as a waste product. The inability to dispose of the slack coal made the cost of the marketed product that much higher and made the returns to the operators less favorable than the slight decline in price would indicate.

The only notable interference with mining operations was the shutdown or suspension in April and May, when the operators and miners were attempting to reach an agreement on the wage scale. Throughout the remainder of the year there were no serious strikes or shutdowns because of labor troubles. During the suspension which occurred there were altogether 47,456 men idle for an average of thirty-seven days each. The number of men idle was about 70 per cent of the total number employed. The total time lost was a little less than 14 per cent of the total time made during the year.

The car supply was good throughout the year, as was also the supply of labor, the latter being indicated by an increase of nearly 2,500 in the number of men employed in 1908, as compared with 1907, notwithstanding the decrease in production.

Dry weather was somewhat embarrassing to many operators, particularly in the central and southern portions of the State, where many were obliged to haul water in tank cars by rail for use in boilers, and at one time water was so scarce in the southern part of Illinois that the interurban car service was discontinued for a period of two weeks.

The total number of men employed in the coal mines of Illinois in 1908 was 68,035, who worked an average of 185 days, as compared with 65,581 men in 1907, who worked for an average of 218 days. The average daily production of each man employed in 1908 was 3.79 tons, an increase of 0.2 ton over 1907. Approximately the same increase was shown in 1907 over 1906, and in 1906 over 1905. The daily record per man for these years was, respectively, 3.59 short tons, 3.49, and 3.29 tons. Owing to the fewer number of days worked, however, the average production by each man for the entire year (1908) was less than in 1907, the figures being 701 and 782.5 short tons, respectively. A part, if not all, of the increased production per man per day was due to the increased use of mining machines. In 1907 there were employed in the coal mines of Illinois 1,080 machines, by the use of which a total of 15,134,401 tons, or 29.49 per cent of the total product, was won. In 1908 there were 1,217 machines in use, and the machine-mined product amounted to 15,045,004 short tons, or 31.57 per cent of the total. The pick or puncher type of machine appeared to be the more popular among the coal operators in Illinois, more than two-thirds, or 871 out of a total of 1,217 in 1908, being of that type; 332 were chain-breast machines, and 3 long-wall. There were also 5 pick and 6 chain shearing machines in use.

The coal-mine workers of Illinois are probably better organized than those of any other bituminous coal-mining State, and by far the larger number of the coal mines in the State are operated on the basis of the eight-hour day. In 1908, 491 mines, employing a total of 65,289 men, worked eight hours a day, and 5 mines, employing 510 men, worked nine hours, while there were 2,236 mine workers the length of whose working day was not reported, but probably most of them worked eight hours per day.

The coal mines of Illinois have been notably free from explosions of either gas or dust, entailing serious loss of life or injuries, during the last three years. In 1906 there were only 2 deaths due to this cause, and in 1907, out of a total of 172 men killed, 7 met death in gas or dust explosions, In 1908 the number of men killed by gas explosions was 9. There were no deaths nor injuries charged to explosions of dust. The statistics of mine accidents in Illinois are for the fiscal year ended June 30, 1908, and are collected by Mr. David Ross, secretary of the bureau of labor statistics. Mr. Ross reports for the fiscal year 1908 a total of 183 men killed and 819 injured in the coal mines of the State. All of the 819 nonfatal accidents reported were of a serious nature, inasmuch as the time lost in every instance was more than thirty days, and from that to several months. Mine inspectors of the State report to the bureau of statistics only those nonfatal accidents which entail a loss of thirty days or more. The great majority of all the accidents are reported as having been due to falls of roof or coal, and are in most cases preventable when proper care is exercised by the miners themselves. In 1908 of the 183 fatalities, 64 were due to falls of rock, slate, etc., and 29 to falls of coal, while 237 injuries were due to falls of rock or slate and 167 to falls of coal. Powder explosions killed 25 and injured 39. Mine-car accidents resulted in 35 deaths and 209 injuries. Shaft accidents caused 4 deaths and 25 injuries. Miscellaneous causes are charged with 17 deaths and 109 injuries. Practically one-half of the number of men killed were married, Mr. Ross having reported 90 wives made widows and

223 children left fatherless. The death rate per thousand, based upon Mr. Ross's figures of production for the fiscal year, was 2.58 in 1908 and 2.62 in 1907. The number of tons mined for each life lost was, in 1908, 269,248, as against 298,356 tons in 1907.

During 1908 there were 3,768,112 short tons of Illinois coal washed before shipment, the cleaned coal from the washeries amounting to 3,202,264 short tons and the refuse to 565,848 tons. In 1907, 2,988,386 tons were washed, yielding 2,465,767 short tons of cleaned coal and 522,619 tons of refuse.

Illinois contains more coal-producing counties than any other State in the Union, there having been, in 1908, 52 counties which produced 1,000 tons or more each. Of these, there are two whose production, both in 1908 and 1907, exceeded 5,000,000 tons, namely, Sangamon and Williamson counties. Macoupin and St. Clair counties, both of which produced over 4,500,000 tons in 1907, produced less than 4,000,000 tons each in 1908. One county, Madison, produced more than 3,000,000 tons in 1908, and four others, Franklin, Fulton, Saline, and Vermilion, each exceeded 2,000,000 tons. Of the 52 counties there were only 16 which showed increases in production during 1908. The most important increases were in Franklin County, which showed a gain of 880,417 short tons, and in Saline County, which gained 304,295 tons. The most serious losses were shown in St. Clair County, which decreased 815,862 tons; Macoupin, 613,071 tons; Madison, 559,901 tons; Vermilion, 520,768 tons, and Bureau, 497,791 tons.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Illinois in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	1,886,740	51,985	72,037	....	2,010,762	$2,979,557	$1.48	223	4,433
Christian	1,224,132	72,012	72,015	....	1,368,159	1,451,625	1.06	194	1,654
Clinton	1,218,343	23,682	60,366	....	1,302,391	1,232,664	.95	217	1,672
Franklin	1,234,840	23,276	48,850	....	1,306,966	1,384,744	1.06	257	1,614
Fulton	1,996,410	73,129	44,104	....	2,113,643	2,387,615	1.13	238	3,037
Gallatin	53,118	12,644	3,698	8,595	78,055	81,445	1.04	156	142
Grundy	1,222,649	53,604	51,068	....	1,327,321	1,945,686	1.47	260	2,610
Henry	82,830	63,575	3,316	....	149,721	246,057	1.64	178	318
Jackson	537,546	40,817	66,970	....	645,333	819,504	1.27	170	956
Knox	....	40,452	544	....	40,996	67,864	1.66	178	92
Lasalle	1,309,045	310,730	58,215	....	1,677,990	2,660,773	1.59	237	3,259
Livingston	234,694	60,987	7,816	....	303,497	424,659	1.40	248	564
Logan	384,301	70,037	22,777	....	477,115	506,971	1.06	195	755
McDonough	21,240	10,489	470	....	32,199	61,335	1.90	183	88
Macoupin	4,280,893	62,106	164,271	....	4,507,270	4,412,539	.98	209	4,779
Madison	3,757,950	87,100	82,671	....	3,927,721	3,594,068	.92	214	4,008
Marion	1,092,976	55,202	37,355	....	1,185,533	1,150,493	.95	282	1,129
Marshall	430,990	27,764	24,042	....	482,796	753,430	1.56	266	973
Menard	300,442	73,711	15,765	....	389,918	413,864	1.06	196	693
Mercer	421,767	16,909	14,945	....	453,621	620,972	1.37	222	633
Montgomery	1,221,638	37,515	29,868	....	1,289,021	1,275,647	.99	180	1,545
Peoria	969,887	115,540	17,885	....	1,103,312	1,274,774	1.16	224	1,373
Perry	1,677,168	43,301	64,000	....	1,784,469	1,678,054	.94	215	2,085
Randolph	780,994	28,117	15,650	....	824,761	779,745	.95	215	960
Rock Island	11,560	39,348	2,030	....	52,938	86,479	1.63	204	89
St. Clair	4,176,080	198,694	137,105	....	4,511,879	3,865,756	.86	191	4,902
Saline	2,178,240	29,251	40,351	....	2,247,842	2,217,018	.99	232	2,711
Sangamon	4,699,368	296,363	164,311	....	5,160,042	5,022,248	.97	191	6,428

Coal production of Illinois in 1907 and 1908, by counties, in short tons—Continued.

1907—Continued.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Scott	7,700	9,399	540	....	17,639	$28,556	$1.62	223	50
Shelby	115,606	32,557	7,767	....	155,930	183,897	1.18	209	294
Stark	3,116	22,181	600	....	25,897	43,628	1.68	189	72
Tazewell	144,149	87,312	4,510	....	235,971	276,127	1.17	240	373
Vermilion	2,780,846	136,887	55,520	....	2,973,253	2,997,416	1.01	248	2,877
Will	163,010	14,198	6,777	....	183,985	290,558	1.58	236	463
Williamson	5,469,847	60,104	167,993	....	5,697,944	5,541,810	.97	214	5,600
Other counties *a* and small mines	818,003	394,343	58,910	....	1,271,256	1,929,804	1.52	233	2,350
	46,908,118	2,775,321	1,625,112	8,595	51,317,146	54,687,382	1.07	218	65,581

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	1,395,610	44,080	73,281	....	1,512,971	$2,205,827	$1.46	175	3,920
Christian	1,214,217	94,510	68,439	....	1,377,166	1,473,887	1.07	177	1,892
Clinton	1,009,470	21,503	47,875	....	1,078,848	985,296	.91	173	1,308
Franklin	2,102,026	28,332	57,025	....	2,187,383	2,231,145	1.02	219	2,191
Fulton	1,906,863	58,524	47,028	....	2,012,415	2,280,334	1.13	184	3,104
Gallatin	42,700	12,498	1,510	2,959	59,667	59,879	1.00	153	121
Grundy	1,008,324	46,452	26,666	....	1,081,442	1,603,153	1.48	230	2,614
Henry	67,810	71,487	2,327	....	141,624	241,653	1.71	205	295
Jackson	527,002	39,682	57,371	....	624,055	776,652	1.24	133	1,270
Knox	....	40,244	796	....	41,040	66,317	1.62	180	90
Lasalle	1,197,642	293,527	66,004	....	1,557,173	2,418,093	1.55	218	3,786
Livingston	204,554	53,218	7,894	....	265,666	382,808	1.44	196	415
Logan	288,190	65,206	19,584	....	372,980	408,836	1.10	154	725
McDonough	736	16,222	860	....	17,818	33,444	1.88	109	82
Macoupin	3,696,056	62,284	135,859	....	3,894,199	3,816,353	.98	177	4,524
Madison	3,175,734	109,383	82,703	....	3,367,820	3,037,941	.90	168	4,087
Marion	905,086	34,552	41,646	....	981,284	898,555	.92	207	1,275
Marshall	349,188	27,638	16,455	....	393,281	620,989	1.58	219	984
Menard	311,133	34,010	10,166	....	355,309	364,663	1.03	174	637
Mercer	337,041	26,416	12,978	....	376,435	505,925	1.34	228	577
Montgomery	1,334,297	40,376	36,305	....	1,410,978	1,344,693	.95	169	1,757
Peoria	772,906	126,934	22,089	....	921,929	1,076,429	1.17	191	1,283
Perry	1,482,791	46,413	47,687	....	1,576,891	1,485,805	.94	153	2,261
Randolph	687,016	47,940	16,649	....	751,605	685,369	.91	173	1,047
Rock Island	16,700	33,512	569	....	50,781	75,069	1.48	179	81
St. Clair	3,415,123	171,596	109,298	....	3,696,017	3,290,064	.89	157	4,671
Saline	2,469,489	33,511	49,137	....	2,552,137	2,400,494	.94	175	3,638
Sangamon	4,605,905	260,299	149,404	....	5,015,608	4,806,946	.96	187	6,371
Scott	....	3,427	....	....	3,427	6,655	1.94	192	14
Shelby	139,186	32,989	9,198	....	181,373	211,759	1.17	155	369
Stark	2,580	17,171	600	....	20,351	35,553	1.75	170	54
Tazewell	133,386	68,954	4,542	....	206,882	236,044	1.14	179	408
Vermilion	2,256,003	155,508	40,974	....	2,452,485	2,445,071	.99	204	3,243
Will	148,007	9,772	4,460	....	162,239	257,764	1.59	178	537
Williamson	5,423,609	73,508	173,357	....	5,670,474	5,313,399	.94	187	6,162
Other counties *b* and small mines	841,865	395,294	50,778	....	1,287,937	1,895,383	1.47	214	2,242
	43,468,245	2,696,972	1,491,514	2,959	47,659,690	49,978,247	1.05	185	68,035

a Bond, Calhoun, Greene, Hancock, Jefferson, Jersey, Kankakee, McLean, Macon, Morgan, Putnam, Schuyler, Wabash, Warren, Washington, White, and Woodford.

b Bond, Calhoun, Edgar, Greene, Hamilton, Hancock, Jefferson, Jersey, Kankakee, McLean, Macon, Morgan, Moultrie, Putnam, Schuyler, Warren, Washington, White, and Woodford.

In the following table are shown the statistics of production of coal in Illinois, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907:

Coal production of Illinois, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Bond	158,116	126,231	132,325	138,990	60,129	− 78,861
Bureau	1,821,867	1,701,255	1,580,085	2,010,762	1,512,971	− 497,791
Calhoun	6,500	4,727	5,045	2,850	3,521	+ 671
Cass	810					
Christian	838,943	879,360	934,452	1,368,159	1,377,166	+ 9,007
Clinton	854,719	579,281	515,796	1,302,391	1,078,848	− 223,543
Franklin				1,306,966	2,187,383	+ 880,417
Fulton	1,247,215	1,529,249	1,579,224	2,113,643	2,012,415	− 101,228
Gallatin	92,908	82,682	92,731	78,055	59,667	− 18,388
Greene	5,986	4,435	2,206	2,310	9,506	+ 7,196
Grundy	1,334,422	1,310,892	1,162,019	1,327,321	1,081,442	− 245,879
Hamilton					(c)	
Hancock	7,923	3,300	4,498	2,034	1,406	− 628
Henry	149,259	146,995	149,188	149,721	141,624	− 8,097
Jackson	889,607	818,841	646,196	645,333	624,055	− 21,278
Jefferson	32,788	25,925	7,600	12,000	18,675	+ 6,675
Jersey			1,397	1,162	1,496	+ 334
Johnson	700					
Kankakee		700	39,499	26,704	30,994	+ 4,290
Knox	73,806	58,972	51,654	40,996	41,040	+ 44
Lasalle	1,542,518	1,772,988	1,467,672	1,677,990	1,557,173	− 120,817
Livingston	186,638	284,984	273,831	303,497	265,666	− 37,831
Logan	350,037	445,546	435,559	477,115	372,980	− 104,135
McDonough	26,211	19,496	43,774	32,199	17,818	− 14,381
McLean	198,513	159,921	145,000	151,146	95,854	− 55,292
Macon	180,851	231,235	292,884	269,766	235,237	− 34,529
Macoupin	2,170,292	3,177,484	3,637,827	4,507,270	3,894,199	− 613,071
Madison	3,341,989	3,434,399	3,324,857	3,927,721	3,367,820	− 559,901
Marion	1,010,508	1,009,759	1,042,866	1,185,533	981,284	− 204,249
Marshall	467,724	499,672	418,904	482,796	393,281	− 89,515
Menard	463,985	415,266	429,971	389,918	355,309	− 34,609
Mercer	566,801	532,854	412,165	453,621	376,435	− 77,186
Montgomery	499,218	598,064	720,415	1,289,021	1,410,978	+ 121,957
Morgan	4,737	4,565	9,109	5,513	3,244	− 2,269
Peoria	912,422	897,946	914,863	1,103,312	921,929	− 181,383
Perry	1,296,962	1,298,572	1,509,716	1,784,469	1,576,891	− 207,578
Putnam			156,928	362,858	466,019	+ 103,161
Randolph	531,465	440,991	634,270	824,761	751,605	− 73,156
Rock Island	86,219	68,383	62,321	52,938	50,781	− 2,157
St. Clair	3,417,632	3,329,914	4,904,811	4,511,879	3,696,017	− 815,862
Saline	568,670	675,701	980,864	2,247,842	2,552,137	+ 304,295
Sangamon	4,219,199	4,324,263	4,543,849	5,160,042	5,015,608	− 144,434
Schuyler	11,673	2,880	3,090	7,553	15,269	+ 7,716
Scott	19,409	13,423	12,437	17,639	3,427	− 14,212
Shelby	129,846	104,216	138,257	155,930	181,373	+ 25,443
Stark	27,657	22,725	17,661	25,897	20,351	− 5,546
Tazewell	194,891	231,373	189,882	235,971	206,882	− 29,089
Vermilion	2,792,046	2,342,238	2,389,285	2,973,253	2,452,485	− 520,768
Warren	10,784	10,354	9,520	9,139	11,687	+ 2,548
Washington	97,069	87,913	85,812	29,000	72,500	+ 43,500
White			8,000	16,453	19,583	+ 3,130
Will	76,538	137,957	154,955	183,985	162,239	− 21,746
Williamson	3,395,397	4,167,952	4,417,987	5,697,944	5,670,474	− 27,470
Woodford	a 105,185	a 348,707	a 717,566	b 158,742	d 174,031	+ 15,289
Small mines	56,405	69,777	69,299	75,036	68,786	− 6,250
Total	36,475,060	38,434,363	41,480,104	51,317,146	47,659,690	− 3,657,456
Total value	$39,941,993	$40,577,592	$44,763,062	$54,687,382	$49,978,247	−$4,709,135

a Includes production of Franklin County.
b Includes production of Wabash County.
c Included with production of Hancock County.
d Includes production of Edgar and Moultrie counties.

Probably the earliest mention of coal in the United States is contained in the journal of Father Hennepin, a French missionary, who as early as 1679 reported a "cole" mine on the Illinois River above Fort Crevecœur, near the site of the present city of Ottawa. Father Hennepin marked the location of the occurrence on the map which illustrates his journal. It is also probable that, outside of anthracite mining in Pennsylvania and the operations of the Richmond basin in Virginia, Illinois holds the record for priority of production. The earliest statement that we have in regard to actual mining in Illinois is that coal was produced in Jackson County in 1810 from a point on Big Muddy River. A flatboat was loaded with coal at this place and shipped to New Orleans, but the quantity is not stated. Again, it is reported that in 1832 several boat loads were sent from the same vicinity to the same market. Another record is found stating that 150,000 bushels (or 6,000 tons) of coal were mined in 1833 in St. Clair County and hauled by wagons to St. Louis. From 1840 to 1860 the bureau of statistics of the State is without any reliable data in regard to the coal-mining industry, although some scattering statistics are found in the geologic reports published by the state government. The production of coal in Illinois from 1833 to the close of 1908 is shown in the following table:

Production of coal in Illinois, 1833 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1833	6,000	1853	375,000	1873	3,920,000	1892	17,862,276
1834	7,500	1854	385,000	1874	4,203,000	1893	19,949,564
1835	8,000	1855	400,000	1875	4,453,178	1894	17,113,576
1836	10,000	1856	410,000	1876	5,000,000	1895	17,735,864
1837	12,500	1857	450,000	1877	5,350,000	1896	19,786,626
1838	14,000	1858	490,000	1878	5,700,000	1897	20,072,758
1839	15,038	1859	530,000	1879	5,000,000	1898	18,599,299
1840	16,967	1860	728,400	1880	6,115,377	1899	24,439,019
1841	35,000	1861	670,000	1881	6,720,000	1900	25,767,981
1842	58,000	1862	780,000	1882	9,115,653	1901	27,331,552
1843	75,000	1863	890,000	1883	12,123,456	1902	32,939,373
1844	120,000	1864	1,000,000	1884	12,208,075	1903	36,957,104
1845	150,000	1865	1,260,000	1885	11,834,459	1904	36,475,060
1846	165,000	1866	1,580,000	1886	11,175,241	1905	38,434,363
1847	180,000	1867	1,800,000	1887	12,423,066	1906	41,480,104
1848	200,000	1868	2,000,000	1888	14,328,181	1907	51,317,146
1849	260,000	1869	1,854,000	1889	12,104,272	1908	47,659,690
1850	300,000	1870	2,624,163	1890	15,292,420		
1851	320,000	1871	3,000,000	1891	15,660,698		693,527,999
1852	340,000	1872	3,360,000				

According to Mr. Campbell's estimate, the original coal supply of Illinois when mining began was 240,000,000,000 short tons, all bituminous, and contained within a total area of 35,600 square miles. The total production of the State at the close of 1908, as far as records are obtainable, amounted to 693,527,999 short tons, which, with a half ton wasted for every ton mined, is equivalent to a total exhaustion of 1,040,000,000 tons, from which it appears that the exhaustion to the close of 1908 was about 0.4 per cent of the total estimated supply. The production of coal in Illinois in 1908 was about 7 per cent of the aggregate production to the close of that year, and the quantity of coal estimated as still remaining in the ground at the close of 1908 is 5,000 times the production of that year, or about 3,300 times the exhaustion represented by that production.

INDIANA.

Total production in 1908, 12,314,890 short tons; spot value, $13,084,297.

Compared with 1907, when the coal production of Indiana amounted to 13,985,713 short tons, valued at $15,114,300, the production in 1908 showed a decrease of 1,670,823 short tons, or 11.95 per cent, in quantity, and of $2,030,003, or 13.43 per cent, in value.

Operators have estimated that about 85 per cent of the total decrease was attributable to the unsettled financial condition and about 15 per cent to the suspension of operations in April and May, pending an adjustment of the wage scale. When mining operations were resumed after the suspension it was under a new agreement for both Illinois and Indiana covering a period of two years, or until April 1, 1910. The summer and fall seasons were exceptionally dry, but this is reported to have had no appreciable effect upon the output of the State, although in some districts operators were compelled to haul water for their boilers in tank cars for distances of from 10 to 100 miles. Had the demand for coal been approximately normal the effect of the drought would probably have been more seriously felt. Owing, no doubt, to the general slack demand for labor during 1908 the response to the call for the suspension of mining operations, on April 1, was not as widespread as in 1906, when entirely different conditions prevailed. The total number of men quitting work during 1908 was 7,076, and these men were idle for an average of 22 days each, while in 1906, two years before, when a similar demand was made, 15,875 out of a total of 20,970 quit work and were idle for an average of 63 days each. The total time lost in 1908 was less than 5 per cent of the total number of working days made. The total number of men employed in the coal mines of Indiana in 1908 was 18,380 and they worked an average of 174 days each, as compared with 21,022 men for an average of 197 days in 1907. That the men were anxious to accomplish all of the effective work possible on the days they were allowed to toil is shown by the fact that the average production per man per day in 1908 was 3.85 short tons, as against 3.38 tons in 1907, 3.3 tons in 1906, and 3.11 tons in 1905, while the average annual output per man for the four years, respectively, was 469.7 tons in 1905, 576.7 in 1906, 665 tons in 1907, and 670 tons in 1908. It is probable that part of this increased productive capacity per man was due to an increased percentage in the proportion of coal mined by the use of machinery. In 1907 there were 513 machines in use in the mines of Indiana with a total machine-mined product amounting to 5,310,607 short tons, or 37.97 per cent of the total output of the State. In 1908 there were 507 machines in use (6 less than in the preceding year), and the machine-mined tonnage was 5,294,092, but the percentage of machine-mined product to the total increased to 42.99.

Practically all of the important coal mines of the State are operated on an eight-hour basis, 18,040 men out of a total of 18,380 having been reported as working eight hours a day in 1908.

According to Mr. James Epperson, state mine inspector, the number of men killed in the coal mines of Indiana during 1908 was 45, a decrease of 8 from 1907. There were 830 men injured, 3 of the accidents resulting in permanent disability; 375 more were of a serious character, and 452 were minor. Of the 45 men killed, 20 met death by falls of rock or coal in rooms and gangways, while 212 others were injured from the same cause; 5 deaths and 297 injuries were caused by mine cars; 4 men were killed, and 20 injured by windy shots, or so-called "smoke explosions;" shaft accidents killed 3 and injured 2; gas explosions killed 1 and injured 13; powder explosions injured 3, and 12 deaths and 283 injuries were attributed to miscellaneous causes.

The statistics of coal production in Indiana in 1907 and 1908, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Indiana in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Clay	1,163,548	62,396	40,563	1,266,507	$1,667,050	$1.32	206	2,570
Daviess	77,127	39,802	4,067	120,996	181,557	1,50	192	244
Dubois and Martin	....	8,460	....	8,460	12,074	1.43	99	18
Fountain and Warren	35,132	5,938	200	41,270	54,365	1.32	196	93
Gibson	145,539	56,260	5,673	207,472	252,717	1.22	248	347
Greene	2,663,246	44,035	66,663	2,773,944	2,951,060	1.06	184	4,244
Knox	341,135	23,585	9,379	374,099	376,142	1.01	169	556
Parke	613,105	18,206	24,001	655,312	918,646	1.40	216	1,322
Perry	8,977	8,748	240	17,965	28,950	1.61	197	39
Pike	469,029	38,316	9,073	516,418	543,912	1.05	170	933
Spencer	1,000	24,916	....	25,916	36,870	1.42	196	44
Sullivan	2,806,593	33,228	58,019	2,897,840	2,949,398	1.02	169	4,084
Vanderburg	90,964	217,291	9,116	317,371	365,996	1.15	235	466
Vermilion	1,400,738	13,300	28,065	1,442,103	1,290,081	.89	207	1,857
Vigo	2,569,049	83,803	71,891	2,724,743	2,903,730	1.07	230	3,564
Warrick	502,755	50,002	15,765	568,522	547,300	.96	208	641
Small mines	....	26,775	....	26,775	34,452	1.29	....	....
	12,887,937	755,061	342,715	13,985,713	15,114,300	1.08	197	21,022
1908.								
Clay	779,879	49,649	34,121	863,649	$1,155,967	$1.34	189	1,704
Daviess	44,930	29,889	2,215	77,034	107,734	1.40	142	213
Dubois and Martin	....	12,020	300	12,320	15,275	1.24	169	18
Fountain and Warren	....	4,600	200	4,800	9,147	1.91	240	22
Gibson	166,143	18,227	4,130	188,500	191,179	1.01	237	233
Greene	2,274,070	31,529	55,805	2,361,404	2,460,227	1.04	163	2,830
Knox	395,737	18,542	14,542	428,821	420,959	.98	184	561
Parke	599,788	19,024	25,250	644,062	870,819	1.35	188	1,151
Perry	2,000	8,451	150	10,601	16,692	1.57	137	46
Pike	418,223	32,808	9,149	460,180	474,827	1.03	179	957
Spencer	4,000	9,186	20	13,206	19,440	1.47	141	47
Sullivan	2,521,793	26,625	54,125	2,602,543	2,647,827	1.02	159	3,694
Vanderburg	59,900	193,677	9,594	263,171	315,408	1.20	216	453
Vermilion	1,087,048	18,464	37,290	1,142,802	1,070,204	.94	158	1,860
Vigo	2,590,226	77,015	68,158	2,735,399	2,807,199	1.03	191	3,807
Warrick	427,451	36,919	18,243	482,613	469,301	.97	150	784
Small mines	....	23,785	....	23,785	32,092	1.35	....	....
	11,371,188	610,410	333,292	12,314,890	13,084,297	1.06	174	18,380

There were only four out of the 17 coal-producing counties of Indiana that reported an increased output in 1908 over the previous year. The largest increase was in Knox County, which gained 54,722 short tons, and the total increases in the four counties amounted to only 75,000 tons. The counties which suffered most serious losses were Greene, with a decrease of 412,540 short tons, and Clay, with a loss of 402,858 tons.

In the following table is shown the production of coal in Indiana, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907:

Coal production of Indiana, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−) 1908.
Clay	960,094	781,574	1,101,228	1,266,507	863,649	− 402,858
Daviess	143,877	101,429	135,985	120,996	77,034	− 43,962
Dubois	[a] 13,833	[a] 7,200	[a] 14,700	[a] 8,460	[a] 12,320	+ 3,860
Fountain	41,452	[b] 79,995	[b] 84,469	[b] 41,270	....	− 41,270
Gibson	98,257	99,322	142,444	207,472	188,500	− 18,972
Greene	2,440,420	2,458,665	2,307,486	2,773,944	2,361,404	− 412,540
Knox	173,406	293,480	333,833	374,099	428,821	+ 54,722
Parke	924,001	750,314	707,027	655,312	644,062	− 11,250
Perry	26,218	17,018	13,261	17,965	10,601	− 7,364
Pike	408,391	452,396	497,957	516,418	460,180	− 56,238
Spencer	17,511	16,935	19,256	25,916	13,206	− 12,710
Sullivan	2,061,212	2,571,818	2,415,847	2,897,840	2,602,543	− 295,297
Vanderburg	258,254	300,112	302,919	317,371	263,171	− 54,200
Vermilion	1,068,427	1,302,667	1,342,478	1,442,103	1,142,802	− 299,301
Vigo	1,756,250	2,189,603	2,197,459	2,724,743	2,735,399	+ 10,656
Warren	6,545	....	....	....	4,800	+ 4,800
Warrick	416,311	447,576	447,995	568,522	482,613	− 85,909
Small mines	27,730	25,148	28,216	26,775	23,785	− 2,990
Total	10,842,189	11,895,252	12,092,560	13,985,713	12,314,890	− 1,670,823
Total value	$12,004,300	$12,492,255	$13,116,261	$15,114,300	$13,084,297	−$2,030,003

[a] Includes Martin County. [b] Includes Warren County.

The United States census for 1840 reports a production of coal in Indiana for that year which amounted to 9,682 tons. The census for 1850 did not include any investigation of the mining industry, and the next official statistics are for the year 1860, when the census reported a production of 101,280 short tons. Ten years later the census of 1870 reported a production of 437,870 short tons. In 1880 the production had grown to 1,454,327 short tons, and in 1890 it amounted to 3,305,737 short tons. In the closing year of the last century the production had nearly doubled again, amounting to 6,484,086 short tons, and this output was again nearly doubled by the tonnage of 1908.

The statistics of coal production in Indiana from 1840 up to the close of 1908 are given in the following table, the years for which no official statistics are available having been estimated from the best information obtainable:

Production of coal in Indiana from 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,682	1858	87,000	1876	950,000	1894	3,423,921
1841	10,000	1859	95,000	1877	1,000,000	1895	3,995,892
1842	18,000	1860	101,280	1878	1,000,000	1896	3,905,779
1843	25,000	1861	128,000	1879	1,196,490	1897	4,151,169
1844	30,000	1862	150,000	1880	1,454,327	1898	4,920,743
1845	35,000	1863	200,000	1881	1,984,120	1899	6,006,523
1846	40,000	1864	250,000	1882	1,976,470	1900	6,484,086
1847	45,000	1865	280,000	1883	2,560,000	1901	6,918,225
1848	50,000	1866	320,000	1884	2,260,000	1902	9,446,424
1849	56,000	1867	350,000	1885	2,375,000	1903	10,794,692
1850	60,000	1868	375,000	1886	3,000,000	1904	10,842,189
1851	60,000	1869	400,000	1887	3,217,711	1905	11,895,252
1852	75,000	1870	437,870	1888	3,140,979	1906	12,092,560
1853	75,000	1871	600,000	1889	2,845,057	1907	13,985,713
1854	80,000	1872	896,000	1890	3,305,737	1908	12,314,890
1855	80,000	1873	1,000,000	1891	2,973,474		
1856	85,000	1874	812,000	1892	3,345,174		171,755,280
1857	85,000	1875	800,000	1893	3,791,851		

Mr. Campbell's estimate regarding the coal fields of Indiana placed the original supply at 44,169,000,000 short tons. The aggregate production of coal in Indiana, to the close of 1908, amounted to 171,755,280 short tons, of which 12,314,890 tons, or about 7 per cent, were produced in 1908. The exhaustion represented by the production to the close of 1908 is estimated at 258,000,000 tons, or 0.58 per cent of the estimated original supply. Upon these estimates the quantity of coal remaining in the ground in Indiana at the close of 1908 was about 3,500 times the production of that year, and 2,400 times the exhaustion represented by that production.

IOWA.

Total production in 1908, 7,161,310 short tons; spot value, $11,706,402.

In the preliminary review of the coal trade of 1908, published early in January, 1909, it was stated that the reports from Iowa indicated that the coal production of that State was as little affected as that of any other State by the depressed conditions which followed the panic of October, 1907. Complete returns for 1908 show that the output of Iowa in that year amounted to 7,161,310 short tons against 7,574,322 tons in 1907, a decrease of 413,012 short tons, or 5.45 per cent. There were only three States whose percentage of decrease in production in 1908 as compared with 1907 was less than that of Iowa. These States were Kentucky, Montana, and Utah, and the falling off in the value of the product in Kentucky showed a larger percentage than did that of Iowa. The value of Iowa's coal product in 1908 was $11,706,402 against $12,258,012 in 1907, a loss of $551,610, or 4.5 per cent. The percentage of decrease in the value of Kentucky's production was 9.54, while that of Utah increased 5.39 per cent. The value of Montana's output decreased only 3.48 per cent. The reason assigned for the comparatively slight decrease in Iowa's production of coal in 1908 is that the State is almost entirely agricultural, manufacturing not having been developed to such an extent as in some other portions of the country. The farmers were generally prosperous throughout 1908, and the consumption of coal was, except for the decrease due to mild weather, equal to normal.

Coal-mining operations were suspended on April 1 at a large number of mines in the State, while the wage scale was under discussion, but as consumers generally had anticipated a shut down and had laid in supplies during the preceding months, this produced no material inconvenience. During this suspension 5,248 men, or a little less than one-third of the total number in the State employed in coal mines, laid down their tools and were idle for an average of twenty-three days each. The total time lost was equivalent to something less than 4 per cent of the total time made during the year.

The total number of men employed in the coal mines of Iowa in 1908 was 16,021, against 15,585 in 1907, the industry in this State as in several others showing an increase in the labor supply notwithstanding the decrease in production, and evincing the lack of employment for labor in other lines of industry. The average number of working-days showed a decrease, from 230 in 1907 to 214 in 1908. The average production per day by each man employed has declined each year since 1905, when the average tonnage per man per day was 2.15. In 1906 it was 2.13; in 1907, 2.11; and in 1908, 2.09. The average annual production per man was 449.9 short tons in

1905; 476.2 tons in 1906; 486 tons in 1907; and 447 tons in 1908. In the report of the Geological Survey for 1907 it was stated that the decrease in the daily production per man was in all probability due to the falling off in the quantity of coal mined by machinery, which had decreased from 193,666 tons in 1906 to 108,022 tons in 1907. It further decreased to 71,463 tons in 1908. The machine-mined product in 1908 was only 1 per cent of the total tonnage.

As is the case in other coal-mining States in which the operations are carried on under agreement with the mine workers' union, the mines of Iowa are for the most part operated eight hours a day. In 1908 there were 218 mines, employing a total of 14,772 men, which were operated eight hours; 3 small mines worked nine hours, and 4 mines worked ten hours a day. These seven mines employed a total of only 52 men. There were 1,197 mine workers whose length of working-day was not reported.

According to Messrs. John Verner, R. T. Rhys, and Edward Sweeney, the inspectors of the three mining districts into which Iowa is divided, there were 121 accidents in the coal mines of the State during 1908. Of these, 31 resulted fatally and 90 were nonfatal accidents. Of the nonfatal accidents, 51 were serious and 39 of a minor character. No record was kept in the first and third districts of the conjugal condition of the men killed. In the second district, out of 8 men killed, 3 left widows, and the total number of children left fatherless was 6. The mines of Iowa were entirely free from explosions of fire damp during 1908, and there was only 1 death due to an explosion of dust. Falls of roof in rooms were responsible for 16 deaths and 47 nonfatal accidents. Falls of rock or coal in gangways killed 3 and injured 2 men. Powder explosions killed 2 and injured 6; mine-car accidents killed 4 and injured 27; and shaft accidents killed 5 and injured 1. In 1908 the death rate per thousand employees was 1.93, and the number of tons mined for each life lost was 231,010. In 1907 the death rate per thousand was 2.63, and the number of tons mined for each life lost was 184,740.

The statistics of coal production in Iowa in 1907 and 1908, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Iowa in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	210	14,090	43	14,343	$33,628	$2.30	138	45
Appanoose	1,052,972	60,067	10,370	1,123,409	2,153,205	1.93	203	3,546
Boone	183,495	17,205	7,450	208,150	415,136	1.99	188	805
Greene	2,707	12,723	859	16,289	33,645	2.07	159	52
Guthrie	....	13,806	34	13,840	36,161	2.61	172	60
Jasper	370,114	7,503	19,680	397,297	641,386	1.61	242	741
Keokuk	....	27,176	540	27,716	63,603	2.29	234	30
Mahaska	702,892	33,810	21,076	757,778	1,107,695	1.46	224	1,436
Marion	310,496	27,682	8,821	346,999	489,968	1.41	229	500
Monroe	2,358,681	53,278	64,062	2,476,021	3,432,799	1.39	263	3,661
Polk	1,224,780	199,492	35,931	1,460,203	2,529,838	1.73	238	2,931
Taylor	13,871	5,761	60	19,692	46,481	2.36	227	76
Van Buren	12,542	2,775	57	15,374	30,913	2.01	202	37
Wapello	179,781	75,546	3,324	258,651	410,298	1.59	237	488
Wayne	134,586	12,315	....	146,901	286,949	1.95	255	438
Webster	67,289	11,028	1,958	80,275	167,547	2.09	230	227
Other counties [a] and small mines	159,728	43,514	8,142	211,384	378,760	1.79	197	512
	6,774,144	617,771	182,407	7,574,322	12,258,012	1.62	230	15,585

[a] Dallas, Davis, Jefferson, Lucas, Page, Scott, and Warren.

Coal production of Iowa in 1907 and 1908, by counties, in short tons—Continued.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	300	17,152	40	17,492	$42,235	$2.41	140	77
Appanoose	1,085,787	47,301	11,317	1,144,405	2,121,191	1.85	184	3,811
Boone	196,537	32,421	8,540	237,498	458,560	1.93	186	735
Greene		15,031	400	15,431	36,481	2.36	215	44
Guthrie		12,679	5	12,684	35,725	2.82	161	66
Jasper	364,500	10,826	18,190	393,516	600,078	1.52	235	796
Keokuk		17,331	970	18,301	34,044	1.86	222	29
Mahaska	753,051	35,191	19,273	807,515	1,180,174	1.46	216	1,781
Marion	264,538	27,779	2,290	294,607	436,442	1.48	202	636
Monroe	1,865,842	49,115	52,380	1,967,337	2,803,539	1.43	243	3,234
Polk	1,350,556	225,795	40,544	1,616,895	2,808,066	1.74	228	3,117
Taylor	7,806	10,057	140	18,003	41,881	2.33	214	66
Van Buren	7,476	7,841	45	15,362	32,389	2.11	188	44
Wapello	127,871	58,903	2,732	189,506	301,214	1.59	191	440
Wayne	114,074	13,253	82	127,409	237,065	1.86	225	421
Webster	46,937	14,730	1,101	62,768	128,061	2.04	184	187
Other counties [a] and small mines	160,315	55,076	7,190	222,581	409,257	1.84	214	537
	6,345,590	650,481	165,239	7,161,310	11,706,402	1.63	214	16,021

[a] Dallas, Davis, Jefferson, Lucas, Page, Scott, and Warren.

The production by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, is shown in the following table:

Coal production of Iowa, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Adams	12,970	13,071	11,724	14,343	17,492	+ 3,149
Appanoose	872,920	884,248	1,101,595	1,123,409	1,144,405	+ 20,996
Boone	285,157	292,659	233,110	208,150	237,498	+ 29,348
Dallas	13,086	5,000	5,522	70,042	174,585	+ 104,543
Davis				1,300	3,700	+ 2,400
Greene	27,704	20,058	19,816	16,289	15,431	− 858
Jasper	258,098	306,164	388,582	397,297	393,516	− 3,781
Jefferson	9,810	3,379	3,744	4,000	3,500	− 500
Keokuk	41,512	16,460	17,144	27,716	18,301	− 9,415
Lucas	189,895	147,093	97,147	105,536	8,739	− 96,797
Mahaska	675,113	714,945	602,487	757,778	807,515	+ 49,737
Marion	314,908	338,812	372,750	346,999	294,607	− 52,392
Monroe	1,987,450	2,225,677	2,458,473	2,476,021	1,967,337	− 508,684
Page	18,302	14,013	11,235	14,338	11,364	− 2,974
Polk	1,130,668	1,210,320	1,369,506	1,460,203	1,616,895	+ 156,692
Scott	9,930	6,222	24,778	1,047	1,248	+ 201
Taylor	16,273	22,345	19,052	19,692	18,003	− 1,689
Van Buren	8,005	6,192	12,137	15,374	15,362	− 12
Wapello	379,560	303,360	243,256	258,651	189,506	− 69,145
Warren	11,290	9,876	2,850	5,054	6,820	+ 1,766
Wayne	98,879	112,549	136,694	146,901	127,409	− 19,492
Webster	134,538	113,393	109,522	80,275	62,768	− 17,507
Other counties and small mines	23,865	32,773	25,100	23,907	25,309	+ 1,402
Total	6,519,933	6,798,609	7,266,224	7,574,322	7,161,310	− 413,012
Total value	$10,504,406	$10,586,381	$11,619,455	$12,258,012	$11,706,402	−$551,610

Iowa probably ranks second among the States west of the Mississippi River in order of priority as a coal producer. At the time of taking the United States census for 1840 Iowa and Missouri were the only States west of the river in which any coal production was reported.

Missouri, however, was credited with an output of nearly 10,000 tons, while Iowa's production was given at 400 tons. It is probable, therefore, that the first mine opened in Missouri antedated Iowa's initial production. The production of coal in Iowa since 1840 will be found in the following table, years for which no official figures are available being estimated:

Production of coal in Iowa, 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	400	1858	37,500	1876	1,250,000	1894	3,967,253
1841	500	1859	42,000	1877	1,300,000	1895	4,156,074
1842	750	1860	41,920	1878	1,350,000	1896	3,954,028
1843	1,000	1861	50,000	1879	1,400,000	1897	4,611,865
1844	2,500	1862	53,000	1880	1,461,116	1898	4,618,842
1845	5,000	1863	57,000	1881	1,960,000	1899	5,177,479
1846	6,500	1864	63,000	1882	3,920,000	1900	5,202,939
1847	8,000	1865	69,574	1883	4,457,540	1901	5,617,499
1848	10,000	1866	99,320	1884	4,370,566	1902	5,904,766
1849	12,500	1867	150,000	1885	4,012,575	1903	6,419,811
1850	15,000	1868	241,453	1886	4,315,779	1904	6,519,933
1851	18,000	1869	295,105	1887	4,473,828	1905	6,798,609
1852	20,000	1870	263,487	1888	4,952,440	1906	7,266,224
1853	23,000	1871	300,000	1889	4,095,358	1907	7,574,322
1854	25,000	1872	336,000	1890	4,021,739	1908	7,161,310
1855	28,000	1873	392,000	1891	3,825,495		
1856	30,000	1874	799,936	1892	3,918,491		148,770,102
1857	33,000	1875	1,231,547	1893	3,972,229		

Iowa's total production of coal from 1840 to the close of 1908 has amounted to 148,770,102 short tons, which, including the waste of the half ton lost for every ton of coal mined and marketed, is equivalent to an exhaustion of 223,000,000 short tons. Mr. Campbell estimates the original coal supply of Iowa at 29,160,000,000 tons. This would leave about 4,000 times the production in 1908. If the ratio of waste to marketed coal continues at the same rate, the supply would last 2,700 years at the rate of production in 1908.

KANSAS.

Total production in 1908, 6,245,508 short tons; spot value $9,292,222.

In a preliminary report issued early in 1908 it was stated that the indications were that the coal production of Kansas in that year would show a decrease of about 20 per cent, as compared with 1907. The official returns to the Geological Survey show that the production actually decreased 14.71 per cent, from 7,322,449 short tons in 1907 to 6,245,508 tons in 1908. The value decreased 16.73 per cent, from $11,159,698 in 1907 to $9,292,222 in 1908. The decrease in quantity was 1,076,941 tons, and the decrease in value was $1,867,476.

While the financial depression naturally exerted some influence upon the production of coal in Kansas and the other States of the Middle West, the main cause of the decreased production of coal in 1908 was the increased production and consumption of oil and natural gas in the Louisiana and the Mid-Continent fields. The exceptionally warm weather which prevailed during the first three and the last three months of 1908 was also partially responsible for the decreased consumption of coal. In addition to this, nearly all of the larger mines were idle during April, May, and a part of June, pending a settlement of the wage scale. This, however, did not materially affect production as at this time the demand was light and customers had supplied their requirements by stocking up. It is believed, however, that the periodic suspensions, coming as they have, recently, each two years, have resulted in fluctuating conditions in production and supply and have prejudiced some of the large steam users against coal, causing them to adopt other fuels, especially oil and natural gas in the place of coal. Natural gas from the eastern Kansas fields is now piped to Kansas City and St. Joseph, Mo,; to Atchison, Leavenworth, Lawrence, Arknasas City, Winfield, Wichita, Wellington, and Hutchinson, Kans.; and also to Pittsburg and Galena, Kans.; to Joplin, Mo., and to some smaller intermediate towns. Oil from the same fields and from northern Oklahoma is now extensively used for fuel at Kansas City. A large quantity of coal once consumed at Fort Smith, Ark., has been replaced by gas produced locally, and the demand for domestic as well as for steam coal at Texarkana, Ark., and Shreveport, La., has been supplied by natural gas from the Caddo gas wells, located midway between Texarkana and Shreveport. Oklahoma City, Shawnee, Guthrie, Tulsa, and Bartlesville are now all supplied by natural gas from the northern Oklahoma fields.

In spite of the unfavorable conditions which prevailed during 1908, as noted above, prices of coal in Kansas were fairly sustained, the average for 1908 being $1.49 per short ton, and $1.52 in 1907. The average price in 1908 was the same as in 1906.

During 1907 there was a decided shortage of labor in the coal mines of Kansas, but no trouble of that kind was experienced in 1908, as is shown by the fact that notwithstanding the decreased production, the number of men employed in the coal mines of the State increased from 12,439 in 1907 to 13,916 in 1908. The average number of days worked, however, decreased from 225 to 181, part of the decrease in the working time being due to the suspension of operations during April and May. The average production per man during 1908 was 449 short tons, as against 589 tons in 1907 and 420 tons in 1906. The average daily production per man was 2.48 short tons in 1908, 2.62 tons in 1907, and 2.54 tons in 1906. The suspension of operations on the first of April affected 11,155 men, or 80 per cent of the total number employed. They were idle for an average of 60 days each, and the total time lost amounted to 665,224 days, or about 25 per cent of the total time made during the year. As previously stated, however, owing to a slack demand at that time, the suspension did not materially affect the production.

The coal miners of Kansas are for the greater part well organized, and under the union rules the large majority of them work eight hours a day. In 1908 there were 138 mines, employing 12,973 men out of a total of 13,916, that were operated under an eight-hour day; 283 men employed at 11 mines worked nine hours, and 363 men employed at 7 mines worked ten hours.

The quantity of coal mined by machinery in Kansas increased from 35,317 short tons in 1907 to 133,248 tons in 1908. The number of machines in use increased from 6 to 17.

According to Mr. Frank Gilday, state mine inspector, there were 27 men killed and 70 injured in the coal mines of Kansas during 1908. Of the total number of men killed, 7 were shot firers who lost their lives in the performance of their work, evidently by improperly placed shots; 14 miners were killed, and 15 injured, by falls of roof and coal in rooms and entries; 2 men met death in falling down a shaft; 1 cager was caught by the cage and killed; and other causes claimed 3 victims. One death was attributed to heart failure and included among the accidents, but does not appear to be properly so charged. Of the 27 men killed, 14 were married, and the total number of children left fatherless was 56. The nonfatal accidents were equally divided between serious and minor injuries. The death rate per thousand men employed was 1.94 in 1908 as against 2.57 in 1907. The number of tons of coal mined for each life lost, in 1908, amounted to 231,315.

The statistics of the production of coal in Kansas in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kansas in 1907 and 1908, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1907.									
Cherokee	2,249,060	27,952	48,732	....	2,325,744	$3,454,966	$1.49	230	3,803
Crawford	4,224,369	59,444	96,815	....	4,380,628	6,302,990	1.44	227	6,606
Leavenworth	338,335	40,496	45,507	....	424,338	923,508	2.18	249	1,197
Linn	16,411	10,794	283	....	27,488	51,488	1.87	206	66
Osage	122,978	14,771	300	....	138,049	363,532	2.63	149	736
Other counties [a]	1,200	11,312	....	....	12,512	34,161	2.73	200	19
Small mines	....	13,690	....	....	13,690	29,053	2.12	225	12
	6,952,353	178,459	191,637	....	7,322,449	11,159,698	1.52	225	12,439
1908.									
Cherokee	1,765,194	20,852	40,035	....	1,826,081	$2,707,769	$1.48	176	3,726
Crawford	3,805,869	34,552	77,397	....	3,917,818	5,479,609	1.40	179	8,291
Leavenworth	260,329	38,255	49,136	397	348,117	728,374	2.09	235	1,137
Linn	8,471	2,850	260	....	11,581	21,660	1.87	118	59
Osage	82,120	44,132	196	....	126,448	317,381	2.51	150	671
Other counties [b]	1,200	6,163	....	....	7,363	18,452	2.51	170	32
Small mines	....	8,100	....	....	8,100	18,977	2.34	....	....
	5,923,183	154,904	167,024	397	6,245,508	9,292,222	1.49	181	13,916

[a] Bourbon, Cloud, and Franklin. [b] Bourbon, Cloud, Franklin, and Republic.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Kansas, 1904–1908, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (—), 1908.
Atchison	....	....	(a)	....	....	....
Cherokee	2,378,624	2,132,589	2,015,107	2,325,744	1,826,081	— 499,663
Cloud	3,000	3,000	3,000	6,512	4,500	— 2,012
Crawford	3,399,334	3,729,953	3,415,068	4,380,628	3,917,818	— 462,810
Franklin	4,740	1,950	2,300	3,560	1,604	— 1,956
Leavenworth	333,419	348,322	377,846	424,338	348,117	— 76,221
Linn	29,657	30,673	32,652	27,488	11,581	— 15,907
Osage	171,454	157,327	137,746	138,049	126,448	— 11,601
Other counties and small mines	13,079	20,165	41,056	16,130	9,359	— 6,771
Total	6,333,307	6,423,979	6,024,775	7,322,449	6,245,508	— 1,076,941
Total value	$9,640,771	$9,350,542	$8,979,553	$11,159,698	$9,292,222	—$1,867,476

[a] Included in other counties.

The earliest record of coal production in Kansas shows that the State produced in 1869 a total of 36,891 tons. From 1870 to 1880 the production has been estimated from the best information obtainable, and since 1882 it has been collected by the statistical division of the United States Geological Survey, as shown in the following table, giving the annual production of coal in Kansas from 1869 to the close of 1908:

Production of coal in Kansas, 1869 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1869	36,891	1880	771,442	1891	2,716,705	1902	5,266,065
1870	32,938	1881	840,000	1892	3,007,276	1903	5,839,976
1871	41,000	1882	750,000	1893	2,652,546	1904	6,333,307
1872	44,800	1883	900,000	1894	3,388,251	1905	6,423,979
1873	56,000	1884	1,100,000	1895	2,926,870	1906	6,024,775
1874	85,000	1885	1,212,057	1896	2,884,801	1907	7,322,449
1875	150,000	1886	1,400,000	1897	3,054,012	1908	6,245,508
1876	225,000	1887	1,596,879	1898	3,406,555		
1877	300,000	1888	1,850,000	1899	3,852,267		97,421,712
1878	375,000	1889	2,221,043	1900	4,467,870		
1879	460,000	1890	2,259,922	1901	4,900,528		

According to the estimates of M. R. Campbell, the total area of Kansas known to contain workable coal beds is 3,100 square miles, while the area of which little is known, but which may contain workable coal, is estimated at 15,780 square miles. The original coal supply is estimated to have been 7,022,000,000 short tons, from which there had been mined, to the close of 1908, 97,421,712 short tons. This represents an exhaustion, including the loss in mining, of about 146,000,000 short tons. It would thus appear that about 2.1 per cent of the supply has been exhausted.

KENTUCKY.

Total production in 1908, 10,246,553 short tons; spot value, $10,317,162.

Although the production of some of the older mines in the State was materially reduced in 1908 as compared with 1907, the operations at a number of new properties which were opened and began shipping in 1908 kept the total decrease within 5 per cent of that of 1907. A number of the larger and older mines reported a decrease of as much as 25 per cent, all of which was attributed to the effects of the panic in reducing requirements of railroads and factories. The exceptionally warm weather that prevailed during the fall of 1908 also decreased the demand for domestic consumption, but this was partly offset by developments in the eastern portion of the State, particularly in Bell, Johnson, Lee, Pike, and Whitley counties, all of which showed substantial increases in production in 1908 over 1907. Part of this development has been made possible through the extension of a branch of the Chesapeake and Ohio Railway, up Big Sandy River from Paintsville in Johnson County, through Floyd County, into Pike County.

The total production in the eastern counties of Kentucky showed a decrease of 11,294 short tons, while in the western counties the production fell off 495,277 short tons. The total decrease for the State amounted, therefore, to 506,571 short tons, or from 10,753,124 short tons in 1907 to 10,246,553 short tons in 1908. The value decreased $1,087,876, or 9.54 per cent, from $11,405,038 in 1907 to $10,317,162 in 1908. The average price per ton declined from $1.06 to $1.01.

The year 1908 was the first in more than a decade in which the coal production of Kentucky was less than in the preceding year, the output having shown steady increases from 1896 to 1907, in which year it was nearly three times that of 1897, ten years before, and nearly double that of 1901. The output in 1908, while less than in 1907, exceeded that of 1906 by nearly 600,000 tons.

The coal mines of Kentucky during 1908 gave employment to 16,996 men, this being an increase of 25 over 1907, when 16,971 men were employed. The average number of working days decreased, however, from 210 in 1907 to 186 in 1908. A large proportion (more than two-thirds) of the coal-mining operations of Kentucky are conducted on the open-shop or nonunion basis, and in consequence the eight-hour day is not so generally observed as in some other coal-mining States. In 1908, out of a total of 16,996 men, 9,166 worked ten hours a day, and 2,072 worked nine hours. There were 4,636 men employed in 56 mines who worked eight hours. In 1907, out of a total of 16,971 men, 6,842 worked ten hours a day, 4,508 worked nine hours, and 4,610 worked eight hours. The average production per man per day in 1908 was 3.24 short tons, against 3.02 tons in 1907 and 2.98 tons in 1906. Owing to the fewer number of days worked, however, the average production of each employee for the year 1908 was only 603 tons, against 634 tons in 1907 and 632 tons in 1906.

The steady improvement in the productive capacity per employee for each day worked has been due in a large degree to the increased use of coal-mining machinery, Kentucky being one of the most progressive States in this respect. In 1903 the number of mining machines in use was 308; in 1904, 453; in 1905, 527; in 1906, 600; in 1907, 708, and in 1908, 759. The machine-mined product increased from 2,843,805 short tons in 1903 to 5,504,262 tons in 1907. In 1908 the machine-mined product was 5,252,753 short tons, or 51.27 per cent of the total output. In 1907, while the machine-mined product was larger than in 1908, the percentage of the total was slightly less, namely, 51.19. Ohio is the only other coal-producing State whose percentage of machine-mined coal to the total exceeds that of Kentucky. Of the total number of machines in use in Kentucky in 1908, 502 were of the pick or puncher type, 209 were chain-breast machines, and 35 were long-wall. There were also employed 13 chain shearing machines.

Although in the western part of the State a strike was called on January 1, comparatively little attention was paid to it and it does not seem to have had any appreciable influence on the total production. The total number of men on strike during the year was 1,002, for an average of twenty-seven days each. At one mine a strike was called on February 9, 1907, and was still officially in effect at the close of 1908. The property was, however, operated throughout the year on a nonunion basis, and as the men on strike had moved away and secured employment elsewhere, they are not included in the strike statistics given above.

A statement by Mr. Charles J. Norwood, chief inspector of mines, gives the number of fatal accidents in the coal mines of Kentucky in 1908 as 39, an increase of 7 over 1907. The nonfatal accidents numbered 127. The number of men killed by falls of roof was 17, an increase of 5 over 1907; 3 men were killed by powder explosions, and 9 by an explosion of dust following a blown-out shot. In this case it is stated that the blown-out shot was due to shooting from the solid, a criminal practice in bituminous coal mines and one which should be absolutely prohibited. The death rate per thousand employees was 2.3, and the number of tons mined for each life lost, 262,732. Of the nonfatal accidents, 42 were due to falls of roof or coal, 27 were injuries by mine cars and motors, 4 were due to powder explosions, 2 to injuries in shafts, 1 to an explosion of dust, and 51 to miscellaneous causes.

There is only one coal-mining establishment in the State at which washing machinery has been installed. This is at the mines of the St. Bernard Mining Company, Earlington, Ky., where six Campbell washers have been installed. The number of tons of coal washed in 1908 was 81,897, yielding 72,798 short tons of cleaned coal and 9,099 tons of refuse. The same company reported in 1907, 99,763 short tons of coal washed, yielding 88,678 tons of cleaned coal and 11,085 tons of refuse.

The statistics of production of coal in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kentucky in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	1,370,179	33,066	27,977	6,664	1,437,886	$1,700,111	$1.18	232	2,668
Boyd	52,456	2,828			55,284	45,479	.82	208	319
Carter	116,343	3,284	1,000		120,627	119,266	.99	219	272
Daviess	39,970	32,716	1,221		73,907	96,450	1.31	234	117
Henderson	149,370	61,255	6,957		217,582	247,681	1.14	223	453
Hopkins and Christian	1,892,959	63,645	70,688	99,763	2,127,055	1,860,697	.87	230	2,334
Johnson	119,087	1,538	1,965		122,590	170,897	1.39	160	299
Knox	684,581	11,991	9,919		706,491	837,361	1.19	199	1,100
Laurel	308,636	5,076	5,569		319,281	368,602	1.15	219	598
Lee	57,882	4,309	450		62,641	97,168	1.55	222	95
McLean	142,449	6,273	1,483		150,205	159,778	1.06	191	231
Morgan	57,647	5,779	1,159		64,585	172,920	2.68	215	201
Muhlenberg	1,826,637	21,524	34,752		1,882,913	1,792,571	.95	209	2,365
Ohio	630,075	12,547	16,023		658 645	618,386	.94	183	991
Pike	525,172	3,394	5,121		533.687	497,866	.93	212	795
Pulaski	128,172	3,527	3,526		135.225	191,079	1.41	168	412
Union	442,590	43,302	18,399	3,564	507,855	512,877	1.01	205	861
Webster	549,263	38,484	20,946		608,693	569,780	.94	193	749
Whitley	732,033	17,461	13,429		762 923	1,086,564	1.42	197	1,807
Other counties[a]	86,214	19,559	14,095		119 868	146,710	1.22	206	304
Small mines		85,181			85,181	112,795	1.32		
	9,911,715	476,739	254,679	109,991	10,753,124	11,405,038	1.06	210	16,971

[a] Breathitt, Butler, Floyd, Greenup, Hancock, Harlan, Knott, Lawrence, Leslie, Magoffin, Menifee, Owsley, Rockcastle, and Wayne.

Coal production of Kentucky in 1907 and 1908, by counties, in short tons—Continued.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	1,500,143	33,427	24,354	....	1,557,924	$1,696,484	$1.09	211	2,423
Boyd	60,989	80	250	....	61,319	51,548	.84	201	165
Carter	76,193	6,653	700	....	83,546	82,560	.99	148	268
Daviess	....	50,678	477	....	51,155	49,810	.97	126	108
Floyd	46,300	7,400	7,350	....	61,050	63,560	1.04	205	96
Henderson	129,045	58,613	8,365	....	196,023	210,585	1.07	173	350
Hopkins and Christian	1,715,559	55,818	78,110	81,899	1,931,386	1,624,982	.84	217	2,445
Johnson	148,932	4,261	5,077	....	158,270	204,657	1.29	173	294
Knox	499,518	5,554	10,138	....	515,210	570,149	1.11	167	1,001
Laurel	196,622	4,326	6,136	....	207,084	222,113	1.07	166	543
Lee	155,476	2,675	300	....	158,451	236,344	1.49	194	278
McLean	97,899	5,966	1,604	....	105,469	96,840	.92	108	223
Morgan	60,967	8,212	957	....	70,136	164,368	2.34	268	157
Muhlenberg	1,738,112	17,725	28,448	....	1,784,285	1,621,683	.91	179	2,783
Ohio	570,514	13,539	17,085	....	601,138	548,679	.91	162	1,056
Pike	538,120	15,059	8,556	....	561,735	472,629	.84	190	791
Pulaski	94,996	2,474	2,035	....	99,505	138,729	1.39	171	268
Union	438,867	32,045	25,961	2,856	499,729	501,332	1.00	177	736
Webster	514,914	24,640	19,693	....	559,247	484,286	.87	178	767
Whitley	783,548	15,827	11,739	....	811,114	1,049,652	1.29	176	1,983
Other counties[a]	53,800	24,837	2,740	....	81,377	104,601	1.29	138	261
Small mines	....	91,400	....	....	91,400	121,571	1.33	....	....
	9,420,514	481,209	260,075	84,755	10,246,553	10,317,162	1.01	186	16,996

[a] Breathitt, Butler, Greenup, Hancock, Knott, Lawrence, Leslie, Magoffin, Menifee, Owsley, and Wayne.

In the following table is presented a statement of production of coal in Kentucky, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907:

Coal production of Kentucky, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Bell	521,662	757,413	989,108	1,437,886	1,557,924	+ 120,038
Boyd	69,095	48,304	48,822	55,284	61,319	+ 6,035
Breathitt and Lee	110,303	126,937	119,168	87,941	181,551	+ 93,610
Butler	1,647	18,199	15,735	10,271	6,858	− 3,413
Carter	245,030	145,169	158,748	120,627	83,546	− 37,081
Christian, Daviess, and Hancock	185,922	199,363	161,753	150,248	128,195	− 22,053
Greenup	2,742	1,543	719	902	1,474	+ 572
Henderson	151,103	175,226	201,007	217,582	196,023	− 21,559
Hopkins	1,691,675	2,013,715	2,165,342	2,064,154	1,864,346	− 199,808
Johnson	41,120	57,310	89,451	122,590	158,270	+ 35,680
Knox	577,778	579,386	549,726	706,491	515,210	− 191,281
Laurel	380,667	445,958	402,373	319,281	207,084	− 112,197
Lawrence	69,036	37,481	47,279	29,673	22,975	− 6,698
McLean	117,616	109,429	168,425	150,205	105,469	− 44,736
Muhlenberg	934,048	1,050,501	1,492,331	1,882,913	1,784,285	− 98,628
Ohio	514,126	542,327	707,585	658,645	601,138	− 57,507
Pulaski	197,796	184,319	181,720	135,225	99,505	− 35,720
Rockcastle	139,340	114,356	13,358	6,500	....	− 6,500
Union	368,194	382,956	416,013	507,855	499,729	− 8,126
Webster	298,715	347,817	501,430	608,693	559,247	− 49,446
Whitley	788,836	793,902	781,354	762,923	811,114	+ 48,191
Other counties and small mines	170,031	300,912	442,200	717,235	801,291	+ 84,056
Total	7,576,482	8,432,523	9,653,647	10,753,124	10,246,553	− 506,571
Total value	$7,868,192	$8,385,232	$9,809,938	$11,405,038	$10,317,162	−$1,087,876

Kentucky is the only one of the coal-producing States which has within its borders areas belonging to any two of the great coal fields. The eastern counties of the State are underlain by the coal-bearing formations of the great Appalachian system, or province, which extend entirely across the State in a northeast-southwest direction, while the southern limits of the Illinois-Indiana field, designated as the eastern region of the interior province, are found in the more northern counties of the western part of Kentucky. Although the coals of the Appalachian system are superior in quality to those of the interior regions, the western district of Kentucky has been more extensively developed and has produced more coal than the eastern portion. In 1907 the western district produced 40 per cent more than did the eastern district, the counties in the eastern part of the State producing 4,457,727 short tons and those of the western district 6,295,397 short tons. The eastern counties showed a relative gain in 1908, the output for this district being 4,446,433 short tons, while the western district produced 5,800,120 short tons, the production of the western district being only 30 per cent larger than that of the eastern.

The following tables show the production in the eastern and western districts, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907:

Coal production of the eastern district of Kentucky, 1904–1908, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase(+) or decrease (−), 1908.
Bell	521,662	757,413	989,108	1,437,886	1,557,924	+120,038
Boyd	69,095	48,304	48,822	55,284	61,319	+ 6,035
Breathitt	42,355	32,340	37,350	25,300	23,100	− 2,200
Carter	245,030	145,169	158,748	120,627	83,546	− 37,081
Greenup	2,742	1,543	719	902	1,474	+ 572
Johnson	41,120	57,310	89,451	122,590	158,270	+ 35,680
Knox	577,778	579,386	549,726	706,491	515,210	−191,281
Laurel	380,667	445,958	402,373	319,281	207,084	−112,197
Lawrence	69,036	37,481	47,279	29,673	22,975	− 6,698
Lee	67,948	94,597	81,818	62,641	158,451	+ 95,810
Pulaski	197,796	184,319	181,720	135,225	99,505	− 35,720
Rockcastle	139,340	114,356	13,358	6,500	....	− 6,500
Whitley	788,836	793,902	781,354	762,923	811,114	+ 48,191
Other counties and small mines	68,013	214,519	386,825	672,404	746,461	+ 74,057
	3,211,418	3,506,597	3,768,651	4,457,727	4,446,433	− 11,294

Coal production of the western district of Kentucky, 1904–1908, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase(+) or decrease (−), 1908.
Butler	1,647	18,199	15,735	10,271	6,858	− 3,413
Christian	91,943	89,766	80,065	62,901	67,040	+ 4,139
Daviess	44,125	61,780	52,643	73,907	51,155	− 22,752
Hancock	49,854	47,817	29,045	13,440	10,000	− 3,440
Henderson	151,103	175,226	201,007	217,582	196,023	− 21,559
Hopkins	1,691,675	2,013,715	2,165,342	2,064,154	1,864,346	−199,808
McLean	117,616	109,429	168,425	150,205	105,469	− 44,736
Muhlenberg	934,048	1,050,501	1,492,331	1,882,913	1,784,285	− 98,628
Ohio	514,126	542,327	707,585	658,645	601,138	− 57,507
Union	368,194	382,956	416,013	507,855	499,729	− 8,126
Webster	298,715	347,817	501,430	608,693	559,247	− 49,446
Other counties and small mines	102,018	86,393	55,375	44,831	54,830	+ 9,999
	4,365,064	4,925,926	5,884,996	6,295,397	5,800,120	−495,277

So far as the records of early coal production in the United States are to be accepted, Kentucky was the third State to enter the list of regular coal producers. According to one of the early reports of the Kentucky Geological Survey (published in 1838), the first coal produced in the State was mined in 1827 on "the right side of the [Cumberland] river below the mouth of Laurel." This was evidently from either Laurel or Pulaski County, but the exact location is not definitely stated. The same report says that in 1828 five boat loads of coal from these mines arrived at Nashville, and that from 1829 to 1834 probably from 25 to 35 boat loads were sent out each year. The boat loads averaged about 1,750 bushels, or 66 tons, each. From 1834 to 1837 the shipments were from 75 to 100 boat loads, or about 3,500 bushels, a year. The coal was for the most part consumed in the salt works and iron furnaces convenient to the rivers, the only means of transportation.

From the best information obtainable it seems that the production of the State from 1829 to 1835 ranged from 2,000 to 6,000 tons per year. The United States census for 1840 gives the total production for the State at 23,527 short tons. By 1860, according to the census for that year, the production amounted to 285,760 short tons. Operations were necessarily somewhat interrupted during the civil war, but since 1870, after the State had begun to recover from the effects of the war, the production increased rapidly, as shown in the table following, giving the history of coal production in Kentucky from the earliest times to the close of 1908:

Production of coal in Kentucky from 1828 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1828	328	1849	140,000	1870	150,582	1891	2,916,069
1829	2,000	1850	150,000	1871	250,000	1892	3,025,313
1830	2,000	1851	160,000	1872	380,800	1893	3,007,179
1831	2,100	1852	175,000	1873	400,000	1894	3,111,192
1832	2,500	1853	180,000	1874	360,000	1895	3,357,770
1833	2,750	1854	190,000	1875	500,000	1896	3,333,478
1834	5,000	1855	200,000	1876	650,000	1897	3,602,097
1835	6,000	1856	215,000	1877	850,000	1898	3,887,908
1836	8,000	1857	240,000	1878	900,000	1899	4,607,255
1837	10,000	1858	250,000	1879	1,000,000	1900	5,328,964
1838	11,500	1859	275,000	1880	946,288	1901	5,469,986
1839	16,000	1860	285,760	1881	1,232,000	1902	6,766,984
1840	23,527	1861	280,000	1882	1,300,000	1903	7,538,032
1841	35,000	1862	275,000	1883	1,650,000	1904	7,576,482
1842	50,000	1863	250,000	1884	1,550,000	1905	8,432,523
1843	60,000	1864	250,000	1885	1,600,000	1906	9,653,647
1844	75,000	1865	200,000	1886	1,550,000	1907	10,753,124
1845	100,000	1866	180,000	1887	1,933,185	1908	10,246,553
1846	115,000	1867	175,000	1888	2,570,000		
1847	120,000	1868	160,000	1889	2,399,755		132,651,127
1848	125,000	1869	160,000	1890	2,701,496		

According to the estimates of M. R. Campbell, the original coal supply in the State of Kentucky, when mining first began, was 104,028,000,000 short tons, of which 67,787,000,000 tons were in the eastern Kentucky region and 36,241,000,000 tons in the coal areas of the western part of the State. From the total original supply there had been mined to the close of 1908, according to the best records obtainable, approximately 132,650,000 tons, which represents an exhaustion estimated at 199,000,000 tons, or 0.18 per cent of the original supply.

MARYLAND.

Total production in 1908, 4,377,093 short tons; spot value, $5,116,753.

The effect of the business depression during 1908 was exhibited in the production of coal in Maryland by a decrease of 1,155,535 short tons in quantity and of $1,506,944 in value. The percentage of decrease was 20.89 in quantity and 22.75 in value. The tonnage of 1908 was the smallest in any year since 1900, when the industry in Maryland was much disturbed by labor troubles, and strikes lasting from 90 to 200 days curtailed the production by nearly 800,000 tons as compared with the preceding year (1899). The year 1900 was the only one since 1896 when the output of the coal mines of Maryland was less than that reported in 1908. The average price per ton in 1908 was $1.17, as compared with $1.20 in 1907 and $1.19 in 1906.

In spite of the decreased production, the number of men employed in the coal mines of the State reported to the Geological Survey shows an increase from 5,880 to 6,079, but the average number of days the mines were worked decreased from 263 in 1907 to 220 in 1908. In 1906 the average number of men employed was 6,438, working an average of 250 days. The most striking feature exhibited in the statistics of labor employed in the coal mines of Maryland in 1908, as compared with the preceding years, is the decline in the average production per man employed. In 1906 the average production per man was 844.3 short tons, in 1907 it was 941 tons, and in 1908 it was 720 tons. The average daily production per man in 1908 was 3.27 short tons, against 3.58 tons in 1907 and 3.38 tons in 1906.

A part of the decreased production per man employed may be attributed to the fewer number of tons mined by machines, this factor in 1908 amounting to 208,134 short tons, as compared with 479,110 tons in 1907. The number of mining machines in use decreased from 43 in 1907 to 39 in 1908, and the percentage of machine-mined coal to the total production decreased from 8.66 to 4.76.

By far the larger number of mines in Maryland worked ten hours a day. In 1908 there were 49 mines employing 5,905 men which worked ten hours as the length of day, 3 mines employing 59 men worked nine hours, and 1 mine employing 80 men worked eight hours.

There were no strikes reported at any of the coal mines of Maryland during 1908.

The report of Mr. John H. Donahue, state mine inspector of Maryland, is made for the fiscal year ended April 30. According to Mr. Donahue's report for the fiscal year ended April 30, 1909, the total production in the State amounted to 3,718,061 long tons, or 4,164,228 short tons, as compared with the production of 4,377,093 short tons reported to the Geological Survey for the calendar year 1908. There were, according to Mr. Donahue, 12 fatal and 96 nonfatal accidents in the coal mines of Maryland during the fiscal year. The most serious accident was a collision of mine cars, which occurred on the incline at the Washington mine No. 5 of the Piedmont and Georges Creek Coal Company on Monday morning, January 25, 1909. This resulted in the death of 5 and the injury of 10 men who were riding on the cars at the time of the collision. Of the other deaths 2 were due to falls of top coal or roof and 2 to falls of breast coal. One man was run over by cars, 1 was caught between mine cars, and 1 was killed in a runaway tramway bucket. Of the nonfatal accidents 55 were due to falls of roof or coal, 2 to powder explosions, and 39 to miscellaneous causes. The death rate per thousand men employed for the fiscal year was 2 and the number of short tons mined for each life lost 347,019.

The statistics of production during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of Maryland, 1904–1908, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1904	4,721,714	49,814	42,094	4,813,622	$5,729,085	$1.19	226	5,671
1905	5,010,997	49,779	47,763	5,108,539	5,831,760	1.14	252	5,948
1906	5,331,321	50,306	53,826	5,435,453	6,474,793	1.19	250	6,438
1907	5,427,882	48,461	56,285	5,532,628	6,623,697	1.20	263	5,880
1908	4,288,306	38,054	50,733	4,377,093	5,116,753	1.17	220	6,079

Although coal was discovered in the Georges Creek basin as early as 1782, the first eastern shipments from the Maryland coal district were not made until 1830, when small amounts were transported by barges down Potomac River. The first company was incorporated in 1836. After the construction of the Baltimore and Ohio Railroad, in 1842, and of the Chesapeake and Ohio Canal, in 1850, the output from the Maryland mines increased rapidly.

The attempts to ship coal from the Maryland mines by barges, prior to the advent of the Baltimore and Ohio Railroad, were not long continued. The method was too destructive of life and was the cause of so much loss in coal that it was soon abandoned, and it was not until 1842 that the industry really began to assume importance. The first shipments over the Chesapeake and Ohio Canal from Cumberland were made in 1850.

Maryland and the adjoining counties in West Virginia, which make up what is known as the Cumberland region, constitute the only districts outside of the anthracite region of Pennsylvania where records of coal production have been kept from the earliest years. These districts have been commonly known as the Georges Creek or Cumberland and the Piedmont regions. The Cumberland region was opened in 1842. The Piedmont region began shipping in 1853. The records of shipments have been carefully preserved and are published annually in the reports of the Cumberland Coal Trade.

The coal-bearing formations of Maryland are contained within an area of 455 square miles, and Mr. Campbell[a] estimates the original supply to have been 8,044,000,000 tons. From this there has been produced since mining began, in 1820, a total of 151,983,641 short tons, which, including the waste of one-half ton for each ton mined, represents an exhaustion of approximately 228,000,000

[a] Campbell, Marius R., Coal fields of the United States, U. S. Geol. Survey, 1908.

tons. This, deducted from the original supply, indicates that there still remains in the coal fields of Maryland a store of 7,816,000,000 short tons. The exhaustion to the close of 1908 was somewhat less than 3 per cent of the original supply.

The annual production since mining began, in 1820, is shown in the following table:

Production of coal in Maryland from 1820 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1820	3,000	1857	654,017	1875	2,808,018	1893	3,716,041
1832	12,000	1858	722,686	1876	2,126,873	1894	3,501,428
1840	8,880	1859	833,349	1877	1,939,575	1895	3,915,585
1842	2,104	1860	438,000	1878	2,068,925	1896	4,143,936
1843	12,421	1861	287,073	1879	2,132,233	1897	4,442,128
1844	18,345	1862	346,201	1880	2,228,917	1898	4,674,884
1845	30,372	1863	877,313	1881	2,533,348	1899	4,807,396
1846	36,707	1864	755,764	1882	1,555,445	1900	4,024,688
1847	65,222	1865	1,025,208	1883	2,476,075	1901	5,113,127
1848	98,032	1866	1,217,668	1884	2,765,617	1902	5,271,609
1849	175,497	1867	1,381,429	1885	2,833,337	1903	4,846,165
1850	242,517	1868	1,529,879	1886	2,517,577	1904	4,813,622
1851	317,460	1869	2,216,300	1887	3,278,023	1905	5,108,539
1852	411,707	1870	1,819,824	1888	3,479,470	1906	5,435,453
1853	657,862	1871	2,670,338	1889	2,939,715	1907	5,532,628
1854	812,727	1872	2,647,156	1890	3,357,813	1908	4,377,093
1855	735,137	1873	3,198,911	1891	3,820,239		
1856	817,659	1874	2,899,392	1892	3,419,962		151,983,641

MASSACHUSETTS AND RHODE ISLAND.

For the first time since the inauguration of this series of reports Massachusetts appears in the list of coal producers. The production, while not to be considered of commercial importance, is of local interest. It amounted to 50 tons of brown coal, or lignite, and was mined at Vineyard Haven, on the island of Marthas Vineyard, Dukes County. All of the output was used in the manufacture of clay products by the company mining it. It was valued at $3 per ton, the value being based upon what other fuel which would do an equivalent amount of work, would cost.

In former years some coal, classed as anthracite, was mined in the eastern part of Rhode Island and in the adjoining counties of Bristol and Plymouth in Massachusetts, but none has been mined there for fuel purposes for a number of years. This coal has really passed the anthracite stage and is of a graphitic character. Some of it has been mined in recent years and used as graphite. It has therefore not been included in the reports on the production of coal. It is reported, however, that an attempt will be made to utilize this coal as a fuel by a process which includes the application of an inexpensive chemical which will aid in the combustion of the fuel. If successful, the venture will be of considerable interest.

MICHIGAN.

Total production in 1908, 1,835,019 short tons; spot value, $3,322,904.

Compared with that of 1907 the output of the coal mines of Michigan in 1908 showed a decrease of 200,839 short tons, or 9.87 per cent in quantity and of $337,929, or 9.23 per cent in value. Notwithstanding this decrease, the tonnage reported for 1908 was larger than in any previous year in the history of the State, with the exception of 1907. As compared with 1906, the coal production of Michigan in 1908 showed an increase of 488,681 short tons, or 36 per cent, and as compared with 1905, when the largest production previous to 1907 was recorded, the increase amounted to 361,808 short tons, or 25 per cent. It would appear, therefore, that in Michigan, at least, the coal-mining industry in 1908 was nearly up to the normal. The coal trade of the State is largely dependent upon the demand of the manufacturing cities along the lake front, and as the manufacturing industries of those cities were seriously influenced by the panic of 1907 and the depressed condition following it, the general feeling at the close of 1908 was that the production for the year would show a decrease of from 25 to 35 per cent. Complete returns indicate, however, that the decrease in production was about one-third that anticipated, and even this was partially compensated for by a decrease in value, which was proportionately less than the decrease in production.

Although the output of the mines of Michigan was more than 200,000 tons less than in 1907 the number of men employed in its production increased from 3,982 in 1907 to 4,247 in 1908, the depression in other lines of industry showing its effect in a surplus of labor available for coal mining. The average number of days worked, however, decreased from 234 days in 1907 to 207 days in 1908. The average production of each man employed decreased from 511 tons in 1907 to 432 tons in 1908, while the daily average production declined from 2.19 to 2.09 tons. Practically all of the coal mines of Michigan are operated eight hours a day, under agreement with the United Mine Workers of America. The operations during 1908 were almost entirely free from labor troubles, a strike at only one mine having been reported. That strike affected 300 men, who were idle 16 days.

During 1908 there were 120 mining machines reported as being used in the coal mines of Michigan, an increase of 17 over 1907. The machine-mined product amounted to 535,543 short tons, or 29.18 per cent of the total product, and in 1907 the machine-mined product amounted to 606,718 short tons, or 29.8 per cent of the total. Of the 120 machines in use, 85 were of the pick or puncher type, 33 were chain-breast machines, and 2 were long-wall.

Mr. M. J. McLeod, the Michigan commissioner of labor and industrial statistics, reports that in 1908 there was a total of 106 accidents in the coal mines of the State. Of these, 5 resulted fatally, 28 of the injuries received were of a serious character, and 73 were minor. No explosions of either dust or gas were reported during the year. Of the 5 fatal accidents 4 were due to falls of rock or coal in gangways, and 1 was due to an explosion of powder. Of the nonfatal accidents, 40 were due to falls of rock or coal in the gangways, 5 to falls of roof in rooms, 10 to explosions of powder, 10 to injuries received from mine cars, and 36 were attributed to other causes.

The death rate per 1,000 employees was 1.18, and the number of tons mined for each life lost was 367,004.

The statistics of the production of coal in Michigan, by counties, during 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Michigan in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	836,060	77,664	48,850	962,574	$1,659,315	$1.72	226	1,720
Eaton, Jackson, and Shiawassee [a]	....	25,357	....	25,357	69,642	2.75	275	52
Saginaw	956,538	26,413	64,976	1,047,927	1,931,876	1.84	239	2,210
	1,792,598	129,434	113,826	2,035,858	3,660,833	1.80	234	3,982

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	725,253	26,098	31,152	782,503	$1,396,846	$1.79	206	1,770
Clinton, Eaton, Jackson, and Tuscola [a]	34,570	14,144	4,464	53,178	112,526	2.12	197	150
Saginaw	914,602	46,981	37,755	999,338	1,813,532	1.81	208	2,327
	1,674,425	87,223	73,371	1,835,019	3,322,904	1.81	207	4,247

[a] Includes the output of small mines.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Michigan, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Bay	410,634	544,154	481,398	962,574	782,503	− 180,071
Eaton	9,057	4,058	18,507	5,982	2,286	− 3,696
Jackson	16,860	9,196	8,658	5,645	5,539	− 106
Saginaw	906,289	915,803	835,475	1,047,927	999,338	− 48,589
Shiawassee	....	....	[a] 2,300	13,730	[b] 45,353	+ 41,623
Total	1,342,840	1,473,211	1,346,338	2,035,858	1,835,019	− 200,839
Total value	$2,424,935	$2,512,697	$2,427,404	$3,660,833	$3,322,904	−$337,929

[a] Including the output of small mines. [b] Clinton and Tuscola counties and small mines.

The coal fields of Michigan are confined entirely to the lower peninsula, and with the exception of the extreme northern part of the Appalachian region, are the only ones within the drainage area of the Great Lakes. The developments have been principally in the eastern portion of the fields and in a line running from Bay City, on the north, to Jackson, at the southern extremity of the coal basin.

Coal was known to exist in Michigan early in the last century, and some mining is said to have been done in the Jackson field as early as 1835. Other mines were opened at Grand Ledge, in Clinton County, in 1838, and while it is known that some coal was produced there in those early years, there is no record of the output prior to the census report of 1860, in which year Michigan was credited with a production of 2,320 tons. The development of mining in this field has, however, been tardy, owing largely to the fact that one of the principal industries of the vicinity, the manufacture of salt, had been carried on in connection with sawmills, using the sawdust and other refuse from these mills as fuel. Wood also formed the chief fuel for other manufacturing industries and for domestic use. It was only in the closing decade of the last century that serious attention began to be paid to the coal resources of the State, and prior to 1896 the production had exceeded 100,000 tons during four years only. In 1897 it exceeded 200,000 tons; in 1899 it exceeded 600,000 tons, and in the first year of the present century it reached a total exceeding 1,200,000 tons. The maximum output of 2,035,858 tons was reached in 1907.

The record by years from 1860 to the close of 1908 is shown in the following table:

Production of coal in Michigan, 1860 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	2,320	1873	56,000	1886	60,434	1899	624,708
1861	3,000	1874	58,000	1887	71,461	1900	849,475
1862	5,000	1875	62,500	1888	81,407	1901	1,241,241
1863	8,000	1876	66,000	1889	67,431	1902	964,718
1864	12,000	1877	69,197	1890	74,977	1903	1,367,619
1865	15,000	1878	85,322	1891	80,307	1904	1,342,840
1866	20,000	1879	82,015	1892	77,990	1905	1,473,211
1867	25,000	1880	100,800	1893	45,979	1906	1,346,338
1868	28,000	1881	112,000	1894	70,022	1907	2,035,858
1869	29,980	1882	135,339	1895	112,322	1908	1,835,019
1870	28,150	1883	71,296	1896	92,882		
1871	32,000	1884	36,712	1897	223,592		15,677,962
1872	33,600	1885	45,178	1898	315,722		

Michigan's original supply of coal, according to the estimate of Mr. Campbell, was 12,000,000,000 tons, contained in an area of 11,000 square miles of coal-productive territory. The production of the State at the close of 1908 amounted to 15,677,962 short tons, which, including the waste involved in the mining operations, represented an exhaustion of 23,500,000 short tons, or 0.2 per cent of the total original supply. Michigan's coal production in 1908 was 12 per cent of the aggregate output to the close of the year.

MISSOURI.

Total production in 1908, 3,317,315 short tons; spot value, $5,444,907.

In Missouri, as in Arkansas, Kansas, and Oklahoma, the coal-mining industry in 1908 was adversely affected, more by the increased production and consumption of petroleum and natural gas in the Mid-Continent field than by the business depression. Natural gas from the eastern Kansas fields is now piped to Kansas City and St. Joseph, Mo.; Atchison, Leavenworth, Lawrence, Arkansas City, Winfield, Wichita, Wellington, and Hutchinson, Kans.; also to Pittsburg and Galena, Kans., and to Joplin, Mo. Oil from the same field and from northern Oklahoma is being extensively used for fuel at Kansas City, and these conditions have naturally affected the coal production of Missouri. The coal-mining industry of the State reached its maximum production in 1903, with an output of 4,238,586 short tons. It decreased slightly in 1904, in 1905, and 1906, and reacted somewhat in 1907, to 3,997,936 short tons. Compared with 1907, the production in 1908 (3,317,315 short tons) shows a decrease of 680,621 short tons, or 17.02 per cent. The tonnage made in 1908 was the smallest in eight years, or since the beginning of the century. The value of the production in 1908 was $5,444,907, as compared with $6,540,709 in 1907, a decrease of $1,095,802, or 16.75 per cent. There was a difference of only a small fraction of a cent in the price per ton in 1908 as compared with 1907.

To Missouri's coal production in the last few years should be added a considerable tonnage credited to Kansas, the working of the mines at Leavenworth on Missouri River extending under that river into Missouri territory, and the larger part of the production of Leavenworth County, Kans., is in fact taken from beds underlying Platte County, Mo. Possibly a quarter of a million tons of the production credited to Kansas is mined in Missouri. It has been customary, however, where mine workings in one State or county extend into another, to credit the coal to the State or county in which the tipple is located. For this reason the tonnage in Platte County, Mo., is credited to Leavenworth County, Kans.

In spite of the decreased production in 1908, there was a larger number of men employed during that year than in 1907. This, as has already been explained in discussing the condition in other States, is due to the slight demand for labor in other lines of industry, particularly among the metal mines, which resulted in a surplus of labor in the coal-mining districts. The number of men employed in the Missouri coal mines in 1908 was 8,988 as compared with 8,448 in 1907, an increase of 540 men, or 6 per cent, in the number of men employed, while the production decreased 17 per cent. The average number of working days in 1908 was 169, against an average of 214 days in 1907. A good deal of the idle time in 1908 was due to the suspension of operations by the union mine workers, on April 1, and which lasted about two months. The total number of men on strike was 6,350. The number of days lost was 355,138, an average of 56 days to a man. The total time lost was about 23 per cent of the total time made during the year. The average production for each employee was 369, compared with 473 tons per man in 1907, and 393.2 tons in 1906. The average daily production for each employee in 1908 was 2.18 short tons, against 2.21 tons in 1907 and 2.13 tons in 1906.

Practically all of the more important coal-mining operations in the State of Missouri are conducted on the basis of an eight-hour day, 149 mines, employing a total of 8,464 men, reporting eight hours as the length of days worked in 1908.

The use of mining machines for undercutting coal in Missouri is almost entirely confined to the thin beds where machines of the long-wall type can be used to advantage. In 1908 the number of machines reported in use was 57, of which 52 were long-wall and 5 were of the pick or puncher type. In 1907 of the 62 machines reported in use 54 were long-wall. The machine-mined tonnage decreased from 486,882 short tons, or 12.18 per cent of the total output of the State in 1907, to 479,850 short tons, or 14.47 per cent of the total output in 1908.

Only one company in Missouri reported having installed machinery for improving the quality of the coal by washing. This company has four Stewart jigs in operation. In 1908, 74,104 short tons of coal were washed, yielding 55,576 tons of cleaned coal and 18,528 tons of refuse.

Mr. J. W. Marstellar, secretary of the Missouri bureau of mines and mine inspection, reports a total of 10 fatal and 36 nonfatal accidents in the coal mines of Missouri during 1908. There were 4 wives made widows and 13 children left fatherless through these casualties. None of the accidents, either fatal or nonfatal, was due to explosions of gas or dust. Nine out of the 10 fatalities were caused by falls of roof, and one death was caused by the victim being crushed by mine cars. Of the nonfatal accidents, 24 were due to falls of roof or coal, and 6 were due to mine cars. Of the other 6 men hurt 2 were caught by the cage, and the other 4 injuries were due to other causes. Mr. Marstellar states that following the suspension of mining operations in the spring of 1908 miners were warned through their respective local unions of the liability of falls of roof and coal after periods of idleness. It was explained to the miners that experience in the past had been that following a period of idleness there was an increased number of accidents when work was resumed. The figures as submitted by Mr. Marstellar show that little attention was paid to the warning and that the temptation to recover the loss from the strike had more influence than the fear of accidents. In 1907 there were 8 fatal and 23 nonfatal accidents. In 1908, with a material reduction in the output, there were 10 fatal and 36 nonfatal accidents. The death rate per thousand in 1907 was a little less than 1; in 1908 it was 1.11. The number of tons mined for each life lost in 1907 was 499,742; in 1908 it was 331,732.

The coal-mining industry of Missouri may be considered as a record of the industrial conditions entirely within the State, modified by such fluctuations as are due to variations in the weather. The market for the coal product of the State is practically confined to its borders. Missouri is surrounded by other large coal-producing States—Iowa on the north, Kansas on the west, Arkansas and Oklahoma on the south, and Illinois and Kentucky on the east—these completing a boundary which confines the Missouri product to local markets. Moreover, some of the larger cities draw their principal fuel supplies from the neighboring States, St. Louis, for instance, being chiefly supplied with coal by Illinois, while Kansas City draws its fuel largely from Kansas.

The statistics of coal production in Missouri in 1907 and 1908, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Missouri in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	559,512	17,598	8,381	585,491	$866,523	$1.48	195	1,072
Audrain	22,403	15,267	595	38,265	71,225	1.86	211	127
Barton	172,616	16,882	3,920	193,418	291,356	1.51	189	446
Bates	80,499	34,486	300	115,285	182,317	1.58	184	213
Boone	11,000	21,634	400	33,034	64,593	1.96	228	94
Callaway	15,600	18,405	408	34,413	52,184	1.52	225	81
Henry	176,090	30,648	2,914	209,652	352,737	1.68	221	371
Lafayette	662,943	44,630	10,015	717,588	1,329,364	1.85	234	1,962
Linn	97,719	18,327	1,357	117,403	255,625	2.18	238	334
Macon	1,109,225	25,765	21,150	1,156,140	1,633,882	1.41	217	1,799
Putnam	50,020	965	690	51,675	105,964	2.05	150	244
Randolph	36,900	34,600	1,000	72,500	104,171	1.44	192	124
Ray	300,899	29,698	6,787	337,384	636,311	1.89	210	915
Other counties [a]	199,707	75,827	7,814	283,348	491,067	1.73	212	666
Small mines		52,340		52,340	103,390	1.98		
	3,495,133	437,072	65,731	3,997,936	6,540,709	1.64	214	8,448

[a] Benton, Caldwell, Cass, Chariton, Clay, Dade, Grundy, Howard, Johnson, Livingston, Moniteau, Monroe, Morgan, Ralls, St. Clair, Schuyler, and Vernon.

Coal production of Missouri in 1907 and 1908, by counties, in short tons—Continued.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	572,960	21,537	5,855	600,352	$875,398	$1.46	189	1,220
Audrain	23,009	12,697	1,773	37,479	75,185	2.01	248	120
Barton	121,330	4,926	3,376	129,632	185,939	1.43	150	420
Bates	112,670	19,588	1,442	133,700	217,730	1.63	140	346
Boone	....	25,868	....	25,868	50,436	1.95	236	50
Callaway	1,500	21,034	....	22,534	44,820	1.99	112	95
Henry	208,650	10,019	1,305	219,974	372,335	1.69	157	449
Lafayette	547,931	38,120	9,627	595,678	1,095,640	1.84	182	1,850
Linn	79,316	22,608	1,180	103,104	223,497	2.17	194	360
Macon	806,558	13,440	13,062	833,060	1,176,958	1.41	149	2,121
Putnam	48,292	1,822	661	50,775	85,963	1.69	145	214
Randolph	43,210	22,181	1,000	66,391	111,770	1.68	175	160
Ray	237,054	21,957	4,277	263,288	470,714	1.79	151	1,112
Other counties [a]	125,168	43,350	3,156	171,674	332,434	1.94	217	471
Small mines	....	63,806	....	63,806	126,088	1.98	....	....
	2,927,648	342,953	46,714	3,317,315	5,444,907	1.64	169	8,988

[a] Benton, Caldwell, Carroll, Cass, Chariton, Clay, Dade, Grundy, Howard, Johnson, Livingston, Moniteau, Monroe, Montgomery, Morgan, Pettis, Ralls, St. Clair, Schuyler, and Vernon.

The statistics of production during the last five years, by counties, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production in Missouri, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Adair	615,607	603,699	442,035	585,491	600,352	+ 14,861
Audrain	44,179	53,123	34,233	38,265	37,479	− 786
Barton	230,875	241,113	218,623	193,418	129,632	− 63,786
Bates	139,026	167,872	210,218	115,285	133,700	+ 18,415
Boone	37,920	40,786	40,626	33,034	25,868	− 7,166
Caldwell	15,366	15,000	14,000	15,000	10,600	− 4,400
Callaway	12,058	17,306	41,162	34,413	22,534	− 11,879
Grundy	15,597	....	7,990	11,040	10,821	− 219
Henry	134,651	125,988	115,679	209,652	219,974	+ 10,322
Jackson	4,050	....	....	....	....	....
Johnson	1,572	1,712	2,383	10,543	13,571	+ 3,028
Lafayette	682,419	667,023	679,679	717,588	595,678	− 121,910
Linn	111,095	95,175	95,326	117,403	103,104	− 14,299
Livingston	2,959	2,825	2,000	2,010	1,010	− 1,000
Macon	914,303	799,513	770,284	1,156,140	833,060	− 323,080
Montgomery and Morgan	8,146	....	....	....	2,783	+ 2,783
Putnam	71,266	79,162	104,899	51,675	50,775	− 900
Ralls	16,572	14,557	17,510	12,024	11,802	− 222
Randolph	585,135	491,404	371,386	72,500	66,391	− 6,109
Ray	244,707	236,598	276,341	337,384	263,288	− 74,096
Vernon	178,006	195,201	140,570	141,379	47,281	− 94,098
Other counties and small mines	102,799	135,321	173,064	143,692	137,612	− 6,080
Total	4,168,308	3,983,378	3,758,008	3,997,936	3,317,315	− 680,621
Total value	$6,801,751	$6,291,661	$6,118,733	$6,540,709	$5,444,907	−$1,095,802

A statement of the annual production of coal in Missouri from 1840 to the close of 1908 will be found in the following table:

Production of coal in Missouri from 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,972	1858	240,000	1876	1,008,000	1894	2,245,039
1841	12,000	1859	260,000	1877	1,008,000	1895	2,372,393
1842	15,000	1860	280,000	1878	1,008,000	1896	2,331,542
1843	25,000	1861	300,000	1879	1,008,000	1897	2,665,626
1844	35,000	1862	320,000	1880	844,304	1898	2,688,321
1845	50,000	1863	360,000	1881	1,960,000	1899	3,025,814
1846	68,000	1864	375,000	1882	2,240,000	1900	3,540,103
1847	80,000	1865	420,000	1883	2,520,000	1901	3,802,088
1848	85,000	1866	450,000	1884	2,800,000	1902	3,890,154
1849	90,000	1867	500,000	1885	3,080,000	1903	4,238,586
1850	100,000	1868	541,000	1886	1,800,000	1904	4,168,308
1851	125,000	1869	550,000	1887	3,209,916	1905	3,983,378
1852	140,000	1870	621,930	1888	3,909,967	1906	3,758,008
1853	160,000	1871	725,000	1889	2,557,823	1907	3,997,936
1854	175,000	1872	784,000	1890	2,735,221	1908	3,317,315
1855	185,000	1873	784,000	1891	2,674,606		
1856	200,000	1874	789,680	1892	2,733,949		100,935,421
1857	220,000	1875	840,000	1893	2,897,442		

The original coal supply of Missouri, as estimated by M. R. Campbell, of the United States Geological Survey, was 40,000,000,000 short tons, included within an area of 16,700 square miles. The production of the State, according to the best records available, amounted at the close of 1908 to 100,935,421 short tons, representing an exhaustion of approximately 151,000,000 tons, or 0.4 per cent of the estimated original supply.

MONTANA.

Total production in 1908, 1,920,190 short tons; spot value, $3,771,248.

From estimates obtained early in January, 1909, the indications were that the coal production of Montana in 1908 would fall far below that of the preceding year. Complete returns, however, show that the earlier estimates of decreased production were considerably in excess of the actual decrease. The record for 1908 shows that the production in that year was 96,667 short tons, or 4.79 per cent, less than in 1907, with a decrease in value of $135,834, or 3.48 per cent. This comparatively small decrease both in production and value was in spite of the fact that large supplies of coal were carried forward in storage from 1907, during the summer and fall of which year heavy purchases had been made by transportation companies and other large consumers in anticipation of a repetition of the experience of the preceding winter, when considerable suffering was felt through the scarcity of fuel. It was supposed from these conditions and from the continued business depression which prevailed during 1908 that the coal output of both Montana and Wyoming in that year would not exceed 60 per cent of that of 1907, whereas in Montana the production in 1908 was over 95 per cent of that of 1907, and in Wyoming it was nearly 88 per cent. In both States the decrease in value was less in proportion than the decrease in production.

The principal decrease in production in 1908 was shown in the output of Cascade County, the most important coal-producing county in the State. The production in this county fell off 214,978 short tons, while the production of Gallatin County decreased 53,284 tons, but these were partly offset by increases of 122,002 short tons in Carbon County and of 44,558 tons in Fergus County.

As was generally the case throughout the Rocky Mountain States, the supply of labor was more abundant than in either 1906 or 1907, the depression in the metal-mining industry having caused miners to seek employment in the coal regions. The number of men employed in the coal mines of Montana increased from 2,735 in 1907 to 3,146 in 1908, the average working time having decreased from 268 days in 1907 to 224 days in 1908. The average production per man in 1908 was 610 tons against an average of 737 tons in 1907 and 764.4 tons in 1906. The average daily production per man declined from 3.15 tons in 1906 to 2.75 tons in 1907 and 2.73 tons in 1908.

The decrease in the average production per man in both 1907 and 1908 was due in all probability to the smaller proportion of the product which was machine mined. In 1906 the quantity of coal undercut by machines was 974,306 short tons, or 53 per cent of the total. In 1907 the machine-mined production was 984,368 short tons, but the proportion of the total was not quite 50 per cent. In 1908 the quantity of coal reported as mined by machnies was 713,217 short tons, or 37.14 per cent of the total. In 1907 there were 86 mining machines reported in use, while in 1908 only 57 machines were in use.

Most of the mines of the State were operated on the basis of an eight-hour day, 2,903 men out of a total of 3,146 working eight hours.

The coal-mining industry of Montana was not materially affected by strikes or other labor disturbances during 1908. There were 8 mines at which strikes occurred, the periods of idleness varying from 6 to 34 days. The total number of men affected was 556, and the average time lost by all of these was 17 days.

There were 3 establishments in the State in which washing machinery had been installed. At these establishments 286,517 tons of coal were washed in 1908, the washing operations yielding 214,729 tons of cleaned coal and 71,788 tons of refuse.

According to Mr. Joseph B. McDermott, state mine inspector, there were 20 fatal and 58 nonfatal accidents in the coal mines of Montana during 1908. As in 1907, the coal-mining operations were exceptionally free from gas or dust explosions. The most serious single accident was a fire in mine No. 2 of the Northwestern Improvement Company at Red Lodge, on November 20. As a result of this fire 9 men lost their lives by suffocation, and 11 more were overcome by gases but afterwards recovered. Of the other fatal accidents, 7 were due to falls of roof or coal, 1 to powder explosion, 2 were crushed by cars, and 1 death was caused by the breaking of the hook on a block and tackle. Nine wives were left widows and 19 children fatherless. The death rate per 1,000 was 6.4 and the number of tons for each life lost was 96,010. In 1907 the death rate was 4.4 per 1,000 and the number of tons mined for each life lost, 168,071.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Montana in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	683,470	15,750	46,890		746,110	$1,431,333	$1.92	274	1,101
Cascade	980,698	19,710	25,815		1,026,223	1,724,056	1.68	260	1,046
Chouteau	14,500	9,997	350		24,847	71,077	2.86	202	59
Fergus	20,520	23,840	1,400		45,760	172,018	3.76	243	81
Park	34,848	1,492	5,976	60,239	102,555	381,940	3.72	291	323
Other counties [a]	59,439	790	9,103		69,332	121,080	1.75	277	125
Small mines		2,030			2,030	5,578	2.75		
	1,793,475	73,609	89,534	60,239	2,016,857	3,907,082	1.94	268	2,735

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	811,272	22,165	34,675		868,112	$1,689,962	$1.95	226	1,646
Cascade	758,761	24,593	27,891		811,245	1,370,948	1.69	214	993
Chouteau	16,500	2,870	400		19,770	46,703	2.36	161	43
Fergus	46,600	42,398	1,320		90,318	268,826	2.98	199	116
Park	40,160	1,044	6,470	59,268	106,942	343,760	3.21	283	280
Other counties [b]	6,254	6,921	8,773		21,948	46,453	2.12	151	68
Small mines		1,855			1,855	4,596	2.48		
	1,679,547	101,846	79,529	59,268	1,920,190	3,771,248	1.96	224	3,146

[a] Deerlodge and Gallatin. [b] Custer, Gallatin, Rosebud, and Valley.

In the following table is presented a statement of the coal production of Montana, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907:

Production of coal in Montana, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Carbon	544,976	588,414	557,148	746,110	868,112	+ 122,002
Cascade	599,158	826,026	1,027,923	1,026,223	811,245	− 214,978
Chouteau	5,764	6,500	12,305	24,847	19,770	− 5,077
Fergus	19,109	15,228	29,182	45,760	90,318	+ 44,558
Gallatin	109,556	123,006	97,926	69,257	15,973	− 53,284
Park	78,646	81,807	102,339	102,555	106,942	+ 4,387
Other counties and small mines	1,710	2,851	3,098	2,105	7,830	+ 5,725
Total	1,358,919	1,643,832	1,829,921	2,016,857	1,920,190	− 96,667
Total value	$2,194,548	$2,823,350	$3,240,357	$3,907,082	$3,771,248	−$135,834

The annual production from 1880 to 1908 is shown in the following table:

Production of coal in Montana from 1880 to 1908, in short tons.

1880	224	1888	41,467	1896	1,543,445	1904	1,358,919
1881	5,000	1889	363,301	1897	1,647,882	1905	1,643,832
1882	10,000	1890	517,477	1898	1,479,803	1906	1,829,921
1883	19,795	1891	541,861	1899	1,496,451	1907	2,016,857
1884	80,376	1892	564,648	1900	1,661,775	1908	1,920,190
1885	86,440	1893	892,309	1901	1,396,081		
1886	49,846	1894	927,395	1902	1,560,823		26,659,323
1887	10,202	1895	1,504,193	1903	1,488,810		

According to the estimates of M. R. Campbell, of the United States Geological Survey, the original coal supply of Montana was 303,060,000,000 short tons, from which there had been mined to the close of 1908 approximately 26,700,000 tons, representing an exhaustion, including the waste in mining, of about 40,000,000 tons, or 0.013 per cent of the original supply. The coal-mining industry of Montana, according to the best records available, began in 1880, in which year, according to the United States census, the production amounted to 224 short tons. It was not until 1889, however, that the industry assumed any importance. The production increased nearly 800 per cent (from 41,467 short tons in 1888 to 363,301 short tons in 1889). During the next six years development advanced rapidly, until in 1895 it exceeded 1,500,000 tons. From 1895 to 1905 the production remained practically steady, ranging from a minimum of 1,358,919 tons in 1904 to a maximum of 1,661,775 in 1900. It increased to 1,852,921 tons in 1906, and exceeded for the first time 2,000,000 tons in 1907.

NEW MEXICO.

Total production in 1908, 2,467,937 short tons; spot value, $3,368,753.

The Territory of New Mexico did not suffer so much from the panic and business depression of 1908 as did some of the other coal-mining regions of the United States. In the preliminary statement issued by the United States Geological Survey early in January it was stated that the production of the Territory in 1908 was not more than 10 per cent less than in 1907. The statistics compiled show that the actual decrease was 161,022 short tons, or 6.12 per cent—from 2,628,959 short tons in 1907 to 2,467,937 tons in 1908. The value decreased in somewhat greater proportion—from $3,832,128 to $3,368,753, a decline of $463,375, or 12.09 per cent. The average price per ton declined from $1.46 in 1907 to $1.37 in 1908.

The features of the year were the heavy falling off in the demand for coal by the railroads and by the manufacturing and smelting industries, and the considerable increase in the production of coke by the Stag Cañon Fuel Company, of Dawson, Colfax County. This coke was shipped to allied interests in Arizona and displaced equivalent quantities of eastern coke in that market.

From the tables below, which give the production of coal in New Mexico in 1907 and 1908, it appears that the quantity of coal made into coke in 1907 was 498,279 short tons, while in 1908 it was 450,114 short tons, an apparent decrease in 1908 of about 48,000 tons. The figures given in 1907, however, were for unwashed coal, while in 1908 they were for washed coal. The quantity of coke produced in New Mexico in 1907 was 265,125 short tons, while in 1908 it was 274,565 short tons, an increase of 9,440 short tons. The coke manufacturers of the Territory, who had to depend upon outside markets, were at a considerable disadvantage, as when the panic came in 1907 the Arizona smelters who did not suspend operations had large amounts of coke in storage and in transit. It has been stated that during the prosperous times of 1906 and 1907 from 300,000 to 500,000 tons of eastern coke had been shipped into the southwestern territory, and as a large portion of this had not been used, there was a decided glut in the market during the first half of 1908. This resulted in the closing down of a number of Colorado and New Mexico ovens. The production of coke at other plants than at Dawson showed a decided decrease. By the latter part of the year the accumulated stocks had been practically used up and the demand for New Mexico coke improved to some extent.

There was during the entire year 1908 an ample supply of cars; there were no strikes nor other labor troubles, and the supply of labor was ample. In New Mexico, as in the other coal-mining districts of the Rocky Mountains, the effects of the depression on the metal-mining industry caused a surplus of labor in the coal mines, so that notwithstanding the decreased production in the Territory the number of men employed in the coal mines showed an increase from 2,970 in 1907 to 3,448 in 1908. The average working time decreased, however, from 269 days in 1907 to 197 days in 1908. During the year there were a good many weeks when the coal mines were operated for one or two days only, but as is usual under such circumstances, the productive efficiency of the men was increased. The average daily production per man, which had decreased from 3.92 tons in 1906 to 3.29 tons in 1907, increased to 3.63 tons in 1908. The average production per man for the entire year (1908) was 716 tons, against 885.2 tons in 1907 and 949 tons in 1906. Most of the mines in the Territory were operated on a ten-hour basis. Fourteen mines, employing 3,015 men, reported ten hours as the length of the working day in 1908; 6 mines, employing 356 men, worked nine hours; and 5 mines, employing 30 men, worked eight hours.

The United States coal-mining law, which governs the mining operations of New Mexico, does not require a report by the mine inspector of nonfatal accidents. Mr. Jo. E. Sheridan, the territorial mine inspector, reports that during the calendar year 1908 there was a total of 23 fatal accidents. In Mr. Sheridan's official report covering the fiscal year ended June 30, 1908, the fatal accidents numbered 34. These included a dust explosion produced by three blown-out shots in the Bernal mine at Carthage, which resulted in the death of 11 men. This explosion occurred, however, on December 31, the last day of the calendar year 1907, and is therefore not included in the casualty statistics of 1908.

A total of 3,448 men were employed in the coal mines of New Mexico in 1908, and the death rate per 1,000 employed was 6.67. As the production amounted to 2,467,937 short tons, the number of tons mined for each life lost was 107,301.6. Two-thirds of the fatalities were due to falls of rock or coal, 5 men having been killed by falls of roof in rooms, and 10 by falls of rock or coal in gangways. One man was killed by a premature blast, 6 by being crushed by mine cars, and 1 death was due to a boiler explosion.

Mr. Sheridan points out that in nearly every case these deaths were due to carelessness, and that there is no section of the law which applies to these classes of negligence where the mine inspector could enforce proper methods to secure safety. With the exception of the 1 man killed by a boiler explosion, all of the deaths were probably due to the carelessness of the victims themselves. Of the total number of men killed, 8 were married and left a total of 17 fatherless children.

During 1905 and 1906 there were no mining machines reported as having been used in the undercutting of coal in the Territory of New

Mexico. In 1907 there were 3 machines reported as in use and 11,615 tons of coal were machine-mined. In 1908 7 machines and a machine-mined product of 30,600 tons were reported.

The statistics of production, by counties, during 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of New Mexico in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Colfax	1,296,253	19,418	30,600	498,279	1,844,550	$2,373,502	$1.29	281	1,792
McKinley	609,475	2,817	17,529	....	629,821	1,065,810	1.69	254	719
Other counties [a]	132,747	13,170	7,871	....	153,788	391,316	2.54	250	459
Small mines	....	800	....	....	800	1,500	1.88	....	....
	2,038,475	36,205	56,000	498,279	2,628,959	3,832,128	1.46	269	2,970

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Colfax	1,308,309	6,472	16,740	450,114	1,781,635	$2,052,322	$1.15	204	1,995
McKinley	520,367	5,076	13,607	....	539,050	934,089	1.73	162	980
Other counties [b]	125,175	10,115	10,562	....	145,852	379,867	2.60	242	473
Small mines	....	1,400	....	....	1,400	2,475	1.77	....	....
	1,953,851	23,063	40,909	450,114	2,467,937	3,368,753	1.37	197	3,448

[a] Lincoln, Rio Arriba, Sandoval, San Juan, Santa Fe, and Socorro.
[b] Bernalillo, Lincoln, Rio Arriba, Sandoval, San Juan, Santa Fe, and Socorro.

In the report for 1907 it was shown that the production of coal in New Mexico increased in every county, with one exception. In 1908 the production decreased in every county but one, the exception being Santa Fe County, whose output showed an increase of 22,788 short tons.

In the following table are presented the statistics of production, by counties, during the last five years, with the increases and decreases in 1908, as compared with 1907:

Coal production of New Mexico, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (—), 1908.
Colfax	788,955	1,031,829	1,292,241	1,844,550	1,781,635	— 62,915
Lincoln	70,964	19,143	....	1,691	1,245	— 446
McKinley	441,865	480,490	560,917	629,821	539,050	— 90,771
Rio Arriba	40,825	31,700	43,600	34,450	20,000	— 14,450
Santa Fe	60,090	69,832	3,938	31,952	54,740	+ 22,788
Other counties	49,626	16,939	64,017	86,495	71,267	— 15,228
Total	1,452,325	1,649,933	1,964,713	2,628,959	2,467,937	— 161,022
Total value	$1,904,499	$2,190,231	$2,638,986	$3,832,128	$3,368,753	—$463,375

The first record of coal production in New Mexico is that contained in the initial issue of the volume, Mineral Resources of the United States, which covered the calendar year 1882. In that year the reported output was 157,092 tons, or about 6 per cent of what it was in 1908, indicating that in twenty-seven years the coal production of New Mexico has increased about 16 times. The annual production since 1882 is given in the following table showing the total production in the period from 1882 to the close of 1908 has amounted to 24,793,369 short tons, which, including mining and other loss, represents a total exhaustion of about 37,000,000 tons.

Production of coal in New Mexico from 1882 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1882	157,092	1890	375,777	1898	992,288	1906	1,964,713
1883	211,347	1891	462,328	1899	1,050,714	1907	2,628,959
1884	220,557	1892	661,330	1900	1,299,299	1908	2,467,937
1885	306,202	1893	665,094	1901	1,086,546		
1886	271,285	1894	597,196	1902	1,048,763		24,793,369
1887	508,034	1895	720,654	1903	1,541,781		
1888	626,665	1896	622,626	1904	1,452,325		
1889	486,943	1897	716,981	1905	1,649,933		

According to the estimate of M. R. Campbell, the original coal supply in the Territory of New Mexico was 163,780,000,000 tons, so that the exhaustion to date represents approximately 0.02 per cent of the original supply. The production in 1908 was equal to nearly 10 per cent of the entire production to the close of that year, while the coal left in the ground is about 66,000 times the production in 1908 and over 44,000 times the exhaustion represented by that production.

NORTH CAROLINA.

No coal production was reported from North Carolina in 1906, 1907, and 1908. The output from the Cumnock mines, which had decreased from 23,000 tons in 1902 to 17,309 tons in 1903, 7,000 tons in 1904, and 1,557 tons in 1905, ceased entirely in 1906.

There are two areas in North Carolina in which coal occurs. Both of these are found in the Triassic formation and are of the same geologic age as the Richmond coal basin of Virginia. The two areas are known as the Deep River and the Dan River fields, being named from the two rivers which drain them. The only productive beds in recent years are those in the Deep River district in Chatham and Moore counties.

The following table contains a statement of the production of coal in North Carolina for such years as have been reported:

Distribution of the coal product of North Carolina, 1901–1905, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1901	10,000	....	2,000	12,000	$15,000	$1.25	300	25
1902	20,400	100	2,500	23,000	34,500	1.50	285	40
1903	14,429	87	2,793	17,309	25,300	1.47	264	49
1904	4,600	300	2,100	7,000	10,500	1.50	240	25
1905	461	1,096	....	1,557	2,336	1.50	60	15

The United States census of 1840 stated that a production of 3 tons was obtained from North Carolina in that year. There is no evidence of any other production prior to the civil war, when the necessities of the confederate government were partly relieved by coal obtained from this region. After the war the production fell off for several years, and from 1874 to 1879 none was reported from this area. The Cumnock, or Egypt, mines were reopened in 1889 and were producing each year from that time until 1906.

NORTH DAKOTA.

Total production in 1908, 320,742 short tons; spot value, $522,116.

All of the mineral fuel produced in North Dakota is brown lignite, extensive beds of which underlie the greater part of the western half of the State. From a purely calorific point of view this lignite is not a high-grade fuel, but it has been found to be particularly well adapted as a fuel for use in the manufacture of brick. The Dickinson Fire and Press Brick Company, of Dickinson; the Scranton Brick and Fuel Works, of Scranton; and the Kenmare Brick and Coal Company, of Kenmare, are all using North Dakota lignite in their kilns, and all testify to its satisfactory behavior for that kind of work. One of the favorable features possessed by the lignite, according to the statement of these brick manufacturers, is its comparatively smokeless and sootless quality in combustion. The concerns mentioned are using lignite for boiler fuel also. The time required for burning a kiln of brick is from eight days to two weeks, according to the quantity of moisture contained by the brick when set in the kiln, and also according to the quality of brick required. One of the manufacturers states that 1 ton of lignite is equal to 1 cord of ordinary brickyard wood.

The investigations of the coal-testing plant of the United States Geological Survey at St. Louis showed that this lignite was also well adapted for making producer gas. It yields a higher quality of gas than does either anthracite or bituminous coal, and used as a gas-engine fuel attained an efficiency as a power producer equal to the best West Virginia coal under boilers.

In sympathy with the general depression, and also owing to the milder winter of 1907–8, the production of lignite in North Dakota decreased from 347,760 short tons, valued at $560,199, in 1907, to 320,742 short tons, valued at $522,116, in 1908, a decrease of 27,018 short tons, or 7.77 per cent in quantity, and of $38,083, or 6.8 per cent in value.

Notwithstanding the decrease in production, the number of men employed in the lignite mines increased from 562 in 1907 to 631 in 1908, while the average number of working days decreased from 223 to 181. The average production per man was 508 tons in 1908, against 619 tons in 1907, while the daily production for each employee increased from 2.78 to 2.81 tons.

There were 11 undercutting machines employed in the mines of North Dakota in 1908, and the machine-mined production amounted to 104,884 short tons, against 12 machines, producing 136,700 tons, in 1907.

Strikes were reported as having occurred at three of the lignite mines in 1908, the periods of idleness ranging from 12 to 20 days.

The total number of men involved was 104 and the average time lost was sixteen days. There were 11 mines that employed 103 men and worked eight hours a day; 5 mines, employing 114 men, that worked nine hours; and 14 mines, employing 275 men, that worked ten hours.

According to Mr. T. R. Atkinson, the state mine inspector, there were 4 fatal and 4 nonfatal accidents in the lignite mines of North Dakota during 1908. Of the nonfatal accidents, 3 were of a serious character and 1 was of minor importance. Two men were killed and 1 was injured by falls of roof in rooms; 2 men were injured by powder explosions, and 1 man was crushed to death by mine cars. One other death and injury were attributed to "other causes."

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of North Dakota in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Morton	5,000	5,640	50	10,690	$15,905	$1.49	125	37
Stark	55,383	12,180	4,000	71,563	99,797	1.39	250	114
Ward	46,208	76,156	1,850	124,214	241,250	1.90	203	269
Other counties[a]	111,717	22,055	5,450	139,222	200,621	1.44	267	142
Small mines	....	2,071	....	2,071	2,626	1.27	....	....
	218,308	118,102	11,350	347,760	560,199	1.61	223	562

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Burleigh	101,912	10,197	4,848	116,957	$159,697	$1.35	161	201
Morton	4,000	16,800	50	20,850	25,605	1.23	168	45
Stark	26,037	10,430	2,000	38,467	72,987	1.90	177	79
Ward	48,866	61,501	5,413	115,780	219,832	1.90	203	262
Other counties[b]	6,280	17,261	50	23,591	36,913	1.56	164	44
Small mines	....	5,097	....	5,097	7,082	1.39	....	....
	187,095	121,286	12,361	320,742	522,116	1.63	181	631

[a] Burleigh, Emmons, McLean, and Williams. [b] Emmons, McLean, Oliver, and Williams.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908, as compared with 1907, are shown in the following table:

Coal production of North Dakota, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Burleigh	92,970	74,357	83,267	123,662	116,957	− 6,705
McLean	13,100	15,515	8,005	9,660	7,452	− 2,208
Morton	10,663	26,100	23,194	10,690	20,850	+ 10,160
Stark	52,744	49,417	63,785	71,563	38,467	− 33,096
Ward	87,766	137,542	120,962	124,214	115,780	− 8,434
Williams	9,185	9,268	4,431	5,400	13,969	+ 8,569
Emmons, Mercer }	2,100	4,000	....	....	....	....
Small mines	3,400	1,343	[a]2,045	[a]2,571	[b]7,267	+ 4,696
Total	271,928	317,542	305,689	347,760	320,742	− 27,018
Total value	$389,052	$424,778	$451,382	$560,199	$522,116	−$38,083

[a] Includes Emmons County. [b] Includes Emmons and Oliver counties.

The lignite areas of North Dakota are estimated by Mr. Campbell to underlie areas aggregating 35,500 square miles, and the original supply is roughly estimated to have been 500,000,000,000 tons. It is probable that some lignite was mined by pioneers and ranchmen prior to 1884, but that is the first year in which any production of coal was reported from the State. From 1884 to the close of 1907 the total production has amounted to only slightly more than 3,000,000 short tons, so that little effect upon the total supply has so far been made.

The annual production since 1884, as reported to the United States Geological Survey, has been as follows:

Production of coal in North Dakota from 1884 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	35,000	1891	30,000	1898	83,895	1905	317,542
1885	25,000	1892	40,725	1899	98,809	1906	305,689
1886	25,955	1893	49,630	1900	129,883	1907	347,760
1887	21,470	1894	42,015	1901	166,601	1908	320,742
1888	34,000	1895	38,997	1902	226,511		
1899	28,907	1896	78,050	1903	278,645	Total	3,105,000
1890	30,000	1897	77,246	1904	271,928		

OHIO.

Total production in 1908, 26,270,639 short tons; spot value, $27,897,704.

From a preliminary statement issued early in January, 1909, in which a review of the coal trade of 1908 was given, it was stated that according to opinions expressed by some of the larger operators the production of coal in Ohio for 1908 would show a decrease of about 15 per cent as compared with 1907. The reports to the Geological Survey show that the production fell off from 32,142,419 short tons, valued at $35,324,746, in 1907, to 26,270,639 short tons, valued at $27,897,704, in 1908, a decrease of 5,871,780 short tons, or 18.27 per cent in quantity, and of $7,427,042, or 21.03 per cent, in value. The average price per ton declined from $1.10 to $1.06. Some of the smaller operators, whose trade was largely domestic in character, held their own during the year, and some of these showed even an increased tonnage, but many of the large operators, whose shipments were made for railroad and factory consumption, showed a marked falling off, some as much as 20 per cent. The coal market of 1908 was affected during the earlier part of the year principally by the uncertainty of manufacturers as to the conditions following the panic, and later by the uncertainty as to the results of the Presidential election. After the results of the election were known operators expressed a feeling of confidence and that there would be a gradual, if not rapid, return of prosperity. The indications during the first half of 1909 were that the feeling of confidence would not be misplaced.

Throughout 1908 the transportation facilities were fully up to the requirements except for a short period toward the close of lake navigation. That the labor supply was ample was shown by the fact that notwithstanding the decreased tonnage there was an increase of nearly 600 in the number of men employed during the year. There was a suspension of operations at a number of mines during the spring, the principal contention being the length of time that the agreement between the operators and the miners should extend, the operators contending for a two-years' agreement, while the miners desired an agreement for one year. The scale was finally signed for a period of two years. Later, in August, the miners of the Crooksfield district, of Guernsey and Muskingum counties (25 in number) struck because of the disagreement over the removal of bone from the coal. There were altogether during the year 21,084 men on strike, the total time lost was 567,450 days, or an average of 27 days each.

The total number of men employed in the coal mines of the State was 47,407, who made an average of 161 days, compared with 46,833 men for an average of 199 days in 1907. The average production per man for each day was about the same in 1908 as in 1907, it being 3.45 days in 1907 and 3.44 in 1908. Owing to the fewer number of days worked in 1908, however, the average production for each man throughout the year was only 554 tons, compared with 686 tons in 1907. As in other States where coal mining is carried on under agreement with the United Mine Workers of America, the mines of Ohio, with a few exceptions, were operated eight hours a day. In 1908 there were 510 mines, employing 45,742 men, out of a total of 47,407 for the State, that were operated on the eight-hour basis. Eight mines, employing 1,004 men, worked nine hours, and 3 mines, employing 35 men, worked ten hours. There were 626 men whose time was not reported.

Ohio continues to lead all of the other coal-producing States in the percentage of the total product which is mined by the use of machines. The statistics for 1908 show that there were 1,343 machines in use, the machine-mined product amounting to 19,799,140 short tons, or 75.37 per cent of the total output of the State. In 1907 there were 1,328 machines in use, and the machine-mined product amounted to 24,843,616 short tons, or 77.29 per cent of the total. Of the 1,343 machines in use in 1908, 1,069 were of the chain-breast pattern, 135 of the pick or puncher type, 5 were long-wall and 134 were chain shearing machines.

The casualty statistics of Ohio, as reported by Mr. George Harrison, state mine inspector, show that there were 113 men killed and 598 injured in the coal mines of Ohio during 1908, against 153 men killed and 662 injured in 1907. Of the total number of deaths, 70 were due to falls of rock or coal, 16 to mine car accidents, 4 to powder explosions, 4 to electric wires, 2 to falls of roof in rooms, 5 to motors and mining machines, 2 to explosions of gas, and the remainder to miscellaneous causes. Of the nonfatal accidents, 273 were due to falls of roof and coal, 191 to mine cars, 37 to motors and mining machines, 24 to powder explosions, 9 to explosions of gas, and 63 to miscellaneous causes. Of the 598 nonfatal accidents, 423 were of a serious character and 175 minor. The death rate per thousand of men employed was 2.4 and the number of tons mined for each life lost was 232,484. In 1907 the death rate per thousand was 3.27 and the number of tons mined for each life lost was 210,081. It may be well to note that the production of coal in Ohio, as reported to the Geological Survey and as given by Mr. Harrison, shows a remarkable agreement. As reported to the Geological Survey the output of Ohio for the year 1908 was 26,270,639 short tons; as reported to Mr. Harrison it was 26,268,239 short tons.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Ohio in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Athens	4,439,889	28,400	93,905	500	4,562,694	$5,097,203	$1.12	159	7,473
Belmont	5,774,471	370,299	63,418	....	6,208,188	6,013,317	.97	228	7,482
Carroll	274,015	81,101	11,946	....	367,062	385,538	1.05	207	615
Columbiana	595,959	103,191	10,365	....	709,515	847,851	1.19	209	1,382
Coshocton	363,276	35,669	4,070	....	403,015	501,978	1.25	217	623
Gallia	29,660	5,535	....	....	35,195	39,434	1.12	182	69
Guernsey	3,860,211	19,287	91,423	....	3,970,921	3,661,399	.92	221	4,466
Harrison	462,062	30,429	6,809	....	499,300	479,717	.96	188	637
Hocking	1,619,118	18,414	11,049	....	1,648,581	1,869,308	1.13	167	2,584
Holmes	8,150	14,015	....	....	22,165	30,071	1.36	181	53
Jackson	1,191,903	60,385	32,589	....	1,284,877	2,154,150	1.68	182	2,760
Jefferson	4,180,890	268,303	78,013	800	4,528,006	4,711,020	1.04	223	5,702
Lawrence	173,306	65,645	4,076	....	243,027	315,003	1.30	193	563
Mahoning	58,083	33,602	2,650	....	94,335	144,478	1.53	195	208
Medina	30,873	14,394	804	....	46,071	70,713	1.53	172	112
Meigs	288,934	40,041	1,528	....	330,503	380,425	1.15	167	782
Muskingum	328,929	83,862	1,330	....	414,121	431,266	1.04	197	631
Perry	2,777,863	62,899	60,385	....	2,901,147	3,179,928	1.10	193	4,560
Stark	540,312	126,492	21,062	....	687,866	1,290,401	1.88	164	1,417
Summit	81,523	16,513	6,200	....	104,236	199,877	1.92	184	350
Tuscarawas	1,608,469	160,704	28,226	....	1,797,399	1,914,435	1.07	219	2,404
Vinton	160,623	89,446	4,460	....	254,529	302,242	1.19	178	524
Wayne	175,905	7,755	1,600	....	185,260	325,806	1.76	205	390
Other counties [a] and small mines	714,364	123,525	6,517	....	844,406	979,186	1.16	214	1,046
	29,738,788	1,859,906	542,425	1,300	32,142,419	35,324,746	1.10	199	46,833

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Athens	3,829,377	31,730	103,791	2,420	3,967,318	$4,300,692	$1.08	144	7,788
Belmont	5,319,885	208,144	65,748	....	5,593,777	5,204,636	.93	179	8,089
Carroll	314,011	35,587	17,150	....	366,748	363,031	.99	162	650
Columbiana	451,604	38,344	19,097	....	509,045	578,689	1.14	181	1,221
Coshocton	316,395	44,537	3,096	....	364,028	428,774	1.18	200	538
Gallia	7,800	3,650	....	....	11,450	11,735	1.02	156	44
Guernsey	2,852,628	29,306	57,616	....	2,939,550	2,693,031	.92	166	4,670
Harrison	435,006	23,826	5,844	....	464,676	448,129	.96	187	621
Hocking	1,398,402	21,020	14,614	....	1,434,036	1,521,711	1.06	167	2,515
Holmes	2,500	12,509	....	....	15,009	19,988	1.33	166	38
Jackson	750,969	53,058	32,301	....	836,328	1,432,553	1.71	175	2,339
Jefferson	3,241,763	287,427	61,210	616	3,591,016	3,576,394	.99	158	6,288
Lawrence	107,214	60,278	3,815	....	171,307	214,710	1.25	160	510
Mahoning	37,822	28,030	1,460	....	67,312	99,552	1.48	161	152
Medina	1,504	9,345	558	....	11,407	20,546	1.80	199	31
Meigs	385,876	59,203	4,890	....	449,969	480,023	1.07	170	921
Muskingum	369,509	59,097	2,047	....	430,653	406,225	.94	181	803
Noble	189,806	6,252	2,441	....	198,499	188,411	.95	118	395
Perry	2,036,770	63,822	46,403	....	2,146,995	2,366,826	1.10	142	4,297
Stark	372,272	99,564	30,084	....	501,920	957,582	1.91	128	1,310
Summit	82,151	11,110	5,380	....	98,641	184,123	1.87	139	238
Tuscarawas	1,184,480	148,107	25,542	....	1,358,129	1,413,955	1.04	189	2,395
Vinton	128,070	7,795	2,680	....	138,545	147,348	1.06	120	454
Wayne	80,184	9,915	6,332	....	96,431	183,415	1.90	114	328
Other counties [b] and small mines	312,226	142,974	52,650	....	507,850	655,625	1.29	134	772
	24,208,224	1,494,630	564,749	3,036	26,270,639	27,897,704	1.06	161	47,407

[a] Monroe, Morgan, Noble, Portage, Scioto, and Trumbull.
[b] Morgan, Portage, Scioto, and Trumbull.

Of the 27 counties in the State in which coal was produced in 1908, 24 showed decreases compared with 1907; only 2 (Meigs and Muskingum) showed increases. The largest decrease was in Guernsey County, whose product fell off 1,031,371 short tons. Jefferson County decreased 936,990 short tons, Perry 754,152 short tons, Belmont 614,411 tons, and Athens 595,376 tons. The small-mines production, which is not distributed by counties, shows an increase of 27,048 short tons.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Ohio, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Athens	3,324,115	3,601,448	4,003,074	4,562,694	3,967,318	− 595,376
Belmont	3,172,350	3,957,980	4,266,865	6,208,188	5,593,777	− 614,411
Carroll	235,010	227,517	195,713	367,062	366,748	− 314
Columbiana	802,667	811,125	607,417	709,515	509,045	− 200,470
Coshocton	340,344	381,752	367,600	403,015	364,028	− 38,987
Gallia	29,642	25,845	47,495	35,195	11,450	− 23,745
Guernsey	3,124,702	2,919,704	3,273,838	3,970,921	2,939,550	− 1,031,371
Harrison	264,519	358,478	280,232	499,300	464,676	− 34,624
Hocking	2,458,402	1,931,017	1,793,112	1,648,581	1,434,036	− 214,545
Holmes	30,528	20,975	39,465	22,165	15,009	− 7,156
Jackson	1,936,451	1,888,932	1,369,800	1,284,877	836,328	− 448,549
Jefferson	2,416,122	3,269,376	4,515,420	4,528,006	3,591,016	− 936,990
Lawrence	183,604	179,546	177,145	243,027	171,307	− 71,720
Mahoning	87,515	116,138	117,989	94,335	67,312	− 27,023
Medina	98,433	56,646	73,119	46,071	11,407	− 34,664
Meigs	185,396	349,191	429,435	330,503	449,969	+ 119,466
Morgan	83,800	173,766	223,625	321,793	268,106	− 53,687
Muskingum	257,498	198,304	282,348	414,121	430,653	+ 16,532
Perry	2,437,824	2,299,419	2,557,588	2,901,147	2,146,995	− 754,152
Portage	101,050	84,178	96,467	95,462	89,906	− 5,556
Stark	768,113	598,061	579,640	687,866	501,920	− 185,946
Summit	89,985	113,443	104,216	104,236	98,641	− 5,595
Trumbull	12,900	1,875	....	1,000	1,000	....
Tuscarawas	1,552,065	1,364,043	1,413,751	1,797,399	1,358,129	− 439,270
Vinton	206,622	226,417	210,984	254,529	138,545	− 115,984
Washington	9,550	1,424	....	....	....	....
Wayne	81,369	190,537	215,031	185,260	96,431	− 88,829
Noble, Scioto	90,963	178,050	401,316	314,761	208,899	− 105,862
Small mines	18,681	27,763	88,955	[a] 111,390	138,438	+ 27,048
Total	24,400,220	25,552,950	27,731,640	32,142,419	26,270,639	− 5,871,780
Total value	$26,579,738	$26,486,740	$30,346,580	$35,324,746	$27,897,704	−$7,427,042

[a] Includes production of Monroe County.

One of the early reports published by Ohio states that in 1838 there were 119,952 short tons produced from the coal mines of the State. It is probable that some coal was mined in Ohio prior to that date, but we have no record of such production. The United States census of 1840 credited Ohio with an output of 140,536 tons. The census of 1850 did not consider the coal-mining industry, and the next report we have of coal production in the State was that of the census of 1860, which recorded an output of 1,265,600 short tons.

A statement of the annual production of coal in Ohio from 1838 to the close of 1908 will be found in the following table:

Production of coal in Ohio from 1838 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1838	119,952	1857	975,000	1876	3,500,000	1895	13,355,806
1839	125,000	1858	1,000,000	1877	5,250,000	1896	12,875,202
1840	140,536	1859	1,060,000	1878	5,500,000	1897	12,196,942
1841	160,000	1860	1,265,600	1879	6,000,000	1898	14,516,867
1842	225,000	1861	1,150,000	1880	6,008,595	1899	16,500,270
1843	280,000	1862	1,200,000	1881	9,240,000	1900	18,988,150
1844	340,000	1863	1,204,581	1882	9,450,000	1901	20,943,807
1845	390,000	1864	1,815,622	1883	8,229,429	1902	23,519,894
1846	420,000	1865	1,536,218	1884	7,640,062	1903	24,838,103
1847	480,000	1866	1,887,424	1885	7,816,179	1904	24,400,220
1848	540,000	1867	2,092,334	1886	8,435,211	1905	25,552,950
1849	600,000	1868	2,475,844	1887	10,300,708	1906	27,731,640
1850	640,000	1869	2,461,986	1888	10,910,951	1907	32,142,419
1851	670,000	1870	2,527,285	1889	9,976,787	1908	26,270,639
1852	700,000	1871	4,000,000	1890	11,494,506		
1853	760,000	1872	5,315,294	1891	12,868,683		519,039,997
1854	800,000	1873	4,550,028	1892	13,562,927		
1855	890,000	1874	3,267,585	1893	13,253,646		
1856	930,000	1875	4,864,259	1894	11,909,856		

Marius R. Campbell, of the United States Geological Survey, in his report on the coal fields of the United States, estimates that there were 86,028,000,000 short tons in the original coal supply of Ohio. The total production of the State to the close of 1908 was 519,039,997 short tons, of which the production in that year amounted to about 5 per cent. The total output to the close of 1908 represents an exhaustion of 779,000,000 tons, or 0.9 per cent of the estimated original supply.

OKLAHOMA.

Total production in 1908, 2,948,116 short tons; spot value $5,976,504.

Compared with 1907, when the coal production of Oklahoma amounted to 3,642,658 short tons, valued at $7,433,914, the output for 1908 shows a decrease of 694,542 short tons, or 19.07 per cent in quantity, and of $1,457,410, or 19.6 per cent in value. The average price per ton declined slightly, from $2.04 to $2.03.

While part of the decrease in production was due to the financial depression and also to the unusually warm weather which prevailed during the winter months, both at the beginning and end of the year, the main cause of the decrease was the increased consumption of oil and natural gas throughout Texas, Oklahoma, and Louisiana. The production of oil alone in the Mid-Continent field increased from 22,836,553 barrels in 1906 to 46,846,267 barrels in 1907, and to approximately 48,000,000 barrels in 1908, and this has naturally influenced the coal-mining industry in the States of Kansas, Missouri, Arkansas, and Oklahoma. Coal-mine operators also claim that the fluctuations in supply and prices due to the almost regularly recurring suspension of operations, pending the settlement of the wage scale, has prejudiced large consumers against the use of coal and caused them to turn to oil or gas as a fuel.

Notwithstanding the decrease in production, the number of men employed in the coal mines of Oklahoma increased from 8,398 in 1907 to 8,651 in 1908. The average number of working days decreased from 216 in 1907 to 172 days in 1908. Part of this decrease in the number of working days was due to the general suspension of operations, which began on April 1 and extended into June. The number of men affected by the suspension was 6,929, the idle time ranged from 48 to 78 days, the average number of days lost by each of the 6,929 men was 57, and the total number of days idle was equivalent to about 25 per cent of the total number of working days made during the year by all of the men employed. The average production per man in 1908 was 341 short tons, against 434 tons in 1907 and 346.6 tons in 1906. The average daily production per man was 1.98 tons in 1908, 2.01 tons in 1907, and 2.09 tons in 1906. Practically all of the mines in the State are operated on the basis of an eight-hour day.

While the quantity of coal mined by machines in 1908 showed an increase over 1907, there has been a decreasing tendency in this regard during the last six years. This decrease has been attributed to the prevalent but dangerous practice of shooting from the solid. In 1902 the machine-mined product in the (then) Indian Territory was 119,195 short tons. In 1905 it had fallen to 40,203 short tons. In 1908 it amounted to 31,352 short tons, or 1.06 per cent of the total.

The statistics relating to the washing of coal in Oklahoma, as reported to the Geological Survey, show that there were 64,812 short tons of coal washed in 1908, yielding 58,252 tons of cleaned coal and 6,560 tons of refuse.

According to the annual report of Mr. Pete Hanraty, chief inspector of mines, there were 44 fatal and 128 nonfatal accidents in the coal mines of Oklahoma during the fiscal year ending October 31, 1908. The production during this period, as reported by Mr. Hanraty, was 2,724,832 short tons. The most serious accident was a fire in mine No. 1 of the Hailey-Ola Coal Company, caused by the accidental ignition of what was supposed to be a noninflammable lubricating oil. A number of miners made their escape by following the return air to the surface, but 29 of the men who attempted to escape by the shaft were suffocated. This accident occurred on the 26th of August, 1908. Taking the production for the fiscal year as reported by Mr. Hanraty, the number of tons mined for each life lost was 61,928. The death rate per thousand, according to the number of men employed (as reported by Mr. Hanraty) was 6.04.

The year 1908 was the first for which it was possible to give the production of Oklahoma, formerly the Indian Territory, by counties, it having been organized and admitted into the Union as a State in 1906. The statistics of production, by counties, in 1908 are shown in the following table:

Coal production of Oklahoma in 1908, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Coal	542,634	12,683	21,429	576,746	$1,019,899	$1.77	186	1,832
Haskell and Latimer	655,172	10,152	47,708	713,032	1,398,186	1.96	162	1,886
Le Flore	132,128	6,634	10,466	149,228	231,965	1.55	126	481
Okmulgee	168,674	1,041	3,219	172,934	294,067	1.70	140	439
Pittsburg	1,211,425	13,272	70,239	1,294,936	2,950,029	2.28	180	3,895
Tulsa	37,000	2,298	550	39,848	78,988	1.98	147	118
Small mines	....	1,392	....	1,392	3,370	2.42	....	....
	2,747,033	47,472	153,611	2,948,116	5,976,504	2.03	172	8,651

The statistics of production of coal in Oklahoma (Indian Territory) during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of Oklahoma (Indian Territory), 1904–1908, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1904	2,823,484	35,512	122,266	65,277	3,046,539	$5,532,066	$1.82	199	8,487
1905	2,707,377	38,898	106,547	71,605	2,924,427	5,145,358	1.76	188	7,712
1906	2,629,731	38,535	122,299	69,635	2,860,200	5,482,366	1.92	166	8,251
1907	3,381,420	58,882	161,957	40,399	3,642,658	7,433,914	2.04	216	8,398
1908	2,747,033	47,472	153,611	....	2,948,116	5,976,504	2.03	172	8,651

The Tenth United States Census (1880) contains the first published record of the production of coal in Oklahoma (Indian Territory), although as a small quantity of coal was mined in Arkansas as early as 1840, it is probable that some was produced in the former Territory earlier than 1880. The maximum production prior to 1907 was obtained in 1903, when a total of 3,517,388 short tons was mined. Compared with this the production of 1908 shows a decrease of 569,272 tons.

A statement of the production of coal in Oklahoma from 1880 to the close of 1908 is shown in the following table:

Production of coal in Oklahoma from 1880 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	120,947	1888	761,986	1896	1,366,646	1904	3,046,539
1881	150,000	1889	752,832	1897	1,336,380	1905	2,924,427
1882	200,000	1890	869,229	1898	1,381,466	1906	2,860,200
1883	350,000	1891	1,091,032	1899	1,537,427	1907	3,642,658
1884	425,000	1892	1,192,721	1900	1,922,298	1908	2,948,116
1885	500,000	1893	1,252,110	1901	2,421,781		
1886	534,580	1894	969,606	1902	2,820,666		42,793,131
1887	685,911	1895	1,211,185	1903	3,517,388		

According to the estimates of M. R. Campbell, the areas containing workable coals in the State of Oklahoma aggregate approximately 10,000 square miles, the original contents of which when mining began being placed at 79,278,000,000 short tons. The production to the close of 1908 has amounted to 42,793,131 short tons. On the basis of a half ton of coal lost for each ton mined and marketed, the exhaustion to the close of 1908 has amounted to 64,200,000 tons, or 0.08 per cent of the original supply. Deducting the exhaustion from the original supply, there would still remain on December 31, 1908, approximately 79,213,800,000 tons, equivalent to 26,869 times the production in 1908.

OREGON.

Total production in 1908, 86,259 short tons; spot value, $236,021.

Oregon, like California, is one of the few States in which the production of coal in 1908 showed an increase over the preceding year, the production in Oregon increasing from 70,981 short tons in 1907 to 86,259 short tons in 1908, a gain of 15,278 short tons, or 21.52 per cent, while the value increased from $166,304 to $236,021, a gain of $69,717, or 41.92 per cent. All of the production was from the Coos Bay field in Coos County, and the increased production in 1908 was due to an increased activity at the Beaver Hill mines. All of the Beaver Hill production was washed, the washing operations yielding 70.03 per cent of cleaned coal and 29.97 per cent of refuse. The refuse, however, contains a sufficient quantity of combustible material to permit its use as fuel in the operation of the mines, and it is consumed in this manner. All of the production is of a lignitic character. Transportation is confined exclusively to Coos Bay and the Pacific Ocean, and the city of San Francisco is the principal market. The large amount of construction work in the rebuilding of the city of San Francisco has been the principal cause for the increased production of Oregon lignite. The average number of men employed increased from 184 in 1907 to 214 in 1908, and the average number of days worked increased from 231 to 249. There were no labor disturbances during the year.

The statistics of coal production in Oregon, with the distribution of the product for consumption during the last five years, are shown in the following table:

Distribution of the coal product in Oregon, 1904–1908, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days worked.	Average number of employees.
1904	79,293	13,968	18,279	111,540	$243,588	$2.18	284	334
1905	84,258	7,883	17,500	109,641	282,495	2.58	242	316
1906	55,232	7,398	17,101	79,731	212,338	2.66	209	224
1907	39,095	14,840	17,046	70,981	166,304	2.34	231	184
1908	45,375	22,518	18,366	86,259	236,021	2.74	249	214

According to the estimates prepared by M. R. Campbell, the total coal-bearing formations of Oregon are limited to an area of 230 square miles, the original contents of which are placed by Mr. Campbell at 1,000,000,000 short tons.

Coal was first noted in the Coos Bay region about fifty years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention. It is known that some mining was done there in 1855 and in 1872, and in 1876 two mines—the Eastport and the Newport—were in active operation. The Newport, however, was the only one to survive. The Beaver Hill mine was opened in 1895. This was at first an uncertain factor but is now one of the important producers. The first record of coal production is contained in the census report of 1880, when 43,205 short tons were mined. The production has exceeded 100,000 tons in four years only—1896, 1897, 1904, and 1905—the maximum being obtained in 1904, when it reached 111,540. The total production to the close of 1908 has amounted to 1,876,651 short tons, as shown in the following table:

Production of coal in Oregon, 1880–1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	43,205	1888	75,000	1896	101,721	1904	111,540
1881	33,600	1889	64,359	1897	107,289	1905	109,641
1882	35,000	1890	61,514	1898	58,184	1906	79,731
1883	40,000	1891	51,826	1899	86,888	1907	70,981
1884	45,000	1892	34,661	1900	58,864	1908	86,259
1885	50,000	1893	41,683	1901	69,011		
1886	45,000	1894	47,521	1902	65,648		1,876,651
1887	37,696	1895	73,685	1903	91,144		

PENNSYLVANIA.

Total production in 1908, 200,448,281 short tons; spot value, $276,995,152.

Anthracite.—Total production in 1908, 74,347,102 long tons (equivalent to 83,268,754 short tons); spot value, $158,178,849.

Bituminous.—Total production in 1908, 117,179,527 short tons; spot value, $118,816,303.

The production of both anthracite and bituminous coal in Pennsylvania in 1908 was less than in 1907, but owing to the fact that anthracite no longer enters to any extent into manufacturing lines of industry, it was not so seriously affected by the financial depression as was its competitor. The aggregate production of anthracite and bituminous coal in Pennsylvania in 1907 amounted to 235,747,489 short tons, valued at $319,248,082, compared with which the production in 1908 (200,448,281 short tons, valued at $276,995,152) showed a decrease of 35,299,208 short tons, or 14.97 per cent, in quantity, and of $42,252,930, or 13.24 per cent, in value. Of the total decrease, 2,085,319 long tons (2,335,558 short tons) in quantity and $5,405,207 in value were in the production of anthracite. The percentage of decrease in anthracite production was almost the same for quantity and value, 2.73 in quantity and 3.3 in value, as, owing to the close control under which the anthracite region is held, the operators are able to maintain prices and to restrict the production according to the market requirements. The output of anthracite coal in 1908, notwithstanding the decrease from 1907, was, with the exception of 1907, the largest ever obtained and exceeded that of 1906 by 10,702,092 long tons in quantity and $26,261,155 in value. The decrease in the production of bituminous coal in Pennsylvania from 1907 to 1908 was 32,963,650 short tons, or 21.95 per cent, in quantity, and of $36,847,723, or 23.67 per cent, in value.

In spite of the decreased production of both anthracite and bituminous coal, the number of men employed in the mines of Pennsylvania in 1908 showed an increase of 9,606 over 1907, the number reported in the two years having been 330,529 in 1907 and 340,135 in 1908. Of the total number employed in 1908, 174,174 were in the anthracite mines, against 167,234 in 1907, an increase of 6,940, while the bituminous mine workers increased 2,666—from 163,295 to

165,961. There was, however, a decided decrease in the number of days worked, both in the anthracite and the bituminous mines. The increase in the number of employees can only be accounted for by the slack demand for labor in other lines of industry, which created an additional supply for the coal mines. The average number of days worked in the anthracite mines decreased from 220 in 1907 to 200 in 1908, while in the bituminous mines the average number of working days in 1908 was 201 against 255 in 1907. The average annual production per man in the anthracite mines in 1908 was 427 long tons, or 478 short tons, against 457 long tons, or 512 short tons in 1907, while in the bituminous mines it was 706 short tons in 1908, against 919.5 tons in 1907. The daily average per man in 1908 was 2.13 long tons, or 2.39 short tons, of anthracite, and 3.51 short tons of bituminous coal. In 1907 the average production per man was 2.08 long tons, or 2.33 short tons of anthracite and 3.61 short tons of bituminous coal.

Mr. James E. Roderick, chief of the department of mines of Pennsylvania, reports that there were 1,250 men killed and 2,189 injured in the coal mines of Pennsylvania in 1908, as against 1,514 men killed and 2,576 injured in 1907. Of the total fatalities in 1908, 678 occurred in the anthracite mines and 572 in the bituminous mines. In 1907 there were 708 men killed in the anthracite mines and 806 in the bituminous mines. Of the nonfatal accidents in 1908, 1,178 occurred in the anthracite mines (against 1,369 in 1907) and 1,019 in the bituminous mines (against 1,207 in 1907). The death rate per thousand employees in the anthracite mines was 3.89 in 1908, against 4.23 in 1907, while the death rate in the bituminous mines was 3.45 in 1908 and 4.94 in 1907. In the production of anthracite 109,656 long tons, or 122,815 short tons, were mined for each life lost in 1908, against 107,955 long tons, or 120,910 short tons, in 1907. In the bituminous mines 204,859 short tons were mined for each life lost in 1908 and 186,281 tons in 1907. In the anthracite mines 57 deaths, or a little less than 9 per cent of the fatalities, were due to gas explosions, while 284, or 42 per cent, were due to falls of roof or coal. Powder explosions killed 23; mine-car accidents killed 90, and shaft accidents, 13. Miscellaneous accidents inside the mines killed 129, while 82 employees were killed outside the mines. In the bituminous mines 162, or 28 per cent of the total, were killed by gas or dust explosions, and 263, or 46 per cent, were killed by falls of roof or coal.

The rapid growth of bituminous coal production compared with that of anthracite during recent years has been marked and forms one of the most interesting features connected with the statistics of coal mining. Reference has been made to this in previous reports of this series, and the following table has been prepared showing the average production of Pennsylvania anthracite and of bituminous coal throughout the United States, by five-year periods, from 1876 to 1905, and for 1906, 1907, and 1908, with the percentage each bears to the total. It will be seen from this table that the average production of anthracite during the five years from 1901 to 1905 was 2.59 times the average yearly production from 1876 to 1880, and that the production of anthracite in 1907 was 3.32 times the average annual production from 1876 to 1880. In the bituminous production the tonnage from 1901 to 1905 was 7.5 times that of the output from 1876 to

1880, and the production in 1907 was 10.83 times that of the average for the five years from 1876 to 1880.

From 1876 to 1880 the average production of bituminous coal was 1.41 times that of anthracite, while from 1901 to 1905 the production of bituminous coal was 4.08 times that of hard coal. From 1866 to 1870 the production of Pennsylvania anthracite was a little more than half the production of the United States. The reason for this comparatively large gain in the production of bituminous coal lies in the fact that anthracite has been for a number of years becoming more and more a luxury, and this condition will continue to obtain until the areas are finally exhausted. The comparatively restricted area in which anthracite is produced and the increasing cost of production as deeper and thinner beds have to be worked have resulted naturally in the gradual advance in price and also in the gradual elimination of anthracite as a fuel for manufacturing purposes. It is now almost entirely restricted to domestic consumption in the Eastern States. Large amounts of the smaller sizes of anthracite which were formerly wasted are now used for steaming purposes, sometimes mixed with bituminous coal and sometimes alone, but for these purposes the smaller sizes are used chiefly for heating and running elevators in office buildings, hotels, and apartment houses rather than for manufacturing purposes. Even for domestic purposes coke and gas, the products of bituminous coal are competing more and more with anthracite in the markets of the larger cities and towns. Under these conditions the statistical situation is not difficult to understand.

The average production of anthracite and bituminous coal, by five-year periods from 1876 to 1905, and for 1906, 1907, and 1908, is shown in the following table:

Production of anthracite and bituminous coal since 1876, by five-year averages, in short tons.

Period.	Anthracite.		Bituminous.	
	Quantity.	Per cent of total.	Quantity.	Per cent of total.
1876-1880	25,800,169	41.44	36,460,776	58.56
1881-1885	36,198,188	33.74	71,092,930	66.26
1886-1890	43,951,763	31.76	94,446,451	68.24
1891-1895	53,405,187	29.87	125,416,327	70.13
1896-1900	55,625,265	24.49	171,498,143	75.51
1901-1905	66,853,778	19.70	272,503,363	80.30
1906	71,282,411	17.21	342,874,867	82.79
1907	85,604,312	17.82	394,759,112	82.18
1908	83,268,754	20.02	332,573,944	79.98

Until 1902 Pennsylvania had enjoyed the distinction of producing more than half the coal output of the United States. From 1889 to 1901, however, the percentage of anthracite production had shown a gradually decreasing tendency and when the anthracite strike of 1902 caused a decided shrinkage in the production of Pennsylvania anthracite the percentage of the State was reduced to 46. In 1903, notwithstanding the increased production of anthracite and bituminous coal in Pennsylvania in that year, the State's proportion of the total production of the United States was still slightly less than half. In 1904 Pennsylvania produced 49 per cent of the total, and in 1905, with an increase of nearly 25,000,000 tons over the preceding year, the State's proportion of the total production was 49.9 per cent. In 1906 Pennsylvania's percentage again fell off to 48.4 per cent, but with the largely increased production of both anthracite and bituminous coal in 1907, the State's percentage again rose to 49.1. It is doubtful if Pennsylvania will in future contribute more than half of the country's total. In 1880 Pennsylvania produced 66 per cent of the entire output of the United States, and during the last twenty-five years has produced about 53 per cent of the total.

Pennsylvania alone produces more coal than any other country in the world, with the exception of Great Britain. Pennsylvania's production of coal exceeds, in fact, the combined production of all the countries of the world outside of Great Britain, Germany, and Austria-Hungary. The State's output in 1908 was 3.8 times that of Austria-Hungary, 4.8 times the production of France, and 7 times the production of Russia, these being, respectively, fourth, fifth, and sixth among the coal-producing countries of the world.

The following table shows the total production of the United States since 1880, with the percentages of the tonnage produced by Pennsylvania in each year:

Production of Pennsylvania coal compared with total United States, 1880–1908, in short tons.

Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.	Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.
1880	71,481,570	47,074,975	66	1895	193,117,530	108,216,565	56
1881	85,881,030	54,320,018	63	1896	191,986,357	103,903,534	54
1882	103,285,789	57,254,507	55	1897	200,223,665	107,029,654	53
1883	115,212,125	62,488,190	54	1898	219,976,267	118,547,777	54
1884	119,735,051	62,404,488	52	1899	253,741,192	134,568,180	53
1885	110,957,522	62,137,271	56	1900	269,684,027	137,210,241	51
1886	112,743,403	62,857,210	56	1901	293,299,816	149,777,613	51
1887	129,975,557	70,372,857	54	1902	301,590,439	139,947,962	46
1888	148,659,402	77,719,624	52	1903	357,356,416	177,724,246	49.7
1889	141,229,514	81,719,059	58	1904	351,816,398	171,094,996	49
1890	157,770,963	88,770,814	56	1905	392,722,635	196,073,487	49.9
1891	168,566,668	93,453,921	55	1906	414,157,278	200,575,617	48.4
1892	179,329,071	99,167,080	55	1907	480,363,424	235,747,489	49.1
1893	182,352,774	98,038,267	54	1908	415,842,698	200,448,281	48.2
1894	170,741,526	91,833,584	54				

Anthracite mining began in Pennsylvania in 1814, when 20 long tons were produced for local consumption. The year 1820 is, however, usually considered to mark the beginning of the anthracite industry as in that year 365 long tons, one for each day of the year were shipped from the anthracite region. From 1814 to the close of 1908 the total production of anthracite had amounted to 1,798,909,888 long tons, or 2,014,779,075 short tons.

The first records of bituminous-coal production in Pennsylvania are for the year 1840, when 464,826 short tons were mined. The total output of bituminous coal from 1840 to the close of 1908 has amounted to 1,963,248,780 short tons, from which it appears that the total production of anthracite and of bituminous coal in Pennsylvania has been nearly equally divided between the two, the output of anthracite exceeding that of bituminous coal by approximately 51,000,000 tons. As, however, the production of bituminous coal in 1908 exceeded that of anthracite by approximately 34,000,000 tons, and in 1907 by nearly 65,000,000 tons, the probability is that by the close of 1909 the total production of bituminous coal will have equaled that of anthracite.

PENNSYLVANIA ANTHRACITE.

By William W. Ruley.

In the year 1908, in spite of the financial and business depression, the general results in the anthracite trade were in the main eminently satisfactory. The production for the year was the second largest in the history of the trade, and it is the more remarkable in that it approached that of the year 1907, in which the production was the largest in the anthracite industry. It may be argued that the production was stimulated by the fear of a strike at the expiration of the three years' agreement, April 1, 1909, but this supposition can hardly account for the relatively large production, as, notwithstanding the mild winter of 1908–9, the stocks of prepared sizes of anthracite in first hands in the East April 1, 1909, did not exceed 4,000,000 tons, or about one month's production of these sizes.

This situation would seem to corroborate the statements made in previous reports that the demand for anthracite coal under normal business conditions was fully equal to the supply, and it is the opinion of those most familiar with the trade that in the future it will be difficult to supply the demand for anthracite even in the territory in which it is now generally used, not to mention any demand which may arise from newly developed territory.

This is in spite of the increased use of bituminous coal and coke for domestic purposes, the installation of central heating plants using bituminous coal as a fuel, and the great number of gas plants throughout the country, a large part of the product of which is consumed for domestic purposes, either in heating, cooking, or in other ways replacing the former use of anthracite.

It is of course impossible to predict anything definitely in regard to the future of the anthracite industry on account of the competition of other fuels and the possibility of more improved methods of using them, but it would seem that with the limited area and the productive capacity of the anthracite measures, and the constantly increasing population in the anthracite-consuming territory, the capacity of the mines to supply the demand will be severely taxed, and ultimately this territory will become more and more limited as the ability of the producing companies to supply the increased demand is relatively reduced.

To illustrate the changed conditions in the anthracite trade during the last five years—that is, from 1904 to 1908, inclusive—as compared with the five-year period from 1894 to 1898, inclusive, it is only necessary to mention that during the latter five-year period the average annual shipments to market amounted to 61,275,125 tons, while in the five-year period ending with 1898 the average annual shipments were 42,923,555 tons, indicating an increase in ten years of nearly 50 per cent, and, as was pointed out before, this is in the face of not only the competition of all other fuels, but also the use of generally improved methods of using such fuels.

What the final results of such conditions may be it is impossible to foresee, but it would seem reasonable that with the increased difficulties and cost of mining and the constantly increasing demand for anthracite that the cost for this commodity would correspondingly increase.

The monthly shipments of anthracite coal for 1906, 1907, and 1908 were as shown below:

Monthly shipments of anthracite coal 1906–1908, in long tons.

Month.	1906.	1907.	1908.
January	5,458,084	5,249,946	5,618,339
February	4,712,099	4,563,720	4,503,756
March	5,797,167	5,235,814	4,766,158
April	488,203	5,916,583	5,987,221
May	3,254,230	5,994,272	6,088,116
June	5,676,018	5,976,906	5,704,852
July	4,981,448	5,669,024	4,541,506
August	5,400,511	5,795,347	4,599,093
September	4,527,886	5,512,717	5,211,047
October	5,384,768	6,108,065	5,977,497
November	5,182,153	5,743,522	5,839,491
December	4,836,028	5,343,477	5,827,938
	55,698,595	67,109,393	64,665,014

In connection with the increase in the general production of anthracite, it is interesting to note the proportion of increase in the domestic sizes and that in the small or steam sizes. In 1890 the proportion was 76.9 per cent of sizes above pea, and 23.1 per cent of pea coal and smaller sizes. In 1900 it was 64.7 and 35.3 per cent, respectively, and in 1908, 59.26 and 40.74 per cent, respectively. This shows a most astonishing change in the percentages of the sizes, but it should be borne in mind that a considerable part of this increase in small-sized coal is due to the washery product; in 1890 this amounted to only 41,600 tons, or 0.11 per cent of the total shipments. In 1908 it amounted to 3,646,250 tons, or 5.64 per cent. If the washery product be deducted from the total shipments, the results are as follows:

Shipments of anthracite, excluding washery product, by sizes, 1890 and 1908, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.98	8,419,181	23.02	36,573,859
1908	38,280,708	62.74	22,738,056	37.26	61,018,764

This table shows that with the washery product eliminated from the total shipments, the percentage of small sizes is very much reduced in 1908, while it is not materially affected in 1890. However, leaving out of consideration the great increase in washery coal, it is plainly evident that the proportion of small sizes in fresh-mined coal has been steadily increasing, although there was a small decrease in 1908 as compared with 1907. As to the causes for this increase, the reader is referred to the reports for 1905 and 1906, in which this subject was discussed at some length.

To illustrate the change in the proportion of domestic and steam sizes since 1890 the following table is appended:

Shipments of anthracite, according to sizes, 1890–1908, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.9	8,460,781	23.1	36,615,459
1891	30,604,566	75.7	9,843,770	24.3	40,448,336
1892	31,868,278	76.0	10,025,042	24.0	41,893,320
1893	32,294,233	74.9	10,795,304	25.1	43,089,537
1894	30,482,203	73.7	10,908,997	26.3	41,391,200
1895	32,469,367	69.9	14,042,110	30.1	46,511,477
1896	30,354,797	70.3	12,822,688	29.7	43,177,485
1897	28,510,370	68.5	13,127,494	31.5	41,637,864
1898	28,198,532	67.3	13,701,219	32.7	41,899,751
1899	31,506,700	66.1	16,158,504	33.9	47,665,204
1900	29,162,459	64.7	15,945,025	35.3	45,107,484
1901	34,412,974	64.2	19,155,627	35.8	53,568,601
1902	19,025,632	61.0	12,175,258	39.0	31,200,890
1903	37,738,510	63.6	21,624,321	36.4	59,362,831
1904	35,636,661	62.0	21,855,861	38.0	57,492,522
1905	37,425,217	60.9	23,984,984	39.1	61,410,201
1906	32,894,124	59.1	22,804,471	40.9	55,698,595
1907	39,332,855	58.6	27,776,538	41.4	67,109,393
1908	38,319,325	59.3	26,345,689	40.7	64,665,014

It should be noted in connection with the division of sizes that pea coal, which was for years a steam coal, is now used extensively for domestic purposes; and while it is impossible to tell what proportion is so used, the fact that it is no longer an exclusively steam size must be taken into consideration in drawing deductions from the figures presented.

To present statistically the comments made on size division, washery production, etc., the following table, showing washery production since 1890, is given:

Shipments of anthracite from washeries, and total shipments, 1890–1908, in long tons.

Year.	Shipments from washeries.	Total shipments.	Percentage of washery output to total shipments.
1890	41,600	36,615,459	0.11
1891	85,702	40,448,336	.21
1892	90,495	41,893,320	.22
1893	245,175	43,089,537	.57
1894	634,116	41,391,200	1.53
1895	1,080,800	46,511,477	2.52
1896	895,042	43,177,485	2.07
1897	993,603	41,637,864	2.39
1898	1,099,019	41,899,751	2.62
1899	1,368,275	47,665,204	2.87
1900	2,059,349	45,107,484	4.57
1901	2,567,335	53,568,601	4.79
1902	1,959,466	31,200,890	6.28
1903	3,563,269	59,362,831	6.00
1904	2,800,466	57,492,522	4.87
1905	2,644,045	61,410,201	4.31
1906	3,846,501	55,698,595	6.91
1907	4,301,082	67,109,393	6.41
1908	3,646,250	64,665.014	5.64

In the preceding discussion of shipments the coal from the mines of Sullivan County has not been considered, the reason therefor being given in a paragraph at the end of this report. It should also be noted that the foregoing comments have dealt only with shipments and have taken no account of coal sold locally at the mines or used for steam and heat. In the following paragraphs and tables Sullivan County is taken into consideration, and also the local trade and mine consumption.

The production for the year 1908 amounted to 74,347,102 tons, being a decrease of 2,085,319 tons as compared with 1907. Of this production 65,118,975 tons (including 453,961 tons from Sullivan County) were shipped to market, 1,536,573 tons were sold to local trade, and 7,691,554 tons were used at mines for steam heat.

Statistics of anthracite production, 1904–1908.

Year	Quantity (long tons).	Value.	Average price per ton.	Average number of men employed.	Average number of days worked.
1904	65,318,490	$138,974,020	$2.35	155,861	200
1905	69,339,152	141,879,000	2.25	165,406	218
1906	63,645,010	131,917,694	2.30	162,355	195
1907	76,432,421	163,584,056	2.35	167,234	220
1908	74,347,102	158,178,849	2.35	174,174	200

In the valuation of the product no account has heretofore been taken of the coal used for steam and heat; but as every size and even dust is now a marketable product, it has been thought advisable to give this coal an arbitrary value of 20 cents per ton, which has been included in the value of the total product for 1907 and 1908, but which does not enter into the values for previous years. The tables following show the production, shipments, local trade, and coal used at mines by counties for the year 1907 and 1908:

Anthracite production in 1907 and 1908, by counties, in long tons.

County.	Shipments.	Sold to local trade and employees.	Used at mines for steam and heat.	Total.
1907.				
Susquehanna	520,955	9,623	44,503	575,081
Lackawanna	17,955,465	382,730	1,570,532	19,908,727
Luzerne	24,081,491	666,902	2,581,483	27,329,876
Carbon	2,150,801	50,035	257,381	2,458,217
Schuylkill	15,625,710	256,264	2,081,171	17,963,145
Columbia	931,767	14,136	115,051	1,060,954
Sullivan	349,391	5,152	32,155	386,698
Northumberland	5,302,642	109,534	596,493	6,008,669
Dauphin	540,562	22,455	178,037	741,054
	67,458,784	1,516,831	7,456,806	76,432,421
1908.				
Susquehanna	388,994	10,375	35,293	434,662
Lackawanna	17,654,782	386,684	1,615,802	19,657,268
Luzerne	24,553,934	669,688	2,753,107	27,976,729
Carbon	2,056,630	60,640	259,180	2,376,450
Schuylkill	13,935,526	258,286	2,088,154	16,281,966
Columbia	911,681	16,428	127,539	1,055,648
Sullivan	453,961	6,039	31,710	491,710
Northumberland	4,609,627	105,067	592,057	5,306,751
Dauphin	553,840	23,366	188,712	765,918
	65,118,975	1,536,573	7,691,554	74,347,102

The following table gives the yearly shipments of anthracite from the earliest date to the close of 1908, divided according to the three trade regions. These shipments include only coal loaded on cars for line or tide points, and do not include any coal sold locally, or used at and about the mines, nor the shipments from the Sullivan County mines:

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1908, in long tons.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1820			365				365
1821			1,073				1,073
1822	1,480	39.79	2,240	60.21			3,720
1823	1,128	16.23	5,823	83.77			6,951
1824	1,567	14.10	9,541	85.90			11,108
1825	6,500	18.60	28,393	81.40			34,893
1826	16,767	34.90	31,280	65.10			48,047
1827	31,360	49.44	32,074	50.56			63,434
1828	47,284	61.00	30,232	39.00			77,516
1829	79,973	71.35	25,110	22.40	7,000	6.25	112,083
1830	89,984	51.50	41,750	23.90	43,000	24.60	174,734
1831	81,854	46.29	40,966	23.17	54,000	30.54	176,820
1832	209,271	57.61	70,000	19.27	84,000	23.12	363,271
1833	252,971	51.87	123,001	25.22	111,777	22.91	487,749
1834	226,692	60.19	106,244	28.21	43,700	11.60	376,636
1835	339,508	60.54	131,250	23.41	90,000	16.05	560,758
1836	432,045	63.16	148,211	21.66	103,861	15.18	684,117
1837	530,152	60.98	223,902	25.75	115,387	13.27	869,441
1838	446,875	60.49	213,615	28.92	78,207	10.59	738,697
1839	475,077	58.05	221,025	27.01	122,300	14.94	818,402
1840	490,596	56.75	225,313	26.07	148,470	17.18	864,379
1841	624,466	65.07	143,037	14.90	192,270	20.03	959,773
1842	583,273	52.62	272,540	24.59	252,599	22.79	1,108,412
1843	710,200	56.21	267,793	21.19	285,605	22.60	1,263,598
1844	887,937	54.45	377,002	23.12	365,911	22.43	1,630,850
1845	1,131,724	56.22	429,453	21.33	451,836	22.45	2,013,013
1846	1,308,500	55.82	517,116	22.07	518,389	22.11	2,344,005
1847	1,665,735	57.79	633,507	21.98	583,067	20.23	2,882,309
1848	1,733,721	56.12	670,321	21.70	685,196	22.18	3,089,238
1849	1,728,500	53.30	781,556	24.10	732,910	22.60	3,242,966
1850	1,840,620	54.80	690,456	20.56	827,823	24.64	3,358,899
1851	2,328,525	52.34	964,224	21.68	1,156,167	25.98	4,448,916
1852	2,636,835	52.81	1,072,136	21.47	1,284,500	25.72	4,993,471
1853	2,665,110	51.30	1,054,309	20.29	1,475,732	28.41	5,195,151
1854	3,191,670	53.14	1,207,186	20.13	1,603,478	26.73	6,002,334
1855	3,552,943	53.77	1,284,113	19.43	1,771,511	26.80	6,608,567
1856	3,603,029	52.91	1,351,970	19.52	1,972,581	28.47	6,927,580
1857	3,373,797	50.77	1,318,541	19.84	1,952,603	29.39	6,644,941
1858	3,273,245	47.86	1,380,030	20.18	2,186,094	31.96	6,839,369
1859	3,448,708	44.16	1,628,311	20.86	2,731,236	34.98	7,808,255
1860	3,749,632	44.04	1,821,674	21.40	2,941,817	34.56	8,513,123
1861	3,160,747	39.74	1,738,377	21.85	3,055,140	38.41	7,954,264
1862	3,372,583	42.86	1,351,054	17.17	3,145,770	39.97	7,869,407
1863	3,911,683	40.90	1,894,713	19.80	3,759,610	39.30	9,566,006
1864	4,161,970	40.89	2,054,669	20.19	3,960,836	38.92	10,177,475
1865	4,356,959	45.14	2,040,913	21.14	3,254,519	33.72	9,652,391
1866	5,787,902	45.56	2,179,364	17.15	4,736,616	37.29	12,703,882
1867	5,161,671	39.74	2,502,054	19.27	5,325,000	40.99	12,988,725
1868	5,330,737	38.52	2,502,582	18.13	5,968,146	43.25	13,801,465
1869	5,775,138	41.66	1,949,673	14.06	6,141,369	44.28	13,866,180
1870	4,968,157	30.70	3,239,374	20.02	7,974,660	49.28	16,182,191
1871	6,552,772	41.74	2,235,707	14.24	6,911,242	44.02	15,699,721
1872	6,694,890	34.03	3,873,339	19.70	9,101,549	46.27	19,669,778
1873	7,212,601	33.97	3,705,596	17.46	10,309,755	48.57	21,227,952
1874	6,866,877	34.09	3,773,836	18.73	9,504,408	47.18	20,145,121
1875	6,281,712	31.87	2,834,605	14.38	10,596,155	53.75	19,712,472

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1908, in long tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1876	6,221,934	33.63	3,854,919	20.84	8,424,158	45.53	18,501,011
1877	8,195,042	39.35	4,332,760	20.80	8,300,377	39.85	20,828,179
1878	6,282,226	35.68	3,237,449	18.40	8,085,587	45.92	17,605,262
1879	8,960,829	34.28	4,595,567	17.58	12,586,293	48.14	26,142,689
1880	7,554,742	32.23	4,463,221	19.05	11,419,279	48.72	23,437,242
1881	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96	28,500,017
1882	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98	29,120,096
1883	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08	31,793,027
1884	9,478,314	30.85	5,562,226	18.11	15,677,753	51.04	30,718,293
1885	9,488,426	30.01	5,898,634	18.65	16,236,470	51.34	31,623,530
1886	9,381,407	29.19	5,723,129	17.89	17,031,826	52.82	32,136,362
1887	10,609,028	30.63	4,347,061	12.55	19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.78	21,852,366	57.29	38,145,718
1889	10,486,185	29.28	6,294,073	17.57	19,036,835	53,15	35,817,093
1890	10,867,822	29.68	6,329,658	17.28	19,417,979	53.04	36,615,459
1891	12,741,258	31.50	6,381,838	15.78	21,325.240	52.72	40,448,336
1892	12,626,784	30.14	6,451,076	15.40	22,815,480	54.46	41,893,340
1893	12,357,444	28.68	6,892,352	15.99	23,839,741	55.33	43,089,537
1894	12,035,005	29.08	6,705,434	16.20	22,650,761	54.72	41,391,200
1895	14,269,932	30.68	7,298,124	15.69	24,943,421	56.63	46,511,477
1896	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63	43,177,485
1897	12,181,061	29,26	6,249,540	15.00	23,207,263	55.74	41,637,864
1898	12,078,875	28.83	6,253,109	14.92	23,567,767	56.25	41,899,751
1899	14,199,009	29.79	6,887,909	14.45	26,578,286	55.76	47,665,204
1900	13,502,732	29.94	6,918,627	15.33	24,686,125	54.73	45,107,484
1901	16,019,591	29.92	7,211,974	13.45	30,337,036	56.63	53,568,601
1902	8,471,391	27.15	3,470,736	11.12	19,258,763	61.73	31,200,890
1903	16,474,790	27.75	7,164,783	12.07	35,723,258	60.18	59,362,831
1904	16,379,293	28.49	7,107,220	12.36	34,006,009	59.15	57,492,522
1905	17,703,099	28.83	7,849,205	12.78	35,857,897	58.39	61,410,201
1906	16,011,285	28.75	7,046,617	12.65	32,640,693	58.60	55,698,595
1907	20,141,288	30.01	8,329,653	12.41	38,638,452	57.58	67,109,393
1908	18,006,464	27.85	7,786,255	12.04	38,872,295	60.11	64,665,014
	522,660,568	32.21	257,323,287	15.86	842,536,860	51.93	1,622,520,715

A tabular arrangement of the various sections of the anthracite fields is given below, and a list of the railroads entering the territory.

Anthracite coal fields, by field, local district, and trade region.

Coal field or basin.	Local district.	Trade region.
Northern	Carbondale Scranton Pittston Wilkes-Barre Plymouth Kingston	Wyoming.
Eastern middle	Green Mountain Black Creek Hazleton Beaver Meadow Panther Creek	Lehigh.
Southern	East Schuylkill West Schuylkill Lorberry Lykens Valley	Schuylkill.
Western middle	East Mahonoy West Mahonoy Shamokin	Schuylkill.

The above-named fields comprise an area of somewhat more than 480 square miles and are located in the eastern-middle part of the State, in the counties of Carbon, Columbia, Lackawanna, Luzerne, Northumberland, Schuylkill, and Susquehanna, and are classed under three general divisions, viz, Wyoming, Lehigh, and Schuylkill regions. Geologically they are divided into fields or basins, which are again subdivided into districts.

The Bernice field, in Sullivan County, is not included in any of these regions. The classification of the product of this field is a matter of much contention. The fracture of the coal and some of its physical characteristics are more like some bituminous or semi-anthracite coals than strict anthracite, but on account of its high percentage of fixed carbon and low percentage of moisture it is classed as anthracite by the Second Pennsylvania Geological Survey, and the product is so included in this report.

The tonnage from this field is not included in the shipments by regions nor in the division according to sizes.

The above territory is reached by ten so-called initial railroads, as follows:

Philadelphia and Reading Railway Company.
Lehigh Valley Railroad Company.
Central Railroad of New Jersey.
Delaware, Lackawanna and Western Railroad Company.
Delaware and Hudson Company's Railroad.
Pennsylvania Railroad Company.
Erie Railroad Company.
New York, Ontario and Western Railroad Company.
Delaware, Susquehanna and Schuylkill Railroad Company.[a]
New York, Susquehanna and Western Railroad Company.[b]

PENNSYLVANIA BITUMINOUS COAL.

Total production in 1908, 117,179,527 short tons; spot value $118,816,303.

The decrease in the production of bituminous coal in Pennsylvania in 1908, compared with 1907, was more than the total production of any other States except Illinois and West Virginia. It was more than the total production of bituminous coal in Pennsylvania in 1887, and more than the entire production of the United States in 1869, yet to such an extent has the coal-mining industry grown that notwithstanding this decrease, the total production of Pennsylvania in 1908 was nearly as much as it was in 1905. It exceeded the production of Pennsylvania alone in any year prior to that date, and was more than the total production of coal in the United States in every year but one prior to 1887.

Compared with 1907, when the bituminous coal production of Pennsylvania amounted to 150,143,177 short tons, valued at $155,-654,026, the output in 1908 showed a decrease of 32,963,650 short tons, or 21.95 per cent in quantity, and of $36,847,723, or 23.67 per cent in value. The average price per ton decreased from $1.04 to $1.01.

The greatest losses in 1908 were shown in Fayette and Westmoreland counties, which constitute the Connellsville coke-producing region, and illustrate the influence exerted on the coal-mining indus-

[a] Part of Lehigh Valley system. [b] Part of Erie system.

try by the depression in the iron-making trade. The production of Fayette County decreased 33 per cent, from 29,260,622 short tons to 19,474,417 short tons, a loss of 9,786,205 tons. Westmoreland County's production decreased 7,417,429 short tons, or something over 25 per cent, from 28,916,721 short tons to 21,499,292 short tons. The total decrease in the quantity of coal made into coke was 13,951,198 short tons, or 40 per cent, from 35,152,189 short tons to 21,200,991 short tons. Every county but one (Beaver) recorded a decreased output in 1908 as compared with 1907. Allegheny County, in which the iron-making city of Pittsburg is situated, had a decreased output of over 4,000,000 tons; Washington County, which also contributes to the Pittsburg trade, decreased over 2,400,000 tons, and Cambria County, in which the iron and steel city of Johnstown is situated, decreased over 2,200,000 tons. The official returns to the Geological Survey bore out the prediction made in the preliminary statement issued January 13, which was to the effect that the bituminous coal production of Pennsylvania in 1908 would show a decrease of from 20 to 25 per cent over that of the preceding year. The actual percentage of decrease was 21.95.

In the production of bituminous coal alone Pennsylvania far outranks the other coal-producing States, the output in 1908 having been nearly two and one-half times that of Illinois, which ranks second, and having exceeded the combined production of Illinois, West Virginia, and Ohio, whose aggregate output in 1908 amounted to 115,828,172 short tons.

In the report for 1907 comment was made on the unprecedented shortage of miners as well as the scarcity of transportation facilities which prevailed in the bituminous-coal districts of Pennsylvania during that year. The supply of railway cars was not appreciably increased in 1908, but the number sufficed for the decreased tonnage produced, while as far as the labor supply was concerned, an entirely different condition, was shown in the statistics of 1908 as compared with 1907. Notwithstanding the decrease of nearly 33,000,000 tons in the production of the State, the number of men employed in the bituminous coal mines increased from 163,295 in 1907, to 165,961 in 1908, indicating that in Pennsylvania, as in other coal-producing States, the slack demand for labor in other lines of industry produced a surplus of labor in the coal mines. The average number of working days decreased from 255 in 1907 to 201 in 1908. The average number of days worked in 1908 was less than in any year since the panic times of 1893 and 1894. The average annual production per man in 1908 was 706 short tons, against 919.5 in 1907 and 850.1 in 1906. The average daily production of each man decreased from 3.68 tons in 1906 to 3.61 tons in 1907 and 3.51 tons in 1908. In two particulars the bituminous coal-mining industry of Pennsylvania showed an increasing tendency. This was in the number of mining machines employed and in the percentage of machine-mined coal to the total production. In 1908 there were 5,103 undercutting machines in use against 4,940 in 1907, and although the quantity of coal mined by machines decreased from 60,771,157 short tons to 52,447,809 short tons, the percentage of machine-mined coal to the total increased from 40.48 to 44.76. Of the 5,103 machines in use in 1908 in the bituminous mines of Pennsylvania 3,427 were pick machines, 1,607 were chain-breast, and 8 long-wall. There were also 9 pick and 52 chain shearing machines in use.

The majority of the bituminous coal mines of Pennsylvania are operated on the eight-hour basis. Out of a total of 165,961 men employed in 1908, 99,406, distributed among 764 mines, worked eight hours; 24,828 men employed in 241 different mines worked nine hours, and 38,125 men employed in 197 mines worked ten hours.

Except for a suspension of operations which lasted practically throughout the month of April, pending an adjustment of the wage scale, there were no strikes nor lockouts of sufficient importance to affect the trade as a whole. Moreover, only about 11 per cent, or a total of 18,780 men, responded to the call for a suspension of operations, and the average time lost by these men was twenty days. The quantity of bituminous coal washed during 1908, in Pennsylvania, was 3,561,222 short tons, yielding 3,254,661 tons of cleaned coal and 306,561 tons of refuse.

The casualty record of the bituminous mines of Pennsylvania, as reported by Mr. James E. Roderick, chief of the department of mines at Harrisburg, shows a decided improvement over the dark record of the preceding year, but when compared with 1906, the showing made in 1908 is still unfavorable. There was no recurrence in 1908 of the numerous disastrous explosions which had shocked humanity the previous year, but the death roll footed up to a total of 572 lives lost, which was 234 less than in 1907, but 95 more than in 1906, when the production exceeded by 12,000,000 tons, or more than 10 per cent, the output of 1908. The death rate per 1,000 men employed in 1908 was 3.45, against 4.94 in 1907, and 3.14 in 1906, and the number of tons of coal mined for each life lost in 1908 was 204,859, against 186,281 in 1907, and 271,055 in 1906. As is usually the case, most of the deaths resulted from falls of roof in rooms and falls of rock or coal in gangways. In 1908, 263, or 46 per cent, of the total number of deaths were due to this cause, and in the majority of cases the accidents were preventable. In addition to the lives lost, 557 men were injured from this same cause. Gas explosions were responsible for 162 deaths and for the injuries to 20 men. Seventy-five miners were killed and 266 injured by being crushed by mine cars. Shaft accidents were responsible for 10 deaths and 1 injury, and powder explosions for 1 death and 21 injuries. Thirty-nine deaths and 111 injuries in the mines were attributed to other causes, while 22 men were killed and 43 injured outside the mines through various causes. Of the 572 men killed, 291 were married, and the number of children left fatherless was 675.

The statistics of production, by counties, with the distribution of the product for consumption in 1907 and 1908 are shown in the following table:

Bituminous coal production of Pennsylvania in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	17,686,649	336,922	292,165	....	18,315,736	$20,110,460	$1.10	250	21,085
Armstrong	3,230,135	75,925	114,018	9,924	3,430,002	3,428,258	1.00	246	5,125
Beaver	71,200	37,025	1,350	....	109,575	140,613	1.28	246	185
Bedford	721,242	9,718	11,974	224,379	967,313	999,828	1.03	236	1,439
Blair	393,011	2,273	6,801	91,134	493,219	508,856	1.03	285	693
Butler	878,710	11,462	12,557	....	902,729	958,051	1.06	256	1,380
Cambria	14,244,241	276,382	320,933	1,520,324	16,361,880	17,230,193	1.05	260	20,751
Center	1,239,450	6,116	3,830	6,987	1,256,383	1,151,866	.92	226	1,738
Clarion	1,040,176	11,051	27,140	....	1,078,367	1,100,433	1.02	224	1,913
Clearfield	7,393,066	117,242	166,680	357,723	8,034,711	7,887,283	.98	229	10,890
Elk	1,312,169	34,370	23,293	58,009	1,427,841	1,442,096	1.01	251	2,003
Fayette	7,243,548	321,578	553,786	21,141,710	29,260,622	30,321,657	1.04	270	22,909
Huntingdon	676,327	7,519	11,363	26,395	721,604	798,115	1.11	268	1,081
Indiana	7,132,241	42,361	150,147	311,249	7,635,998	7,231,684	.95	251	9,744
Jefferson	4,536,052	28,944	112,966	1,286,435	5,964,397	5,712,576	.96	251	6,894
Lawrence	183,646	22,983	14,089	....	220,718	294,786	1.34	271	385
Mercer	909,496	7,918	37,876	....	955,290	1,041,137	1.09	269	1,487
Somerset	7,407,835	46,676	207,806	107,391	7,769,708	8,579,132	1.10	263	9,835
Tioga	1,096,637	40,925	8,791	....	1,146,353	1,768,394	1.54	241	2,178
Washington	13,741,410	96,840	342,204	355,273	14,535,727	15,612,757	1.07	246	15,033
Westmoreland	18,341,804	332,461	613,200	9,629,256	28,916,721	28,618,176	.99	266	25,676
Other counties[a] and small mines	530,628	74,441	7,214	26,000	638,283	727,675	1.20	252	871
	110,009,673	1,941,132	3,040,183	35,152,189	150,143,177	155,664,026	1.04	255	163,295

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	13,551,805	302,056	229,982	....	14,083,843	$14,843,665	$1.05	189	22,384
Armstrong	2,611,071	80,149	86,266	....	2,777,486	2,736,542	.99	188	4,552
Beaver	142,605	77,682	2,424	....	222,711	261,537	1.17	211	309
Bedford	412,023	5,050	9,559	84,382	511,014	519,219	1.02	146	1,099
Blair	258,249	2,621	5,957	48,340	315,167	337,871	1.07	180	554
Butler	772,343	13,838	16,281	....	802,462	808,205	1.01	207	1,339
Cambria	12,354,638	209,275	320,313	1,254,082	14,138,308	14,792,377	1.05	213	22,804
Center	1,058,824	24,562	2,998	....	1,086,384	1,021,227	.94	187	1,757
Clarion	937,310	10,845	24,630	....	972,785	967,940	1.00	190	1,882
Clearfield	5,783,688	79,552	164,355	219,939	6,247,534	6,049,552	.97	171	11,376
Elk	1,050,095	32,168	22,029	42,917	1,147,209	1,265,208	1.17	201	2,056
Fayette	5,798,619	266,951	487,870	12,920,977	19,474,417	19,707,839	1.01	214	19,866
Huntingdon	528,095	10,724	12,851	46,424	598,094	670,525	1.12	195	1,264
Indiana	6,441,351	28,587	175,120	198,121	6,843,179	6,359,687	.93	200	10,311
Jefferson	3,767,418	33,742	108,257	943,896	4,853,313	4,695,603	.97	170	6,202
Lawrence	117,808	13,637	11,194	....	142,639	168,371	1.18	126	355
Mercer	681,421	4,977	37,760	....	724,158	763,471	1.05	201	1,408
Somerset	7,150,123	53,878	198,101	2,843	7,404,945	7,848,656	1.06	236	10,244
Tioga	643,285	31,182	7,632	....	682,099	1,022,913	1.50	133	2,050
Washington	11,309,761	96,202	313,387	398,657	12,118,007	12,470,171	1.03	196	17,364
Westmoreland	15,555,657	330,457	572,765	5,040,413	21,499,292	20,915,077	.97	214	26,041
Other counties[b] and small mines	433,818	93,157	7,506	....	534,481	590,647	1.11	229	744
	91,360,007	1,801,292	2,817,237	21,200,991	117,179,527	118,816,303	1.01	201	165,961

[a] Bradford, Cameron, Clinton, Greene, Lycoming, and McKean.
[b] Bradford, Clinton, Greene, and Lycoming.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Bituminous coal production of Pennsylvania, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906	1907.	1908.	Increase (+) or decrease (–), 1908.
Allegheny	12,291,261	13,662,610	16,823,027	18,315,736	14,083,843	– 4,231,893
Armstrong	1,996,661	2,497,314	2,574,758	3,430,002	2,777,486	– 652,516
Beaver	67,923	82,678	81,531	109,575	222,711	+ 113,136
Bedford	540,850	752,715	734,855	967,313	511,014	– 456,299
Blair	244,932	348,749	402,438	493,219	315,167	– 178,052
Butler	497,316	550,589	803,499	902,729	802,462	– 100,267
Cambria	10,845,560	12,600,891	12,439,152	16,361,880	14,138,308	– 2,223,572
Center	712,036	810,441	895,434	1,256,383	1,086,384	– 169,999
Clarion	551,532	714,478	719,548	1,078,367	972,785	– 105,582
Clearfield	5,746,870	7,248,305	5,944,745	8,034,711	6,247,534	– 1,787,177
Clinton	341,967	296,988	233,674	322,624	253,958	– 68,666
Elk	1,129,231	1,249,337	944,367	1,427,841	1,147,209	– 280,632
Fayette	19,231,011	24,250,989	27,044,451	29,260,622	19,474,417	– 9,786,205
Greene	80,646	105,000	144,251	158,187	145,644	– 12,543
Huntingdon	487,223	559,039	630,155	721,604	598,094	– 123,510
Indiana	2,683,951	4,477,431	4,657,457	7,635,998	6,843,179	– 792,819
Jefferson	6,043,564	6,393,985	5,160,195	5,964,397	4,853,313	– 1,111,084
Lawrence	182,662	267,470	257,716	220,718	142,639	– 78,079
Lycoming	78,837	33,844	44,425	51,956	34,626	– 17,330
Mercer	619,648	707,964	842,648	955,290	724,158	– 231,132
Somerset	5,317,161	6,412,672	6,674,191	7,769,708	7,404,945	– 364,763
Tioga	616,828	706,723	826,925	1,146,353	682,099	– 464,254
Washington	8,900,254	10,609,051	12,714,405	14,535,727	12,118,007	– 2,417,720
Westmoreland	18,688,974	22,998,726	27,573,420	28,916,721	21,499,292	– 7,417,429
Small mines	[a] 41,389	[a] 75,650	[a] 125,939	[b] 105,516	[c] 100,253	– 5,263
Total	97,938,287	118,413,637	129,293,206	150,143,177	117,179,527	– 32,963,650
Total value	$94,428,219	$113,390,507	$130,290,651	$155,664,026	$118,816,303	–$36,847,723

[a] Includes production of Cameron County.
[b] Includes production of Bradford, Cameron, and McKean counties.
[c] Includes production of Bradford County.

The statistics of the early production of bituminous coal in Pennsylvania, particularly as compared with the anthracite records, are sadly wanting. The United States census of 1840 shows a production of bituminous coal in the State, which amounted to 464,826 short tons. The census of 1860 reports a production of 2,690,786 short tons; that of 1870 shows a production of 7,798,518 short tons. The production for the intervening years, as shown on the table following, has been estimated from the best information obtainable. Since 1871 the records are official. The total production of bituminous coal, as shown in the above-mentioned table, has amounted to 1,963,248,780 short tons. The anthracite production from 1814 to the close of 1908 has amounted to 2,014,779,075 short tons, showing that the total production for the State has been nearly evenly divided between anthracite and bituminous coal.

Production of bituminous coal in Pennsylvania from 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	464,826	1858	2,200,000	1876	12,880,000	1894	39,912,463
1841	475,000	1859	2,400,000	1877	14,000,000	1895	50,217,228
1842	500,000	1860	2,690,786	1878	15,120,000	1896	49,557,453
1843	650,000	1861	3,200,000	1879	16,240,000	1897	54,417,974
1844	675,000	1862	4,000,000	1880	18,425,163	1898	65,165,133
1845	700,000	1863	5,000,000	1881	22,400,000	1899	74,150,175
1846	760,000	1864	5,839,000	1882	24,640,000	1900	79,842,326
1847	399,840	1865	6,350,000	1883	26,880,000	1901	82,305,946
1848	500,000	1866	6,800,000	1884	28,000,000	1902	98,574,367
1849	750,000	1867	7,300,000	1885	26,000,000	1903	103,117,178
1850	1,000,000	1868	7,500,000	1886	27,094,501	1904	97,938,287
1851	1,200,000	1869	6,750,000	1887	31,516,856	1905	118,413,637
1852	1,400,000	1870	7,798,518	1888	33,796,727	1906	129,293,206
1853	1,500,000	1871	9,040,565	1889	36,174,089	1907	150,143,177
1854	1,650,000	1872	11,695,040	1890	42,302,173	1908	117,179,527
1855	1,780,000	1873	13,098,829	1891	42,788,490		
1856	1,850,000	1874	12,320,000	1892	46,694,576		1,963,248,780
1857	2,000,000	1875	11,760,000	1893	44,070,724		

Mr. Campbell places the quantity of coal originally in the anthracite fields of Pennsylvania at 21,000,000,000 short tons, and in the bituminous fields at 112,574,000,000 short tons. Under the conditions in which mining in the anthracite region was carried on in former years, it was estimated that for every ton of coal mined and marketed 1½ tons approximately were either wasted or left in the ground as pillars for the protection of the workings, so that the actual yield of the beds was only about 40 per cent of the contents. This percentage of waste has been materially reduced by the modern methods of mining, but it is probable that the exhaustion to the close of 1908 has actually doubled the production, or, say, 4,030,000,000 short tons. This would leave still in the ground approximately 16,970,000,000 tons, which would be capable of producing, at the rate of 1 ton of coal lost for each ton mined, 8,485,000,000 tons, or approximately 102 times the quantity of anthracite produced in 1908. If all of the coal were to be recovered the supply would last 204 years at the rate of production in 1908. The quantity of anthracite which would actually be produced would probably lie somewhere between half the remaining supply and the total.

Estimating for the bituminous production 1 ton of coal lost for every 2 tons mined, the exhaustion to the close of 1908 has been 2,945,000,000 tons, which would leave still in the ground more than 109,000,000,000 short tons—about 930 times the production of 1908—or, in other words, if the exhaustion is one and one-half times the production of bituminous coal in Pennsylvania, at the rate of production in 1908 the supply would last approximately 620 years.

PHILIPPINE ISLANDS.[a]

In 1906 and the early part of 1907 rather vigorous exploration work was being carried on in no less than five coal fields. At the present time this activity has become confined to the narrow limits of one island, Batan, off the east coast of Albay, Luzon. At this locality is found the coal mine of the United States Army on the west and on the east the Batan Coal Company's property. The former is producing 80 tons per day, the latter 50 tons.

There is a marked difference in the coals of the two fields, the coal of the army mine on the west end being somewhat better, but more difficult to mine, while on the east end it is just the reverse. Development work has corroborated the prediction made in 1905 that there would be found to be no inconsiderable faulting on the west end of the island. This may seriously embarrass the operations there. At any rate, it will call for the most experienced engineering and managing ability. As this work is a matter entirely separate from any civil or private enterprise, the writer does not feel called upon to discuss the situation further.

An important feature in the growth of coal mining in the islands is the coaling of the U. S. Army transport *Dix* for her trip to Seattle. During the last year the inter-island transport *Wright* has been using this coal with good results, but the *Dix*, by taking on 2,500 tons in April, 1909, marked the first use of Philippine coal on a trans-Pacific steamer.

---

[a] From advance sheets of a report on the nonmetallic minerals of the Philippines, by Warren D. Smith, Ph. D., chief of the division of mines, Bureau of Science, Manila.

The Batan Coal Company's mine is the first one since the American occupation to furnish coal to the general market, and the first successful coal property in the whole history of these islands. This mine was visited in March, 1909, by Mr. H. G. Ferguson, geologist of this bureau, to whom Mr. Daniels, the superintendent, kindly furnished the information as given in this paper.

For fear that the charge may be made that the Government is advertising private properties, the writer desires to state that this company is the only private concern operating, and, therefore, it can not be benefited at the expense of any other. In the second place, no guaranty is given as to the future welfare of the property merely by stating what has been done, nor is there any official indorsement of the methods employed. The writer believes, in the third place, in encouraging an infant industry in every legitimate way, and that its interests are subserved by giving these facts at this stage of the mining industry. The facts given are of vital importance to the prospective investor and to the mining engineer who may be sent out to open up new properties.

This mine is located within a few hundred feet of the barrio of Batan, on the island of the same name. It is approximately 700 feet from the sea. The outside plant in March, 1909, consisted of one 30-horsepower Sedgwood double-drum hoisting engine and boiler. The cars are hoisted from the tunnel and run down by gravity on a small track to the sea, where the coal is loaded into lighters in which it is conveyed out to deep water beyond the reef to the ship's side. A new wharf, 300 feet long with 33 feet of water at low tide alongside, is nearly completed. A stock pile will be placed 1,000 feet from the wharf end and will be located at about 2,000 feet from the tunnel. Two small steam locomotives are used now.

Coming now to the underground work, the coal seam varies from 5 feet 6 inches to 5 feet 9 inches with 3 to 5 inches of clay parting, 18 inches from the roof, and dips 13° N. The roof is a hard, sandy clay, and stands remarkably well, with only a slight tendency to slab off in the first 2 feet.

There are two adits and three air shafts. The system adopted is the room and pillar, with the rooms running up the dip 15 feet wide and 300 to 400 feet long, with 50-foot pillars. The coal is sometimes worked 50 feet beyond the timbering. The west gallery is 800 feet long and the main tunnel 650 feet.

Wire haulage is used in the main tunnel, but cars are pushed by hand in the rooms. Rails are soon to be laid up to the working face.

The coal is easily broken from the face by working up the dip. Coal-cutting machines are not required. The coal breaks evenly from the clay. It possesses a good cleat. All sorting is done underground. Only Japanese pickers were originally used, but the natives have been trained and have been found entirely satisfactory. They win from 5 to 7 tons per day. Japanese are now used mainly for timbering and advancing main tunnels.

The following is the daily scale of wages:

Scale of wages of coal miners, Philippine Islands.

Japanese foremen	₱2.50
Filipino pickers	1.20
Filipino helpers	1.00
Surface laborers	.80

There was some difficulty with the labor at first, but now there is none. The Filipino laborers are all Bicols from the surrounding country. They have proved steady workers.

Narra has been found to be the most satisfactory timber available.

Preliminary work was begun in October, 1906, in this mine. The first shipment of coal was 77 tons in the bunkers of the *San Juan*. The production to date amounts to 15,000 tons, approximately. At present only one shift is working, giving a daily output of 45 to 50 tons.

In this district only the uppermost seam is being worked. From the general relations which obtain over southern Luzon and the Visayas, the writer feels safe in predicting the discovery of at least two more and perhaps considerably thicker seams below this one. It is probable also that the entire east end of this island is underlain by workable, merchantable coal.

One of the best features connected with this mine is the absence of dust. Dust has been found to be one of the most potent factors in mine explosions. So large a part does it play that all European dry coal mines are required by law to be constantly sprinkled. Here this is not necessary. Pumping is required, particularly in the rainy season.

In order to show in as concise a manner as possible the natural value of this coal, the statements of the engineers of two coast-guard cutters, the *Busuanga* and the *Negros*, are given:

Relative merits of Australian and Batan coal based on tests during two months' use of each on the cutters Busuanga and Negros.

	Australian.	Batan.
Miles steamed (two months)	5,662	5,442
Tons coal consumed steaming	229	348
Total cost coal consumed	₱3,744.15	₱2,088.00
Cost per mile steaming	₱0.66	₱0.38
Cost per 1,000 miles steaming	₱660.00	₱380.00

Compared with Australian coal, Batan coal burns freely, requires light firing and often, and no working with tools. It gives hardly any soot in tubes and connections and very light clinkers. It disintegrates very rapidly after being spread on fires and quite a percentage is lost if used on coarse grates.

It is seen that about 50 per cent more of the Batan coal is required for a given run, but this coal costs just a trifle more than half, so that where bunker space counts, there would be nothing gained by using Batan coal.

On Cebu Island the mine of the Insular Coal Company was in operation during a part of the year. At present, however, the mine is closed down, though the company is hoping to reopen in the near future.

PRODUCTION.

In 1907 the total production, all of which was from Albay, was 4,123 metric tons, or 4,534 short tons. The production in 1908 amounted to 10,035 metric tons or 11,059 short tons, valued at ₱77,166, or $38,583. Of the total output in 1908, 9,248 metric tons was from Albay and 787 tons from Cebu.

BIBLIOGRAPHY.

The following is a list of publications in which the coal fields of the Philippine Islands are discussed:

1876. Centeno y García, José. Ministerio de Ultramar, Memoria geologico-minera de las islas Filipinas, Madrid, Tello, vol. 8, p. 64. 1 map.
1886. Abella y Casariego, Enrique. Rápida descripción física, geológica y minera de la isla de Cebú. Madrid, Tello, p. 187. 5 pls. 1 map.
1890. Abella y Casariego, Enrique. Descripción . . . de la isla de Panay. Manila, Chofri, p. 203. 2 maps. 1 table.
1901. Becker, G. F. Report on the geology of the Philippine Islands, Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 3, pp. 493–614. 2 maps.
1901. Burritt, Charles H. The coal measures of the Philippines. Washington.
1903. Wigmore, H. L. Report of the investigation of coal deposits on the Batan Military Reservation, Batan Island, P. I. Washington.
1905. McCaskey, H. D., Fifth Ann. Rept. of the Mining Bureau for the year ending August 31, 1904. Manila.
1905. McCaskey, H. D. Sixth Ann. Rept. of the Chief of the Mining Bureau (1905).
1905. Smith, W. D. The coal deposits of Batan Island, Mining Bureau Bull. No. 5.
1906. Ickis, H. M. Polillo coal deposits (MS. report).
1906. Cox, A. J. Philippine coals and their gas-producing power. Philippine Jour. Sci., vol. 1, pp. 877–902.
1907. Cox, A. J. The proximate analysis of Philippine coals. Philippine Jour. Sci., sec. A, vol. 2, pp. 41–65.
1907. Smith, W. D. Nonmetallic minerals. Far Eastern Rev., vol. 4, p. 10.
1907. Smith, W. D. Coal in Cebu. Far Eastern Rev., vol. 4, p. 14.
1907. Smith, W. D. Mining prospects on and near the Zamboanga Peninsula, Mindanao. Far Eastern Rev., vol. 4, p. 184. Abstr. Min. Sci., vol. 57, 1908, p. 175.
1907. Smith, W. D. The geology of the Compostela-Danao coal field. Philippine Jour. Sci., sec. A, vol. 2, pp. 377–403, 15 pls., 3 maps.
1908. Smith, W. D. Mining prospects on and near Zamboanga Peninsula, Mindanao. Min. Res. Philippine Islands, Manila, p. 31.
1908. Cox, A. J. Summary of the chief characteristics of Philippine coals. Min. Res. Philippine Islands, Manila, p. 34.
1908. Ferguson, H. G. Coal in the Cagayan Valley. Philippine Jour. Sci., sec. A, vol. 3, pp. 535–537, 1 map.
1908. Cox, A. J. Philippine coals as fuel. Philippine Jour. Sci., sec. A, vol. 3, pp. 301–355, 13 pls.
1909. Cox, A. J. Calorimetry and the determination of the calorific value of Philippine and other coals from the results of proximate analysis. Philippine Jour. Sci., sec. A, vol. 4, May.

TENNESSEE.

Total production in 1908, 6,199,171 short tons; spot value, $7,118,499.

In a preliminary statement issued early in January the writer ventured the prophecy that Tennessee's production in 1908 would be shown to have decreased somewhat more than that of Kentucky, as the larger portion of the product of Tennessee was made into coke to supply the blast furnaces at Rockwood and Chattanooga. Complete returns to the Geological Survey showed that the production of Tennessee decreased 611,072 short tons, or 8.97 per cent, from 6,810,243 short tons in 1907 to 6,199,171 tons in 1908. The value decreased $1,371,835, or 16.16 per cent, from $8,490,334 in 1907 to $7,118,499 in 1908. Kentucky's production showed a decrease of 506,571 short tons, or 4.71 per cent, in quantity, and of $1,087,876, or 9.54 per cent, in value. The decrease in Tennessee would probably have been somewhat greater had it not been for the long strike in Alabama, which resulted in some benefit to the industry in Tennessee.

The average price per ton of Tennessee's product in 1908 was $1.15, as compared with $1.25 in 1907. The average price in 1908 was the lowest, with one exception, within the last six years.

There were employed in the coal mines of Tennessee in 1908 11,812 men, who worked an average of 209 days, compared with 12,052 men working an average of 232 days in 1907. The increase in the efficiency of Tennessee mine employees, which was referred to in the reports for 1906 and 1907, continued in 1908, the average daily production per man having shown an increase from 2.29 short tons in 1905 to 2.39 tons in 1906, 2.44 tons in 1907, and 2.51 tons in 1908. Owing to the fewer number of days worked in 1908, however, the average production per man for the year was less than in either 1907 or 1906. The average tonnage per man in 1908 was 525, against 565 in 1907 and 546.6 in 1906. The increase in the average daily production per man is partly attributable to the fact that the mines were worked a fewer number of days and that the intensity of labor was greater for the time the mine employees were permitted to work than it was in 1907.

During 1908, 787,502 tons of coal, or 12.7 per cent of the total output, were mined by the use of machines, as compared with 874,925 tons, or 12.85 per cent, in 1907. The number of machines reported in operation in 1908 was 122, as compared with 137 in 1907. Of the 122 machines reported in 1908, 96 were pick machines, 18 chain-breast, and 8 long-wall.

In one respect the operation of the coal mines of Tennessee is unique—in the number of hours worked per day. Tennessee is the only State in which by far the largest number of men work nine hours per day. In most of the coal-mining States the majority of the mines are worked either eight or ten hours daily, but in Tennessee 8,220 out of a total of 11,812 men employed in 1908 worked nine hours a day. These were distributed among 87 mines. Five mines, employing 287 men, reported eight hours to the day's work, and 19 mines, employing 1,921 men, worked ten hours.

According to the annual report of Mr. R. A. Shiflett, chief of the bureau of mines, 34 men were killed and 195 injured in the coal mines of Tennessee during 1908. The causes of the accidents are not given. Of the total number of men killed, 23 were married and left 47 children fatherless. The number of tons mined for each life lost was 182,329.

The coal mines of Tennessee were not seriously affected by labor disturbances during 1908. Strikes occurred at only 4 mines, and involved a total of 349 men, who were idle an average of thirty-three days.

There were five companies which employed washing machinery in Tennessee during 1908, 278,928 tons of coal being washed, yielding 258,477 tons of cleaned coal and 20,451 tons of refuse. In 1907, 604,557 tons of coal were put through washeries, and from this 543,333 short tons of cleaned coal and 61,224 tons of refuse were obtained.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Tennessee in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	823,389	11,108	17,446	....	851,943	$1,020,293	$1.20	217	1,708
Campbell	1,212,252	37,764	27,435	122,549	1,400,000	1,951,861	1.39	196	2,507
Claiborne	1,113,670	14,900	19,330	....	1,147,900	1,153,294	1.00	239	1,636
Grundy	526,010	2,568	2,747	33,266	564,591	637,478	1.13	270	897
Hamilton	284,507	7,091	7,923	82,523	382,044	510,501	1.34	241	697
Marion	341,515	1,535	3,969	54,397	401,416	560,006	1.39	282	665
Morgan	520,515	5,718	10,727	102,247	639,207	838,598	1.31	264	1,199
Overton	73,876	320	538	....	74,734	97,817	1.31	234	150
Scott	182,387	12,142	2,636	....	197,165	300,545	1.52	205	474
Other counties [a]	663,867	41,708	36,902	408,620	1,151,097	1,419,690	1.23	234	2,119
Small mines	....	146	....	....	146	251	1.72	....	....
	5,741,988	135,000	129,653	803,602	6,810,243	8,490,334	1.25	232	12,052

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	838,523	6,606	9,068	....	854,197	$951,535	$1.11	226	1,473
Campbell	1,542,521	17,411	19,983	4,628	1,584,543	1,938,100	1.22	193	3,102
Claiborne	1,130,826	7,050	20,290	....	1,158,166	1,161,348	1.00	211	1,511
Grundy	553,806	2,537	2,095	13,663	572,101	638,815	1.12	263	930
Hamilton	47,509	5,650	4,184	1,400	58,743	73,761	1.26	41	564
Marion	346,330	5,745	4,423	35,668	392,166	535,402	1.37	246	821
Morgan	466,751	4,653	11,152	102,578	585,134	651,214	1.11	239	1,203
Overton	44,809	499	770	....	46,078	52,199	1.13	148	177
Scott	114,745	12,761	931	....	128,437	175,796	1.37	129	559
Other counties [b]	482,851	29,722	29,819	276,705	819,097	939,118	1.15	245	1,472
Small mines	....	509	....	....	509	1,211	2.38	....	....
	5,568,671	93,143	102,715	434,642	6,199,171	7,118,499	1.15	209	11,812

[a] Bledsoe, Cumberland, Fentress, Franklin, Rhea, Roane, Sequatchie, and White.
[b] Bledsoe, Cumberland, Fentress, Franklin, Rhea, Roane, and White.

It appears from the above table that the mines in Hamilton County were operated for an average of only forty-one days during 1908, which is explained by the fact that the largest company in the county operated only five days in the year, thus reducing the average of the county to forty-one days.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Tennessee, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Anderson	630,109	845,778	763,834	851,943	854,197	+ 2,254
Campbell	804,750	1,080,540	1,282,107	1,400,000	1,584,543	+ 184,543
Claiborne	961,255	1,020,453	1,099,747	1,147,900	1,158,166	+ 10,266
Cumberland	91,718	35,052	64,247	86,362	22,617	− 63,745
Grundy	357,219	421,210	449,367	564,591	572,101	+ 7,510
Hamilton	252,735	296,445	316,532	382,044	58,743	− 323,301
Marion	388,605	416,768	389,525	401,416	392,166	− 9,250
Morgan	484,232	620,587	615,705	639,207	585,134	− 54,073
Overton	106,403	84,493	81,603	74,734	46,078	− 28,656
Rhea	204,992	240,590	264,918	242,421	173,719	− 68,702
Roane	98,519	122,403	158,421	170,748	162,669	− 8,079
Scott	123,478	140,230	168,203	197,165	128,437	− 68,728
White	149,286	309,233	438,602	425,328	326,729	− 98,599
Other counties and small mines	128,910	132,908	166,464	226,384	133,872	− 92,512
Total	4,782,211	5,766,690	6,259,275	6,810,243	6,199,171	− 611,072
Total value	$5,642,393	$6,577,881	$7,667,415	$8,490,334	$7,118,499	−$1,371,835

The United States census of 1840 states that 558 short tons of coal were produced in Tennessee in that year. It is probable that very little was mined in the State prior to that date. By 1860 the production had increased to 165,300 tons, but after that date development was retarded by the civil war. Since 1880 the production of Tennessee has increased quite regularly, but not so rapidly as that of Alabama. The annual production of the State from 1840 to the close of 1908 is shown in the following table:

Production of coal in Tennessee from 1840 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	558	1858	135,000	1876	550,000	1894	2,180,879
1841	600	1859	150,000	1877	450,000	1895	2,535,644
1842	1,000	1860	165,300	1878	375,000	1896	2,663,106
1843	4,500	1861	150,000	1879	450,000	1897	2,888,849
1844	10,000	1862	140,000	1880	495,131	1898	3,022,896
1845	18,000	1863	100,000	1881	840,000	1899	3,330,659
1846	25,000	1864	100,000	1882	850,000	1900	3,509,562
1847	30,000	1865	100,000	1883	1,000,000	1901	3,633,290
1848	40,000	1866	100,000	1884	1,200,000	1902	4,382,968
1849	52,000	1867	110,000	1885	1,440,957	1903	4,798,004
1850	60,000	1868	125,000	1886	1,714,290	1904	4,782,211
1851	70,000	1869	130,000	1887	1,900,000	1905	5,766,690
1852	75,000	1870	133,418	1888	1,967,297	1906	6,259,275
1853	85,000	1871	180,000	1889	1,925,689	1907	6,810,243
1854	90,000	1872	224,000	1890	2,169,585	1908	6,199,171
1855	100,000	1873	350,000	1891	2,413,678		
1856	115,000	1874	350,000	1892	2,092,064		90,503,772
1857	125,000	1875	360,000	1893	1,902,258		

The total production of Tennessee to the close of 1908 amounted to 90,503,772 short tons, representing an exhaustion of 135,000,000 tons. According to the estimate by Marius R. Campbell, of the United States Geological Survey, the bituminous coal fields of Tennessee cover an area of 4,400 square miles, the original contents of which when mining began were 25,665,000,000 short tons, of which the exhaustion to the close of 1908 represented a little more than one-half of 1 per cent of the total estimated supply. The coal still left in the ground is about 189 times the exhaustion to the close of 1908; 4,118 times the production in 1908, or 2,745 times the exhaustion represented by that production.

TEXAS.

Total production in 1908, 1,895,377 short tons; spot value, $3,419,481.

Texas enjoyed the distinction of being one of the few States which exhibited an increase in the production of coal in 1908 over 1907. Part of this increase was due to the continued decrease in the production of petroleum and its use for fuel purposes within the State, for while the pools of Louisiana and Oklahoma showed substantial increases in production during 1908, there was a decrease of more than a million barrels, or about 10 per cent, in the production of petroleum in Texas. Another reason for the increase has been the rather rapid growth of the population of the State and of the prosperous conditions which were not in any material degree adversely influenced by the general depression throughout the country in 1908. That these conditions were fairly general throughout the State is indicated by the fact that production increased, both in the bituminous and lignite producing areas. The output of bituminous coal increased from 940,337 short tons, valued at $2,062,918 in 1907, to 1,047,407 short tons, valued at $2,580,991 in 1908, a gain of 107,070 short tons, or 11.4 per cent in quantity, and of $518,073, or 25.1 per cent in value. In some of the coal-producing States there was not only a decrease in production but also a decline in price. In Texas the average price for bituminous coal showed an advance of from $2.19 in 1907 to $2.46 in 1908. There was a slight falling off in the average price of lignite, from $1.01 in 1907 to 99 cents in 1908, but the production increased from 707,732 short tons to 847,970 tons in quantity and from $715,893 to $838,490 in value. The total increase shown in 1908 was 247,308 short tons, or 15.01 per cent in quantity, from 1,648,069 short tons in 1907 to 1,895,377 short tons in 1908, while the total value increased $640,670, or 23.06 per cent, from $2,778,811 to $3,419,481.

In the report for 1907 it was stated that the Wichita Falls and Southern Railway Company was reported to have under construction a branch line from Wichita Falls to the bituminous-coal areas of Young County. This railroad was completed in 1908, furnishing transportation facilities to the Young County coal properties, and that county entered the list of producers in 1908 with a total output of 1,000 tons. The bituminous-coal mines in McCullough County were idle in 1908, so that the number of producing counties was the same in that year as in 1907. There were altogether 16 counties which produced coal or lignite in Texas in 1907 and 1908. In the latter year the counties producing bituminous coal were Erath, Maverick, Palo Pinto, Parker, Webb, Wise, and Young. The lignite-producing counties were Bastrop, Fayette, Hopkins, Houston, Leon, Medina, Milam, Robertson, and Wood.

The bituminous and lignite mines of Texas gave employment in 1908 to 4,400 men, who worked an average of 254 days, against 4,227 men for an average of 242 days in 1907. The bituminous mines employed 3,213 men for an average of 266 days in 1908, and the lignite mines 1,187 men for an average of 221 days. The average daily production per man in the bituminous mines was 1.23 short tons and in the lignite mines 3.23 tons. The average daily production per man for both the bituminous and lignite coals was 1.7 tons in 1908, against 1.6 in 1907. The average annual production per man in 1908 was 431 short tons, against 390 tons in 1907. In the bituminous mines the average annual production per man in 1908 was 326 short tons and in the lignite mines it was 714 tons.

There were 6 mining machines in use in the coal mines of Texas in 1908, a decrease from 13 in 1907, and the machine-mined tonnage decreased from 36,100 to 15,000. In most of the bituminous mines of the State the men worked eight hours a day, while in the lignite mines the rule was ten hours.

The labor disturbances in the coal mines of Texas in 1908 were limited to the suspension of operations at one mine where 169 men were employed, these miners being idle only two days.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table. Owing to the fact that there are only one or two mines in each county, the production of the bituminous-producing and of the lignite-producing counties, respectively, is combined.

Coal production of Texas in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bituminous: Erath McCullough Maverick Palo Pinto Parker Webb Wise	906,181	7,348	26,808	940,337	$2,062,918	$2.19	255	3,137
Lignite: Bastrop Fayette Hopkins Houston Leon Medina Milam Robertson Wood	678,395	19,770	9,567	707,732	715,893	1.01	204	1,090
	1,584,576	27,118	36,375	1,648,069	2,778,811	1.69	242	4,227

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bituminous: Erath Maverick Palo Pinto Parker Webb Wise Young	1,002,541	30,954	13,912	1,047,407	$2,580,991	$2.46	266	3,213
Lignite: Bastrop Fayette Hopkins Houston Leon Medina Milam Robertson Wood	821,099	21,800	5,071	847,970	838,490	.99	221	1,187
	1,823,640	52,754	18,983	1,895,377	3,419,481	1.80	254	4,400

The first reported production of coal in Texas is contained in the volume Mineral Resources of the United States for 1884. The production reported to the United States Geological Survey for that year was 125,000 tons. The growth of the industry from that date to the close of 1908 is shown in the following table:

Coal production of Texas from 1884 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	125,000	1891	172,100	1898	686,734	1905	1,200,684
1885	100,000	1892	245,690	1899	883,832	1906	1,312,873
1886	100,000	1893	302,206	1900	968,373	1907	1,648,069
1887	75,000	1894	420,848	1901	1,107,953	1908	1,895,377
1888	90,000	1895	484,959	1902	901,912		
1889	128,216	1896	544,015	1903	926,759		16,340,325
1890	184,440	1897	639,341	1904	1,195,944		

Mr. Campbell's estimates of the coal areas of Texas place the bituminous fields known to contain workable coal at 8,200 square miles, with 5,300 square miles of area not so well known but which may contain workable coal. The known lignite areas cover 2,000 square miles, while there are 53,000 square miles, extending from Sabine and Red rivers on the east and north to the Rio Grande on the southwest, which may contain workable beds of lignite. The estimated original supply of bituminous coal in Texas is placed at 8,000,000,000 short tons, and of lignite at 23,000,000,000 tons, making a total of 31,000,000,000 tons as the original supply. From this there had been produced to the close of 1908 a total of 16,340,325 short tons, which represents an exhaustion of approximately 25,000,000 tons, the exhaustion representing 0.08 per cent of the original supply. The supply left in the ground at the close of 1908 would be equal to 16,300 times the production of that year.

UTAH.

Total production in 1908, 1,846,792 short tons; spot value, $3,119,338.

Although the coal production of Utah in 1908 decreased in sympathy with the general falling off as compared with the preceding year, an increase is reported in the value of the product. The production decreased from 1,947,607 short tons in 1907 to 1,846,792 short tons in 1908, a loss of 100,815 short tons or 5.18 per cent. The value increased from $2,959,769 to $3,119,338, a gain of $159,569, or 5.39 per cent. The average price per ton advanced from $1.52 in 1907 to $1.69 in 1908. This increase in value and advance in price in the face of the general financial depression appears to have been due in part to more exacting requirements of consumers, in part to inability to dispose of slack and other low-grade qualities and in part to a lessened efficiency in the productive capacity of the mine workers. As compared with 1905, 1906, and 1907, the average production for each man employed in 1908 shows a decided falling off. In 1905 the average daily production for each man employed in the coal mines of Utah was 3.96 tons. In 1906 it was 3.92 tons, in 1907 it was 3.43 tons, and in 1908 it was 3.05 tons. The average production per man for the year shows an even more marked decline. In 1905 the average output for each man employed was 979 tons; in 1906 it was 1,127 tons; in 1907 it was 884 tons, and in 1908 it dropped to 693 tons. Practically all of the mines in the State are operated under agreements with the United Mine Workers of America, and out of a total of 2,664 men, 2,620 worked at mines operated on the basis of an eight-hour day. As in the other coal-producing States of the Rocky Mountain region the number of men employed in the mines shows an increase, the number of employees increasing from 2,203 in 1907, to 2,664 in 1908. The average number of working days decreased from 258 in 1907 to 227 in 1908. The supply of cars, like that of labor, was, generally speaking, ample throughout the year, and there was no trouble from strikes, lockouts, or other labor difficulties. The latter half of the year showed a marked improvement over the first half, and the conditions in the metalliferous mining industry at the end of the year were gradually improving, so that the outlook for the current year for the coal mines was hopeful.

According to Mr. J. E. Pettit, state coal-mine inspector, there was a total of 136 coal-mining accidents during 1908. Of these 8 were fatal and 128 nonfatal, and of the 128 nonfatal accidents only 17 were of a serious character. There were 4 wives made widows and 11 children made fatherless by the fatalities. Of the 8 fatal accidents 2 should not properly be included among coal-mining accidents, as the men in these cases were crushed by coke cars. Dust explosions were responsible for 2 deaths and 2 injuries. Falls of roof in rooms killed 2 men and injured 6. Falls of rock in gangways injured 4 men. Powder explosions injured 2, and 2 men were killed and 12 injured by being crushed by mine cars. The death rate per thousand of employees was 3, counting the men killed by coke cars as among the coal-mining accidents. The number of tons mined for each life lost was 230,849.

The statistics of production by counties in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Utah in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,199,145	6,217	58,636	572,441	1,836,439	$2,729,664	$1.49	267	2,010
Emery	200	4,847	5	....	5,052	8,371	1.66	107	22
Morgan, Sanpete	1,963	1,773	....	....	3,736	9,637	2.58	123	18
Summit, Uinta	86,341	8,957	6,727	....	102,025	211,519	2.07	174	153
Small mines	....	355	....	....	355	578	1.63	....	....
	1,287,649	22,149	65,368	572,441	1,947,607	2,959,769	1.52	258	2,203

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,427,018	10,414	53,262	229,141	1,719,835	$2,889,564	$1.68	227	2,442
Emery	940	2,769	16	....	3,725	4,922	1.32	99	15
Summit	99,207	3,666	8,511	....	111,384	192,312	1.73	243	185
Morgan, Sanpete, Uinta	....	9,650	....	....	9,650	27,783	2.88	170	22
Small mines	....	2,198	....	....	2,198	4,757	2.16	....	....
	1,527,165	28,697	61,789	229,141	1,846,792	3,119,338	1.69	227	2,664

The production by counties during the last five years, with the increases and decreases in 1908 as compared with 1907, has been as follows:

Coal production of Utah, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Carbon	1,416,623	1,258,346	1,693,081	1,836,439	1,719,835	− 116,604
Emery	4,031	3,692	4,954	5,052	3,725	− 1,327
Morgan, Sanpete	7,733	6,136	6,269	3,736	4,500	+ 764
Summit, Uinta	61,320	61,966	67,043	102,025	116,534	+ 14,509
Small mines	3,320	2,232	1,204	355	2,198	+ 1,843
Total	1,493,027	1,332,372	1,772,551	1,947,607	1,846,792	− 100,815
Total value	$1,943,440	$1,793,510	$2,408,381	$2,959,769	$3,119,338	+$159,569

The areas in Utah known to contain workable beds of coal are estimated by M. R. Campbell to aggregate 13,130 square miles, while there are 2,000 square miles of which little is known but which may contain workable beds of coal. The original contents of these fields are estimated by Mr. Campbell to have been 196,458,000,000 short tons of coal. The first production of coal in Utah was reported in the census year of 1870, when 5,800 short tons were mined. In 1880 the Census reported a total of 14,748 tons, although this was undoubtedly an underestimate. In 1890 the production had increased to 318,159 tons, and it reached an amount exceeding 1,000,000 tons for the first time in 1900 and reached its maximum output of 1,947,607 tons in 1907. The annual production since 1870 is shown in the following table:

Annual production of coal in Utah, 1870–1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1870	5,800	1881	52,000	1892	361,013	1903	1,681,409
1871	....	1882	100,000	1893	413,205	1904	1,493,027
1872	....	1883	200,000	1894	431,550	1905	1,332,372
1873	....	1884	200,000	1895	471,836	1906	1,772,551
1874	....	1885	213,120	1896	418,627	1907	1,947,607
1875	....	1886	200,000	1897	521,560	1908	1,846,792
1876	50,400	1887	180,021	1898	593,709		
1877	50,400	1888	258,961	1899	786,049		20,683,974
1878	67,200	1889	236,651	1900	1,147,027		
1879	50,000	1890	318,159	1901	1,322,614		
1880	14,748	1891	371,045	1902	1,574,521		

The total production since mining began in 1870 is shown by this table to have amounted to 20,683,974 short tons. Upon the basis of one ton of coal being lost for every two tons of coal mined and marketed, the exhaustion to the close of 1908 has amounted approximately to 31,000,000 short tons, or 0.016 per cent of the original supply.

VIRGINIA.

Total production in 1908, 4,259,042 short tons; spot value, $3,868,524.

Notwithstanding the important developments in the Black Mountain district of Lee County, which resulted in an increased production in that county from 198,913 short tons in 1907 to 464,261 short tons in 1908, the total production of Virginia decreased from 4,710,895 short tons, valued at $4,807,533, in 1907, to 4,259,042 short tons, valued at $3,868,524, in 1908, a decrease of 451,853 short tons, or 9.59 per cent, in quantity, and of $939,009, or 19.54 per cent, in value. Wise County, which is now the most important coal-producing county in the State, showed a decrease of 586,972 short tons in 1908, while Tazewell County's production fell off 136,520 short tons.

It is to be noted that practically all of the decrease in the production of 1908 was in the quantity of coal made into coke, this factor having decreased from 2,175,732 short tons in 1907 to 1,736,163 tons in 1908, a decrease of 439,569 short tons, while the total decrease in the State was 451,853 short tons.

The number of employees in the coal mines of Virginia decreased from 6,670 in 1907 to 6,208 in 1908, and the average number of days worked decreased from 241 to 200. The fewer number of days worked in 1908 resulted in a greater intensity of labor on the part of the mine employees, and the average daily production per man increased from 2.93 tons in 1907 to 3.43 tons in 1908. The average annual production per man decreased on account of the fewer working days from 706 short tons in 1907, to 686 tons in 1908. A part of the apparent increased daily production per man was attributable to the large number of men employed in development work during 1907, which naturally reduced the efficiency record for that year. The larger number of the mine workers in Virginia are unorganized and the majority of the coal-mining operations are conducted on the basis of the ten-hour day. In 1908, 32 mines employing 5,214 men worked ten hours; 10 mines employing 802 men worked nine hours, and 2 mines employing 112 men worked eight hours a day. There were no strikes nor lockouts during the year 1908, which was the fifth year in succession in which this condition existed.

The number of mining machines in use in the coal mines of Virginia increased from 37 in 1906 to 77 in 1907 and 85 in 1908. There has been a corresponding increase in the tonnage won by machines. The machine-mined product in 1906 amounted to 424,343 short tons; in 1907 to 788,793 tons; in 1908 to 1,035,832 tons. In 1907 the percentage of machine-mined coal to the total output was 16.74; in 1908 it was 24.32. Of the total product in 1908, 30,872 tons were washed, yielding 29,745 tons of cleaned coal and 1,127 tons of refuse.

The statistics of production by counties in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Virginia in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Lee	179,016	17,545	1,452	....	198,913	$228,888	$1.15	199	432
Tazewell	866,259	17,256	19,575	213,444	1,116,534	1,240,747	1.11	206	1,580
Wise	1,079,280	36,395	67,883	1,962,288	3,145,846	3,066,075	.97	262	3,846
Other counties[a] and small mines	234,351	7,508	7,743	....	249,602	271,823	1.09	232	812
	2,359,806	78,704	96,653	2,175,732	4,710,895	4,807,533	1.02	241	6,670

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Lee	348,240	13,210	8,720	94,091	464,261	$429,531	$0.93	234	621
Tazewell	766,533	21,987	36,558	154,936	980,014	971,927	.99	150	1,677
Wise	989,831	27,154	54,753	1,487,136	2,558,874	2,204,093	.86	204	3,324
Other counties[a] and small mines	239,704	5,549	10,640	....	255,893	262,973	1.03	280	586
	2,344,308	67,900	110,671	1,736,163	4,259,042	3,868,524	.91	200	6,208

[a] Montgomery, Pulaski, and Russell.

The statistics of production, by counties, for the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Virginia, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Tazewell	871,720	961,380	910,638	1,116,534	980,014	− 136,520
Wise	2,359,661	2,990,698	3,041,225	3,145,846	2,558,874	− 586,972
Chesterfield	2,100					
Pulaski	[a]177,133	[b]323,073	[b]302,896	[b]448,515	[b]719,954	+ 271,439
Small mines	300	120	120		200	+ 200
Total	3,410,914	4,275,271	4,254,879	4,710,895	4,259,042	− 451,853
Total value	$2,921,911	$3,777,325	$4,183,991	$4,807,533	$3,868,524	−$939,009

[a] Includes Montgomery County. [b] Includes Lee, Montgomery, and Russell counties.

The first bituminous coal mined in the United States was taken from what is usually termed the Richmond basin, a small area of Triassic age in the southeastern portion of the State, near the city of Richmond. This basin is situated on the eastern margin of the Piedmont Plateau, 13 miles above tide, on James River. It lies in Goochland, Henrico, Powhatan, and Chesterfield counties. The coal beds are much distorted, and the coal is of rather low grade when compared with that from other districts with which it has to come into competition. The mines are also gaseous, and since the high-grade coals from the New River district, in West Virginia, and from other sources have been brought to the markets formerly supplied by coal from the Richmond basin the production has fallen off rapidly, until at the present time only a small quantity is occasionally mined there for purely local consumption. No production was reported from this district in 1907 or 1908.

The occurrence of coal was known in the Richmond basin as early as 1700, and it was used in the latter quarter of the eighteenth century. In 1789 shipments were made to some of the Northern States. In 1822, according to Mr. R. C. Taylor, the production amounted to 48,214 long tons or 54,000 short tons. During the latter part of the nineteenth century expensive, but unsuccessful efforts were made to reestablish the industry in this field. The coal could not be forced upon the market, in competition with the higher-grade coals from other districts, and at the present time what little coal is produced there is for local consumption only. With the completion of the Norfolk and Western Railway, in 1882, the coal fields in the southwestern part of the State, which belong to the Appalachian system, were opened up. A portion of the famous Pocahontas district is included within the county of Tazewell, in Virginia, and the construction of the Clinch Valley branch of the Norfolk and Western Railway, in 1892, opened up valuable coal lands in Wise County, which has since become the most important producing district in the State.

The development of the Black Mountain field, in Lee County, following the completion of railroad connections from Pennington Gap to Appalachia, was begun in 1905 and a small production was reported in 1906. In 1907 the output of this county amounted to nearly 200,000 tons, and in 1908, to more than 460,000 tons. Further development of this district is anticipated and it is expected to materially increase the production of the State.

The annual production of Virginia from 1822 to the close of 1908 is shown in the following table:

Production of coal in Virginia from 1822 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1822	54,000	1845	350,000	1868	59,051	1891	736,399
1823	60,000	1846	340,000	1869	65,000	1892	675,205
1824	67,040	1847	325,000	1870	61,803	1893	820,339
1825	75,000	1848	318,000	1871	70,000	1894	1,229,083
1826	88,720	1849	315,000	1872	69,440	1895	1,368,324
1827	94,000	1850	310,000	1873	67,200	1896	1,254,723
1828	100,080	1851	310,000	1874	70,000	1897	1,528,302
1829	100,000	1852	325,000	1875	60,000	1898	1,815,274
1830	102,800	1853	350,000	1876	55,000	1899	2,105,791
1831	118,000	1854	370,000	1877	50,000	1900	2,393,754
1832	132,000	1855	380,782	1878	50,000	1901	2,725,873
1833	125,000	1856	352,687	1879	45,000	1902	3,182,993
1834	124,000	1857	363,605	1880	43,079	1903	3,451,307
1835	120,000	1858	377,690	1881	50,000	1904	3,410,914
1836	124,000	1859	359,055	1882	112,000	1905	4,275,271
1837	160,000	1860	473,360	1883	252,000	1906	4,254,879
1838	300,000	1861	445,165	1884	336,000	1907	4,710,895
1839	396,000	1862	445,124	1885	567,000	1908	4,259,042
1840	424,894	1863	[a] 40,000	1886	684,951		
1841	379,600	1864	40,000	1887	825,263		61,488,194
1842	373,640	1865	40,000	1888	1,073,000		
1843	370,000	1866	40,000	1889	865,786		
1844	365,000	1867	50,000	1890	784,011		

[a] West Virginia separated from Virginia.

Mr. Campbell's estimate of the coal fields of Virginia show that the area containing workable coals in the southwestern part of the State cover about 1,550 square miles, and the original contents amounted to 21,000,000,000 short tons. The Brushy Mountain field, in Montgomery County, is estimated at 200 square miles in area, with 900,000,000 tons. The Richmond Basin is estimated to cover 150 square miles, with 600,000,000 short tons. The total area is, therefore, 1,900 square miles and the original contents were approximately 22,500,000,000 short tons. From this there have been extracted to the close of 1908, 61,488,194 short tons, equivalent to an exhaustion of approximately 92,000,000 short tons, or 0.4 per cent of the original supply.

WASHINGTON.

Total production in 1908, 3,024,943 short tons; spot value, $6,690,412.

The record made by the coal-mining industry of Washington in 1908 was in pronounced contrast to that of the preceding year. In 1907, notwithstanding the increased production of fuel oil in California, the principal market for Washington coals, the production increased 404,348 short tons over that of 1906, the mines of the State sharing in the general prosperity which marked the first nine months of 1907. It was estimated, however, that in November and December, 1907, the output at the mines was curtailed about 33 per cent as compared with the earlier months of the year. The statistics for 1908 show that the unsatisfactory conditions which obtained in November and December, 1907, continued throughout 1908. Compared with the record output of 1907, the production in 1908 showed a decrease of 655,589 short tons, or 17.81 per cent. The value declined $989,389, or 12.88 per cent, and the output was the smallest in any one year, with one exception (1905) since 1903. Notwithstanding the fact that the decrease in production was due to the business depression, the average price per ton in 1908 showed an increase over 1907. The same condition has been shown in connection with the production of other States and may be attributed to the fact that in periods of dull times buyers demand a higher grade of fuel and the market for slack and other low grades used for steam-raising purposes show the greatest decrease.

The coal mines of Washington gave employment to an average of 5,484 men in 1908, a decrease from 5,945 men in 1907. The average working time decreased from 273 days in 1907 to 202 days in 1908, but as is frequently the case where men work a fewer number of days during the year the intensity of labor is increased. In the coal production of Washington this is shown by the fact that the average daily production per man increased from 2.27 tons in 1907 to 2.73 in 1908, but because of the fewer number of days worked the total production per man for the year shows a decline from 619 tons in 1907 to 552 in 1908. In 1906 the average tonnage per man for the year was 723.4 short tons and for each day 2.72 tons.

All of the important mines of the State are operated on the basis of an eight-hour day. Out of a total of 5,484 men in 1908, 4,665 were reported as working eight hours. In 1907, 5,594 men out of a total of 5,945 worked eight hours. The labor difficulties in 1908 were limited to the strike of 226 men at the Wilkeson mines, in Pierce County. This strike began in November, 1907, and had not been officially declared off at the close of 1908. The mines continued to operate, however, notwithstanding the labor troubles, although the production decreased approximately 50 per cent.

Four mining machines were in use in Washington during 1908, and the machine-mined product amounted to 20,000 tons. No machine-mined coal was reported in 1907. Something over one-third of the total, or 1,098,879 short tons, of Washington's coal production in 1908 was washed at the mines before shipment. The washing operations yielded 859,942 short tons of cleaned coal and 238,937 tons of refuse.

According to Mr. D. C. Botting, state mine inspector, the accidents in the coal mines of Washington during 1908 aggregated 104, of which 25 were attended with fatal results and 79 were nonfatal. As is generally the case, most of the fatal accidents were preventable. Practically 50 per cent, or 12 out of 25, deaths were due to falls of roof in rooms, and there were 19 men injured from this cause. Seven men were killed and 23 injured by being crushed by mine cars. One man only was killed by an explosion of gas, but 14 were injured from this cause. The cave in of a pillar killed 1 man, and 1 man each was killed by electricity and by a fall down a shaft. Two men were killed by being struck by pieces of timber. Of the 25 men killed 7 were married, and there were 19 children left fatherless. The death rate per 1,000 men employed was 4.56, and the number of tons mined for each life lost was 120,998.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the production for consumption, are shown in the following table:

Coal production of Washington in 1907 and 1908, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1907.									
King	1,325,054	55,470	61,189	3,920	1,445,633	$2,799,747	$1.94	283	2,166
Kittitas	1,467,055	22,571	35,261	....	1,524,887	3,159,501	2.07	284	2,380
Lewis	91,985	6,344	5,210	....	103,539	260,262	2.51	237	191
Pierce	451,833	4,821	29,027	86,488	572,169	1,380,010	2.41	248	1,099
Other counties[a]	29,170	1,556	3,578	....	34,304	80,281	2.34	161	109
	3,365,097	90,762	134,265	90,408	3,680,532	7,679,801	2.09	273	5,945
1908.									
King	800,182	69,184	59,277	3,000	931,643	$2,058,908	$2.21	192	1,691
Kittitas	1,357,073	20,328	37,220	....	1,414,621	2,993,113	2.12	188	2,230
Lewis	60,438	7,065	6,172	....	73,675	164,090	2.23	233	162
Pierce	448,174	8,882	28,952	65,670	551,678	1,373,298	2.49	239	1,249
Other counties[b]	50,053	785	2,488	....	53,326	101,003	1.89	182	152
	2,715,920	106,244	134,109	68,670	3,024,943	6,690,412	2.21	202	5,484

[a] Cowlitz, Thurston, and Whatcom. [b] Clallam, Thurston, and Whatcom.

Considering the production of 1908 by counties, it is seen that the greatest decrease occurred in King County, whose output declined something over one-third—from 1,445,633 short tons in 1907 to 931,643 tons in 1908. The decrease in Kittitas County was 110,266 tons. In all the coal-producing counties except those in which the production is reported from a number of small mines decreases were shown, as exhibited in the following table:

Production of coal in Washington, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Cowlitz	1,800	[a] 3,706	[a] 3,523	[a] 7,424	([b])	− 7,424
King	1,219,230	1,099,163	1,310,530	1,445,633	931,643	− 513,990
Kittitas	1,340,400	1,280,845	1,422,612	1,524,887	1,414,621	− 110,266
Lewis	1,335	1,300	25,880	103,539	73,675	− 29,864
Pierce	531,589	479,912	513,639	572,169	551,678	− 20,491
Skagit	10,650	....	....	....	....	....
Whatcom	1,837	....	....	....	([c])	....
Other counties	30,840	....	....	26,880	53,326	+ 26,446
Total	3,137,681	2,864,926	3,276,184	3,680,532	3,024,943	− 655,589
Total value	$5,120,931	$5,141,258	$5,908,434	$7,679,801	$6,690,412	−$989,389

[a] Includes Whatcom County. [b] No production in Cowlitz County. [c] Included in other counties.

The United States census report for 1860 contains the first record of coal production in Washington. This production was entirely from the Bellingham Bay properties, in Whatcom County, and amounted to 5,374 tons. The State did not assume much importance as a coal producer, however, until the opening of the Green River field, in King County, between 1880 and 1885, and of the Roslyn mines, in Kittitas County, which began producing about the same time. The growth of the industry since 1860, when production in Washington began, is shown in the following table:

Production of coal in Washington, 1860–1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	5,374	1873	26,000	1886	423,525	1899	2,029,881
1861	6,000	1874	30,352	1887	772,601	1900	2,474,093
1862	7,000	1875	99,568	1888	1,215,750	1901	2,578,217
1863	8,000	1876	110,342	1889	1,030,578	1902	2,681,214
1864	10,000	1877	120,896	1890	1,263,689	1903	3,193,273
1865	12,000	1878	131,660	1891	1,056,249	1904	3,137,681
1866	13,000	1879	142,666	1892	1,213,427	1905	2,864,926
1867	14,500	1880	145,015	1893	1,264,877	1906	3,276,184
1868	15,000	1881	196,000	1894	1,106,470	1907	3,680,532
1869	16,200	1882	177,340	1895	1,191,410	1908	3,024,943
1870	17,844	1883	244,990	1896	1,195,504		
1871	20,000	1884	166,936	1897	1,434,112		46,133,640
1872	23,000	1885	380,250	1898	1,884,571		

The production of coal in Washington from the time when coal mining began, in 1860, has amounted to 46,133,640 short tons, representing an exhaustion of approximately 69,000,000 tons. Mr. Campbell estimates the original coal supply of the State as 20,000,000,000 short tons, of which the exhaustion to the close of 1908 represented 0.35 per cent. According to these estimates, the quantity of coal still in the ground at the close of 1908 was 19,931,000,000 tons, 6,600 times the production of 1908 and 4,400 times the exhaustion represented by that output.

WEST VIRGINIA.

Total production in 1908, 41,897,843 short tons; spot value, $40,009,054.

Owing to conditions more favorable for the cheap production of coal in West Virginia, the percentage of decrease in that State during 1908 was less than in Ohio, Pennsylvania, Maryland, and Alabama. In the preliminary statement issued early in January, 1909, it was stated that the output of coal in West Virginia would show a decrease between 10 and 15 per cent, which would reduce the tonnage to an amount about equal to that of 1906. The decrease was 6,193,740 short tons, or 12.88 per cent, from 48,091,583 short tons in 1907 to 41,897,843 tons in 1908. The production in 1908 was 1,392,507 short tons less than in 1906. The value of the production in 1908 was $40,009,054, which, compared with the value in 1907 ($47,846,630), shows a decrease of $7,837,576, or 16.38 per cent. The per cent of decrease in Pennsylvania bituminous coal was 21.95, in Ohio 18.27 per cent, in Maryland 20.89 per cent, and in Alabama 18.57 per cent. Besides the conditions favorable to the cheap production of coal, there is another reason why the percentage of decrease in West Virginia was less than in the other States. This is because, with the exception of the Kanawha district, few of the miners in the State have organized, and there was no suspension of operations pending the adjustment of the wage scale in West Virginia as there was in the adjoining States.

The decreases in 1908 were particularly noticeable in the important coke-making counties of Fayette and McDowell. The decrease in the former county was 936,417 short tons, and in the latter 1,239,173 tons. The quantity of coal made into coke in Fayette County decreased from 1,125,566 short tons in 1907 to 607,656 tons in 1908, and in McDowell County the quantity of coal made into coke decreased from 3,039,094 short tons to 2,348,945 tons. The total decrease for the State in the coal made into coke was 2,432,208 short tons. Both Fayette and McDowell counties are located in the southern part of the State. Kanawha County, which is also among the southern counties, decreased its production 957,526 short tons, Mercer County decreased 256,083 tons, and Mingo 428,847 tons. Fayette, McDowell, and Kanawha counties are the largest coal producers in the State. Among the northern counties, the ones which suffered the greatest losses were Harrison, with a decrease of 677,328 short tons; Preston, 627,187 short tons; Marshall, 352,836 short tons; Randolph, 309,566 short tons; Marion, 305,833 short tons; Tucker, 236,842 short tons; Monongalia, 200,042 short tons, and Barbour, 152,734 short tons. The decreases in the counties of the southern portion of the State were partly offset by gains in Logan, Putnam, and Raleigh counties, the increases in these counties being, respectively, 434,934 short tons, 95,373 short tons, and 209,768 short tons. A small increase of 13,832 short tons was made in the production of Taylor County, in the northern portion of the State. These were the only counties which showed increases in 1908 as compared with 1907. The large decrease in Kanawha County was due in part to the low water caused by the continued dry weather of the summer of 1908, the shipments through the Kanawha River locks showing a decrease of 42 per cent in 1908 as compared with 1907.

West Virginia more than any other coal-producing State depends upon market conditions outside of the State borders for the disposition of its product. The manufacturing industries of West Virginia are comparatively unimportant when considered in connection with its large and cheap supply of high-grade fuel. Probably more than 50 per cent of West Virginia's coal production is shipped away to support manufacturing industries in other States, for, with the exception of what goes into railroad consumption and a comparatively small amount used for manufacturing purposes (particularly along Ohio River), added to that used for purely domestic consumption, all of the State's production of coal—some of it the highest quality of bituminous coal produced in the United States—is shipped outside of the State for consumption.

The coal mines of West Virginia in 1908 gave employment to 56,861 men, who worked an average of 185 days, as compared with 59,029 men for an average of 230 days in 1907. The average production per man for the year 1908 was 737 short tons, against 815 tons in 1907 and 849.5 tons in 1906. The fewer number of days worked in 1908 resulted in an increase in the daily record made by the men employed, and the average daily production per man increased from 3.54 short tons in 1907 to 3.98 tons in 1908.

There was a substantial increase in the proportion of coal mined by the use of machines in 1908 as compared with the preceding year, although the actual machine-mined tonnage decreased. The number of machines in use increased from 1,533 in 1907 to 1,574 in 1908. The machine-mined coal decreased from 17,627,925 short tons to 16,653,174 tons, but the percentage of the machine-mined product to the total increased from 36.65 to 39.75. Of the total number of machines in use in 1908, 599 were pick machines, 899 chain machines, and 53 long-wall machines. There were also 23 chain shearing machines in use.

Although some vigorous attempts have been made from time to time to organize the coal mines of West Virginia, the majority of the mines continue to be operated either on the "open-shop" or nonunion basis. Many of the mines in the Kanawha region have for several years been operated under agreements with the miners' union, but in other portions of the State the employees are for the greater part unorganized. As a consequence of these conditions when mines in other States were shut down in April and May West Virginia was not affected. The strike record for the State was a total of 501 men, who were idle for an average of 144 days each. Only four mines reported a suspension due to labor troubles. One of these was more in the nature of a shut down than a strike. It was at the Tunnelton mine of the Merchants' Coal Company, located in Preston County, which was shut down on April 1. This mine employed 300 men and was idle the remainder of the year. The other shut downs were of minor importance.

Because of the "open-shop" or nonunion rules under which most of the mines of West Virginia are operated, the ten-hour day prevails in the majority of cases. In 1908, 403 mines, employing 39,550 men, worked ten hours a day; 180 mines, employing 14,426 men, worked nine hours; and 30 mines, employing 1,242 men, worked eight hours.

According to Mr. John Laing, chief of the department of mines, the record of accidents in the coal mines of West Virginia in 1908 was in favorable contrast to that of the preceding year, but the number of accidents was still regrettably large. The fatality record of 1907 was unusually bad because of the disaster at Monongah in December of that year, which alone claimed 361 victims. The total number of men killed in 1907 in the coal mines of West Virginia was 729. In 1908 the number of fatalities was reduced to 313. In the latter year the largest single disaster was a dust explosion in the Lick Branch mine of the Pocahontas Consolidated Collieries Company, in which 50 men are said to have lost their lives. The most prolific cause of deaths was falls of roofs in rooms, as from that cause nearly one-half—a total of 153—of the deaths occurred. There were also 431 men injured from that cause. There were 49 men killed and 285 injured by being crushed by mine cars; 4 were killed and 6 injured by powder explosions; and 7 deaths were due to shaft accidents. The total number of deaths by explosions of gas and dust was 63; 37 deaths and 211 injuries were attributed to miscellaneous causes. Of the total number of men killed, 125 were married and 253 children were left fatherless. The death rate per 1,000 employees was 5.5 in 1908, against 12.35 in 1907, and the number of tons of coal mined for each life lost was 133,859 in 1908 against 65,969 in 1907.

Among the important developments looking toward increased production of coal in West Virginia have been, first, the completion of the Virginian Railway from Deepwater, on Kanawha River, to Sewells Point, near Norfolk. This important outlet for West Virginia coal, and the only railroad built from the coal fields to the seaboard, was completed in the spring of 1909 and will have a marked influence upon the future production of the State. Another noteworthy development has been the construction of the Coal River Railroad from St. Albans into the rich coal fields of the Coal River valley. This road has been purchased by the Chesapeake and Ohio Railway and will be an important feeder to that line. The Coal and

Coke Railroad, extending from Charleston to Elkins, and penetrating the coal fields in the central portion of the State, has under construction branch lines which will develop other coal fields in that part of the State, and the indications are that with these developments completed West Virginia will again take second place among the coal-producing States. West Virginia occupied second place in 1906, but fell back to third in 1907 and 1908.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of West Virginia in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	894,127	5,160	19,987	256,489	1,175,763	$1,010,824	$0.86	250	1,133
Brooke	435,579	16,540	2,000	....	454,119	462,763	1.02	203	628
Clay	62,232	599	916	....	63,747	64,612	1.01	172	111
Fayette	7,128,491	178,207	167,714	1,125,566	8,599,978	9,486,938	1.10	225	12,375
Harrison	3,858,274	17,990	37,078	26,623	3,939,965	3,557,515	.90	239	3,710
Kanawha	5,405,183	70,170	74,520	38,201	5,588,074	5,643,180	1.01	224	8,141
Logan	1,222,576	12,148	13,798	....	1,248,522	1,205,994	.97	200	1,648
McDowell	6,554,649	97,180	150,052	3,039,094	9,840,975	10,042,444	1.02	228	11,653
Marion	3,804,648	27,838	63,729	332,016	4,228,231	3,927,102	.93	232	3,730
Marshall	469,222	129,804	13,579	....	612,605	616,834	1.01	271	618
Mason	97,438	49,535	3,753	....	150,726	160,951	1.07	182	338
Mercer	1,785,452	13,709	45,069	500,196	2,344,426	2,258,267	.96	247	2,433
Mineral	740,487	4,279	1,902	....	746,668	700,205	.94	260	778
Mingo	2,148,646	42,329	38,461	....	2,229,436	2,109,965	.95	213	2,673
Monongalia	196,460	22,223	10,650	195,664	424,997	380,293	.89	262	475
Nicholas	79,309	1,660	1,277	....	82,246	77,370	.94	148	231
Ohio	140,445	44,820	2,280	....	187,545	193,985	1.03	247	242
Preston	883,036	30,564	30,445	342,490	1,286,535	1,070,757	.83	252	1,506
Putnam	425,109	6,422	5,542	....	437,073	495,072	1.13	262	893
Raleigh	1,360,872	24,697	26,264	560	1,412,393	1,561,471	1.11	245	2,571
Randolph	453,987	36,710	15,436	165,284	671,417	636,614	.95	239	441
Taylor	465,445	7,760	2,032	....	475,237	383,920	.81	168	657
Tucker	764,243	11,000	28,069	413,955	1,217,267	1,143,072	.94	282	1,320
Other counties[a] and small mines	566,805	81,308	18,973	6,552	673,638	656,482	.97	237	724
	39,942,715	932,652	773,526	6,442,690	48,091,583	47,846,630	.99	230	59,029

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	921,860	12,340	20,735	68,094	1,023,029	$825,055	$0.81	194	1,238
Brooke	421,364	10,384	1,625	....	433,373	414,319	.96	175	660
Fayette	6,778,459	100,896	176,550	607,656	7,663,561	7,921,704	1.03	179	11,747
Harrison	3,204,378	25,670	30,549	2,040	3,262,637	2,674,521	.82	172	3,959
Kanawha	4,492,872	59,994	77,682	....	4,630,548	4,574,316	.99	157	7,543
Logan	1,652,912	15,022	15,522	....	1,683,456	1,586,388	.94	187	1,761
McDowell	5,982,099	85,881	184,877	2,348,945	8,601,802	8,567,449	.99	192	11,487
Marion	3,718,088	24,929	59,673	119,708	3,922,398	3,514,553	.90	214	3,892
Marshall	189,178	60,056	10,535	....	259,769	253,539	.98	132	462
Mason	68,828	34,089	16,806	....	119,723	122,104	1.02	167	284
Mercer	1,741,387	17,288	37,943	291,725	2,088,343	1,902,613	.91	203	2,300
Mineral	691,024	2,967	2,235	....	696,226	631,631	.91	190	818
Mingo	1,748,185	17,646	34,758	....	1,800,589	1,591,536	.88	216	2,213
Monongalia	113,686	2,357	9,577	99,335	224,955	217,867	.97	220	359
Ohio	121,951	22,911	1,125	....	145,987	152,699	1.05	171	201
Preston	423,820	11,053	22,322	202,153	659,348	564,701	.86	162	1,058
Putnam	502,199	17,128	13,119	....	532,446	652,330	1.23	251	971
Raleigh	1,562,140	24,042	35,979	....	1,622,161	1,618,357	.99	189	2,708
Randolph	249,718	2,756	5,394	103,983	361,851	302,977	.84	130	358
Taylor	472,515	10,413	2,741	3,400	489,069	355,514	.73	182	646
Tucker	772,793	22,519	21,694	163,419	980,425	909,294	.93	195	1,365
Other counties[b] and small mines	611,366	61,186	23,571	24	696,147	655,587	.94	201	831
	36,440,822	641,527	805,012	4,010,482	41,897,843	40,009,054	.95	185	56,861

[a] Braxton, Gilmer, Grant, Greenbrier, Hancock, Lewis, Lincoln, Ritchie, and Upshur.
[b] Boone, Braxton, Clay, Gilmer, Grant, Greenbrier, Hancock, Lewis, Lincoln, Nicholas, Ritchie, and Upshur.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of West Virginia, by counties, 1904–1908, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−), 1908.
Barbour	666,019	615,437	993,681	1,175,763	1,023,029	− 152,734
Brooke	67,706	239,396	483,256	454,119	433,373	− 20,746
Clay	55,814	80,424	79,385	63,747	6,622	− 57,125
Fayette	7,222,247	7,985,327	8,260,307	8,599,978	7,663,561	− 936,417
Grant	161,665	207,926	297,026	312,407	217,074	− 95,333
Hancock	79,528	57,683	70,251	87,100	85,631	− 1,469
Harrison	2,714,832	2,850,678	3,626,337	3,939,965	3,262,637	− 677,328
Kanawha	3,134,256	3,973,717	4,880,307	5,588,074	4,630,548	− 957,526
Logan	326	223,319	592,895	1,248,522	1,683,456	+ 434,934
McDowell	6,755,138	8,245,167	8,707,677	9,840,975	8,601,802	− 1,239,173
Marion	3,407,469	3,621,219	4,163,462	4,228,231	3,922,398	− 305,833
Marshall	398,594	438,773	511,335	612,605	259,769	− 352,836
Mason	117,437	95,786	112,660	150,726	119,723	− 31,003
Mercer	1,761,265	2,269,076	2,199,830	2,344,426	2,088,343	− 256,083
Mineral	569,649	575,294	661,938	746,668	696,226	− 50,442
Mingo	1,469,710	1,679,526	2,210,276	2,229,436	1,800,589	− 428,847
Monongalia	200,567	218,360	328,408	424,997	224,955	− 200,042
Nicholas	38,452	58,179	79,635	82,246	41,629	− 40,617
Ohio	118,725	109,201	121,464	187,545	145,987	− 41,558
Preston	665,626	837,666	1,129,344	1,286,535	659,348	− 627,187
Putnam	386,840	548,767	548,725	437,073	532,446	+ 95,373
Raleigh	591,794	827,868	1,105,318	1,412,393	1,622,161	+ 209,768
Randolph	379,622	517,078	387,762	671,417	361,851	− 309,566
Taylor	283,332	348,105	445,427	475,237	489,069	+ 13,832
Tucker	1,126,883	1,095,059	1,199,041	1,217,267	980,425	− 236,842
Other counties and small mines	33,256	72,549	94,603	274,131	345,191	+ 71,060
Total	32,406,752	37,791,580	43,290,350	48,091,583	41,897,843	− 6,193,740
Total value	$28,647,014	$32,341,790	$41,051,939	$47,846,630	$40,009,054	−$7,837,576

For commercial purposes the principal coal-producing regions of West Virginia may be divided into four distinct districts. These may be distinguished by certain geographic or physiographic features. They do not include all of the coal-producing counties of the State, but do include the more important ones, and they contributed over 90 per cent of the total output of the State in 1908. Two of these districts are in the northern part of the State and two in the southern portion. The two in the northern portion are designated, respectively, the Fairmont, or upper Monongahela, district and the Elk Garden, or upper Potomac. Those in the southern portion of the State are the Pocahontas, or Flat Top, district and the New and Kanawha rivers district. The upper Monongahela district is penetrated by the Baltimore and Ohio Railroad, and sends its coal to market over that highway.

The upper Potomac region is also reached by the Baltimore and Ohio Railroad, and is penetrated by the West Virginia Central and Pittsburg Railway. The Pocahontas, or Flat Top, region is tributary to the main branch of the Norfolk and Western Railway. All of the product of this district goes either west or to tide water over that line. The New and Kanawha rivers district is named from the two rivers which drain it, the coal being shipped partly by the Chesapeake and Ohio Railway and the Kanawha and Michigan Railway, which pass through it, and partly by barges on Kanawha River. The Virginian Railway, to which reference has already been made, will afford additional transportation to both the Pocahontas, or Flat Top, and the New River districts. The most important district from the productive point of view is that of New and Kanawha rivers, which embraces the counties of Fayette, Kanawha, Raleigh, and Putnam. The coal from these four counties is drawn from two different areas, most of the coal from Kanawha and Putnam counties being from a higher geologic horizon than that of Fayette and Raleigh counties, but the district is practically compact and continuous and is drained by the same waters and reached by the same railroads, so the two areas are considered as one district in this report.

Coal production of the principal districts of West Virginia, 1886–1907, in short tons.

Year.	New and Kanawha rivers district.[a]	Pocahontas, or Flat Top, district.[b]	Fairmont, or Upper Monongahela, district.[c]	Upper Potomac, or Elk Garden, district.[d]
1886	2,290,563	968,484	406,976	383,712
1887	2,379,296	1,357,040	520,064	503,343
1888	2,840,630	1,912,695	473,489	518,878
1889	2,669,016	2,290,270	456,582	666,956
1890	3,012,414	2,702,092	600,131	819,062
1891	3,632,209	3,137,012	1,150,569	1,052,308
1892	3,773,021	3,503,260	1,141,430	942,154
1893	4,099,112	3,815,280	1,255,956	1,129,397
1894	3,650,971	5,059,025	1,655,532	927,220
1895	4,399,623	4,044,998	1,550,256	1,125,601
1896	4,650,455	4,608,113	1,743,590	1,245,012
1897	4,921,701	4,859,373	2,074,663	1,425,026
1898	5,947,272	5,521,160	2,525,294	1,531,562
1899	6,544,956	6,033,344	3,374,183	1,786,009
1900	7,804,879	6,901,637	4,187,630	1,999,797
1901	8,427,574	6,736,107	5,174,160	1,856,677
1902	7,089,805	7,431,687	5,463,791	2,581,218
1903	9,843,063	8,319,775	5,638,337	2,229,065
1904	11,429,403	10,858,159	7,937,845	1,858,197
1905	13,474,282	13,378,468	8,491,465	1,878,279
1906	14,953,677	14,621,316	10,686,659	2,158,005
1907	16,183,511	16,779,893	11,530,728	2,276,342
1908	14,496,967	15,154,204	9,581,436	1,893,725

[a] Includes Clay, Fayette, Kanawha, Nicholas, Putnam, and Raleigh counties.
[b] Includes Logan, McDowell, Mercer, and Mingo counties, and Tazewell County, Va.
[c] Includes Barbour, Harrison, Marion, Monongalia, Preston, and Taylor counties.
[d] Includes Grant, Mineral, and Tucker counties.

Since 1881, or in a period of twenty-seven years, there have only been two instances in which the coal production of West Virginia has shown a decrease in one year as compared with the preceding. These exceptions were in 1895 and in 1908, both of them being years of marked industrial depression, and in order to show the great increase made by West Virginia as a coal-producing State the following table has been prepared. The average annual increase in this period of twenty-seven years has been 1,489,550 short tons.

Annual increase in the coal production of West Virginia, 1881–1908, in short tons.

Year.	Quantity.	Year.	Quantity.
1882 over 1881	560,000	1896 over 1895	1,488,335
1883 over 1882	95,833	1897 over 1896	1,371,863
1884 over 1883	1,024,167	1898 over 1897	2,452,840
1885 over 1884	9,062	1899 over 1898	2,551,996
1886 over 1885	636,734	1900 over 1899	3,394,212
1887 over 1886	875,824	1901 over 1900	1,421,195
1888 over 1887	617,180	1902 over 1901	502,424
1889 over 1888	733,080	1903 over 1902	4,766,415
1890 over 1889	1,162,774	1904 over 1903	3,069,511
1891 over 1890	1,826,011	1905 over 1904	5,384,828
1892 over 1891	518,090	1906 over 1905	5,498,770
1893 over 1892	969,823	1907 over 1906	4,801,233
1894 over 1893	919,179		
		Total increase in 26 years	46,411,583
Total increase in 13 years	9,947,757	Decrease in 1908	6,193,740
Decrease in 1895	239,796		
		Total increase in 27 years	40,217,843
Total increase in 14 years	9,707,961	Average annual increase	1,489,550

The statistics of coal production in West Virginia since 1863, when the State was formed out of Virginia, to the close of 1908, are shown in the following table.

Production of coal in West Virginia from 1863 to the close of 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1863	444,648	1875	1,120,000	1887	4,881,620	1899	19,252,995
1864	454,888	1876	896,000	1888	5,498,800	1900	22,647,207
1865	487,897	1877	1,120,000	1889	6,231,880	1901	24,068,402
1866	512,068	1878	1,120,000	1890	7,394,654	1902	24,570,826
1867	589,360	1879	1,400,000	1891	9,220,665	1903	29,337,241
1868	609,227	1880	1,829,844	1892	9,738,755	1904	32,406,752
1869	603,148	1881	1,680,000	1893	10,708,578	1905	37,791,580
1870	608,878	1882	2,240,000	1894	11,627,757	1906	43,290,350
1871	618,830	1883	2,335,833	1895	11,387,961	1907	48,091,583
1872	700,000	1884	3,360,000	1896	12,876,296	1908	41,897,843
1873	1,000,000	1885	3,369,062	1897	14,248,159		
1874	1,120,000	1886	4,005,796	1898	16,700,999		476,096,382

The total production of coal in West Virginia to the close of 1908, as shown in the foregoing table, amounted to 476,096,382 short tons, equivalent to an exhaustion of 715,000,000 short tons. As a result of recent study of the coal fields of West Virginia by Dr. I. C. White, state geologist, the estimates of the original supply as prepared by M. R. Campbell have been materially reduced. The revised estimates by Doctor White and Mr. Campbell place the original supply in West Virginia at 150,000,000,000 short tons. Deducting from this the exhaustion to the close of 1908, the apparent supply now available amounts to 149,285,000,000 short tons, about 3,500 times the production of 1908 and 2,400 times the exhaustion represented by that production.

WYOMING.

Total production in 1908, 5,489,902 short tons; spot value, $8,868,157.

In addition to the decline in business caused by the financial depression, coal-mining operations in Wyoming, as in the adjoining State of Montana, suffered from an oversupply of fuel mined during the summer and early fall of 1907, when, because of repeated warnings of a fuel famine by the transportation companies, consumers laid in their supplies of fuel in order to avoid a repetition of the preceding winter, when the public suffered greatly from the scarcity of coal. This action resulted in a large business which extended well into October. Some of the railroad companies and steam users of the Northwest, particularly in Washington and Idaho, went so far as to ship in British Columbia coal, both by rail and water, in anticipation of short fuel supplies. The Northern Pacific and the Union Pacific railroads stored large quantities of coal along their tracks, some of it being brought from the eastern fields via the Lakes and by rail from Lake Superior points. All of this supply was on hand when the panic started in 1907 and closed down a great many of the mining and milling properties in Washington, Idaho, and Montana. Many of these had not resumed operations at the close of 1908, and nearly all had in their bins large quantities of coal which had been purchased during the preceding year. The ultimate result of these conditions, as shown in the coal production of Wyoming, was the decrease of 763,068 short tons, or 12.2 per cent, in quantity and of $864,511, or 8.88 per cent, in value. The fact that the decrease in value was less in proportion than the decrease in production was due to two causes. In September, 1907, just preceding the panic and when prosperity was at its height, the coal operators of Wyoming entered into an agreement with the United Mine Workers of America. The demand for coal at that time was brisk, and prices were remunerative, and the operators entered into what they considered a liberal arrangement with the miners, paying an average of $3.40 a day for eight hours' labor and 60 cents per ton for mining on a mine-run basis. On the termination of this agreement, in September, 1908, an attempt was made to reduce the wage scale, and as the miners would not accept any reduction a number of mines were shut down. After an idleness of thirty days some of the mines resumed operations at the old rate and the others were obliged to follow suit. Adherence to this agreement increased the expense of mining coal and necessitated an increase in price. In addition to this the market for steam coal where slack or screenings could be used was practically cut off, and the coal marketed consisted of a larger proportion of screened coal, which commands a higher price.

The shortened demand for labor in other branches of the mining industry increased the supply at the coal mines, and the average number of men employed showed an increase from 6,645 in 1907 to 6,915 in 1908. The average number of days worked, however, decreased from 275 to 217. The fewer number of days worked in 1908 increased the intensity of labor, as shown by the fact that, although the average production per man for the year decreased from 941 tons in 1907 to 794 tons in 1908, the average production for each man per day increased from 3.42 tons to 3.66 tons, the latter being comparable with 1906, when the average output per man was 3.68 tons per day and 1,033.7 tons for the year.

The statistics relating to the use of mining machines showed that there were 88 coal-cutting machines in use in Wyoming during 1908, an increase of 3 over 1907. The machine-mined product decreased, however, from 1,328,709 short tons in 1907 to 1,072,619 tons in 1908, and the percentage of the machine-mined tonnage to the total decreased from 21.25 to 19.54. Of the total number of machines in use in 1908, 47 were of the pick or puncher type, 40 were chain-breast, and 1 was a long-wall machine.

As a result of the agreement made with the United Mine Workers, nearly all of the mines in Wyoming have been placed on an eight-hour basis, 6,802 men employed at 51 mines, out of a total of 6,915, working eight hours a day during 1908.

As previously stated, such labor troubles as occurred in the coal mines of Wyoming during 1908 were the result of an attempt to reduce wages upon the termination of the wage-scale agreement on the 1st of September. The suspension of operations affected the larger mining concerns, there being 14 mines employing 4,658 men (a little more than two-thirds of the total number of mine workers in the State) which reported idleness on account of strikes. The average number of days idle was 21 per man, and the total amount of time lost was 6.6 per cent of the total time made.

In the latter part of March there occurred at Hanna No. 1 mine, of the Union Pacific Coal Company, one of the worst disasters in the history of coal mining in the State of Wyoming. While spoken of as one disaster, it was in reality two explosions, the first of which occurred about 3 o'clock in the afternoon of March 28 and resulted in the death of 18 men, including most of the mine bosses and experienced miners who were fighting a fire in one of the new entries. The second explosion occurred about 10 o'clock on the night of the same day, and killed 41 men, including the mine inspector of the district, who were engaged in rescue work.

Aside from the men killed in the Hanna disaster, over two-thirds of the accidents which occurred in the coal mines of district No. 1 and resulted in loss of life were caused by falls of rock and coal, many of which might have been avoided, according to the mine inspector, by proper timbering. There were but two fatal accidents in district No. 2, and the loss of both lives was due, in the opinion of the mine inspector, to carelessness on the part of the unfortunate men.

The statistics of production, by counties, in 1907 and 1908, with the distribution of the product for consumption, are shown in the following table:

Coal production of Wyoming, in 1907 and 1908, by counties, in short tons.

1907.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Sheridan	1,162,830	22,612	40,779	1,226,221	$2,112,003	$1.72	259	1,425
Sweetwater	1,988,760	9,185	73,897	2,071,842	3,134,799	1.51	288	2,092
Uinta	1,780,306	8,293	101,143	1,889,742	2,844,805	1.51	284	1,830
Other counties [a]	949,159	33,171	82,115	1,064,445	1,639,249	1.54	257	1,298
Small mines	....	740	....	740	1,812	2.45	....	....
	5,881,055	74,001	297,934	6,252,990	9,732,668	1.56	275	6,645

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bighorn	91,000	7,475	2,800	101,275	$174,860	$1.73	214	241
Sheridan	784,141	18,597	36,795	839,533	1,276,649	1.52	172	1,165
Sweetwater	2,093,244	11,903	75,786	2,180,933	3,692,267	1.69	226	2,749
Uinta	1,263,577	18,966	97,945	1,380,488	2,035,821	1.47	224	1,547
Other counties [b]	918,336	18,677	49,726	986,739	1,686,325	1.71	233	1,213
Small mines	....	934	....	934	2,235	2.39	....	....
	5,150,298	76,552	263,052	5,489,902	8,868,157	1.62	217	6,915

[a] Bighorn, Carbon, Converse, Crook, Fremont, Johnson, and Weston.
[b] Carbon, Converse, Crook, Fremont, Johnson, and Weston.

The counties which suffered most from decreased production in 1908 were Uinta, in which the production fell off 509,254 tons, and Sheridan, whose loss amounted to 386,688 tons. Sweetwater County, the most important producing county in the State, showed an increase, however, of 109,091 short tons. Big Horn County, in which there has been considerable development work during the last year, increased its output 44,309 tons. This promises to be one of the important coal-producing regions in the State.

The statistics of the production of coal, by counties, during the last five years with the increases and decreases in 1908 as compared with 1907, are shown in the following table:

Coal production of Wyoming, 1904–1908, by counties, in short tons.

County.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−) 1908.
Bighorn	6,235	4,605	4,743	56,966	101,275	+ 44,309
Carbon	336,292	354,358	450,636	583,402	543,009	− 40,393
Converse	77,386	64,939	69,495	48,700	32,745	− 15,955
Sheridan	554,785	742,314	1,014,318	1,226,221	839,533	− 386,688
Sweetwater	1,992,993	2,113,979	2,121,546	2,071,842	2,180,933	+ 109,091
Uinta	1,800,069	1,897,668	2,078,772	1,889,742	1,380,488	− 509,254
Weston	398,367	409,690	379,990	361,015	337,815	− 23,200
Crook, Fremont, Johnson, Natrona	9,254	11,798	[a]12,929	[b]14,362	[b]73,170	+ 58,808
Small mines	3,175	2,670	1,565	740	934	+ 194
Total	5,178,556	5,602,021	6,133,994	6,252,990	5,489,902	− 763,088
Total value	$6,747,909	$7,336,951	$8,013,528	$9,732,668	$8,868,157	−$864,511

[a] Crook and Johnson only.

[b] Crook, Fremont, and Johnson.

The first production of coal in Wyoming was reported in 1865, one year later than the first output of coal in Colorado. This pioneer coal mining was probably carried on in connection with the construction of the Union Pacific Railroad. The total output in that year amounted to 800 tons. Five years later, when the railroad was completed, the production amounted to about 50,000 tons.

The growth of the coal-mining industry, indicating as it does the increase in population and the industrial development of the State since 1865 and up to the close of 1908, is shown in the following table:

Production of coal in Wyoming from 1865 to 1908, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1865	800	1877	342,853	1889	1,388,947	1901	4,485,374
1866	2,500	1878	333,200	1890	1,870,366	1902	4,429,491
1867	5,000	1879	400,991	1891	2,327,841	1903	4,635,293
1868	6,925	1880	589,595	1892	2,503,839	1904	5,178,556
1869	49,382	1881	420,000	1893	2,439,311	1905	5,602,021
1870	50,000	1882	707,764	1894	2,417,463	1906	6,133,994
1871	147,328	1883	779,689	1895	2,246,911	1907	6,252,990
1872	221,745	1884	902,620	1896	2,229,624	1908	5,489,902
1873	259,700	1885	807,328	1897	2,597,886		
1874	219,061	1886	829,355	1898	2,863,812		83,308,667
1875	300,808	1887	1,170,318	1899	3,837,392		
1876	334,550	1888	1,481,540	1900	4,014,602		

The estimate of the original coal supply of Wyoming, as made by Marius R. Campbell, of the United States Geological Survey, credited that State with the largest original supply, with the single exception of North Dakota, which is estimated to have contained originally 500,000,000,000 short tons of coal. The areas of North Dakota are, however, entirely of lignite, while in Wyoming the coal is either of bituminous or of subbituminous character. Wyoming's supply is estimated to have been 424,085,000,000 short tons, compared with which the aggregate production to the close of 1908 (83,308,667 short tons) appears insignificant. The total exhaustion of the beds up to the close of 1908 amounted to 125,000,000 short tons, or 0.029 per cent of the total estimated supply.

CLASSIFIED LIST OF PAPERS DEALING WITH COAL, COKE, LIGNITE, AND PEAT CONTAINED IN PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

Compiled by WILLIS T. LEE and JOHN M. NICKLES.

The following list contains the more important papers dealing with coal, coke, lignite, and peat, from an economic standpoint, except the statistical reports contained in the volumes of Mineral Resources. The page references indicate whether a paper is devoted wholly, or in part, to these subjects.

Papers dealing with geologic work in the several States and Territories, alphabetically arranged, are given first, then those general in scope arranged in chronologic order, followed by papers on technologic subjects.

ALABAMA.

The coal measures of Alabama, by E. A. Smith. Mineral Resources U. S. for 1892, 1893, pp. 293–300.

Stevenson folio, Alabama-Georgia-Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 19, 1895.

Gadsden folio, Alabama, description, by C. W. Hayes. Geologic Atlas U. S., folio 35, 1896.

The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227–263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

The Warrior coal basin in the Brookwood quadrangle, Alabama, by Charles Butts. Bull. No. 260, 1905, pp. 357–381.

The Warrior coal basin in the Birmingham quadrangle, Alabama, by Charles Butts. Bull. No. 285, 1906, pp. 211–222.

The northern part of the Cahaba coal field, Alabama, by Charles Butts. Bull. No. 316, 1907, pp. 76–115.

ALASKA.

The mining industry in 1905, by A. H. Brooks. Bull. No. 284, 1906, pp. 4–9.

The mining industry in 1906, by A. H. Brooks. Bull. No. 314, 1907, pp. 19–39.

The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bull. No. 250, 1905, 64 pp.

Markets for Alaska coal, by G. C. Martin. Bull. No. 284, 1906, pp. 18–29.

The Alaska coal fields, by G. C. Martin. Bull. No. 314, 1907, pp. 40–46.

Bering River coal field, by G. C. Martin. Bull. No. 259, 1905, pp. 140–150.

Coal resources of southwestern Alaska, by R. W. Stone. Bull. No. 259, 1905, pp. 151–171.

Mineral resources of the Kenai Peninsula; coal fields of the Kachemak Bay region, by R. W. Stone. Bull. No. 277, 1906 pp., 53–73.

Preliminary statement on the Matanuska coal field, by G. C. Martin. Bull. No. 284, 1906, pp. 88–100.

A reconnaissance of the Matanuska coal field, Alaska, in 1905, by G. C. Martin. Bull. No. 289, 1906, 36 pp. (Out of stock; can be purchased of Superintendent of Documents for 25 cents.)

The Herendeen Bay coal field, by Sidney Paige. Bull. No. 284, 1906, pp. 101–108.

The coal resources of the Yukon, Alaska, by A. J. Collier. Bull. No. 218, 1903, 71 pp.

Coal fields of the Cape Lisburne region, by A. J. Collier. Bull. No. 259, 1905, pp. 172–185.

The possible use of peat fuel in Alaska, by C. A. Davis. Bull. No. 379, 1909, pp. 63–66.

ARIZONA.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1884–85. Bull. No. 27, 1886, p. 74.

Gives analyses of coal from Deer Creek valley, Arizona.

The Deer Creek coal field, Arizona, by M. R. Campbell. Bull. No. 225, 1904, pp. 240–258.

ARKANSAS.

The coal fields of Arkansas, by J. C. Branner. Mineral Resources U. S. for 1892, 1893, pp. 303–306.

Preliminary report on the Camden coal field of southwestern Arkansas, by J. A. Taff. Twenty-first Ann. Rept., pt. 2, 1900, pp. 313–329.

The southwestern coal field, by J. A. Taff. Twenty-second Ann. Rept., pt. 3, 1902, pp. 367–413.

An account of the coals of Arkansas, Indian Territory, and northern Texas

Fayetteville folio, Arkansas-Missouri, description, by G. I. Adams and E. O. Ulrich. Geologic Atlas U. S., folio 119, 1905, p. 6.

The Arkansas coal field, by A. J. Collier. Bull. No. 316, 1907, pp. 137–160.

The Arkansas coal field, by A. J. Collier, with reports on the paleontology by David White and G. H. Girty. Bull. No. 326, 1907, 158 pp.

Winslow folio, Arkansas-Indian Territory, description, by A. H. Purdue. Geologic Atlas U. S., folio 154, 1907, p. 6.

CALIFORNIA.

The coal deposits of California, by H. W. Turner. Mineral Resources U. S. for 1892, 1893, pp. 308–310.

Sacramento folio, California, description, by Waldemar Lindgren. Geologic Atlas U. S., folio 5, 1894.

Jackson folio, California, description, by H. W. Turner. Geologic Atlas U. S., folio 11, 1894.

Lassen Peak folio, California, description, by J. S. Diller. Geologic Atlas U. S., folio 15, 1895.

Marysville folio, California, description, by Waldemar Lindgren and H. W. Turner. Geologic Atlas U. S., folio 17, 1895.

The coal fields of the Pacific coast, by G. O. Smith. Twenty-second Ann. Rept., pt. 3, 1902, pp. 473–513.

An account of the coals occurring in Washington, California, and Oregon.

Coal in the Mount Diablo Range, Monterey County, Cal., by Ralph Arnold. Bull. No. 285, 1906, pp. 223–225.

Coal of Stone Canyon, Monterey County, Cal., by M. R. Campbell. Bull. No. 316, 1907, pp. 435–438.

COLORADO.

A report of work done in the division of chemistry and physics mainly during the fiscal year 1888–89, by F. W. Clarke. Bull. No. 64, 1890, p. 55.

Gives analyses of coals from Gunnison County, Colo.

Coal fields of Colorado, by R. C. Hills. Mineral Resources U. S. for 1892, 1893, pp. 319–365.

Anthracite-Crested Butte folio, Colorado, description of the sedimentary formations, by G. H. Eldridge. Geologic Atlas U. S., folio 9, 1894.

Geology of the Denver Basin in Colorado: Economic geology, by G. H. Eldridge. Monograph XXVII, 1896, pp. 317–387.

Elmoro folio, Colorado, description, by R. C. Hills. Geologic Atlas U. S., folio 58, 1899.

La Plata folio, Colorado, description: Economic geology, by C. W. Purington, Geologic Atlas U. S., folio 60, 1899, p. 14.

Walsenburg folio, Colorado, description, by R. C. Hills. Geologic Atlas U. S., folio 68, 1900, pp. 4–5.

Spanish Peaks folio, Colorado, description, by R. C. Hills. Geologic Atlas U. S., folio 71, 1901, pp. 4–6.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper No. 32, 1905, pp. 372–379.

Gives a general account of the occurrence of coal in Colorado, Wyoming, South Dakota, and Nebraska.

The Yampa coal field, Routt County, Colo., by N. M. Fenneman and H. S. Gale. Bull. No. 285, 1906, pp. 226–239.

The Durango-Gallup coal field of Colorado and New Mexico, by F. C. Schrader. Bull. No. 285, 1906, pp. 241–258.

The Yampa coal field, Routt County, Colo., by N. M. Fenneman and H. S. Gale. With a chapter on the character and use of the Yampa coals by M. R. Campbell. Bull. No. 297, 1906. 96 pp.

Coal fields of the Danforth Hills and Grand Hogback, in northwestern Colorado, by H. S. Gale. Bull. No. 316, 1907, pp. 264–301.

The Book Cliffs coal field between Grand River, Colo., and Sunnyside, Utah, by G. B. Richardson. Bull. No. 316, 1907, pp. 302–320.

The Durango coal district, Colorado, by J. A. Taff. Bull. No. 316, 1907, pp. 321–337.

A reconnaisance survey of the western part of the Durango-Gallup coal field of Colorado and New Mexico, by M. K. Shaler. Bull. No. 316, 1907, pp. 376–426.

Ouray folio, Colorado; description by Whitman Cross, Ernest Howe, and J. D. Irving. Geologic Atlas U. S., folio 153, 1907. Coal by Whitman Cross, p. 19.

Coal fields of northwestern Colorado and northeastern Utah, by H. S. Gale. Bull. No. 341, 1909, pp. 283–315.

The Grand Mesa coal field, Colorado, by W. T. Lee. Bull. No. 341, 1909, pp. 316–334.

The coal field between Durango, Colo., and Monero, N. Mex., by J. H. Gardner. Bull. No. 341, 1909, pp. 352–363.

Reconnaissance of the Book Cliffs coal field between Grand River, Colo., and Sunnyside, Utah, by G. B. Richardson. Bull. No. 371, 1909. 54 pp.

GEORGIA.

Ringgold folio, Georgia-Tennessee, descriptive text, by C. W. Hayes. Geologic Atlas U. S., folio 2, 1894.

Stevenson folio, Alabama-Georgia-Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 19, 1895.

The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227–263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

IDAHO.

Boise folio, Idaho, description, by Waldemar Lindgren. Geologic Atlas U. S., folio 45, 1898.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

ILLINOIS.

Danville folio, Illinois-Indiana, description, by M. R. Campbell. Geologic Atlas U. S., folio 67, 1900, pp. 6–7.

The eastern interior coal field, by G. H. Ashley. Twenty-second Ann. Rept., pt. 3, 1902, pp. 265–305.

An account of the coal field embracing parts of Indiana, Illinois, and Kentucky.

Recent work in the coal field of Indiana and Illinois, by M. L. Fuller and G. H. Ashley. Bull. No. 213, 1903, pp. 284–293.

Patoka folio, Indiana-Illinois, description, by M. L. Fuller and F. G. Clapp. Geologic Atlas U. S., folio 105, 1904, pp. 7–9.

Coal investigation in the Saline-Gallatin field, Illinois, and the adjoining area, by F. W. DeWolf. Bull. No. 316, 1907, pp. 116–136.

INDIANA.

Danville folio, Illinois-Indiana, description, by M. R. Campbell. Geologic Atlas U. S., folio 67, 1900, pp. 6–7.

The eastern interior coal field, by G. H. Ashley. Twenty-second Ann. Rept., pt. 3, 1902, pp. 265–305.

An account of the coal field embracing parts of Indiana, Illinois, and Kentucky.

Ditney folio, Indiana, economic geology, by G. H. Ashley. Geologic Atlas U. S., folio 84, 1902, p. 7.

Recent work in the coal field of Indiana and Illinois, by M. L. Fuller and G. H. Ashley. Bull. No. 213, 1903, pp. 284–293.

Patoka folio, Indiana-Illinois, description, by M. L. Fuller and F. G. Clapp. Geologic Atlas U. S., folio 105, 1904, pp. 7–9.

INDIAN TERRITORY (OKLAHOMA).

Geology of the McAlester-Lehigh coal field, Indian Territory, by J. A. Taff. Nineteenth Ann. Rept., pt. 3, 1899, pp. 423–456.

Geology of the eastern Choctaw coal field, Indian Territory, by J. A. Taff and G. I. Adams. Twenty-first Ann. Rept., pt. 2, 1900, pp. 257–311.

Coalgate folio, Indian Territory, description, by J. A. Taff. Geologic Atlas U. S., folio 74, 1901, p. 6.

The southwestern coal field, by J. A. Taff. Twenty-second Ann. Rept., pt. 3, 1902, pp. 367–413.

An account of the coals of Arkansas, Indian Territory, and northern Texas.

Atoka folio, Indian Territory, description, by J. A. Taff. Geologic Atlas U. S., folio 79, 1902, p. 7.

Progress of coal work in Indian Territory, by J. A. Taff. Bull. No. 260, 1905, pp. 382–401.

Muscogee folio, Indian Territory, description, by J. A. Taff. Geologic Atlas U. S., folio 132, 1906, p. 6.

IOWA.

Sketch of the coal deposits of Iowa, by C. R. Keyes. Mineral Resources U. S. for 1892, 1893, pp. 398–404.

The western interior coal field, by H. F. Bain. Twenty-second Ann. Rept., pt. 3, 1902, pp. 333–366.

An account of the coal field occupying portions of Missouri, Kansas, Nebraska, and Iowa.

KANSAS.

The western interior coal field, by H. F. Bain. Twenty-second Ann. Rept., pt. 3, 1902, pp. 333–366.

An account of the coal field occupying portions of Missouri, Kansas, Nebraska, and Iowa.

Stratigraphy and paleontology of the upper Carboniferous rocks of the Kansas section, by G. I. Adams, G. H. Girty, and David White. Bull. No. 211, 1903, 123 pp.

Includes notes on the occurrence of coal beds.

Economic geology of the Iola quadrangle, Kansas, by G. I. Adams, E. Haworth, and W. R. Crane. Bull. No. 238, 1904, pp. 74–75.

Notes the occurrence of coal of no economic value.

Economic geology of the Independence quadrangle, Kansas, by F. C. Schrader and E. Haworth. Bull. No. 296, 1906. Coal, pp. 48–52.

Joplin district folio, Missouri-Kansas, description, by W. S. T. Smith and C. E. Siebenthal. Geologic Atlas U. S., folio 148, 1907, pp. 19–20.

Independence folio, Kansas, description, by F. C. Schrader. Geologic Atlas U. S., folio 159, 1908, p. 6.

KENTUCKY.

The coal fields of Kentucky, by J. R. Procter. Mineral Resources U. S. for 1892, 1893, pp. 415–417.

Geology of the Big Stone Gap coal field of Virginia and Kentucky, by M. R. Campbell. Bull. No. 111, 1893. 106 pp.

Estillville folio, Kentucky-Virginia-Tennessee, description, by M. R. Campbell. Geologic Atlas U. S., folio 12, 1894.

Richmond folio, Kentucky, description, by M. R. Campbell. Geologic Atlas U. S., folio 46, 1898.

London folio, Kentucky, description, by M. R. Campbell. Geologic Atlas U. S., folio 47, 1898.

The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227–263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

The eastern interior coal field, by G. H. Ashley. Twenty-second Ann. Rept., pt. 3, 1902, pp. 265–305.

An account of the coal field embracing parts of Indiana, Illinois, and Kentucky.

The Cumberland Gap coal field of Kentucky and Tennessee, by G. H. Ashley. Bull. No. 225, 1904, pp. 259–275.

Coal resources of the Kenova quadrangle, by W. C. Phalen. Bull. No. 285, 1906, pp. 259–268.

Geology and mineral resources of part of the Cumberland Gap coal field, Kentucky, by G. H. Ashley and L. C. Glenn. Prof. Paper No. 49, 1906, 239 pp.

The Elkhorn coal field, Kentucky, by R. W. Stone. Bull. No. 316, 1907, pp. 42–54.

Coal resources of the Russell Fork basin in Kentucky and Virginia, by R. W. Stone. Bull. No. 348, 1908, 127 pp.

Economic geology of the Kenova quadrangle in Kentucky, Ohio, and West Virginia, by W. C. Phalen. Bull. No. 349, 1908, pp. 25–112.

MAINE.

Peat deposits of Maine, by E. S. Bastin and C. A. Davis. Bull. No. 376, 1909, 127 pp.

MARYLAND.

Piedmont folio, West Virginia-Maryland, description, by N. H. Darton and J. A. Taff. Geologic Atlas U. S., folio 28, 1896.

The bituminous coal field of Maryland, by David White. Twenty-second Ann. Rept., pt. 3, 1902, pp. 201–214.

Accident-Grantsville folio, Maryland-Pennsylvania-West Virginia, description, by G. C. Martin. Geologic Atlas U. S., folio 160, 1908, pp. 11–13.

MICHIGAN.

The northern interior coal field, by A. C. Lane. Twenty-second Ann. Rept., pt. 3, 1902, pp. 307–331.

MISSOURI.

The coal measures of Missouri, by Arthur Winslow. Mineral Resources U. S. for 1892, 1893, pp. 429–436.

The western interior coal field, by H. F. Bain. Twenty-second Ann. Rept., pt. 3, 1902, pp. 333–366.

An account of the coal field occupying portions of Missouri, Kansas, Nebraska, and Iowa.

Joplin district folio, Missouri-Kansas, description, by W. S. T. Smith and C. E. Siebenthal. Geologic Atlas U. S., folio 148, 1907, pp. 19–20.

MONTANA.

The Laramie and the overlying Livingston formation in Montana, by W. H. Weed. Bull. No. 105, 1893, p. 105.

A brief statement regarding the occurrence and character of the coal beds.

Livingston folio, Montana, description, by J. P. Iddings and W. H. Weed. Geologic Atlas U. S., folio 1, 1894.

Three Forks folio, Montana, description, by A. C. Peale. Geologic Atlas U. S., folio 24, 1896.

Geology and mineral resources of the Judith Mountains of Montana, by W. H. Weed and L. V. Pirsson. Eighteenth Ann. Rept., pt. 3, 1898, pp. 614–616.

Gives an account of the coals mined in the area.

Fort Benton folio, Montana, description, by W. H. Weed. Geologic Atlas U. S., folio 55, 1899.

Little Belt Mountains folio, Montana, description, by W. H. Weed. Geologic Atlas U. S., folio 56, 1899.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Development of the Bear Creek coal fields, Montana, by C. A. Fisher. Bull. No. 285, 1906, pp. 269–270.

The North Dakota-Montana lignite area, by A. G. Leonard. Bull. No. 285, 1906, pp. 316–330.

The Great Falls coal field, Montana, by C. A. Fisher. Bull. No. 316, 1907, pp. 161–173.

Coals of Carbon County, Mont., by N. H. Darton. Bull. No. 316, 1907, pp. 174–193.

The coal fields of parts of Dawson, Rosebud, and Custer counties, Mont., by A. G. Leonard. Bull. No. 316, 1907, pp. 194–211.

The Sentinel Butte lignite field, North Dakota-Montana, by A. G. Leonard and Carl D. Smith. Bull. No. 341, 1909, pp. 15–35.

The Miles City coal field, Montana, by A. J. Collier. Bull. No. 341, 1909, pp. 36–61.

The Bull Mountain coal field, Montana, by L. H. Woolsey. Bull. No. 341, 1909, pp. 62–77.

Coal near the Crazy Mountains, Montana, by R. W. Stone. Bull. No. 341, 1909, pp. 78–91.

The Red Lodge coal field, Montana, by E. G. Woodruff. Bull. No. 341, 1909, pp. 92–107.

The Lewistown coal field, Montana, by W. R. Calvert. Bull. No. 341, 1909, pp. 108–122.

Coal fields of the northeast side of the Bighorn Basin, Wyoming, and of Bridger, Mont., by C. W. Washburne. Bull. No. 341, 1909, pp. 165–199.

Geology of the Great Falls coal field, Montana, by C. A. Fisher. Bull. No. 356, 1909, 85 pp.

Geology of the Lewistown coal field, Montana, by W. R. Calvert. Bull. No. 390, 1909, 79 pp..

NEBRASKA.

The western interior coal field, by H. F. Bain. Twenty-second Ann. Rept., pt. 3, 1902, pp. 333–366.

An account of the coal field occupying portions of Missouri, Kansas, Nebraska, and Iowa.

Lignites of the middle and upper Missouri Valley, by E. F. Burchard. Bull. No. 225, 1904, pp. 276–288.

Describes the occurrence and character of lignite deposits in Dakota County, Nebr., and in North Dakota.

Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper No. 32, 1905, pp. 372–379.

Gives a general account of the occurrence of coal in Colorado, Wyoming, South Dakota, and Nebraska.

Elk Point folio, South Dakota-Nebraska-Iowa, description, by J. E. Todd. Geologic Atlas U. S., folio 156, 1908, p. 6.

NEVADA.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Coal deposits between Silver Peak and Candelaria, Esmeralda County, Nev., by J. E. Spurr. Bull. No. 225, 1904, pp. 289–292.

Ore deposits of the Silver Peak quadrangle, Nevada, by J. E. Spurr. Prof. Paper No. 55, 1906, pp. 165–168.

NEW MEXICO.

Report of work done in the division of chemistry and physics, mainly during the fiscal year 1885–86, by F. W. Clarke. Bull. No. 42, 1887, p. 147.

Gives an analysis of "natural coke" from Purgatory Canyon, N. Mex.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Coal fields of the White Mountain region, New Mexico, by C. A. Fisher. Bull. No. 225, 1904, pp. 293–294.

The Engle coal field, New Mexico, by W. T. Lee. Bull. No. 285, 1906, p. 240.

The Durango-Gallup coal field of Colorado and New Mexico, by F. C. Schrader. Bull. No. 285, 1906, pp. 241–258.

A reconnaissance survey of the western part of the Durango-Gallup coal field of Colorado and New Mexico, by M. K. Shaler. Bull. No. 316, 1907, pp. 376–426.

The Una del Gato coal field, Sandoval County, N. Mex., by M. R. Campbell. Bull. No. 316, 1907, pp. 427–430.

Coal in the vicinity of Fort Stanton Reservation, Lincoln County, N. Mex., by M. R. Campbell. Bull. No. 316, 1907, pp. 431–434.

The coal field between Gallina and Raton Spring, N. Mex., in the San Juan coal region, by J. H. Gardner. Bull. No. 341, 1909, pp. 335–351.

The coal field between Durango, Colo., and Monero, N. Mex., by J. H. Gardner. Bull. No. 341, 1909, pp. 352–363.

The coal field between Gallup and San Matec, N. Mex., by J. H. Gardner. Bull. No. 341, 1909, pp. 364–378.

NORTH CAROLINA.

Report of work done in the division of chemistry and physics, mainly during the fiscal year 1885–86, by F. W. Clarke. Bull. No. 42, 1887, p. 146.

Gives analyses of coals from Gulf and from Stokes County, N. C.

Correlation Papers—the Newark system, by I. C. Russell. Bull. No. 85, 1892, coal, pp. 36–43.

The Atlantic coast Triassic coal field, by J. B. Woodworth. Twenty-second Ann. Rept., pt. 3, 1902, pp. 25–53.

NORTH DAKOTA.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Lignites of the middle and upper Missouri Valley, by E. F. Burchard. Bull. No. 225, 1904, pp. 276–288.

Describes the occurrence and character of the lignite deposits in Dakota County, Nebr., and in North Dakota.

The lignite of North Dakota and its relation to irrigation, by F. A. Wilder. Water-Sup. and Irr. Paper No. 117, 1905, 59 pp.

The North Dakota-Montana lignite area, by A. G. Leonard. Bull. No. 285, 1906, pp. 316–330.

The Sentinel Butte lignite field, North Dakota-Montana, by A. G. Leonard and Carl D. Smith. Bull. No. 341, 1909, pp. 15–35.

OHIO.

Stratigraphy of the bituminous coal field in Pennsylvania, Ohio, and West Virginia, by I. C. White. Bull. No. 65, 1891, pp. 212.

Huntington folio, West Virginia-Ohio, description, by M. R. Campbell. Geologic Atlas U. S., folio 69, 1900, pp. 5–6.

The bituminous coal field of Ohio, by R. M. Haseltine. Twenty-second Ann. Rept., pt. 3, 1902, pp. 215–226.

Coal resources of the Kenova quadrangle, by W. C. Phalen. Bull. No. 285, 1906, pp. 259–268.

Economic geology of the Kenova quadrangle in Kentucky, Ohio, and West Virginia, by W. C. Phalen. Bull. No. 349, 1908, pp. 25–112.

OKLAHOMA. *See* Indian Territory.

OREGON.

Report of work done in the division of chemistry and physics, mainly during the fiscal year 1887–88, by F. W. Clarke. Bull. No. 60, 1890, p. 170.

Gives an analysis of coal from Pend d'Oreille, Oreg.

A geological reconnaissance in northwestern Oregon, by J. S. Diller. Seventeenth Ann. Rept., pt. 1, 1896, pp. 491–508.

Includes an account of the coal fields of northwestern Oregon.

Roseburg folio, Oregon, description, by J. S. Diller. Geologic Atlas U. S., folio 49, 1898.

The Coos Bay coal field, Oregon, by J. S. Diller. Nineteenth Ann. Rept., pt. 3, 1899, pp. 309–376.

The coal and pitch coal of the Newport mine, by W. C. Day. Nineteenth Ann. Rept., pt. 3, 1899, pp. 370–376.

Discusses the origin of the pitch coal.

Coos Bay folio, Oregon, description, by J. S. Diller. Geologic Atlas U. S., folio 73, 1901, pp. 4–5.

The coal fields of the Pacific coast, by G. O. Smith. Twenty-second Ann. Rept., pt. 3, 1902, pp. 473–513.

An account of the coals occurring in Washington, California, and Oregon.

Port Orford folio, Oregon, description, by J. S. Diller. Geologic Atlas U. S., folio 89, 1903, pp. 4–5.

The Rogue River valley coal field, Oregon, by J. S. Diller. Bull. No. 341, 1909, pp. 401–405.

A coal prospect on Willow Creek, Morrow County, Oreg., by W. C. Mendenhall. Bull. No. 341, 1909, pp. 406–408.

PENNSYLVANIA.

Anthracite coal mining, by H. M. Chance. Mineral Resources U. S. for 1883 and 1884, 1885, pp. 104–131.

Stratigraphy of the bituminous coal field in Pennsylvania, Ohio, and West Virginia, by I. C. White. Bull. No. 65, 1891, 212 pp.

The stratigraphic succession of the fossil floras of the Pottsville formation in the southern anthracite coal field, Pennsylvania, by David White. Twentieth Ann. Rept., pt. 2, 1900, pp. 854–857.

An account of the occurrence of the Lykens coals in Stony Mountain and in the Dauphin Basin.

The Pennsylvania anthracite coal field, by H. H. Stoek. Twenty-second Ann. Rept., pt. 3, 1902, pp. 55–117.

The bituminous coal field of Pennsylvania, by David White and M. R. Campbell. Twenty-second Ann. Rept., pt. 3, 1902, pp. 127–200.

Masontown-Uniontown folio, Pennsylvania, description, by M. R. Campbell. Geologic Atlas U. S., folio 82, 1902, pp. 10–18.

Gaines folio, Pennsylvania-New York, description, by M. L. Fuller. Geologic Atlas U. S., folio 92, 1903, p. 9.

Brownsville-Connellsville folio, Pennsylvania, description, by M. R. Campbell. Geologic Atlas U. S., folio 94, 1903, pp. 11–17.

Recent work in the bituminous coal field of Pennsylvania, by M. R. Campbell. Bull. No. 213, 1903, pp. 270–275.

The Barnesboro-Patton coal field of central Pennsylvania, by J. S. Burrows. Bull. No. 225, 1904, pp. 295–310.

The Elders Ridge coal field, Pennsylvania, by R. W. Stone. Bull. No. 225, 1904, pp. 311–324.

Coal mining along the southeastern margin of the Wilmore Basin, Cambria County, Pa., by Charles Butts. Bull. No. 225, 1904, pp. 325–329.

Indiana folio, Pennsylvania, description, by G. B. Richardson. Geologic Atlas U. S., folio 102, 1904, pp. 4–6.

Latrobe folio, Pennsylvania, description, by M. R. Campbell. Geologic Atlas U. S., folio 110, 1904, pp. 12–15.

Kittanning folio, Pennsylvania, description, by Charles Butts. Geologic Atlas U. S., folio 115, 1904, pp. 12–13.

Mineral resources of the Elders Ridge quadrangle, Pennsylvania, by R. W. Stone. Bull. No. 256, 1905. Coal, pp. 31–54. Coke, p. 55.

Pittsburg coal in the Burgettstown quadrangle, Pennsylvania, by W. T. Griswold. Bull. No. 260, 1905, pp. 402–410.

Waynesburg folio, Pennsylvania, description, by R. W. Stone. Geologic Atlas U. S., folio 121, 1905, pp. 9–10.

Elders Ridge folio, Pennsylvania, description, by R. W. Stone. Geologic Atlas U. S., folio 123, 1905, pp. 7–9.

Rural Valley folio, Pennsylvania, by Charles Butts. Geologic Atlas U. S., folio 125, 1905, pp. 7–10.

Ebensburg folio, Pennsylvania, description, by Charles Butts. Geologic Atlas U. S., folio 133, 1905, pp. 7–9.

Beaver folio, Pennsylvania, description, by L. H. Woolsey. Geologic Atlas U. S., folio 134, 1905, pp. 11–12.

Economic geology of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts. Bull. No. 279, 1906. Coal, pp. 44–102.

Clearfield coal field, Pennsylvania, by G. H. Ashley. Bull. No. 285, 1906, pp. 271–275.

The Punxsutawney and Glen Campbell coal fields of Indiana and Jefferson counties, Pa., by F. B. Peck and G. H. Ashley. Bull. No. 285, 1906, pp. 276–279.

Economic geology of the Beaver quadrangle, Pennsylvania (southern Beaver and northwestern Allegheny counties), by L. H. Woolsey. Bull. No. 286, 1906. Coal, pp. 26–55.

Economic geology of the Amity quadrangle, eastern Washington County, Pennsylvania, by F. G. Clapp. Bull. No. 300, 1907, 145 pp.

Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. Bull. No. 304, 1907. Map showing coal outcrops, in pocket.

Amity folio, Pennsylvania, description, by F. G. Clapp. Geologic Atlas U. S., folio 144, 1907, pp. 12–13.

Rogersville folio, Pennsylvania, description, by F. G. Clapp. Geologic Atlas U. S., folio 146, 1907, pp. 12–14.

Coals of the Clarion quadrangle, Clarion County, Pa., by E. F. Lines. Bull. No. 316, 1907, pp. 13–19.

Coal resources of Johnstown, Pa., and vicinity, by W. C. Phalen. Bull. No. 316, 1907, pp. 20–41.

Accident–Grantsville folio, Maryland–Pennsylvania–West Virginia, description, by G. C. Martin. Geologic Atlas U. S., folio 160, 1908, pp. 11–13.

RHODE ISLAND.

A report of work done in the Washington laboratory during the fiscal year 1883–84, by F. W. Clarke and T. M. Chatard. Bull. No. 9, 1884, p. 18.

Gives an analysis of coal from Cranston, R. I.

General geology of the Narragansett basin, by N. S. Shaler. Monograph XXXIII, 1899, pp. 79–88.

Describes the stratigraphy, occurrence, and character of the coal deposits in the Narragansett basin in Rhode Island.

SOUTH DAKOTA.

The lignites of the Great Sioux Reservation: A report on the region between the Grand and Moreau rivers, Dakota, by Bailey Willis. Bull. No. 21, 1885. 16 pp.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Edgemont folio, South Dakota-Nebraska, description, by N. H. Darton and W. S. T. Smith. Geologic Atlas U. S., folio 108, 1904, pp. 9–10.

Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper No. 32, 1905, pp. 372–379.

Gives a general account of the occurrence of coal in Colorado, Wyoming, South Dakota, and Nebraska.

The North Dakota-Montana lignite area, by A. G. Leonard. Bull. No. 285, 1906, pp. 316–330.

TENNESSEE.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1887–88, by F. W. Clarke. Bull. No. 60, 1890, p. 170.

Gives analyses of coal from Claiborne County, Tenn.

A report of work done in the division of chemistry and physics mainly during the fiscal year 1888–89, by F. W. Clarke. Bull. No. 64, 1890, pp. 54–55.

Gives analyses of coals and cokes from Campbell County, Tenn.

The Tennessee coal measures, by J. M. Safford. Mineral Resources U. S. for 1892, 1893, pp. 497–506.

Ringgold folio, Georgia-Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 2, 1894.

Kingston folio, Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 4, 1894.

Chattanooga folio, Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 6, 1894.

Sewanee folio, Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 8, 1894.

Stevenson folio, Alabama-Georgia-Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 19, 1895.

Pikeville folio, Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 21, 1895.

McMinnville folio, Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 22, 1895.

Loudon folio, Tennessee, description, by Arthur Keith. Geologic Atlas U. S., folio 25, 1896.

Briceville folio, Tennessee, description, by Arthur Keith. Geologic Atlas U. S., folio 33, 1896.

Wartburg folio, Tennessee, description, by Arthur Keith. Geologic Atlas U. S., folio 40, 1897.

Standingstone folio, Tennessee, description, by M. R. Campbell. Geologic Atlas U. S., folio 53, 1899.

Maynardville folio, Tennessee, description, by Arthur Keith. Geologic Atlas U. S., folio 75, 1901, p. 5.

The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227–263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

The Cumberland Gap coal field of Kentucky and Tennessee, by G. H. Ashley. Bull. No. 225, 1904, pp. 259–275.

TEXAS.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1886–87, by F. W. Clarke. Bull. No. 55, 1889, p. 87.

Gives an analysis of coal from Burnet County, Tex.

The coal fields of Texas, by R. T. Hill. Mineral Resources U. S. for 1892, 1893, pp. 507–510.

Reconnaissance in the Rio Grande coal fields of Texas, by T. W. Vaughan. Bull. No. 164, 1900. 100 pp.

Uvalde folio, Texas, description, by T. W. Vaughan. Geologic Atlas U. S., folio 64, 1900, p. 5.

The southwestern coal field, by J. A. Taff. Twenty-second Ann. Rept., pt. 3, 1902, pp. 367–413.

An account of the coals of Arkansas, Indian Territory, and northern Texas.

UTAH.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1890–91, by F. W. Clarke. Bull. No. 90, 1892, p. 75.

Gives analyses of coals from Little Cottonwood gulch and from the Wasatch Mountains.

Coal fields of Utah, by Robert Forrester. Mineral Resources U. S. for 1892, 1893, pp. 511–520.

The Colorado formation and its invertebrate fauna, by T. W. Stanton. Bull. No. 106, 1893, pp. 35–36.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Coal in Sanpete County, Utah, by G. B. Richardson. Bull. No. 285, 1906, pp. 280–284.

Notes on the Weber River coal field, Utah, by J. A. Taff. Bull. No. 285, 1906, pp. 285–288.

Book Cliffs coal field, Utah, west of Green River, by J. A. Taff. Bull. No. 285, 1906, pp. 289–302.

The Pleasant Valley coal district, Carbon and Emery counties, Utah, by J. A. Taff. Bull. No. 316, 1907, pp. 338–358.

The Iron County coal field, Utah, by W. T. Lee. Bull. No. 316, 1907, pp. 359–375.

Coal fields of northwestern Colorado and northeastern Utah, by H. S. Gale. Bull. No. 341, 1909, pp. 283–315.

The Harmony, Colob, and Kanab coal fields, southern Utah, by G. B. Richardson. Bull. No. 341, 1909, pp. 379–400.

Reconnaissance of the Book Cliffs coal field between Grand River, Colorado, and Sunnyside, Utah, by G. B. Richardson. Bull. 371, 1909. 54 pp.

VIRGINIA.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1885–86, by F. W. Clarke. Bull. No. 42, 1887, p. 146.

Gives an analysis of "natural coke" from Midlothian, Va.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1886-87, by F. W. Clarke. Bull. No. 55, 1889, p. 87.

Gives analyses of coal and coke from Scott County, Va.

Correlation papers—the Newark system, by I. C. Russell. Bull. No. 85, 1892, coal, pp. 36-43.

The Clinch Valley coal fields, by A. S. McCreath and E. V. D'Invilliers. Mineral Resources U. S. for 1892, 1893, pp. 521-528.

Geology of the Big Stone Gap coal field of Virginia and Kentucky, by M. R. Campbell. Bull. No. 111, 1893. 106 pp.

Estillville folio, Kentucky-Virginia-Tennessee, description, by M. R. Campbell. Geologic Atlas U. S., folio 12, 1894.

Staunton folio, Virginia-West Virginia, description, by N. H. Darton. Geologic Atlas U. S., folio 14, 1894.

Pocahontas folio, Virginia-West Virginia, description, by M. R. Campbell. Geologic Atlas U. S., folio 26, 1896.

Tazewell folio, Virginia-West Virginia, description, by M. R. Campbell. Geologic Atlas U. S., folio 44, 1897.

Geology of the Richmond basin, Virginia, by N. S. Shaler and J. B. Woodworth. Nineteenth Ann. Rept., pt. 2, 1899, pp. 511-515.

Bristol folio, Virginia-Tennessee, description, by M. R. Campbell. Geologic Atlas U. S., folio 59, 1899.

The Atlantic coast Triassic coal field, by J. B. Woodworth. Twenty-second Ann. Rept., pt. 3, 1902, pp. 25-53.

The Russell Fork coal field, Virginia, by R. W. Stone. Bull. No. 316, 1907, pp. 55-67.

Coal mining at Dante, Va., by R. W. Stone. Bull. No. 316, 1907, pp. 68-75.

Coal resources of the Russell Fork basin in Kentucky and Virginia, by R. W. Stone. Bull. No. 348, 1908. 127 pp.

The Pocket coal district, Virginia, in the Little Black Mountain coal field, by C. A. Fisher. Bull. No. 341, 1909, pp. 409-418.

WASHINGTON.

A geological reconnaissance in central Washington, by I. C. Russell. Bull. No. 108, 1893, p. 76.

A brief note on the occurrence of coal of little economic value near Wenatchee.

Some coal fields of Puget Sound, by Bailey Willis. Eighteenth Ann. Rept., pt. 3, 1898, pp. 393-436.

Tacoma folio, Washington, description, by Bailey Willis and G. O. Smith. Geologic Atlas U. S., folio 54, 1899.

A preliminary paper on the geology of the Cascade Mountains in northern Washington, by I. C. Russell. Twentieth Ann. Rept., pt. 2, 1900, coal, pp. 205-206.

The coal fields of the Pacific coast, by G. O. Smith. Twenty-second Ann. Rept., pt. 3, 1902, pp. 473-513.

An account of the coals occurring in Washington, California, and Oregon.

A geological reconnaissance across the Cascade Range near the forty-ninth parallel, by G. O. Smith and F. C. Calkins. Bull. No. 235, 1904, p. 97.

Notes the occurrence of coal and coal mines in northwestern Washington.

Mount Stuart folio, Washington, description, by G. O. Smith. Geologic Atlas U. S., folio 106, 1904, pp. 9-10.

Coal in Washington, near Portland, Oreg., by J. S. Diller. Bull. No. 260, 1905, pp. 411-412.

Coal in Clallam County, Wash., by Ralph Arnold. Bull. No. 260, 1905, pp. 413-421.

Snoqualmie folio, Washington, description, by G. O. Smith and F. C. Calkins. Geologic Atlas U. S., folio 139, 1906, p. 13.

WEST VIRGINIA.

Coal mining in the Kanawha Valley of West Virginia, by S. M. Buck. Mineral Resources U. S. for 1883 and 1884, 1885, pp. 131-143.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1884-85. Bull. No. 27, 1886, pp. 73-74.

Gives analyses of coals from Randolph County, W. Va.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1887–88, by F. W. Clarke. Bull. No. 60, 1890, p. 169.

Gives analyses of coals and cokes from Piedmont, W. Va.

A report of work done in the division of chemistry and physics mainly during the fiscal year 1888–89, by F. W. Clarke. Bull. No. 64, 1890, p. 54.

Gives analyses of coals from Kanawha County, and of coal and coke from Tucker County, W. Va.

Stratigraphy of the bituminous coal field in Pennsylvania, Ohio, and West Virginia, by I. C. White. Bull. No. 65, 1891, 212 pp.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1889–90, by F. W. Clarke. Bull. No. 78, 1891, p. 128.

Gives analyses of coals from Barbour County, W. Va.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1890–91, by F. W. Clarke. Bull. No. 90, 1892, p. 75.

Gives analyses of coal and coke from Tucker County, W. Va.

The Potomac and Roaring Creek coal fields in West Virginia, by J. D. Weeks. Fourteenth Ann. Rept., pt. 2, 1894, pp. 567–590.

Geologic section along the New and Kanawha rivers in West Virginia, by M. R. Campbell and W. C. Mendenhall. Seventeenth Ann. Rept., pt. 2, 1896, pp. 473–511.

Describes the stratigraphy of the coal measures in this section. Includes analyses of the coals.

Pocahontas folio, Virginia-West Virginia, description, by M. R. Campbell. Geologic Atlas U. S., folio 26, 1896.

Piedmont folio, West Virginia-Maryland, description, by N. H. Darton and J. A. Taff. Geologic Atlas U. S., folio 28, 1896.

Franklin folio, West Virginia-Virginia, description, by N. H. Darton. Geologic Atlas U. S., folio 32, 1896.

Buckhannon folio, West Virginia, description, by J. A. Taff and A. H. Brooks. Geologic Atlas U. S., folio 34, 1896.

Tazewell folio, Virginia-West Virginia, description, by M. R. Campbell. Geologic Atlas U. S., folio 44, 1897.

Huntington folio, West Virginia-Ohio, description, by M. R. Campbell. Geologic Atlas U. S., folio 69, 1900, pp. 5–6.

Charleston folio, West Virginia, description, by M. R. Campbell. Geologic Atlas U. S., folio 72, 1901, pp. 6–9.

Raleigh folio, West Virginia, description, by M. R. Campbell. Geologic Atlas U. S., folio 77, 1902, pp. 4–8.

The Meadow Branch coal field of West Virginia, by M. R. Campbell. Bull. No. 225, 1904, pp. 330–344.

Coal in the Nicholas quadrangle, West Virginia, by G. H. Ashley. Bull. No. 260, 1905, pp. 422–428.

Coal resources of the Kenova quadrangle, by W. C. Phalen. Bull. No. 285, 1906, pp. 259–268.

Economic geology of the Kenova quadrangle in Kentucky, Ohio, and West Virginia, by W. C. Phalen. Bull. No. 349, 1908, pp. 25–112.

Accident-Grantsville folio, Maryland-Pennsylvania-West Virginia, description, by G. C. Martin. Geologic Atlas U. S., folio 160, 1908, pp. 11–13.

WYOMING.

The coal fields of Wyoming, by G. C. Hewitt. Mineral Resources U. S. for 1893, 1894, pp. 412–414.

A geological reconnaissance in northwest Wyoming, by G. H. Eldridge. Bull. No. 119, 1894, coal, pp. 49–62.

Coals and coal measures of Wyoming, by W. C. Knight. Sixteenth Ann. Rept., pt. 4, 1895, pp. 208–215.

Field observations in the Hay Creek coal field, by W. P. Jenney. Nineteenth Ann. Rept., pt. 2, 1899, pp. 568–587.

Includes some account of the coals of the area.

Preliminary description of the geology and water resources of the southern half of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. Twenty-first Ann. Rept., pt. 4, 1901, pp. 582–584.

Gives an account of the distribution of coal in the Lakota formation in northeastern Wyoming.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.
The copper deposits of the Encampment district, Wyoming, by A. C. Spencer. Prof. Paper 25, 1904, pp. 16–17.
Gives brief description of coal beds and a coal analysis.

Coal of the Bighorn basin, in northwest Wyoming, by C. A. Fisher. Bull. No. 225, 1904, pp. 345–362.
Newcastle folio, Wyoming-South Dakota, description, by N. H. Darton. Geologic Atlas U. S., folio 107, 1904, pp. 8–9.
The coal of the Black Hills, Wyoming, by N. H. Darton. Bull. No. 260, 1905, pp. 429–433.
Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper No. 32, 1905, pp. 372–379.
Gives a general account of the occurrence of coal in Colorado, Wyoming, South Dakota, and Nebraska.

Sundance folio, Wyoming-South Dakota, description, by N. H. Darton. Geologic Atlas U. S., folio 127, 1905, p. 12.
Aladdin folio, Wyoming-South Dakota-Montana, description, by N. H. Darton and C. C. O'Harra. Geologic Atlas U. S., folio 128, 1905.
Mineral resources of the Bighorn Mountain region, by N. H. Darton. Bull. No. 285, 1906, pp. 303–310.
Includes an account of coal deposits in northeastern Wyoming.

Mineral resources of the Bighorn Basin, by C. A. Fisher. Bull. No. 285, 1906, pp. 311–315.
Coal and oil in southern Uinta County, Wyo., by A. C. Veatch. Bull. No. 285, 1906, pp. 331–353.
Geology of the Bighorn Mountains, by N. H. Darton. Prof. Paper No. 51, 1906, pp. 62–67, 111–112.
Gives an account of the stratigraphy, character, and mining of coal in the Bighorn Mountains of Wyoming.

Geology and water resources of the Bighorn Basin, Wyoming, by C. A. Fisher. Prof. Paper No. 53, 1906, pp. 46–56.
Describes the character, occurrence, and development of the coal deposits of the area.

Bald Mountain-Dayton folio, Wyoming, description, by N. H. Darton. Geologic Atlas U. S., folio 141, 1906, p. 14.
Cloud Peak-Fort McKinney folio, Wyoming, description, by N. H. Darton. Geologic Atlas U. S., folio 142, 1906, p. 15.
Devils Tower folio, Wyoming, description, by N. H. Darton and C. C. O'Harra. Geologic Atlas U. S., folio 150, 1907, p. 8.
Coal fields in a portion of Central Uinta County, Wyo., by A. R. Schultz. Bull. No. 316, 1907, pp. 212–241.
The Lander coal field, Wyoming, by E. G. Woodruff. Bull. No. 316, 1907, pp. 242–243.
Coal fields of east central Carbon County, Wyo., by A. C. Veatch. Bull. No. 316, 1907, pp. 244–260.
Coal of Laramie Basin, Wyoming, by C. E. Siebenthal. Bull. No. 316, 1907, pp. 261–263.
Coal fields of the southwest side of the Bighorn Basin, Wyoming, by E. G. Woodruff. Bull. No. 341, 1909, pp. 200–219.
Coal fields on the northeast side of the Bighorn Basin, Wyoming, and of Bridger, Mont., by Chester W. Washburne. Bull. No. 341, 1909, pp. 165–199.
The Sheridan coal field, Wyoming, by J. A. Taff. Bull. No. 341, 1909, pp. 123–150.
The western part of the Little Snake River coal field, Wyoming, by Max W. Ball. Bull. No. 341, 1909, pp. 243–255.
The eastern part of the Great Divide Basin coal field, Wyoming, by E. E. Smith. Bull. No. 341, 1909, pp. 220–242.
The northern part of the Rock Springs coal field, Sweetwater County, Wyo., by A. R. Schultz. Bull. No. 341, 1909, pp. 256–282.
The Glenrock coal field, Wyoming, by E. W. Shaw. Bull. No. 341, 1909, pp. 151–164.
Geography and geology of a portion of southwestern Wyoming, by A. C. Veatch. Prof. Paper No. 56, 1908. 178 pp.

GENERAL.

AREAL.

General account of the fresh-water morasses of the United States, with a description of the Dismal Swamp district of Virginia and North Carolina, by N. S. Shaler. Tenth Ann. Rept., 1890, pp. 303-304.

Discusses briefly the utilization of peat.

Stratigraphy of the bituminous coal field in Pennsylvania, Ohio, and West Virginia, by I. C. White. Bull. No. 65, 1891, 212 pp.

Origin, distribution, and commercial value of peat deposits, by N. S. Shaler. Sixteenth Ann. Rept., pt. 4, 1895, pp. 305-314.

General discussion.

The coal fields of the United States, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 7-24.

Distribution and geologic relations of the various coal fields in the United States, classification of coals, production, and marketing.

The northern Appalachian coal field, by David White, M. R. Campbell, and R. M. Haseltine. Twenty-second Ann. Rept., pt. 3, 1902, pp. 119-226.

The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227-263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

The eastern interior coal field, by G. H. Ashley. Twenty-second Ann. Rept., pt. 3, 1902, pp. 265-305.

An account of the coal field embracing parts of Indiana, Illinois, and Kentucky.

The western interior coal field, by H. F. Bain. Twenty-second Ann. Rept., pt. 3, 1902, pp. 333-366.

An account of the coal field occupying parts of Missouri, Kansas, Nebraska, and Iowa.

The southwestern coal field, by Joseph A. Taff. Twenty-second Ann. Rept., pt. 3, 1902, pp. 367-413.

An account of the coals of Arkansas, Indian Territory, and Northern Texas.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415-471.

The coal fields of the Pacific coast, by George Otis Smith. Twenty-second Ann. Rept., pt. 3, 1902, pp. 473-513.

An account of the coals occuring in Washington, California, and Oregon.

Coal fields of the United States, by C. W. Hayes. Bull. No. 213, 1903, pp. 257-269.

A general account of the distribution and geologic relations of the coal fields, and the classification and marketing of coals.

Lignites of the middle and upper Missouri Valley, by E. F. Burchard. Bull. No. 225, 1904, pp. 276-288.

Describes the occurrence and character of lignite deposits in Dakota County, Nebr., and in North Dakota.

Field work, by M. R. Campbell. Bull. No. 261, 1905, pp. 18-29.

Field work, by M. R. Campbell. Prof. Paper No. 48, pt. 1, 1906, pp. 156-173.

Survey work on coal during 1905, by M. R. Campbell. Bull. No. 285, 1906, pp. 203-210.

Gives a short account of geologic work on coal areas in 1905, of the work of the fuel-testing division, and of the classification of coals.

Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper No. 32, 1905, pp. 372-379.

Gives a general account of the occurrence of coal in Colorado, Wyoming, South Dakota, and Nebraska.

Contributions to economic geology, 1906, pt. 2, Coal, lignite, and peat, by M. R. Campbell and others. Bull. No. 316, 1907, pp. 5-13.

Classified list of papers dealing with coal, coke, lignite and peat, contained in publications of U. S. Geol. Survey, by W. T. Lee and J. M. Nickles. Bull. No. 316, 1907, pp. 518-532; Bull. No. 341, 1909, pp. 419-436.

TECHNOLOGIC.

Preliminary report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904. E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. Bull. No. 261, 1905. 172 pp.

Preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905. J. A. Holmes, in charge. Bull. No. 290, 1906. 240 pp.

Report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904. E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. Prof. Paper No. 48, 1906. (In three parts.) 1492 pp.

The present status of the producer-gas power plant in the United States, by R. H. Fernald. Bull. No. 316, 1907, pp. 439–459.

Condition of the coal-briquetting industry in the United States, by Edward W. Parker. Bull. No. 316, 1907, pp. 460–485.

The importance of uniform and systematic coal-mine sampling, by J. S. Burrows. Bull. No. 316, 1907, pp. 486–517.

Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., by N. W. Lord. Bull. No. 323, 1907. 49 pp.

A study of four hundred steaming tests, by L. P. Breckenridge. Bull. No. 325, 1907. 196 pp.

Report of the United States fuel-testing plant at St. Louis, Mo., January 1, 1906, to June 30, 1907. J. A. Holmes, in charge. Bull. No. 332, 1908. 299 pp.

Coal mine accidents, their cause and prevention, by Clarence Hall, W. O. Snelling, and J. A. Holmes. Bull. No. 333, 1907. 21 pp.

The burning of coal without smoke in boiler plants, by D. T. Randall. Bull. No. 334, 1908. 26 pp.

Washing and coking tests of coal and cupola tests of coke, by Richard Moldenke, A. W. Belden, and G. R. Delamater, with introduction by J. A. Holmes. Bull. No. 336, 1908. 76 pp.

The purchase of coal under government and commercial specifications on the basis of its heating value, by D. T. Randall. Bull. No. 339, 1908. 27 pp.

Binders for coal briquets, by J. E. Mills. Bull. No. 343, 1908. 56 pp.

Mine sampling and chemical analyses of coals tested at the United States fuel-testing plant, Norfolk, Va., in 1907. Bull. No. 362, 1908. 23 pp.

Comparative tests of run-of-mine and briquetted coal on locomotives, by W. F. M. Goss. Bull. No. 363, 1908. 57 pp.

Tests of coal and briquets as fuel for house-heating boilers, by D. T. Randall. Bull. No. 366, 1908. 44 pp.

The significance of drafts in steam-boiler practice, by W. T. Ray and H. Kreisinger. Bull. No. 367, 1909. 60 pp.

Washing and coking tests of coal at the fuel-testing plant, Denver, Colo., July 1, 1907, to June 30, 1908, by A. W. Belden, G. R. Delamater, and J. W. Groves. Bull. No. 368, 1909. 53 pp.

The prevention of mine explosions, by V. Watteyne, C. Meissner, and A. Desborough. Bull. No. 369, 1908. 11 pp.

The smokeless combustion of coal in boiler plants, by D. T. Randall and H. W. Weeks. Bull. No. 373, 1909. 188 pp.

Results of purchasing coal under government specifications, by J. S. Burrows. Bull. No. 378, 1909. 44 pp.

The effect of oxygen in coal, by David White. Bull. No. 382, 1909. 78 pp.

Briquetting tests at Norfolk, Va., by C. L. Wright. Bull. No. 385, 1909. 41 pp.

The utilization of fuel in locomotive practice, by W. F. M. Goss. Bull. No. 402, 1909.

Comparative tests of run-of-mine and briquetted coal on the torpedo boat *Biddle*, by W. T. Ray and H. Kreisinger. Bull. No. 403, 1909. 47 pp.

COAL BRIQUETTING IN 1908.

By Edward W. Parker.

INTRODUCTION.

The word "briquet" has been adopted in this country as a general term applicable to the product obtained by compressing finely comminuted coal or lignite into convenient shapes for handling and burning, either with or without the addition of an agglomerating or binding material. Under this general term are included "boulets," "eggettes," "carbonets," "patent fuel," "coalettes," or other special names given to their product by the manufacturers.

The development of the industry in this country must depend upon the ability to utilize one or more of three classes of low-grade fuel and to produce an article which will compete in efficiency and price with raw or unmanufactured coal or with coke. The three classes of low-grade fuel are (1) anthracite culm, (2) slack coal from semianthracite, bituminous, and subbituminous coal mines, which does not possess fusing or coking quality, and (3) lignite, which disintegrates on exposure to the air, will not stand transportation, and can not be stored for any length of time. The slack from bituminous coals which possess coking quality can be and is used for making coke and can also be used satisfactorily under boilers. It is, therefore, not one of the fuels for which it is necessary to find a method of utilization. The use of powdered fuel in the manufacture of cement, which has shown great development in recent years, has created a market for large quantities of slack from the dry, noncoking coals, but there are still larger quantities available for manufacture into briquets. The principal reason for the somewhat tardy growth of briquetting in the United States is the cheapness of raw coal with which the manufactured product has to compete. The numerous commercially unsuccessful attempts to exploit secret processes have also had the effect of discouraging the investment of capital in enterprises of this character.

Binders.—Experience in European countries and the investigations which have been carried on at the fuel-testing plant of the United States Geological Survey have demonstrated clearly that the successful briquetting of lignite may be accomplished without the use of any additional binding material and that for the anthracites, semianthracites, bituminous, and subbituminous coals the only satisfactory binders are coal-tar pitch, gas-tar pitch, and asphaltic pitch, or inexpensive mixtures of which one or more of these are the principal constituents. The plants in successful operation in this country at the present time have added their experience to the evidence on this point. Inorganic binders, though efficient in cementing quality, have the serious objection of adding to the ash and clinker and of adding nothing to the combustible character of the fuel. Pitch binders, on the other hand, contribute combustible material and do not increase the ash.

In order to meet with popular favor in this country briquets must be of a convenient shape for shoveling and for the circulation of air in the fire box. They must be of suitable size for the purposes they are intended to serve, and must possess sufficient cohesion to resist fracture and abrasion under rough handling. The very large briquets made in European countries, particularly in Germany, the chief reason for which is the advantage for stowage in bunkers of steamships and tenders of locomotives, are not adapted for use in this country. They must be handled and stowed by hand, and must be broken up before shoveled into the fire. Labor conditions in this country make the cost of such handling prohibitive.

Historical.—C. T. Malcolmson, of Chicago, Ill., in a paper[a] read before the International Railway Fuel Association at Chicago, Ill., in June, 1909, gave an interesting historical review of some of the earlier attempts at briquetting in Europe and in the United States, from which the following, by permission, is quoted:

The earliest record on the briquetting of coal was suggested in a pamphlet by Sir Hugh Pratt in 1594. The first satisfactory briquetting machine was built in France in 1842 by M. Marsais. And since that time the industry has gone steadily forward in all the European countries. The first briquetting plants were installed in England in 1846, Belgium in 1852, and Germany in 1861. About 1870 the briquetting of brown coals was first successfully accomplished in the latter country.

Prominence was given to the industry by the exhibits of briquetting machinery at the Paris Exhibition of 1867, and the following year we find the first recorded interest for coal briquetting in America. In 1870 E. F. Loiseau installed at Port Richmond, Philadelphia, the first coal-briquetting plant. The press used was of Belgian type known as the "Loiseau rolls," and made eggettes weighing about 8 ounces, using 92 per cent anthracite culm and 8 per cent clay as a bond. These briquets were waterproofed with a varnish of shellac and benzine, but the cost was prohibitive. The plant was never a success, either mechanically or commercially, and was finally abandoned, but it marks the first step of the briquetting industry in this country and had its influence on the future, not without, we believe, beneficial results.

The Delaware and Hudson Canal Company built a similar plant at Rondout in 1876, which was later absorbed by the Anthracite Fuel Company in 1878 and operated until 1880. This plant also briquetted anthracite screenings, using pitch made from gas-house tar as a binder. The third plant in the east to use the Loiseau roll press was built at Mauch Chunk, Pa., and was short lived. The binder in these briquets made a smoky fuel which disintegrated in the fire and was otherwise unsatisfactory.

The next important plant established in the United States was at Mahanoy City, Pa., in 1890, by the Anthracite Pressed Fuel Company. The plant was designed by the Uskside Engineering Company of Newport, England, using a Stevens press. The briquets were rectilinear with an eagle on one side and the word "Reading" on the other and weighed 18 pounds. The plant had a capacity of 400 tons per day of ten hours. The dies were changed later to make 2-pound briquets and the capacity reduced to 300 tons. The binder was pitch made from coke-oven tar imported from England and 8 per cent was used in making the briquets. The Philadelphia and Reading Railroad expected to save $50,000 a year in their fuel by means of this plant, but the briquets were not satisfactory, owing to the high ash content of the culm and the excessive cost of binder. The plant failed in 1892, owing to a slump in the price of coal and inability to get sufficient quantities of binder, but it is noteworthy as marking the first important attempt to make briquets for railroad purposes.

---

[a] Briquetted coal and its value as a railroad fuel. Published in pamphlet form by Roberts & Schaefer Co., Chicago, 1909.

In 1892 Mr. Ware B. Gay built a plant at Gayton, near Richmond, using one set of Loiseau rolls for the briquetting of Virginia semianthracite slack and using coal-tar pitch as a binder. The capacity of this plant was doubled later. Similar plants were installed at this time at Milwaukee and Chicago for briquetting anthracite dust and bituminous slack made at transfer plants in these cities. In the dull coal season the Chicago plant made briquets of iron ore dust for the Illinois Steel Company.

A more pretentious plant was built in the same year at Huntington, Ark., under patents of M. Nirdlinger, controlled by the National Eggette Coal Company of New Jersey. The Huntington plant made briquets of a mixture of Arkansas semianthracite and bituminous coals, using hard pitch and coal tar as a binder. These plants failed generally because of inexperience in preparing the coal which, as a rule, was too dirty; inability to get uniform pitch of the proper specifications; the expense of briquetting; and the cheapness of the coal with which the briquets must compete. These observations were made by Mr. Gay in referring to the Richmond plant, to which he added that "prismatic shape is less desirable than one affording better combustion by forming interstices between the pieces, especially when used for domestic purposes."

None of the plants mentioned above survived. They are a few of the wrecks which have strewn the pathway. Some others are noted by the writer in Bulletin 316 of the United States Geological Survey and in contributions to previous volumes of Mineral Resources. In spite of the many failures, however, progress has been made, and the manufacture of briquets is being established as an important collateral of the coal mining industry. It will grow more rapidly as we take advantage of experience gained in Europe and profit by the failures of the past. One large engineering company of Chicago has established a department for the construction of fuel briquetting plants and another company in New York makes a specialty of this class of business. The subject is rather thoroughly discussed in recent literature (see bibliography in final pages of this chapter), and more rational attention is being given to it than at any previous period of our history. It is a campaign of education, to which the publications of the Geological Survey, it is hoped, give some assistance. The present chapter attempts only to note the progress made.

Statistical.—According to Dr. W. Galloway,[a] there were made in Great Britain 1,513,220 long tons of briquets in 1906; in Belgium there were made 1,711,920 tons in 1905; in the same year Italy produced 842,250 tons; France, in 1907, produced 1,872,628 tons; and Germany, in 1906 (including those made from lignite), produced 14,500,851 tons. The production of the United States in 1908 was 90,358 short tons, valued at $323,057, as compared with 66,524 tons in 1907, valued at $258,426, a gain of 23,834 tons, or 36 per cent, in quantity, and of $64,631, or 25 per cent, in value.

BRIQUETTING PLANTS OF THE UNITED STATES IN 1908.

Standard Fuel Company, Birmingham, Ala.—A detailed description of this plant is published in the Iron Age of January 28, 1909. The article was written by R. M. Hale, of Chicago, the inventor and patentee of the briquetting machine described. The press is of the internal plunger type, in which the plunger never leaves the mold cavity and forms the bottom of the cavity itself. The molds are made in the periphery of a drum, there being 32 rows of 12 molds each. The briquet molds are cylindrical, but can be made rectangular if desired. The briquets from the press described are 2¼ inches in diameter and weigh about 6 ounces each. No production in 1908 was

[a] Briquette making: Proc. South Wales Inst. Eng., vol. 26, No. 2, 1909.

reported to the Survey by this plant, but it will probably contribute to the output in 1909.

Arizona Copper Company, Clifton, Ariz.—This plant has been described in Bulletin 316 of the United States Geologial Survey. The press is of English design, built by Messrs. Yeadon & Son, of Leeds, and constructed for the purpose of utilizing slack from bituminous coal mined in New Mexico, and asphaltic pitch from California crude petroleum as a binder. The briquets weigh approximately 4 pounds each and are used under the boilers of the company's plant. They have the advantage over the coal from which they are made in that they can be stored without danger of spontaneous combustion. Owing to the business depression of 1908, which particularly affected metal mining in the Rocky Mountain States, this briquetting plant was not operated in 1908.

Western Fuel Company, Oakland, Cal.—The plant of this company was constructed for the purpose of utilizing the screenings from the company's coal yards with asphaltic pitch as a binding material. The plant is described in detail in Bulletin 316. The briquetting press, which was designed by Robert Schorr, of San Francisco, has a capacity of 60 tons a day of ten hours. The briquetting mixture consists of 90 per cent of slack and 10 per cent of binder. The briquets are cubical in shape and weigh approximately 10 ounces. The plant was constructed in 1905.

Pittsburg Coal Mining Company, Pittsburg Landing, Cal.—This plant, the press for which was designed by Charles R. Allen, of Oakland, was constructed early in 1907, but was partly burned in July of the same year. It has been restored and is now being used for experimental purposes, principally for demonstrating the Allen press. It was originally intended to utilize Pittsburg (California) subbituminous coal and make briquets for boiler use, but the increased production and consumption of petroleum in California and the increased activity in the producer-gas development, have militated against the commercial use of briquets for power purposes.

San Francisco and San Joaquin Coal Company, San Francisco, Cal.—This was the first briquetting plant erected in California and one of the first operated on a commercial scale in the United States. The plant was located at Stockton, Cal., and the press was designed by Robert Schorr, of San Francisco. The material used was subbituminous coal from the Tesla mine, with asphaltic pitch as a binder. The plant was destroyed by fire in 1904 and has not been rebuilt.

Primrose Coal Company, Pueblo, Colo.—This company has in contemplation the construction of a briquetting plant, but has not yet decided upon its character.

Indianapolis Pressed Fuel Company, Indianapolis, Ind.—This company, formerly the Indianapolis Briquetting Company, has installed a briquetting press invented by George W. Ladley, secretary and treasurer of the company. It began operations on a commercial scale November 15, 1908, and produced during that year and the early part of 1909, 2,500 tons of briquets from bituminous slack, using from 5 to 7 per cent of coal-tar pitch as a binder. The plant is located at the corner of State and Deloss streets, Indianapolis. In addition to the bituminous briquets made commercially, some tests were run on anthracite culm, on subbituminous coal, and on coke breeze. The briquets are cylindrical in shape, weigh about 10 ounces each, and are intended for household use. The entire product has been sold in the city of Indianapolis. The machine has a capacity of 160 tons per day of ten hours. In the operation of this plant the coal used is first passed through a drying machine; the dry coal is elevated to hopper-bottom bins, from which it is sent to the grinding machine and ground to the consistency of coarse corn meal; the pitch is pulverized separately; and both coal and pitch are automatically measured so that the exact percentages of each may be obtained. The coal and pitch are mixed cold and from the mixing machine the material is elevated by bucket conveyor to the heater. Two and one-half minutes are required for the mixture to pass through the heater in a continuous stream. The process requires pitch with a melting point of 175° F. From the heater the mass is dumped into the feed box for the briquetting machine, and the briquets are submitted to a pressure of 30,000 pounds. The briquets are manufactured at the rate of 1,080 per minute.

Semet-Solvay Company, Detroit, Mich.—As originally designed, this plant consisted of a Johnson (English) briquetting machine, but the product was found unsuited to the market. This machine was discarded in August, 1907, and the installation of two rotary presses was begun. One is of French design, made by the Société Nouvelle des Etablissements de l'Horme et de la Buire, and the other is a Mashek press, made by the Traylor Engineering Company, of New York. The plant has been constructed for the purpose of utilizing the coke breeze, an otherwise wasted product of the Semet-Solvay coke ovens, but the plant was not finished until the spring of 1909. It is designed to use from 30 to 60 per cent of bituminous coal slack and from 70 to 40 per cent of coke breeze, with coal-tar pitch as a binder. The briquets, which are of the boulet pattern, weigh about 60 grams ($2\frac{1}{8}$ ounces), and are used for household purposes. Each machine has a capacity of 6 short tons per hour. The coal and the coke breeze are delivered from railroad cars to hopper and then by elevator to the storage bins. If necessary, the coke breeze is first dried in a Ruggles-Cole drier. From the bins the coal and the coke breeze are drawn into a Trump measuring machine, from which they go to a Jeffries mill where they meet the hard coal-tar pitch as a binder. The pitch has been broken to $\frac{3}{4}$-inch size. In the Jeffries mill the mixture is finely pulverized and is then elevated to a rotary heater and mixer where it is heated by steam to the proper temperature. From the heater the briquet mixture goes to the feed box over the press.

Standard Briquette Fuel Company, Kansas City, Mo.—This is a recently incorporated company which has contracted for the construction of a briquetting plant at Twelfth street and Elmwood avenue, Kansas City. It is proposed to manufacture briquets for domestic use, using Arkansas semianthracite coal. The Roberts & Schaefer Company, of Chicago, Ill., have supervision of the construction. The equipment of the plant will be somewhat on the order of that installed at Hartshorne, Okla., by the Rock Island Coal Mining Company.

Western Coalette Fuel Company, Kansas City, Mo.—This plant, which has been described in Bulletin 316 and in the report on briquetting in Mineral Resources of the United States for 1907, was in active operation in 1908, using Arkansas semianthracite coal and water-gas pitch. The briquets are cylindrical in shape, with convex ends, and weigh about 14 ounces each. They are intended for domestic use.

New Jersey Briquetting Company, Perth Amboy, N. J.—The plant, formerly located in Brooklyn was removed to Perth Amboy early in 1908, and was put in operation about November 1.

Robert Devillers, Brooklyn, N. Y.—Mr. Devillers has succeeded to the business of the National Fuel Briquette Machinery Company, whose plant was described in Bulletin 316. This plant was in active operation during 1908, producing about 50 per cent more than it did in 1907. It is conveniently located for the receiving of supplies by water, being on the Gowanus Canal, at the foot of Court street, Brooklyn. The material used is anthracite culm and coal-tar pitch, the percentages reported being 95½ and 4½, respectively. The briquets, which weigh 1 ounce each, are of eggette shape and are intended principally for household consumption.

D. Grieme Coal Company, New York, N. Y.—A description of the briquetting plant of the D. Grieme Coal Company at the foot of West Forty-seventh street, New York, was published in Bulletin 316. The plant was started in October, 1907, and although it was not operated continuously during 1908, the quantity of briquets made was an increase of something more than 50 per cent over 1907. The briquets, which are manufactured in a press of Mashek design, are small and rectangular convex (pillow shape) in shape, weigh approximately 2¼ ounces each, and are intended entirely for domestic consumption. The material used is anthracite culm with 6½ to 7 per cent of coal-tar pitch as a binding material. The press has a capacity of 12 short tons per hour.

The Briquette Coal Company, Staten Island, N. Y.—A description of this plant was published in Bulletin 316. The plant consisted of two presses, one of them of Couffinhal type, built by Schuchtermann & Kremer, Dortmund, Germany, and the other a Belgian press made by H. Stevens, of Charleroi. The location of the plant was not a desirable one, and it is reported that the plant has been dismantled and removed to Murphysboro, Ill., to make briquets under contract for the St. Louis and Big Muddy Coal and Iron Company.

The Scranton Anthracite Briquette Company, Dickson City, Pa.—This plant, located adjacent to the Delaware, Lackawanna and Western Railroad Company's mines, near Dickson City, Pa., has the largest capacity of any briquetting plant so far established in the United States, and in 1907 produced more than 50 per cent of the entire output of briquets in this country. During 1908 an additional press was installed, doubling the capacity of the plant. The culm storage capacity was also increased. The briquets, which are of eggette shape and weigh about 6 ounces each, are manufactured from anthracite culm, using a binder the exact nature of which the company prefers not to disclose.

Dakota Lignite Briquette Coal Company, Aberdeen, S. Dak.—This company has in contemplation the construction of a briquetting plant for the utilization of North Dakota lignite without the use of any cementing material, though it is probable some fibrous material, such as straw, may be mixed with the lignite. It is proposed to install a machine of German manufacture, similar to the one used for testing purposes at the United States Geological Survey's testing laboratories, at Pittsburg, Pa. The plant will be located either at Scranton or Ives, N. Dak.

Rock Island Coal Mining Company, Hartshorne, Okla.—This plant was constructed by the Rock Island Coal Mining Company for the purpose of utilizing the slack coal produced at its several mines in Oklahoma. It consists of a Renfrow press and was constructed under the supervision of Charles T. Malcolmson. It was fully described in Mines and Minerals for March, 1909. The company has given to its product the trade name of "carbonets." The plant was completed and in operation in September, 1908, and was operated actively during the rest of the year. It uses 92 per cent of bituminous coal slack and 8 per cent of water-gas pitch. The briquets weigh about 13½ ounces each, are of cylindrical shape with convex ends, and are intended for household purposes and for use under locomotive and stationary boilers. The machine has a capacity of 8 short tons per hour.

United Gas Improvement Company, Point Breeze, Philadelphia, Pa.—As stated in the previous reports on the subject of briquetting, this plant is operated primarily for the purpose of utilizing coke breeze produced at the gas works of the company. It is found advantageous to mix the coke breeze with anthracite culm and bituminous slack. The plant has been in active operation since March, 1906, and the production in 1908 was about 2½ times what it was in 1907. The briquets are used by the company in the manufacture of water gas and are not put on the market.

United States Coal Manufacturing Company, Philadelphia, Pa.—Up to the close of 1908, the operation of this company was still of an experimental character, but it reports that it has secured 5½ acres of ground, with water and rail facilities and a stone building, where it proposes to install a manufacturing plant. The plant is expected to be in operation in October of 1909. A few tons of briquets were made in an experimental manner during 1908.

R. B. Metcalf, Providence, R. I.—Mr. Metcalf reports that negotiations are in progress for the construction of two briquetting plants in Rhode Island, the purpose being to utilize the hard anthracite in the vicinity of Providence.

Texas Briquette Fuel Company, Dallas, Tex.—The Texas Briquette Fuel Company is a corporation organized for the exploiting of the briquetting process patented by A. M. Mannewitz. The company has found difficulty in securing a press suited to the requirements and no briquets have been made upon a commercial scale.

Northwestern Improvement Company, Tacoma, Wash.—During 1908 the Northwestern Improvement Company constructed, at South Tacoma, an experimental briquetting plant which was designed originally by R. C. Hills, of Denver, Colo. The method of treatment is entirely unique, in that the coal is first heated in retorts and the gas and tarry products distilled off. The gas is recovered and afterwards used for heating the tar stills and the briquet mixers. The tarry products recovered from the gas are pumped into a still of 217 gallons. The light and creosoting oils are distilled off and recovered, and the pitch, still hot, is pumped into a tank over the mixers.

In the coal retorts the coal is reduced to about the quality of coke breeze. After retorting, the breeze is discharged to a screw conveyer and elevated to a 32-mesh screen, oversize from which is crushed in roll crushers and reelevated to the screen. The material passing through the screen is elevated by bucket conveyers to bins over the briquetting mixture. This plant was visited by the writer in November, 1908, at which time the coal used for briquetting was "No. 5 screenings" from Red Lodge, Mont. The retorts are fired with refuse from Ravensdale, Wash., collieries.

The briquets are manufactured in a plunger press of Hills design. They are cubical in shape, 2½ inches on each side. Although this plant is for purely experimental purposes, some improvements have been made during 1909—improvements principally in the enlarging and increasing of the efficiency of the cylindrical heater for the press.

The Coal-Briquette Machine Company, Oshkosh, Wis.—In the report for 1907 this company was reported as expecting to be in operation during 1908. On account of unforeseen delays the plant was not completed until March, 1909. No detailed description of the plant has been furnished. It may be stated, however, that it is proposed to use 90 to 92 per cent of anthracite culm and 8 to 10 per cent of coal-tar pitch. The briquets are of cylindrical pattern, weighing 1 pound 3 ounces each, and are intended for use under locomotive and stationary boilers. The briquetting machine is reported as having a capacity of 4 short tons per hour.

RECENT LITERATURE.

The following list comprises recent publications in which the subject of briquetted fuel is discussed:

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

Mineral Resources of the United States, 1897. Nineteenth Annual Report, pt. 6, 1898; Coal, by Edward W. Parker, pp. 273–543; Coke, by Edward W. Parker, pp. 545–642.

Mineral Resources of the United States, 1898. Twentieth Annual Report, pt. 6, 1899; Coal, by Edward W. Parker, pp. 295–507; Coke, by Edward W. Parker, pp. 509–608.

Mineral Resources of the United States, 1899. Twenty-first Annual Report, pt. 6, 1901; Coal, by Edward W. Parker, pp. 321–519; Coke by Edward W. Parker, pp. 521–633.

Briquetting tests at the United States Geological Survey fuel-testing plant, St. Louis, Mo., in 1904, by Joseph Hyde Pratt: Bulletin 261, 1905, pp. 134–168.

Briquetting tests at the United States Geological Survey fuel-testing plant, St. Louis, Mo., in 1904, by Joseph Hyde Pratt: Professional Paper 48, 1906, pp. 1389–1459.

Briquetting tests at the United States Geological Survey fuel-testing plant, St. Louis, Mo., in 1905, by J. A. Holmes: Bulletin 290, 1906, pp. 40–48.

Condition of the coal-briquetting industry in the United States in 1906, by Edward W. Parker: Bulletin No. 316, 1907, pp. 460–485.

Briquetting tests at the United States Geological Survey fuel-testing plant, St. Louis, Mo., from Jan. 1, 1906, to June 30, 1907, by Charles T. Malcolmson: Bulletin No. 332, 1908, pp. 36–46.

Binders for briquets, by J. E. Mills: Bulletin No. 343, 1908, 56 pp.

The combustion of briquets on locomotives, by W. F. M. Goss: Bulletin No. 363, 1908, 57 pp.

Briquetting tests at the United States Geological Survey fuel-testing plant, Norfolk, Va., 1907-8, by Charles L. Wright: Bulletin No. 385, 1909, 41 pp.

OTHER PUBLICATIONS.

The briquetting plant at Bankhead, Alberta, by Edward W. Parker; paper read at meeting of Am. Inst. Min. Eng. at New York City, February, 1908: Trans. Am. Inst. Min. Eng., 1908.

Southern coal for briquets, by Frederick E. Saward: Manufacturers' Record, October 21, 1907.

Briquetting of fuels in British Columbia; description of Pacific Coal Company's plant at Bankhead, Alberta, by J. G. Mashek: Can. Min. Jour., January 15 and February 1, 1908.

Lignite briquetting in Germany, by Robert Schorr: Eng. and Min. Jour., February 29, 1908.

Briquets in Europe: Their use as locomotive fuel in France, by Frank H. Mason, United States consul at Paris: Daily Cons. Reports, No. 3117, March 6, 1908.

Coal briquets: their importation and use on Swiss railways, by United States Vice-Consul Leo. J. Frankenthal, Berne: Daily Cons. Reports, No. 3139, April 18, 1908.

Briquets from coke dust; abstract of paper by Max Rosenkrans in Journal für Gasbeleuchtung und Wasserversorgung, Munich: Indust. World, April 27, 1908.

To make coal briquets at Hartshorne, Okla., by Carl Scholz; description of plant in course of construction for Rock Island Coal Mining Company to briquet Arkansas and Oklahoma coals: "Fuel," June 9, 1908.

Briquet making a commercial possibility: Details of Rock Island Coal Mining Company's plant at Hartshorne, Okla., illustrated: The Black Diamond, June 13, 1908.

Briquets made with tar; description of Shedlock process, by United States Consul Lorin A. Lathrop, Cardiff, Wales: Daily Cons. Reports, No. 3201, June 13, 1908.

New binding agent for briquets, a report on the use of "sulphite pitch" as a binding material, by United States Consul George Eugene Eager, Barmen, Prussia: Daily Cons. Reports, No. 3361, December 21, 1908.

Coal briquetting, with special reference to the briquetting machine built and used by the Standard Fuel Company, Birmingham, Ala., by R. M. Hale, Chicago, Ill. The Iron Age, January 28, 1909.

Briquets and their effect on market values of coal, by Matthew Ferguson: The Black Diamond, February 27, 1909.

Coal briquetting at the Hartshorne, Oklahoma, plant: Description of plant and process of making briquets from Oklahoma slack, by Charles T. Malcolmson: Mines and Minerals, March, 1909.

Briquetted coal and its value as a railroad fuel, by Charles T. Malcolmson; a paper presented before the International Railway Fuel Association, Chicago, Ill., June 23, 1909: Published in pamphlet form by Roberts & Schaefer Company, Chicago, Ill.

Manufacture of coal briquets in Belfast, Ireland, by United States Vice-Consul Paul Knabenshue: Daily Cons. Reports, No. 3539, July 23, 1909.

Handbook of briquetting, in 2 volumes. Vol. 1. Briquetting of coals, lignites, and other fuels, by G. Franke, Berlin, Germany: Published by Ferdinand Enke, Stuttgart.

COKE.

By Edward W. Parker.

INTRODUCTION.

The term "coke" as used in the reports of this series is limited to the product that is obtained by the distillation or partial combustion of bituminous coal in retorts or ovens and that is commonly called "oven coke." All of the coke considered in this report is suitable for, though not restricted to, blast furnaces, foundries, and smelters. The coke obtained as a by-product in the manufacture of illuminating gas, and known as "gas-house coke," is not considered as coming within the scope of this report. In former years practically all of the oven coke produced in the United States was used for metallurgical purposes, but owing to changes that have taken place in the industry within the last few years it is not possible any longer to limit the discussion of the subject according to the uses to which the coke is put. A not inconsiderable portion of the coke manufactured in the United States is now prepared and sold for domestic use, and comes into competition in that way with anthracite coal, with gas-house coke, and with both natural and manufactured gas. Some establishments which produce coke for metallurgical use have installed coke crushers and screens for the preparation of coke into domestic sizes, in much the same manner as anthracite is prepared at the breakers. Prior to 1893 practically all of the coke produced in the United States was made in ovens or pits, and no effort was made to recover or utilize the gases and other constituents of the coal. With the construction in 1893 of what might be termed an experimental plant of by-product ovens at Syracuse, N. Y., another feature was added to the industry, and this feature has developed so rapidly that at the present time more than 16 per cent of the total production of coke is obtained from retort ovens. All of the coke produced in retort ovens is a fuel suitable for metallurgical purposes, but its use is not restricted to the metallurgical industries. In some cases where the retort ovens are located at iron or steel plants the coke may be considered as the primary product, and in such cases it is used almost exclusively in the blast furnaces. In other cases where the ovens are located in or near large cities, the coke becomes a secondary product, some of it being used for metallurgical purposes and some for manufacturing, railroad, or domestic trade. The location of the plant rather than the quality of the coke determines whether the coke product is primary or secondary; but as it is impossible to make any accurate separation of the uses to which the coke is put, the entire production is included in the statistics as compiled by the Geological Survey.

The first plant of by-product ovens established in the United States was a bank of 12 ovens constructed by the Semet-Solvay Company, of Syracuse, N. Y., in 1893. Since that time there has been a steady and noteworthy increase in the construction of by-product recovery ovens in the United States. At the close of 1907 there were 3,892 by-product ovens completed in the United States, and 330 were in course of construction. On December 31, 1908, there were 4,007 retort ovens completed and 240 under construction, and although, in sympathy with the general falling off in business, the production of by-product coke in 1908 was less than in 1907, the proportion of decrease was not so great as in the output of beehive coke. The details of the production of coke in retort ovens, with the quantity and value of by-products obtained, and estimates of the waste of the constituents of coal other than coke resulting from beehive practice, are discussed fully in the subsection on by-product coke.

The coal consumed in the manufacture of coke in the United States is drawn from the following bituminous regions or fields:

1. The Appalachian region, embracing the great coking coal fields of Pennsylvania, Virginia, West Virginia, Ohio, eastern Kentucky, Tennessee, Alabama, and Georgia.

2. The Eastern Interior region, which includes the coal fields of Illinois, Indiana, and western Kentucky.

3. The Western Interior region, embracing the States of Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Arkansas.

4. The Rocky Mountain regions, contained within the States of Colorado, New Mexico, Utah, Montana, and Wyoming.

5. The Pacific Coast regions, in which the only coking coals are found in the State of Washington.

The coal of the northern interior region lying wholly within the State of Michigan has not been used in the manufacture of coke. A considerable quantity of coke is made in States in which there are no coal fields—Massachusetts, Minnesota, New York, New Jersey, and Wisconsin. The ovens near Baltimore, Md., and at Delray and Wyandotte, Mich., are supplied with coal from other States. One of the two plants in Wisconsin is composed of beehive ovens in which coal drawn from the mines of Pennsylvania is used. This is the only beehive plant in operation outside of the coal-producing States. All of the other coking extablishments outside of the States producing coking coal are retort-oven plants.

The unit of measurement used in this chapter is uniformly the short ton of 2,000 pounds.

PRODUCTION.

The combined production of beehive and retort-oven coke in the United States in 1908 amounted to 26,033,518 short tons, valued at \$62,483,983, against 40,779,564 short tons, valued at \$111,539,126, in 1907, in which year the production exceeded all previous records in the history of coke making in the United States; the average price per ton in that year was also the highest ever recorded. Compared with 1907 the production in 1908 shows a decrease of 14,746,046 short tons, or 36.14 per cent in quantity, and of \$49,055,143, or 43.98 per cent, in value. The average price per ton at the ovens declined from \$2.74 to \$2.40. Of the total production in 1908, 21,832,292 tons, or 83.86 per cent, was produced in beehive ovens, and 4,201,226, or 16.14 per cent, was the output of retort-oven plants. The production of beehive coke decreased from 35,171,665 short tons in 1907 to 21,832,292 short tons in 1908, and by-product coke decreased from 5,607,899 tons to 4,201,226 tons. The decrease in beehive coke was 13,339,373 short tons, or 37.93 per cent, and in by-product coke 1,406,673 tons, or 25.08 per cent. In 1907, when the production showed a marked increase over the preceding year, the gain in beehive coke was 10.45 per cent, and in retort-oven coke 23.03 per cent; so that although both decreased in 1908 as compared with 1907, by-product coke showed a relative gain.

In considering the total value and the average selling price for the coke produced in the United States it should be remembered that in many cases the values are arbitrarily fixed. A considerable number of the coke ovens in this country are operated by large corporations which operate also coal mines and blast furnaces, the coke making being really only an incidental part of the business. In such cases the coke product is sometimes charged against the furnace department at cost and sometimes at a figure based upon the cost of coal mining and coke making, plus a percentage of profit on these operations. The value is not fixed by the market price. In other cases the value is estimated upon the average prices for coke of a similar quality produced and sold in the immediate vicinity. These conditions, however, continue from year to year and do not affect comparisons.

The quantity of coal consumed in the manufacture of coke in 1908 amounted to 39,440,837 short tons, valued at $45,222,474. The value of the coke produced from this coal was $62,483,983, a difference of $17,261,509, which represents the profit on the coking operations less the cost of manufacture and the expenses of administration, etc. In 1907 the value of the coal used was $72,784,851, and the value of the coke produced from this was $111,539,126, a difference of $38,754,275.

Following the depression which marked the closing months of 1907 the early part of 1908 showed signs of returning activity in the iron industry, and there were some indications of revival of business in the coke-making districts. During January the production increased considerably as compared with the closing months of 1907, and operators were hopeful of an early return of prosperity. Toward the latter part of February, however, the demand and production fell off, and by March there was a general depression in the business. By May conditions were improved and there were again signs of returning activity, though in the Connellsville district of Pennsylvania, which can be considered as reflecting market conditions, two-thirds of the ovens were idle. The production increased slightly during June, July, and August, and in the latter months the ovens in blast in the Connellsville region had increased to nearly one-half the total. During the latter months of the year the coke-making industry was seriously affected by a drought which prevailed throughout the coking regions; otherwise the trade showed improvement over the earlier months of the year. In the latter part of November the number of ovens in blast in the Connellsville region exceeded for the first time in the year the number of ovens idle, and in December two-thirds of the ovens were in operation and one-third idle, as compared with the reverse condition in May. Altogether, however, the year 1908 must be considered one of general stagnation in the coke-making industry. The average price per ton was lower than that of either 1906 or 1907, but exceeded that of 1904 and 1905. The reason for this is that large quantities of coke are sold on contract prices made the year before, and the industry is under a sufficiently strong control to prevent demoralization in values. In addition to this, as previously stated, the fixing of values at ovens operated by large iron and steel making establishments is largely an arbitrary matter.

Notwithstanding the decrease in production in 1908 as compared with 1907, there was an increase of 1,538 in the number of ovens in the United States, from 99,680 in 1907 to 101,218 in 1908. Of the total number of ovens in existence 12,920 were idle throughout the entire year 1908, though many more were out of blast for a good portion of the time. In 1907, out of a total of 99,680 ovens 4,934 were idle during the year, the total number of ovens that were idle throughout the entire year 1908 being 7,986 more than in 1907. The number of ovens that were active, that is, that were in blast for all or for part of the year 1908, was 88,298, which produced 26,033,518 tons of coke, or an average of 294.8 tons per oven. In 1907 there were 94,746 active ovens that produced a total of 40,779,564 tons of coke, an average of 430.4 tons per oven. The 4,007 retort ovens in 1908 included 120 Semet-Solvay and 56 Newton-Chambers ovens that were idle throughout the year, the latter being a bank of ovens at Pocahontas, Va., which have not been operated to any extent since their installation several years ago. The Newton-Chambers ovens at Vintondale, Pa., 152 in number, were operated during 1908, but no by-products were recovered, and the production has been included with the beehive coke. Deducting these 328 from the total leaves 3,679 active retort ovens, which produced 4,201,226 short tons of coke, an average of 1,142 tons per oven. In 1907, 3,811 active retort ovens produced 5,607,899 tons of coke, or an average of 1,472 tons per oven. The total number of active beehive ovens in 1908 was 84,619, the total production from which was 21,832,292 tons, making an average of 258 tons per oven, as against 1,142 as the average production from each retort oven. The average production for each beehive oven for the last four years has been, respectively, 365.8 tons in 1905, 373.6 tons in 1906, 386.8 tons in 1907, and 258 tons in 1908. The average production for the retort ovens in the same years was, respectively, 1,158.8 tons, 1,356 tons, 1,472 tons, and 1,142 tons. In 1905 the average production from by-product ovens was a little more than three times that from beehive ovens, and in 1908 it was nearly six times.

At the close of 1908 there were 2,241 ovens in course of construction, this being the smallest number of ovens reported as under construction in any year since 1899. Of the ovens building 240, or 10.71 per cent, were by-product recovery ovens. Of the 240 retort ovens building at the end of the year, 140 were Koppers regenerative ovens under construction by the Illinois Steel Company at Joliet, Ill. This plant was originally designed to be composed of 280 ovens, 140 of which were completed during 1908. Of the other 100 ovens, 50 were United-Otto ovens building by the Citizens' Gas Company of Indianapolis, Ind., and 50 were United-Otto ovens building at Kokotto, near Hamilton, Ohio, doubling the plant at that point.

Considering each bank of ovens as a separate establishment, the statistics for 1908 show a total of 551 establishments, as against 552 in 1907 and 532 in 1906. Of these 551 establishments, 130, with a total of 12,920 ovens, were idle throughout the year, compared with 67 in 1907 and 69 in 1906. The 551 establishments included 6, having a total of 350 ovens, which were incomplete or, if completed, were not put in blast before the close of the year.

The statistics of the production of coke in 1907 and 1908 are presented, by States and Territories, in the following tables:

Manufacture of coke in the United States, by States and Territories, in 1907 and 1908.

1907.

State or Territory.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton.
Alabama	43	9,889	50	4,973,296	61.0	3,021,794	$9,216,194	$3.05
Colorado [a]	16	3,799	50	2,388,911	59.5	1,421,579	4,747,436	3.34
Georgia	2	350	0	136,031	55.1	74,934	315,371	4.21
Illinois	5	309	280	514,983	72.3	372,697	1,737,464	4.66
Indiana	1	28	0	0	....	0	0	....
Kansas	6	83	0	11,392	55.0	6,274	19,837	3.16
Kentucky	6	495	0	129,538	51.7	67,068	157,288	2.35
Missouri	1	5	0	0	....	0	0	....
Montana	5	567	15	68,948	59.0	40,714	295,174	7.25
New Mexico	4	896	125	446,140	59.4	265,125	840,253	3.17
Ohio	8	600	50	376,759	71.8	270,634	819,262	3.03
Oklahoma (Indian Territory)	5	490	50	38,615	49.4	19,089	82,447	4.32
Pennsylvania	253	51,364	1,337	39,733,177	66.7	26,513,214	67,638,024	2.55
Tennessee	18	2,806	80	825,221	56.6	467,499	1,592,225	3.41
Utah	2	884	0	(b)	....	(b)	(b)	....
Virginia	19	5,333	50	2,264,720	68.2	1,545,280	3,765,733	2.44
Washington	5	216	0	85,860	60.6	52,028	293,019	5.63
West Virginia	142	19,688	459	6,536,795	62.9	4,112,896	9,717,130	2.36
Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Wisconsin	11	1,878	0	3,415,723	74.0	2,528,739	10,302,269	4.07
	552	99,680	2,546	61,946,109	65.8	40,779,564	111,539,126	2.74

1908.

State or Territory.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton.
Alabama	45	10,103	0	3,875,791	61.0	2,362,666	$7,169,901	$3.04
Colorado [a]	16	3,841	0	1,546,044	63.5	982,291	3,238,888	3.30
Georgia	2	350	0	71,452	55.2	39,422	137,524	3.72
Illinois	6	430	140	503,359	72.0	362,182	1,538,952	4.25
Kansas	6	67	0	3,790	65.9	2,497	8,011	3.21
Missouri	1	4	0	0	....	0	0	....
New Mexico	4	1,016	0	454,873	60.4	274,565	826,780	3.01
Ohio	7	481	50	237,448	67.2	159,578	491,982	3.08
Pennsylvania	252	52,606	1,720	23,215,964	66.8	15,511,634	32,569,621	2.10
Tennessee	17	2,792	20	395,936	54.2	214,528	561,789	2.62
Utah	2	864	0	(b)	....	(b)	(b)	....
Virginia	19	4,853	158	1,785,281	65.1	1,162,051	2,121,980	1.83
Washington	6	231	50	68,069	57.1	38,889	213,138	5.48
West Virginia	138	20,124	0	4,127,730	63.9	2,637,123	5,267,054	2.00
Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, Wisconsin	30	3,456	103	3,155,100	72.5	2,286,092	8,338,363	3.65
	551	101,218	2,241	39,440,837	66.0	26,033,518	62,483,983	2.40

[a] Includes the production of Utah. [b] Production included with Colorado.

PRODUCTION IN PREVIOUS YEARS.

According to the report of the Seventh Census, taken in 1850, there were in that year four coke-making establishments in the United States. The census report, however, did not contain any statement either of the number of ovens or of the quantity and value of the coke produced. The Eighth and Ninth censuses, covering the fiscal years 1860 and 1870, respectively, also reported the number of coke-making establishments, but did not give any statistics of the coke production. In 1875, according to statistics compiled by the American Iron and Steel Association, the use of coke in iron furnaces exceeded that of anthracite coal; prior to 1855, according to the same authority, most of the iron produced in this country was made with charcoal as fuel. In 1855 the use of anthracite exceeded that of charcoal, and the supremacy of anthracite in iron making continued until 1875, when it was superseded by coke. The first year in which any record of coke production is given is contained in the census report for 1880. In that year the total quantity of coke produced in the United States amounted to 3,338,300 short tons. Since 1880 the statistics have been compiled annually by the Geological Survey. In the twenty-nine years from 1880 to 1908, inclusive, there have been eight instances of decreased production in one year as compared with the preceding one. The most notable decrease was that of 1908 as compared with 1907, the difference in the production of these two years being larger than the total production of coke in 1897. Previous to 1908 the most notable decreases were in 1893 and 1894. Like the decreased production in 1908, they were due to panic and depression which have made these years memorable in recent industrial history.

In the following table is presented a statement of the quantity of coke produced in the United States in each year since 1880:

Quantity of coke produced in the United States, 1880–1908, in short tons.

1880	3,338,300	1890	11,508,021	1900	20,533,348
1881	4,113,760	1891	10,352,688	1901	21,795,883
1882	4,793,321	1892	12,010,829	1902	25,401,730
1883	5,464,721	1893	9,477,580	1903	25,274,281
1884	4,873,805	1894	9,203,632	1904	23,661,106
1885	5,106,696	1895	13,333,714	1905	32,231,129
1886	6,845,369	1896	11,788,773	1906	36,401,217
1887	7,611,705	1897	13,288,984	1907	40,779,564
1888	8,540,030	1898	16,047,209	1908	26,033,518
1889	10,258,022	1899	19,668,569		

In the following table is presented a statement of the production of coke in each State from 1904 to 1908, inclusive, with the increases and decreases in the 1908 production as compared with 1907. Among the States and Territories for which the statistics are published separately there was only one—New Mexico—which showed an increase in output. In Illinois the decrease was slight, amounting to 10,515 tons, or 2.82 per cent. Among the other individual States the percentage of decrease ranged from 22 per cent in Alabama to 60 per cent in Kansas. The decrease in Pennsylvania was a little over 11,000,000 tons, and as indicating the rapidity with which the coking industry has developed in recent years up to the close of 1907, and also as indicating the marked depression in 1908, it may be noted that the decrease in Pennsylvania alone in 1908 was more than the entire production of the United States in any year prior to 1895 with one exception.

Quantity of coke produced in the United States, 1904–1908, by States and Territories, in short tons, with increases and decreases in 1908.

State or Territory.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (—) in quantity of coke produced, 1907–8.	Per cent of increase (+) or decrease (—) in quantity of coke produced.
Alabama	2,340,219	2,576,986	3,034,501	3,021,794	2,362,666	— 659,128	—21.81
Colorado [a]	789,060	1,378,824	1,455,905	1,421,579	982,291	— 439,288	—30.90
Georgia	75,812	70,593	70,280	74,934	39,422	— 35,512	—47.39
Illinois	4,439	10,307	268,693	372,697	362,182	— 10,515	— 2.82
Kansas	9,460	4,425	1,698	6,274	2,497	— 3,777	—60.20
Kentucky	64,112	79,487	74,064	(b)	(b)	(b)	(b)
Missouri	2,446	1,580	....	....	....	....	....
Montana	41,497	31,482	38,182	(b)	(b)	(b)	(b)
New Mexico	58,259	89,638	147,747	265,125	274,565	+ 9,440	+ 3.56
Ohio	109,284	277,130	293,994	270,634	159,578	— 111,056	—41.04
Oklahoma (Indian Territory)	44,808	54,781	49,782	(b)	(b)	(b)	(b)
Pennsylvania	14,861,064	20,573,736	23,060,511	26,513,214	15,511,634	—11,001,580	—41.49
Tennessee	379,240	468,092	483,428	467,499	214,528	— 252,971	—54.11
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	1,101,716	1,499,481	1,577,659	1,545,280	1,162,051	— 383,229	—24.80
Washington	45,432	53,137	45,642	52,028	38,889	— 13,139	—25.25
West Virginia	2,283,086	3,400,593	3,713,514	4,112,896	2,637,123	— 1,475,773	—35.88
Other States	1,451,172	1,660,857	2,085,617	2,655,610	2,286,092	— 369,518	—13.91
	23,661,106	32,231,129	36,401,217	40,779,564	26,033,518	—14,746,046	—36.14

a Colorado includes Utah.
b Included with other States having less than three producers.
c Included with Colorado.

In the following table is given a statement of the establishments, the number of ovens built and building, the quantity of coal used, the quantity of coke produced, the value of the coke, the average price per ton, and the percentage yield of coal in coke for the years 1880, 1890, 1900, and from 1901 to 1908, inclusive:

Statistics of the manufacture of coke in the United States in 1880, 1890, and 1900–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Percentage yield of coal in coke.
		Built.	Building.					
1880	186	12,372	1,159	5,237,741	3,338,300	$6,631,267	$1.99	63.0
1890	253	37,158	1,547	18,005,209	11,508,021	23,215,302	2.02	64.0
1900	396	58,484	5,804	32,113,553	20,533,348	47,443,331	2.31	63.9
1901	423	63,951	5,205	34,207,965	21,795,883	44,445,923	2.039	63.7
1902	456	69,069	8,758	39,604,007	25,401,730	63,339,167	2.49	64.1
1903	500	79,334	6,175	39,423,525	25,274,281	66,498,664	2.63	64.1
1904	507	83,599	4,430	36,531,608	23,661,106	46,144,941	1.95	64.8
1905	519	87,564	4,751	49,530,677	32,231,129	72,476,196	2.25	65.1
1906	532	93,901	4,519	55,746,374	36,401,217	91,608,034	2.52	65.3
1907	552	99,680	2,546	61,946,109	40,779,564	111,539,126	2.74	65.8
1908	551	101,218	2,241	39,440,837	26,033,518	62,483,983	2.40	66.0

VALUE OF COKE PRODUCED.

In a period of such depression as that which prevailed throughout the United States in 1908, particularly in the iron and allied industries, it is natural that the value of the coke product should show a decrease larger in proportion than the decrease in output. The statistics compiled by the Geological Survey show that while the quantity of coke produced in 1908 decreased 36.14 per cent as compared with 1907, the value decreased 43.98 per cent. In 1907 the total value of the coke produced in the United States was $111,539,126; in 1908 it was $62,483,983, a decrease of $49,055,143. In the following tables are presented statements showing the value of the coke produced in each State and Territory during the last five years, with the decreases in 1908 as compared with 1907, and the total value of the coke product of the United States in each year since 1880. It is noted that there was no individual State or Territory in which the value of the product in 1908 exceeded that of 1907, though in Indiana, included among "Other States" there was a small increase.

Total value, at the ovens, of the coke made in the United States, 1904–1908, by States and Territories, with decreases in 1908.

State or Territory.	1904.	1905.	1906.	1907.	1908.	Increase (+) or decrease (−) in value of coke produced.	Per cent of increase (+) or decrease (−) in value of coke produced.
Alabama	$5,716,413	$7,646,957	$8,477,899	$9,216,194	$7,169,901	−$2,046,293	−22.20
Colorado [a]	2,590,251	4,157,517	4,504,748	4,747,436	3,238,888	− 1,508,548	−31.78
Georgia	212,697	224,260	277,921	315,371	137,524	− 177,847	−56.39
Illinois	9,933	27,681	1,205,462	1,737,464	1,538,952	− 198,512	−11.43
Kansas	23,485	13,818	4,101	19,837	8,011	− 11,826	−59.62
Kentucky	138,226	159,659	169,846	(b)	(b)	(b)	(b)
Missouri	6,115	4,072	....	....	....	....	....
Montana	280,745	211,351	266,024	(b)	(b)	(b)	(b)
New Mexico	171,976	253,229	442,712	840,253	826,780	− 13,473	− 1.60
Ohio	337,606	970,897	1,013,248	819,262	491,982	− 327,280	−39.95
Oklahoma (Indian Territory)	209,165	199,424	204,205	(b)	(b)	(b)	(b)
Pennsylvania	25,027,462	42,253 178	54,184,531	67,638,024	32,569,621	−35,068,403	−51.85
Tennessee	905,540	1,184,442	1,350,856	1,592,225	561,789	− 1,030,436	−64.72
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	1,772,717	2,869,452	3,611,659	3,765,733	2,121,980	− 1,643,753	−43.65
Washington	207,357	251,717	226,977	293,019	213,138	− 79,881	−27.26
West Virginia	3,757,850	6,548,205	8,192,956	9,717,130	5,267,054	− 4,450,076	−45.80
Other States	4,777,403	5,500,337	7,474,889	10,837,178	8,338,363	− 2,498,815	−23.06
	46,144,941	72,476,196	91,608,034	111,539,126	62,483,983	−49,055,143	−43.98

[a] Includes value of Utah coke.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Total value, at the ovens, of the coke made in the United States, 1880–1908.

1880	$6,631,265	1890	$23,215,302	1900	$47,443,331
1881	7,725,175	1891	20,393,216	1901	44,445,923
1882	8,462,167	1892	23,536,141	1902	63,339,167
1883	8,121,607	1893	16,523,714	1903	66,498,664
1884	7,242,878	1894	12,328,856	1904	46,144,941
1885	7,629,118	1895	19,234,319	1905	72,476,196
1886	11,153,366	1896	21,660,729	1906	91,608,034
1887	15,321,116	1897	22,102,514	1907	111,539,126
1888	12,445,963	1898	25,586,699	1908	62,483,983
1889	16,630,301	1899	34,670,417		

From the preceding statements, showing the quantity and value of the coke produced in a series of years, the following tables have been prepared. These show the average price per ton obtained for the coke product in each State and Territory for the last five years and the average price of the total product since 1880. These average prices are obtained by dividing the total value by the total quantity of coke produced or sold. Although the figures may be accepted as indicating the general tendency of prices, they do not always represent the actual selling value of the coke, as has already been explained. Some of the largest producers of coke consume their entire product in their own blast furnaces. In some such cases the value of the coke is given at the actual cost of production; in others it is based upon the cost of production, adding a percentage of profit on the coking operations, and in still other cases the values are based upon the marketed product of a similar quality of coke in the immediate vicinity. These conditions, however, continue without material change from year to year, so that the prices as given may be generally accepted as indicating the general condition of the market.

As will be seen from the following table, the average price per ton in 1907 was the highest recorded in the twenty-nine years covered by this series of reports. Previous to 1907 the highest average price recorded was in 1903, when, because of the fuel famine produced by a strike in the anthracite region of Pennsylvania, the demand for coke was abnormally large and prices were stimulated accordingly. A slump in the iron trade in 1904 added to local competition for trade in the coking regions created a violent reaction, and prices were lower in that year than in any year of the present century. When the conditions that existed in 1908 are considered, the decline in price was less than might have been expected. There were only four years in the previous history of the coking trade when the average price exceeded that of 1908. The ability to maintain prices in the face of existing conditions is significant of the better control exercised by powerful interests. It should be stated, however, that a large quantity of the coke delivered in 1908 was sold on contracts made in 1907, while a third factor in the maintaining of prices is the continually increasing proportion of the coke product manufactured in connection with iron and steel establishments, where the fixing of the prices is largely an arbitrary matter.

The average prices of coke, by States, from 1904 to 1908, inclusive, and for the United States from 1880 to 1908 are shown in the following tables:

Average price per short ton, at the ovens, of the coke made in the United States, 1904–1908, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	$2.44	$2.97	$2.79	$3.05	$3.04
Colorado [a]	3.28	3.02	3.09	3.34	3.30
Georgia	2.81	3.18	3.95	4.21	3.72
Illinois	2.24	2.69	4.48	4.66	4.25
Kansas	2.48	3.12	2.42	3.16	3.21
Kentucky	2.15	2.01	2.29	2.35	([b])
Missouri	2.50	2.58			
Montana	6.77	6.71	6.97	7.25	([b])
New Mexico	2.95	2.83	3.00	3.17	3.01
Ohio	3.09	3.50	3.45	3.03	3.08
Oklahoma (Indian Territory)	4.67	3.64	4.10	4.32	([b])
Pennsylvania	1.68	2.05	2.35	2.55	2.10
Tennessee	2.39	2.53	2.79	3.41	2.62
Utah	([c])	([c])	([c])	([c])	([c])
Virginia	1.61	1.91	2.29	2.44	1.83
Washington	4.56	4.74	4.97	5.63	5.48
West Virginia	1.65	1.92	2.21	2.36	2.00
Other States	3.29	3.31	3.58	4.07	3.65
Average	1.95	2.25	2.52	2.74	2.40

[a] Includes Utah.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Average price per short ton, at the ovens, of the coke made in the United States, 1880–1908.

1880	$1.99	1890	$2.02	1900	$2.31
1881	1.88	1891	1.97	1901	2.04
1882	1.77	1892	1.96	1902	2.49
1883	1.49	1893	1.74	1903	2.63
1884	1.49	1894	1.34	1904	1.95
1885	1.49	1895	1.44	1905	2.25
1886	1.63	1896	1.84	1906	2.52
1887	2.01	1897	1.66	1907	2.74
1888	1.46	1898	1.59	1908	2.40
1889	1.62	1899	1.76		

NUMBER OF COKE WORKS AND OVENS IN THE UNITED STATES.

Considering each bank of ovens as a separate establishment, there were 551 establishments manufacturing coke in the United States at the close of 1908, a decrease of 1 as compared with 1907. These 551 establishments included 7, with a total of 370 ovens, which were not completed or had not been put in blast during the year and consequently did not contribute to the production. The ovens of these 7 establishments, which had been completed but which were not put in blast are included among the idle ovens. The ovens which were not completed are not considered as idle. In 1907 there were 16 establishments, with a total of 1,525 ovens, which had not been completed, or if completed were not put in blast during that year. In addition to the 7 establishments not completed in 1908 there were 123 other establishments, with a total of 12,570 ovens, which were idle throughout the year. The idle plants averaged about 100 ovens each. There were 8 establishments, with a total of 418 ovens, reported as permanently abandoned, as against 3 establishments, with 161 ovens, abandoned the previous year. The idle plants and those not completed before the end of the year, a total of 130 establishments, being deducted, there appears to have been 421 active establishments, comprising 88,298 ovens, or an average of 210 ovens to each plant.

The 421 active establishments in 1908 produced 26,033,518 short tons of coke, an average of 61,837 tons for each plant. In 1907 there were 485 active establishments, which produced 40,779,564 tons of coke, an average of 84,082 tons for each plant.

In 1906 there were 448 active establishments, the total production from which was 36,401,217 short tons, an average of 81,253 tons for each bank. The average output for each plant in 1908 was 26.46 per cent less than in 1907 and 23.9 per cent less than in 1906. In 1880, the first year for which these statistics were collected, there were 186 establishments, with an average production from each of 17,948 tons, indicating that the average output from each plant in 1908 was 3.5 times that of 1880.

It should be stated that the word "establishment" as used in this report is intended to designate the number of separate plants or banks of ovens whether operated or idle and whether reported from one central office or not. Different plants controlled or operated by one company are considered separate establishments.

The total number of establishments manufacturing coke in the United States at the end of each decade from 1850 to 1900 and at the end of each year from 1901 to 1908, inclusive, is shown in the following table. The numbers reported in 1850, 1860, and 1870 are for census years; the others are for calendar years.

Number of coke establishments in the United States since 1850.

1850 (census year)	4	1900, December 31	396	1905, December 31	519
1860 (census year)	21	1901, December 31	423	1906, December 31	532
1870 (census year)	25	1902, December 31	456	1907, December 31	552
1880, December 31	186	1903, December 31	500	1908, December 31	551
1890, December 31	253	1904, December 31	506		

In the following table is shown the number of coke ovens in existence in each State and Territory on December 31 for each of the last five years, and at the end of each five years since 1880. The total number of ovens in existence at the close of 1908 (101,218) was 21 per cent more than in 1904, 122 per cent, or more than double the number in existence in 1895, and nearly nine times the number in existence in 1880.

Number of coke ovens in each State or Territory at the close of each year, 1904–1908.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	9,059	9,586	9,731	9,889	10,103
Colorado	3,419	3,421	3,419	3,799	3,841
Georgia	500	533	531	350	350
Illinois	155	275	309	309	430
Indiana	36	36	48	28	46
Kansas	90	91	81	83	67
Kentucky	499	495	462	495	495
Maryland	200	200	200	200	200
Massachusetts	400	400	400	400	400
Michigan	135	135	150	150	150
Minnesota	50	50	50	50	50
Missouri	8	6	6	5	4
Montana	520	555	555	567	551
New Jersey	100	100	150	150	150
New Mexico	234	258	571	896	1,016
New York	352	399	540	540	540
Ohio	539	573	575	600	481
Oklahoma (Indian Territory)	286	388	490	490	486
Pennsylvania	42,165	42,608	47,185	51,364	52,606
Tennessee	2,436	2,615	2,731	2,806	2,792
Utah	504	504	684	884	864
Virginia	4,345	4,549	4,641	5,333	4,853
Washington	256	216	216	216	231
West Virginia	16,929	19,189	19,714	19,688	20,124
Wisconsin	308	308	388	388	388
Wyoming	74	74	74	0	0
	83,599	87,564	93,901	99,680	101,218

Number of coke ovens in the United States on December 31 of each fifth year, from 1880 to 1908.

1880	12,372	1900	58,484
1885	20,116	1905	87,564
1890	37,158	1908	101,218
1895	45,565		

A statement of the number of ovens in course of construction at the end of each year since 1903 is shown in the following table. It is not intended to show by this the increase in the number of new ovens from year to year, nor does it include the number of new ovens completed during any one year. It merely exhibits the condition of the industry as shown by plants under construction at the close of each year.

Number of coke ovens building in the United States at the close of each year, 1903–1908.

1903	6,175	1906	4,519
1904	4,430	1907	2,546
1905	4,751	1908	2,241

RANK OF COKE-PRODUCING STATES.

In the manufacture of coke, as in the production of coal and in the manufacture of iron and steel, Pennsylvania far outranks the other States of the Union, and for the entire period covered by the annual reports Mineral Resources of the United States has contributed more than 50 per cent of the total quantity of coke produced in the United States. West Virginia and Alabama have during the same period been close rivals for second place among the coke-producing States, frequently alternating from one year to another, although during the last four years West Virginia has held the place of honor, with Alabama ranking third. In 1908 West Virginia had more than three times as many coke-making establishments as Alabama, and nearly double the number of ovens, so that the indications for the future are that West Virginia will continue next to Pennsylvania in the importance of its coke production. Virginia has held fourth place and Colorado fifth during the last decade. New York, because of the operations of the by-product oven plant of the Lackawanna Steel Company at Buffalo, took sixth place in 1907 and maintained it in 1908, with Massachusetts seventh and Wisconsin eighth. Illinois has advanced from twenty-third, in 1904, to ninth place, in 1908; and New Mexico, which stood seventeenth in 1904, ranked tenth in 1908, this change being due to development of the Stag Canyon Fuel Company, of Dawson.

The relative rank of the various coal-producing States and Territories during the last five years is shown in the following table:

Rank of the States and Territories in production of coke, 1904–1908.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Pennsylvania	1	1	1	1	1
West Virginia	3	2	2	2	2
Alabama	2	3	3	3	3
Virginia	4	4	4	4	4
Colorado	5	5	5	5	5
New York	11	14	8	6	6
Massachusetts	6	7	7	9	7
Wisconsin	12	12	13	7	8
Illinois	23	22	14	10	9
New Mexico	17	15	16	15	10
Maryland	8	8	9	11	11
New Jersey	13	13	15	16	12
Michigan	10	9	11	13	13
Tennessee	7	6	6	8	14
Ohio	14	10	12	14	15
Utah	9	11	10	12	16
Minnesota	21	16	17	17	17
Georgia	15	18	19	18	18
Washington	18	20	21	20	19
Kentucky	16	17	18	19	20
Montana	20	21	22	21	21
Oklahoma	19	19	20	22	22
Kansas	22	23	23	23	23
Indiana	....	....	....	....	24
Wyoming	24	24	24	....	....
Missouri	25	25	....	....	....

COAL CONSUMED IN THE MANUFACTURE OF COKE.

The determination of the quantity of coal consumed in the manufacture of coke is, to a considerable extent, a matter of estimate, as a large quantity of the coal so used is charged directly into the ovens from the mines without having been previously weighed or measured. The only method of ascertaining the quantity of coal thus used is by the amount paid to the miners for mining, which is based sometimes upon the measured bushel or ton and sometimes by the cubical contents of the mine car. All these standards are likely to differ materially from that of the weighed ton or bushel. There are comparatively few establishments in this country at which the quantity of coal made into coke is accurately ascertained, though as the industry becomes better organized, greater attention is being paid to exactness in this regard, and year by year the quantities as presented in the following tables become more accurate. It is still necessary, however, to estimate a large quantity of the coal consumed in the manufacture of coke.

A considerable quantity of the coal which is not run directly from the mines to the coke ovens is crushed and washed before coking. In some of such cases the weight of this coal before washing is given approximately. In other cases the weight, after the slate, pyrite, and other impurities have been removed, is reported for the weight of the coal charged into the ovens. In still other instances coke ovens have been constructed chiefly for the purpose of utilizing the slack coal produced, in which cases little or no account is taken of the weight of the coal. It can readily be seen, therefore, that any statement as to the quantity of coal used in the manufacture of coke is necessarily approximate; but as these differences appear from year to year, the statistics as collected may be accepted as sufficiently accurate for comparative analysis. As has been stated in previous reports of this series, an apparent discrepancy appears between the statements regarding the quantities of coal consumed in the manufacture of coke as published in the chapter on coal production and those presented herewith. These discrepancies are in general due to the fact that a large quantity of coal is shipped to ovens at a distance from the mine. Where this is the case, the tonnage so shipped would be included in the shipments, the coal statistics showing only the quantity of coal made into coke at the mines.

The total quantity of coal made into coke in 1908 was 39,440,837 short tons, which, compared with 61,946,109 short tons used in 1907, shows a decrease of 22,505,272 short tons, or 36.33 per cent. The consumption of coal for coke making in 1908 was only 17,312 tons more than in 1903.

In the chapter on the production of coal the statistics show that the quantity of coal made into coke in 1908 at the mines was 32,228,344 short tons, the difference of 7,212,493 short tons being the coal which was included in the shipments and sent to points distant from the mines before being charged into the coke ovens.

The quantity of coal used in the manufacture of coke, as obtained for this report from the several States and Territories, from 1904 to 1908, and the total quantity used during each of the five years since 1880, are shown in the following tables:

Quantity of coal used in the manufacture of coke in the United States, 1904–1908, by States and Territories, in short tons.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	3,996,578	4,409,854	5,184,597	4,973,296	3,875,791
Colorado [a]	1,376,354	2,368,365	2,566,196	2,388,911	1,546,044
Georgia	132,270	119,036	128,052	136,031	71,452
Illinois	8,131	16,821	362,163	514,983	503,359
Kansas	14,525	6,504	2,807	11,392	3,790
Kentucky	140,139	154,783	148,448	129,538	(b)
Missouri	3,815	2,551	0	0	0
Montana	78,303	68,777	69,045	68,948	(b)
New Mexico	94,397	148,469	261,609	446,140	454,873
Ohio	165,487	396,961	437,567	376,759	237,448
Oklahoma (Indian Territory)	98,847	123,389	95,296	38,615	(b)
Pennsylvania	22,432,064	31,030,345	34,503,513	39,733,177	23,215,964
Tennessee	718,181	862,320	929,405	825,221	395,936
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	1,636,905	2,184,369	2,296,227	2,264,720	1,785,281
Washington	76,993	85,715	76,896	85,860	68,069
West Virginia	3,543,338	5,329,695	5,822,619	6,536,795	4,127,730
Other States	2,015,281	2,222,723	2,861,934	3,415,723	3,155,100
	36,531,608	49,530,677	55,746,374	61,946,109	39,440,837

[a] Includes coal coked in Utah.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Quantity of coal used in the manufacture of coke in the United States each fifth year, 1880–1908.

	Short tons.		Short tons.
1880	5,237,741	1900	32,113,543
1885	8,071,126	1905	49,530,677
1890	18,005,209	1908	39,440,837
1895	20,848,323		

QUANTITY AND VALUE OF COAL USED IN COKE MAKING.

The total quantity and value of the coal consumed in the manufacture of coke in 1907 and 1908, with the quantity and value of the coal consumed per ton of coke produced, by States and Territories, are shown in the following tables:

Quantity and value of coal used in the manufacture of coke in the United States in 1907 and 1908, and quantity and value of same per ton of coke, by States and Territories.

1907.

State or Territory.	Coal used (short tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (short tons).	Value of coal to a ton of coke.
Alabama	4,973,296	$6,656,742	$1.34	1.646	$2.206
Colorado [a]	2,388,911	2,563,433	1.07	1.680	1.798
Georgia	136,031	167,704	1.23	1.815	2.232
Illinois	514,983	1,343,410	2.61	1.382	3.607
Kansas	11,392	14,777	1.30	1.816	2.361
Kentucky	129,538	66,170	.51	1.933	.986
Montana	68,948	242,327	3.51	1.693	5.942
New Mexico	446,140	618,043	1.39	1.683	2.339
Ohio	376,759	654,588	1.74	1.392	2.422
Oklahoma (Indian Territory)	38,615	56,697	1.47	2.023	2.974
Pennsylvania	39,733,177	42,732,546	1.08	1.499	1.619
Tennessee	825,221	1,108,820	1.34	1.765	2.365
Virginia	2,264,720	2,443,067	1.08	1.466	1.583
Washington	85,860	232,821	2.71	1.650	4.472
West Virginia	6,536,795	5,957,568	.92	1.589	1.462
Maryland Massachusetts Michigan Minnesota New Jersey New York Wisconsin	3,415,723	7,926,138	2.32	1.351	3.134
	61,946,109	72,784,851	1.18	1.519	1.792

[a] Includes Utah.

Quantity and value of coal used in the manufacture of coke in the United States in 1907 and 1908, and quantity and value of same per ton of coke, by States and Territories—Con.

1908.

State or Territory.	Coal used (short tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (short tons).	Value of coal to a ton of coke.
Alabama	3,875,791	$4,917,350	$1.27	1.640	$2.083
Colorado [a]	1,546,044	1,605,951	1.04	1.574	1.637
Georgia	71,452	91,260	1.28	1.813	2.321
Illinois	503,359	1,316,065	2.61	1.390	3.628
Kansas	3,790	5,222	1.38	1.518	2.095
New Mexico	454,873	519,115	1.14	1.657	1.889
Ohio	237,448	434,184	1.83	1.488	2.723
Pennsylvania	23,215,964	23,250,885	1.001	1.497	1.498
Tennessee	395,936	492,089	1.24	1.846	2.289
Virginia	1,785,281	1,503,447	.84	1.536	1.290
Washington	68,069	167,571	2.46	1.750	4.305
West Virginia	4,127,730	3,560,342	.86	1.565	1.346
Other States [b]	3,155,100	7,358,993	2.33	1.380	3.215
	39,440,837	45,222,474	1.15	1.515	1.742

[a] Includes Utah.
[b] Includes Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, and Wisconsin.

The quantity of coal used decreased from 61,946,109 short tons in 1907 to 39,440,837 short tons in 1908, while the value decreased from $72,784,851 to $45,222,474. The decrease in the value of the coal used was considerably less in proportion than the decrease in the value of the coke produced. The difference in the values of the coal used in 1907 and 1908 was $27,562,377, or 37.87 per cent. The average value per ton of coal decreased from $1.18 to $1.15, but in considering these values it must be remembered that, as previously explained, the fixing of them is purely an arbitrary matter and they can not be said to represent actual market conditions. The total value of the coke produced decreased $49,055,143, or 43.98 per cent, from 1907 to 1908, while the average selling prices per ton of coke declined from $2.74 to $2.40.

The following table shows approximately the quantity of coal, expressed in tons and pounds, required to produce a ton of coke, in 1880, 1890, 1900, and annually since 1901. It will be noted that up to 1903 the quantity of coal required to produce a short ton of coke was from 3,120 to 3,140 pounds, or 1.56 to 1.57 tons. Since 1903 there has been a steady decrease in the quantity of coal required to produce a ton of coke, the lowest figure, 3,030 pounds, being reported in 1908. This improvement has been due entirely to the increased production of coke in retort ovens, this output having increased from 1,882,394 tons in 1903 to 5,607,899 tons in 1907, although decreasing, in sympathy with the general decline in business, to 4,201,226 tons in 1908.

Coal required to produce a ton of coke, in tons and pounds.

Year.	Tons.	Pounds.	Year.	Tons.	Pounds.
1880	1.57	3,140	1904	1.544	3,088
1890	1.56	3,120	1905	1.537	3,074
1900	1.57	3,140	1906	1.531	3,062
1901	1.57	3,140	1907	1.519	3,038
1902	1.56	3,120	1908	1.515	3,030
1903	1.56	3,120			

YIELD OF COAL IN COKE.

By the yield of coal in coke is meant the percentage by weight of the constituents of the coal that remain as coke after the process of coking has been completed. In the preceding paragraph attention has been called to the decreasing quantity of coal required to produce a ton of coke, and it has been explained that such decrease is due to the development of by-product coke-oven practice. Conversely, there has been a relative increase in the percentage yield of coke. From 1880 to 1901 the yield of coal in coke ranged from 63 to 64 per cent. In 1902 and 1903 it was 64.1 per cent, increasing each year since then until 1908, when it reached 66 per cent.

For reasons previously stated in the discussion of the quantity of coal made into coke it is not always possible to obtain exact information concerning the actual quantity of coal charged into the ovens, as in many cases the coal is not weighed previous to coking and the quantity charged into the ovens is largely an estimate based sometimes upon the measured bushel or car, sometimes upon the cubical contents of the "larry," and sometimes upon the amount paid to the miner for his labor. There has been, however, a gratifying tendency on the part of producers to employ more exact methods in coke-oven operations, and also in the keeping of records. For this reason these figures have shown greater accuracy from year to year. It is entirely probable that the percentage yield as reported for earlier years was in excess of that actually obtained.

The following table shows the percentage yield of coal in coke in each State and Territory during the last five years, and for the United States in each ten years since 1880, and annually since 1901:

Percentage yield of coal in coke, 1904–1908, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	58.6	58.4	58.5	61	61
Colorado [a]	57.3	58.2	56.7	59.5	63.5
Georgia	57.3	59.3	54.9	55.1	55.2
Illinois	54.6	61.3	74.2	72.3	72
Indiana	....	....	....	....	70
Kansas	65	68	60.5	55	65.9
Kentucky	45.7	51.4	49.9	51.7	50
Missouri	64	61.9	....	....	....
Montana	53	45.8	55.3	59	58.3
New Mexico	61.7	60.4	56.5	59.4	60.4
Ohio	66	69.8	67.2	71.8	67.2
Oklahoma (Indian Territory)	45.3	44.4	52.2	49.4	46
Pennsylvania	66.2	66.3	66.8	66.7	66.8
Tennessee	52.8	54.3	52	56.6	54.2
Virginia	67.3	68.6	68.7	68.2	65.1
Washington	59	62	59.4	60.6	57.1
West Virginia	64.4	63.8	63.8	62.9	63.9
Maryland				73	72.1
Massachusetts				75	76.4
Michigan				77	74.5
Minnesota				68	66.4
New Jersey	72	74.7	72.9	80	72.3
New York				72	71.3
Wisconsin				74	74.5
Wyoming				....	....
Total average	64.8	65.1	65.3	65.8	66

[a] Includes Utah.

Percentage yield of coal in coke, 1880-1908.

1880	63.0	1902	64.1	1906	65.3
1890	64.0	1903	64.1	1907	65.8
1900	63.9	1904	64.8	1908	66.0
1901	63.7	1905	65.1		

CONDITION IN WHICH COAL IS CHARGED INTO THE OVENS.

During recent years considerable progress has been made in the preparation of the coal before being charged into the ovens for coking. This preparation has consisted chiefly in the washing of the coal for the removal of impurities, such as slate and pyrite. The increasing quantity of coal thus prepared has had some influence in the increasing yield of coal in coke, which has been discussed in the preceding paragraphs. It is not possible to state accurately how much the increased yield is due to the washing of the coal, as in some cases operators in reporting the quantity of coal washed give the weights before washing, while in other cases the weights of the washed coal are given.

In 1890, out of 18,005,209 short tons of coal used in coke making, 1,269,810 tons, or about 7 per cent of the total, were washed. Of this washed coal 338,563 tons were run-of-mine and 931,247 tons were slack. In 1907, out of 61,946,109 tons of coal used for coke making, 11,680,184 tons, or 18.9 per cent, were washed, the quantity of washed coal being nearly equally divided between run-of-mine and slack. In 1908 the total quantity of coal coked was 39,440,837 tons, of which 9,208,914 tons, or 23.3 per cent, were washed. The washed coal in 1908 consisted of 3,830,879 tons of run-of-mine and 5,378,035 tons of slack. In the two leading coke-producing States, Pennsylvania and West Virginia, the larger part of the coal used for coking was unwashed, Pennsylvania showing 85.1 per cent of unwashed coal in 1908, and West Virginia 94.5 per cent. In Virginia all of the coal used for coke making was unwashed. In Alabama 84.5 per cent and in Colorado 73.6 per cent of the coal was washed before coking, and in both instances the larger part of the coal used was slack. In Georgia, New Mexico, and Washington all of the coal charged into the ovens was washed, that of Georgia and New Mexico being slack and that of Washington run-of-mine. A considerable portion of the run-of-mine coal used in coke making, whether washed or unwashed, is crushed before being charged into the ovens, it having been learned through experience that the coking process is in many instances facilitated and a better strength and structure of the coke obtained when the coal is disintegrated before being charged into the ovens. This is included in the run-of-mine coal charged, and is not considered as slack. Slack coal is that which is produced in the mining operations.

In the following table are shown the quantity of run-of-mine and of slack coal, unwashed and washed, charged into the ovens in 1907 and 1908, by States, and the percentages of each:

Character of coal used in the manufacture of coke, by States and Territories, in 1907 and 1908, in short tons.

1907.

State or Territory.	Run-of-mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage.
Alabama	1,020,907	1,697,913	27,433	2,227,043	1,048,340	21.1	3,924,956	78.9
Colorado [a]	2,956	676,226	1,055,189	654,540	1,058,145	44.3	1,330,766	55.7
Georgia	0	41,000	0	95,031	0	....	136,031	100.0
Illinois	311,999	0	194,389	8,595	506,388	98.3	8,595	1.7
Kansas	0	0	11,392	0	11,392	100.0	....	....
Kentucky	30,632	0	0	98,906	30,632	23.6	98,906	76.4
Montana	18,648	50,300	0	0	18,648	27.0	50,300	73.0
New Mexico	0	0	2,498	443,642	2,498	0.6	443,642	99.4
Ohio	268,637	45,712	36,514	25,896	305,151	81.0	71,608	19.0
Oklahoma	0	0	38,615	0	38,615	100.0	....	....
Pennsylvania	33,589,751	2,267,142	2,566,090	1,310,194	36,155,841	91.0	3,577,336	9.0
Tennessee	54,397	386,094	0	384,730	54,397	6.6	770,824	93.4
Virginia	1,271,518	0	993,202	0	2,264,720	100.0	....	....
Washington	0	72,268	0	13,592	....	....	85,860	100.0
West Virginia	2,451,811	27,067	3,874,817	183,100	6,326,628	96.8	210,167	3.2
Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Wisconsin	2,044,328	326,013	400,202	645,180	2,444,530	71.6	971,193	28.4
	41,065,584	5,589,735	9,200,341	6,090,449	50,265,925	81.1	11,680,184	18.9

1908.

State or Territory.	Run-of-mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage.
Alabama	548,093	1,457,360	53,218	1,817,120	601,311	15.5	3,274,480	84.5
Colorado [a]	0	237,540	407,533	900,971	407,533	26.4	1,138,511	73.6
Georgia	0	0	0	71,452	....	....	71,452	100.0
Illinois	500,400	0	0	2,959	500,400	99.4	2,959	0.6
Kansas	397	0	3,393	0	3,790	100.0	....	....
New Mexico	0	0	0	454,873	....	....	454,873	100.0
Ohio	180,458	27,481	6,244	23,265	186,702	78.6	50,746	21.4
Pennsylvania	18,691,073	1,718,944	1,062,478	1,743,469	19,753,551	85.1	3,462,413	14.9
Tennessee	29,668	250,120	102,578	13,570	132,246	33.4	263,690	66.6
Virginia	1,438,754	0	346,527	0	1,785,281	100.0	....	....
Washington	0	68,069	0	0	....	....	68,069	100.0
West Virginia	1,694,470	35,226	2,206,623	191,411	3,901,093	94.5	226,637	5.5
Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, Wisconsin	2,182,415	36,139	777,601	158,945	2,960,016	93.8	195,084	6.2
	25,265,728	3,830,879	4,966,195	5,378,035	30,231,923	76.7	9,208,914	23.3

[a] Includes Utah.

In the following table are given the statistics of the character of the coal used in coke making each fifth year since 1890, including 1908:

Character of coal used in the manufacture of coke in the United States, 1890–1908, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	14,060,907	338,563	2,674,492	931,247	18,005,209
1895	15,609,875	237,468	3,052,246	1,948,734	20,848,323
1900	21,062,090	1,369,698	5,677,006	4,004,749	32,113,543
1905	31,783,314	3,187,994	8,196,226	6,363,143	49,530,677
1908	25,265,728	3,830,879	4,966,195	5,378,035	39,440,837

COKE MAKING IN BY-PRODUCT OVENS.

The year 1908 was not marked by any notable gain in the construction of by-product coking plants, though some new work was done. There was a net increase of 115 in the number of completed ovens in 1908 over 1907, the totals for the two years being, respectively, 3,892 and 4,007. The additional equipment consisted of 140 Koppers regenerative ovens built at Joliet, Ill., by the United States Steel Corporation, but this increase was partly offset by the dismantling of 25 Semet-Solvay ovens at Sharon, Pa., the net gain being 115 ovens. Included in the total of 4,007 completed ovens in 1908 are 152 Newton-Chambers ovens at Vintondale, Pa., but as no recovery of by-products was made at this plant in 1908, the production of coke is included with that from beehive ovens. The 56 ovens of the same type at Pocahontas, Va., have not been in practical operation since they were first installed. In addition to these there was one other by-product plant of 120 ovens that was not operated during the year. The number of retort ovens producing coke in 1908 was 3,679, as compared with 3,811 active ovens in 1907.

The total production of coke by the 3,679 retort ovens in 1908 amounted to 4,201,226 short tons, against 5,607,899 tons produced in 3,811 ovens in 1907. The decrease in production of by-product coke from 1907 to 1908 was 1,406,673 short tons, or 25.08 per cent; the decrease in beehive-coke production was 13,339,373 short tons, or 37.93 per cent, so that although the output of retort-oven coke decreased over 1,400,000 short tons in 1908, it exhibited a relative gain. In 1907 the output from by-product ovens represented 13.75 per cent of the total coke production; in 1908, 16.14 per cent of the total was by-product coke.

The average production from each of the 3,679 retort ovens in 1908 was 1,142 short tons of coke, as compared with 1,472 tons per oven in 1907 and 1,356 tons in 1906. The average production for each beehive oven in 1908 was 258 short tons, as compared with 386.8 tons in 1907 and 373.6 tons in 1906. The quantity of coal consumed in the manufacture of the 4,201,226 tons of by-product coke in 1908 was 5,699,058 short tons, indicating a yield of coal in coke of 73.7 per cent. In 1907 the percentage yield of coal in by-product ovens was 75 and in 1906 it was 73.6. All of these are much larger yields than it is possible to obtain in beehive ovens, as the beehive process, being one of partial combustion, unavoidably consumes a portion of the fixed carbon in the coal, while in the retort ovens the operation is one of distillation, and practically all of the fixed carbon remains as coke. The yield of coal in coke in beehive practice for the last three years has been 64.3 per cent in 1906, 64.6 per cent in 1907, and 64.7 per cent in 1908, but as shown in the returns to the Geological Survey and as previously explained, even these figures are probably higher than the results actually obtained.

The construction work on plants that were not completed at the end of 1908 consisted of 140 additional Koppers ovens at Joliet, Ill., 50 United-Otto ovens at Kokotto, near Cincinnati, doubling the plant at that place, and 50 United-Otto ovens at Indianapolis, Ind. The last mentioned are the first by-product ovens to be constructed in Indiana, and they will probably use West Virginia coal.

In the report for 1907 some estimates were given of the values of the constituents of the coal that were lost as the result of making coke in beehive ovens and that might have been saved had the by-products been recovered as in retort oven practice. The edition of the separate report on coke and the edition of the annual report, Mineral Resources of the United States, were both exhausted early in 1909, and as there has been some demand for comparative statistics on beehive and retort oven coke production, the following "argument" from the report for 1907 is reproduced:

The coal consumed in retort ovens in 1907 amounted to 7,506,174 short tons. The quantity of coal used in beehive ovens was 54,439,935 short tons, from all of which the possible by-products are apparently wasted. Assuming that the coal consumed in beehive ovens was of the same average quality as that charged into the retort ovens and that the prices would be not less than 80 per cent of those ruling in 1907, the value of recoverable products which were thus apparently wasted last year amounted to $44,000,000, a sum equal to nearly 80 per cent of the total value of all the coal used in beehive ovens during the year. At the prices which prevailed in 1907 the value of the by-products wasted in beehive coke ovens was a little over $55,000,000. The value of the by-products from the retort ovens in 1907 was a little more than one-third the value of the coke produced in them.

It should be remembered, however, that beehive ovens are located in the coal-mining regions and that the cost of the coal charged into them represents only a little more than that represented by the expense of mining the coal, whereas in locating by-product recovery plants provision must be made for utilizing or marketing the by-products. It is for this reason that in the much larger number of cases the recovery plants are established near the larger cities and at considerable distances from the mining regions, and the expense of transportation is added to the mining cost of the coal. Hence it is that the value of the 7,506,174 tons of coal charged into by-product ovens in 1907 was $15,920,017, or over $2 per ton, while the 54,439,935 tons of coal used in beehive ovens was $56,864,834, or $1.05 per ton. It must also be remembered that the original cost of installation for a by-product recovery plant is from four to five times that of a beehive plant of equal capacity. These disadvantages are in turn partly offset by the higher percentage yield of coke in the retort ovens and a lower delivery charge on the coke produced. In the case of beehive coke, railroad-transportation expense is borne by the coke, while in retort-oven practice all, or nearly all, of the freight charge is borne by the coal.

The total value of the 5,607,899 tons of by-product coke produced in 1907 was $21,665,157, an average of $3.86 per ton. The value of the 35,171,665 tons of beehive coke made in 1907 was $89,873,969, or $2.56 per ton. If we consider that the difference in the value of the by-product coke and beehive coke was due only to the difference in freight charges, then the total value of the entire product of beehive coke made in 1907 would, if made in retort ovens close to the market, have been worth $135,750,000. Add to this the value of the by-products that should have been recovered, of $44,000,000, at 80 per cent of the market price in 1907, the total value of the coke and by-products would have amounted to nearly $180,000,000 instead of the value of $89,873,969 for the beehive coke alone. The value of the coal charged into these ovens would have been $108,879,870 instead of $56,864,834. Carrying the hypothesis further, the difference between the value of the coke and by-products if the coal had been coked in retort ovens and the value of the coke alone from the beehive ovens was, say, $90,000,000. From this should be deducted the difference between what the value of the coal would have been at retort ovens and what it was at beehive ovens, i. e., $52,000,000. The remainder ($38,000,000), less the difference in operating expenses, wear and tear, interest on capital, etc., may be considered as approximately the actual net loss in value as the result of beehive coke production compared with by-product coke practice in 1907.[a]

In 1908 there were 33,741,779 short tons of coal used in making 21,832,292 tons of coke in beehive ovens, a percentage yield of 64.7. If this coal had been coked in retort ovens, supposing the yield to have been the same as that actually obtained for the product made, the output of coke would have been 24,867,691 short tons, which, at the average price of retort coke in 1908, would have been worth $85,544,857. The value of the by-products, taken at 80 per cent of the value of those obtained at retort ovens in 1908, would have

[a] Mineral Resources U. S. for 1907, pt. 2, U. S. Geol. Survey, 1908, pp. 250-251.

been $26,710,364, so that the total value of coke and by-products would have been $112,255,221. The value of the coal charged into the ovens would have been increased by $36,840,298. The value of the beehive coke made in 1908 was $48,018,554. Deducting these two items from the hypothetical value of $112,255,221 for the coke and by-products that might have been obtained, the difference of $27,396,369 represents the assumptive loss in values as the result of beehive operations in 1908.

The total value of the coke, gas, tar, and ammonia produced at by-product recovery ovens in 1908 was $21,847,728, as compared with $29,213,228 in 1907. These totals were made up as follows:

Value of products obtained in manufacture of coke in retort ovens in 1907 and 1908.

	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Gas.....M cubic feet..	20,516,731	$3,130,839	16,205,925	$2,557,483
Tar.....gallons..	53,995,795	1,242,530	42,720,609	1,007,613
Ammonia, sulphate or reduced to equivalent in sulphate.....pounds..	125,372,360	3,174,702	43,329,426	1,286,224
Anhydrous ammonia.....	.....	.....	15,445,030	2,530,979
Total value of by-products.....	.....	7,548,071	.....	7,382,299
Coke.....short tons..	5,607,899	21,665,157	4,201,226	14,465,429
Grand total.....	.....	29,213,228	.....	21,847,728

The gas included in the foregoing statement is the "surplus" not consumed in the coking process, which is either sold or used at manufacturing establishments operated in connection with the coke-oven plant. In a few instances where the surplus gas was consumed by the producing companies the quantity was not measured, nor was any value placed upon it in the reports made to the Geological Survey. In such cases careful estimates have been made, based upon the average surplus gas obtained from similar coals used at ovens of the same type. The value, similarly estimated, has been placed at from 10 to 15 cents per thousand cubic feet.

According to W. Galloway,[a] patents on coke ovens with recovery of by-products were issued in England as early as 1773 and again in 1782. It was not until one hundred and eleven years after the latter date, or in 1893, that the first plant of by-product recovery ovens was completed in the United States. This was a bank of 12 Semet-Solvay ovens at Syracuse, N. Y. In the first year of their operation these ovens produced 12,850 short tons of coke. This plant has since been increased to 40 ovens. The first plant of United-Otto (Otto-Hoffmann) ovens was one of 60 units, constructed at Johnstown, Pa., and operated in connection with the iron and steel works of the (now) Cambria Steel Company. This plant has since been enlarged several times and now contains a total of 372 ovens. An experimental plant of Newton-Chambers ovens was built at Latrobe, Pa., about ten years ago, but was never operated. These ovens were afterwards torn down and rebuilt at Pocahontas, Va., in 1900, but have not been in blast except for a short time immediately after completion. In 1907 a bank of this type of oven, 152 in number,

[a] The genesis and development of the coking oven: Proc. South Wales Inst. Eng., vol. 26, 1909.

was begun at Vintondale, Pa. The ovens were completed and put in blast in 1907, but without recovery of by-products. In 1904 the Lackawanna Steel Company constructed a plant of 94 Rothberg ovens at Buffalo, N. Y. This plant has since been enlarged to 282 ovens. The first establishment of Koppers regenerative ovens was also begun in 1907, by the Illinois Steel Company, at Joliet, Ill. The plant is designed for 280 ovens, 140 of which were finished and put in blast in 1908. The other half of the plant will be finished during 1909. If the operations of this plant prove satisfactory, the United States Steel Corporation will, it is stated, construct a 1,000-oven plant at its Gary, Ind., works. At the close of 1908 there were 4,007 by-product recovery ovens in existence in the United States—an increase of 115 over 1907. These ovens include the Newton-Chambers ovens at Vintondale, though the production of that plant is included with beehive coke. They also include the idle Newton-Chambers plant at Pocahontas, Va. The development of the by-product recovery coking process in the United States since 1893 is shown in the following table:

Record of by-product coke making, 1893–1908.

Year.	Ovens.		Production (short tons).	Year.	Ovens.		Production (short tons).
	Built.	Building.			Built.	Building.	
1893	12	0	12,850	1901	1,165	1,533	1,179,900
1894	12	60	16,500	1902	1,663	1,346	1,403,588
1895	72	60	18,521	1903	1,956	1,335	1,882,394
1896	160	120	83,038	1904	2,910	832	2,608,229
1897	280	240	261,912	1905	3,159	417	3,462,348
1898	520	500	294,445	1906	3,603	112	4,558,127
1899	1,020	65	906,534	1907	3,892	330	5,607,899
1900	1,085	1,096	1,075,727	1908	[a] 4,007	[b] 240	4,201,226

[a] Includes 1,270 Semet-Solvay, 2,002 United-Otto, 387 Rothberg, 208 Newton-Chambers, and 140 Koppers ovens.
[b] Includes 100 United-Otto and 140 Koppers ovens.

In the following table is shown the record of by-product coke ovens, by States, at the close of 1904–1908:

Record of by-product ovens, by States, 1904–1908.

State.	Dec. 31, 1904.		Dec. 31, 1905.		Dec. 31, 1906.		Dec. 31, 1907.		Dec. 31, 1908.	
	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.
Alabama	240	40	280	0	280	0	280	0	280	0
Illinois	0	120	120	0	160	0	160	280	300	140
Indiana										50
Maryland	200	0	200	0	200	0	200	0	200	0
Massachusetts	400	0	400	0	400	0	400	0	400	0
Michigan	135	0	135	15	150	0	150	0	150	0
Minnesota	50	0	50	0	50	0	50	0	50	0
New Jersey	100	0	100	50	150	0	150	0	150	0
New York	352	658	399	0	540	0	540	0	540	0
Ohio	116	14	130	0	130	0	155	50	155	50
Pennsylvania	1,061	0	1,089	272	1,207	112	1,471	0	1,446	0
Virginia	56	0	56	0	56	0	56	0	56	0
West Virginia	120	0	120	0	120	0	120	0	120	0
Wisconsin	80	0	80	80	160	0	160	0	160	0
	2,910	832	3,159	417	3,603	112	3,892	330	4,007	240

The distribution, by States and by kinds, of by-product ovens built and building in the United States at the close of 1908 is shown in the following table:

Kinds of by-product coke ovens built and building in the United States, by States, at the close of 1908.

State.	United-Otto.[a]	Semet-Solvay.	Roth-berg.	New-ton-Cham-bers.	Kop-pers.	Total.	
	Built.	Built.	Built.	Built.	Built.	Built.	Build-ing.
Alabama	....	280	....	....	....	280	....
Illinois	....	160	....	....	140	300	[b] 140
Indiana	....	....	....	....	....	....	[c] 50
Maryland	200	....	....	....	....	200	....
Massachusetts	400	....	....	....	....	400	....
Michigan	30	120	....	....	....	150	....
Minnesota	50	....	....	....	....	50	....
New Jersey	150	....	....	....	....	150	....
New York	188	70	282	....	....	540	....
Ohio	50	....	105	....	....	155	[c] 50
Pennsylvania	934	360	....	152	....	1,446	....
Virginia	....	....	....	56	....	56	....
West Virginia	....	120	....	....	....	120	....
Wisconsin	....	160	....	....	....	160	....
	2,002	1,270	387	208	140	4,007	240

[a] Includes the Otto-Hoffmann and Schniewind types. [b] Koppers ovens. [c] United-Otto ovens.

The following table, originally compiled by Mr. Albert Ladd Colby, consulting engineer, South Bethlehem, Pa., was first published in the report for 1906. It has since been revised for this report by Mr. Colby, and also by Mr. C. G. Atwater, of the United Coke and Gas Company, Whitehall Building, New York City, and by Mr. W. H. Blauvelt, of the Semet-Solvay Company, Syracuse, N. Y.

This table shows, in addition to the number of ovens at each by-product coke-oven plant in the United States and Canada, the uses to which the coke and gas are put, the dates the plants were put in operation, and other interesting information regarding their construction and operation. The statement includes also the garbage-carbonizing plant of Semet-Solvay ovens at Boston, Mass. This plant was originally planned for 400 ovens, but only 7 were completed. The plant has since been partly wrecked by fire and has been dismantled.

Complete list of by-product and retort coke-oven plants of the United States and Canada, January 1, 1909.

State.	Town.	System.	Name of company owning plant.	Number of installments.	Date put in operation.	Number of ovens.	Uses of coke.	Uses of surplus gas.	Remarks.
Mass.	Boston	Semet-Solvay	The New England Sanitary Product Co. (plant for carbonizing garbage tankage).		1898	7	Fertilizer base	Fuel	Damaged by fire and dismantled.
	Everett	Otto-Hoffmann	New England Gas and Coke Co.		June, 1899	400	Domestic, industrial, and locomotive in about equal proportion.	Illuminating gas and fuel gas; 6,500,000 to 7,500,000 cubic feet daily of illuminating gas.	First illuminating-gas system installed.
N. Y.	Syracuse	Semet-Solvay	Solvay Process Co.	First	Jan., 1893	12	Burning limestone; also iron foundry.	Fuel	First by-product plant in United States Main purpose originally to obtain ammonia for alkali works.
				Second	1896	a 25			
				Third	Bet. 1900–1903.	a 40			
	Geneva	do	The Empire Coke Co.	First	Aug., 1904	30	Foundry and domestic.	Illuminating	
	Buffalo	United Otto	Lackawanna Steel Co.	do	May, 1904	b 564	Blast furnace	Fuel gas	First used stamped coal, but changed to top-charging, 1907.
	do	Rothberg	do	do		282	do	do	
N. J.	Camden	Otto-Hoffmann	Camden Coke Co.	do	About Jan., 1903.	100	Blast furnace. Foundry and domestic (domestic coke crushed and sized for sale).	Illuminating gas and fuel gas 2,500,000 to 3,000,000 cubic feet. Illuminating gas pumped daily under 10 pounds pressure to Trenton, 38 miles distant. In 1906 extended delivery of illuminating gas to New Brunswick and Plainfield, 83 miles from Camden. Towns now included: Camden, Bordentown, Woodbury, Trenton, New Brunswick, Plainfield, and smaller towns.	First to install enrichment by benzol transfer.
	do	United Otto		Second	July, 1906	50			
Pa.	Dunbar	Semet-Solvay	The Dunbar Furnace Co.	First	Aug., 1896	50	Blast furnace	Fuel gas	
				Second	July, 1903	60			
	Chester	do	The Suburban Gas Co.	First	Apr., 1904	40	Blast furnace	Illuminating	
	Sharon	do	F. H. Buhl Coke Works.	do	Oct., 1896	25	do	Fuel gas	Dismantled.
	South Sharon	United Otto	Carnegie Steel Co.	do	July, 1903	210	do	do	

	Glassport	Otto-Hoffmann	United Coke and Gas Co.		Feb., 1897	120	Blast furnace and mestic. Installed a crushing outfit in 1905.	Illuminating gas and fuel gas to McKeesport.	
	Johnstown	do	Cambria Steel Co.	First	Nov., 1895	60	Blast furnace	Fuel gas and power gas	
		United Otto	do	Second	Mar., 1899	100	do	do	
		do	do	Third	Sept., 1904	100	do	do	
		do	do	Fourth	Feb., 1907	112	do	do	
	Lebanon	Semet-Solvay	Pennsylvania Steel Co.	First	July, 1904	90	do	Semet-Solvay Co. delivers surplus gas to Pennsylvania Steel Co., which sells it to American Iron and Steel Mfg. Co. for use in heating furnaces and gas engine.	
	do	Otto-Hoffmann	Lackawanna Iron and Steel Co.	do	Mar., 1903	252	do	Fuel gas	Went back to top-charging since resumption in September, 1905. The 5 Rothberg ovens were shut down in August 1903.
		Rothberg	do	do	May, 1903	5			
	Steelton	Semet-Solvay	Pennsylvania Steel Co.	do	Jan., 1907	120	do	do	
W. Va	Benwood	do	National Tube Co	do	Oct., 1898	60	do	do	
				Second	Mar., 1901	60			
Md	Sparrows Point	United Otto	Maryland Steel Co	First	Mar., 1903	200	Blast furnace	Illuminating gas for city of Baltimore, 11 miles distant; 4,000,000 cubic feet daily.	
Ala	Ensley (near Birmingham).	Semet-Solvay	Tennessee Coal, Iron, and R. R. Co.	do	Oct., 1898	120	do	Fuel gas	
				Second	Mar., 1902	120	do	do	
	Tuscaloosa	do	Central Iron and Coal Co.	First	Feb., 1906	40	do	do	
Ohio	Hamilton	Otto-Hoffmann	Hamilton Otto Coke Co.	do	Apr., 1901	50	Mostly domestic; some foundry. Installed crushing outfit 1905.	Illuminating gas for Hamilton; also power gas.	
	do	United Otto	do	Second	Not completed.	50	Blast furnace	do	
	Cleveland	Rothberg	Retort-Coke Oven Co.	First	About Apr., 1905.	80	do	Fuel gas	Used stamped coal, side charged.
				Second	Oct., 1907	25	do	do	Plant closed down March, 1908.
Ind	Indianapolis	United Otto	Citizens Gas Co	First	Not completed.	50			
Ill	Joliet	Koppers	Illinois Steel Co	do	140 completed in 1908.	280	Blast furnace	Fuel and power	
	South Chicago, on Calumet River.	Semet-Solvay	By-products Coke Corporation.	do	Dec., 1905	120	Blast furnace, foundry, and domestic.	Illuminating	
				Second	Dec., 1906	40			

[a] Increased to.

[b] Contracted for; 188 completed.

Complete list of by-product and retort coke-oven plants of the United States and Canada, January 1, 1909—Continued.

State.	Town.	System.	Name of company owning plant.	Number of installments.	Date put in operation.	Number of ovens.	Uses of coke.	Uses of surplus gas.	Remarks.
Wis.	Milwaukee	Semet-Solvay	Milwaukee Coke and Gas Co.	First	Mar., 1904	80	Blast furnace, foundry, and domestic.	Illuminating	
				Second	Mar., 1906	80			
Mich.	Delray	do	The Solvay Process Co.	First	Sept., 1901	30	Furnace, foundry, domestic, and lime-burning.	Illuminating	
				Second	Nov., 1902	30			
				Third	Mar., 1906	60			
	Wyandotte	United Otto	Michigan Alkali Co.	First	Oct., 1902	15	Burning limestone.	Fuel gas	Use the by-products in their works.
				Second	Aug., 1906	15			
Minn.	Duluth	do	Zenith Furnace Co.	First	July., 1904	50	Blast furnace	Illuminating gas for Duluth.	
Nova Scotia.	Halifax	Semet-Solvay	People's Heat and Light Co.		Apr., 1898	10	Domestic	Illuminating gas for Halifax.	Originally the Slocum Oven. Not in operation.
	Sydney	Otto-Hoffmann	Dominion Iron and Steel Co.		Dec., 1900	500	Blast furnace	Fuel gas	
	Sydney Mines	von Bauer	Nova Scotia Steel and Coal Co. (Limited).		1900	30	do		Nonby-product ovens.
	do	Bernard	do		1902	120	do		Do.

NOTES.—1. Of the 12 plants of the Semet-Solvay Company now in operation, 2 are operated by the owners, and the remaining 10 by the Semet-Solvay Company, or under its immediate direction, the coke produced being turned over to the company whose name appears as owner.

2. Tar and ammonia are recovered as by-products from all of the plants included in the above table, except that of the Nova Scotia Steel and Coal Company (Limited).

IMPORTS AND EXPORTS.

The following table gives the quantity and value of coke imported and entered for consumption in the United States from 1903 to 1908, inclusive. In the reports of the Bureau of Statistics of the Department of Commerce and Labor, from which these figures are obtained, the quantities are expressed in long tons of 2,240 pounds. These have been reduced to short tons in order to make them conform to the standard unit of this report.

Coke imported and entered for consumption in the United States, 1903–1908, in short tons.

1903	142,776	$437,625	1906	147,819	$570,150
1904	180,855	648,521	1907	135,968	596,366
1905	203,142	796,545	1908	147,427	606,294

The quantity of coke exported from the United States increased each year from 1900 to 1907, but decreased in 1908. The exports for the last six years are shown in the following table, the quantities in this case also being reduced to short tons:

Coke exported from the United States since 1903, in short tons.

1903	466,351	$2,091,875	1906	857,013	$2,753,551
1904	585,861	2,311,401	1907	979,652	3,206,793
1905	670,939	2,243,010	1908	696,895	2,161,032

It has been contended that the development of the by-product coking industry would have shown more rapid progress if markets for the by-products were assured. This pertains essentially to the coal tar and its products, as there is no difficulty in disposing of the surplus gas, and there is practically at all times a fair demand for ammonia. As to the coal tar, the total value of this by-product from retort ovens at first hand in 1908 was $1,007,613. The value of the coal-tar products imported into this country in 1908, including duty paid, was $8,560,406. The values in all cases of imports are at point of shipment, and do not include ocean freights, commissions, and other expenses. It is probable that these importations have reached the consumer at a total cost of not less than $12,000,000, and in the three preceding years the cost probably reached $15,000,000. The kinds of coal-tar products imported, the value thereof, and the amount of duty paid on each during the last five years are shown in the following table:

Coal-tar products imported into the United States, 1904–1908.

Year.	Salicylic acid.		Alizarine and colors or dyes, natural and artificial.		Aniline salts.		Coal-tar colors or dyes, not specially provided for.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.	Value.	Duty.
1904	$7,305	$3,276	$636,418	Free.	$686,184	Free.	$4,903,077	$1,470,923
1905	2,214	923	625,491	Free.	789,052	Free.	5,673,242	1,701,973
1906	2,772	991	661,155	Free.	806,901	Free.	5,717,932	1,715,380
1907	1,240	489	782,368	Free.	667,758	Free.	5,830,651	1,749,196
1908	1,183	345	752,386	Free.	450,891	Free.	4,573,217	1,371,965

Coal-tar products imported into the United States, 1904–1908—Continued.

Year.	Coal tar, all preparations, not colors or dyes.		Coal-tar products not medicinal, not dyes, known as benzol, toluol, etc.		Total.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.
1904	$522,242	$104,448	$391,645	Free.	$7,146,871	$1,578,647
1905	768,556	153,711	486,439	Free.	8,344,994	1,856,607
1906	864,067	172,814	483,416	Free.	8,536,243	1,889,185
1907	911,096	182,219	653,288	Free.	8,846,401	1,931,904
1908	717,556	143,511	549,352	Free.	7,044,585	1,515,821

PRODUCTION OF COKE BY STATES.

ALABAMA.

For a quarter of a century, from 1880 to 1905, Alabama and West Virginia were close rivals for second place in the rank of coke-producing States, and during the last five years of that period each State held the place alternately. Since 1905, however, West Virginia has outranked Alabama, and in 1907 produced over a million tons, or about 33⅓ per cent more coke than her rival. It would appear, therefore, that West Virginia is permanently established as second among the coke-producing States. In 1908 West Virginia produced nearly 275,000 tons more than Alabama. Alabama's production of coke decreased from 3,034,501 short tons in 1906 to 3,021,794 in 1907 and to 2,362,666 tons in 1908. The value, however, increased from $8,477,899 in 1906 to $9,216,194 in 1907, but fell off to $7,169,901 in 1908. The decrease in 1908 as compared with 1907 was 659,128 short tons, or 21.81 per cent in quantity, and $2,046,293, or 22.2 per cent in value.

The advantage possessed by Alabama's coke manufacturers over those in West Virginia in having a home market for the product has been referred to in previous reports. It is illustrated particularly in the difference in value between Alabama's production and that of West Virginia. Although West Virginia coke is certainly of as good a quality as that of Alabama, the value of the smaller tonnage of Alabama in 1908 was greater by over $1,900,000 than the larger production of West Virginia. Notwithstanding the depression in 1908, the average price per ton of Alabama coke declined only 1 cent, from $3.05 to $3.04, while that of West Virginia declined from $2.36 to $2. A part of the higher price for Alabama coke is due to the operations of the 280 Semet-Solvay ovens at Ensley and Tuscaloosa, this being due to the fact that the transportation cost in the manufacture of by-product coke is borne by the coal, and the value of the coke at the ovens (the ovens being located at the point of consumption) is therefore greater than in the beehive coke, where the ovens are located at a distance from the market and the transportation charges are borne by the coke.

There were 45 establishments in Alabama in 1908, an increase of 2 over 1907. The total number of ovens increased from 9,889 to 10,103. Of the 45 establishments, 10, having a total of 1,885 ovens, were idle during 1908, as compared with 6 idle establishments with a total of 715 ovens in 1907. There were no new ovens building at the close of 1908. The establishments in Alabama include 2 by-product recovery plants, with a total of 280 ovens, all of which were operated during the year. Both of these by-products recovery plants are of Semet-Solvay ovens, one being located at Ensley, operated in connection with the iron furnaces of the Tennessee Coal, Iron and Railroad Company; the other, at Tuscaloosa, operated in connection with the Central Iron and Coal Company.

The production of coke in Alabama in 1880, 1890, 1900, and from 1904 to 1908 is shown in the following table:

Statistics of the manufacture of coke in Alabama, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	4	316	100	106,283	60,781	$183,063	$3.01	57.0
1890	20	4,805	371	1,809,964	1,072,942	2,589,447	2.41	59.0
1900	30	6,529	690	3,582,547	2,110,837	5,629,423	2.67	58.9
1904	42	9,059	440	3,996,578	2,340,219	5,716,413	2.44	58.6
1905	42	9,586	150	4,409,854	2,576,986	7,646,957	2.97	58.4
1906	42	9,731	160	5,184,597	3,034,501	8,477,899	2.79	58.5
1907	43	9,889	50	4,973,296	3,021,794	9,216,194	3.05	61.0
1908	45	[a]10,103	0	3,875,791	2,362,666	7,169,901	3.04	61.0

[a] Includes 280 Semet-Solvay ovens.

Considerable increase is noted in the percentage of coal washed before coking in 1908 as compared with 1907. In 1907 the total quantity of coal washed was 3,924,956 short tons, or 79 per cent of the total; in 1908 the quantity of coal washed was 3,274,480, or 84 per cent of the total. Of the coal used in 1908, for coke making, 2,005,453 tons were run of mine and 1,870,338 tons were slack.

Character of coal used in the manufacture of coke in Alabama, 1890–1908, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	1,480,669	....	206,106	123,189	1,809,964
1900	1,729,882	152,077	165,418	1,535,170	3,582,547
1904	670,271	922,864	741	2,402,702	3,996,578
1905	1,297,376	1,247,924	....	1,864,554	4,409,854
1906	1,493,549	1,810,089	121,122	1,759,837	5,184,597
1907	1,020,907	1,697,913	27,433	2,227,043	4,973,296
1908	548,093	1,457,360	53,218	1,817,120	3,875,791

COLORADO AND UTAH.

The statistics of the manufacture of coke in Colorado and Utah are combined in order not to divulge individual operations, there being but two establishments in Utah, both of which are owned by one company. The production of the two States in 1908 amounted to 982,291 short tons, valued at $3,238,888, against 1,421,579 short tons in 1907, valued at $4,747,436. The decrease in 1908 was 439,288 short tons, or 30.90 per cent in quantity, and $1,508,548, or 31.78 per cent in value. The average price per ton declined from

$3.34 to $3.30. A notable increase is observed in the percentage yield of coal in coke during 1908 as compared with preceding years. This is probably due to the larger proportion of coal which was washed before being charged into the ovens. In 1908 nearly 75 per cent of the coal used for coke making was washed; in 1907 only a little more than half of the coal made into coke was washed. There were 18 establishments in the two States during 1908, the same as in 1907. The total number of ovens noted was 4,705, an increase of 22 over 1907. Of the 18 establishments 6, having a total of 1,169 ovens, were idle throughout the year.

The statistics of the manufacture of coke in Colorado and Utah in 1880, 1890, 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Colorado and Utah, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	200	50	51,891	25,568	$145,226	$5.68	49.0
1890	8	916	30	407,023	245,756	959,246	3.90	60.0
1900	14	1,692	0	997,861	618,755	1,746,732	2.82	62.0
1904	17	3,923	0	1,376,354	789,060	2,590,251	3.28	57.3
1905	17	3,925	150	2,368,365	1,378,824	4,157,517	3.02	58.2
1906	17	4,103	250	2,566,196	1,455,905	4,504,748	3.09	56.7
1907	18	4,683	50	2,388,911	1,421,579	4,747,436	3.34	59.5
1908	18	4,705	0	1,546,044	982,291	3,238,888	3.30	63.5

For several years prior to 1906 practically all of the coal used in the manufacture of coke in Colorado and Utah was slack, a large proportion of which was washed before being charged into the ovens. In 1906, however, there were 708,306 tons of run-of-mine coal used, of which 703,440 tons were washed. In 1907 the run-of-mine coal used decreased to 679,182 tons, of which 676,226 tons were washed, and in 1908 a further decrease was noted to 237,540 tons, all of which was washed. The amount of slack used in 1908 amounted to 1,308,504 tons, 900,971 tons of which were washed before coking.

The character of the coal used in the manufacture of coke in Colorado and Utah in 1890, 1900, and for the last five years is shown in the following table:

Character of coal used in the manufacture of coke in Colorado and Utah, 1890–1908.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	36,058	0	395,023	0	431,081
1900	229,311	0	316,527	452,023	997,861
1904	400	0	745,450	630,504	1,376,354
1905	0	0	691,982	1,676,383	2,368,365
1906	4,866	703,440	1,065,353	792,537	2,566,196
1907	2,956	676,226	1,055,189	654,540	2,388,911
1908	0	237,540	407,533	900,971	1,546,044

GEORGIA.

Dade County, in the extreme northwestern corner of Georgia, contains a small area of the Walden Ridge (Tennessee) coal basin, and a portion of the adjoining county of Walker is underlain by an extension of the beds of Lookout Mountain, of Alabama. Coal mining on an extensive scale is carried on in both counties, and a good grade of coke is made from the slack coal produced in mining. The iron furnaces in and near Chattanooga, Tenn., furnish the principal market for the coke. All of the coal used in coking was washed before being charged into the ovens.

There are only two establishments in the State, one of which was operated during the year. The statistics of production at this establishment, the Durham Coal and Coke Company, are published with the definite permission to do so. In sympathy with the general depression in the iron trade, the coke production of Georgia decreased from 74,934 short tons, valued at $315,371, in 1907 to 39,422 short tons, valued at $137,524, in 1908, a decrease of 35,512 short tons, or 47.39 per cent in quantity, and of $177,847, or 56.39 per cent in value. The average price per ton increased from $3.95 in 1906 to $4.21 in 1907, but declined to $3.72 in 1908.

The statistics of the manufacture of coke in Georgia in 1880, 1890, 1900, and from 1904 to 1908 are shown in the following table:

Statistics of the manufacture of coke in Georgia, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building					
1880	1	140	40	63,402	38,041	$81,789	$2.15	60.0
1890	1	300	0	170,388	102,233	150,995	1.48	60.0
1900	2	480	0	140,988	73,928	210,646	2.85	52.4
1904	2	500	0	132,270	75,812	212,697	2.81	57.3
1905	2	533	0	119,036	70,593	224,200	3.18	59.3
1906	2	531	0	128,052	70,280	277,921	3.95	54.9
1907	2	350	0	136,031	74,934	315,371	4.21	55.1
1908	2	350	0	71,452	39,422	137,524	3.72	55.2

ILLINOIS.

The coke industry of Illinois has gained prominence, first, by the construction in 1906 of 160 Semet-Solvay ovens at South Chicago, and, second, by the construction of 280 Koppers regenerative by-product ovens by the Illinois Steel Company at Joliet. Of these latter, which were begun in 1907, one-half, or 140, were put in operation in 1908. The coal for these by-product ovens is drawn from the mines of Fayette County in West Virginia and not from the mines of Illinois. One other establishment making coke in this State in 1908 was the Gallatin Coal and Coke Company, at Equality, which makes coke in Belgian ovens from Illinois coal. On account of the operation of the 140 Koppers ovens at Joliet the production of coke in Illinois shows a smaller percentage of decrease than in any other State of any importance in the coke-making industry.

The production in 1908 amounted to 362,182 short tons, valued at $1,538,952, against 372,697 short tons, valued at $1,737,464, in 1907, a decrease of 10,515 tons, or 2.82 per cent, in quantity, and $198,512, or 11.43 per cent, in value. The average price per ton declined from $4.66 to $4.25.

The statistics of the manufacture of coke in Illinois during the last five years are shown in the following table:

Statistics of the manufacture of coke in Illinois, 1904–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1904	5	155	120	8,131	4,439	$9,933	$2.24	54.6
1905	5	275	0	16,821	10,307	27,681	2.685	61.3
1906	4	309	0	362,163	268,693	1,205,462	4.48	74.2
1907	5	309	280	514,983	372,697	1,737,464	4.66	72.3
1908	6	[a] 430	[b] 140	503,359	362,182	1,538,952	4.25	72.0

[a] Includes 160 Semet-Solvay and 140 Koppers ovens. [b] Koppers regenerative by-product ovens.

INDIANA.

For the first time since 1903 Indiana appears as a coke producer, the output being obtained from 10 ovens constructed during 1908 by the United Fourth Vein Coal Company at Black Creek. The coal used was unwashed slack, and the total quantity of coke produced was 1,747 short tons. The details of production are included among other States. The 36 ovens of the Ayrshire Coal Company at Ayrshire have not been operated for several years. During 1908 the Citizens' Gas Company of Indianapolis began the construction of 50 United-Otto ovens, and these will possibly be completed and placed in operation before the close of 1909. The probability is that West Virginia coal will be used in these ovens.

KANSAS.

All of the coke made in Kansas is used for zinc smelting, and the ovens are operated in connection with the zinc works. The ovens are charged with slack obtained in the vicinity of Pittsburg, and all of this is used unwashed, as the zinc smelters do not require a high-grade coke. The industry has never been of much importance, the largest production of 20,902 tons having been obtained in 1902, since which time it has shown a declining tendency. The production had decreased to 1,698 tons in 1906, but revived somewhat with the industrial activity of 1907 to 6,274 tons. In 1908 the production again decreased to 2,497 tons. There were 6 establishments in the State at the close of 1908 with a total of 67 ovens, or an average of 11 ovens to a plant. The largest plant is one of 50 ovens at Cokedale, and this has not been operated in the last five or six years. The state authorities have constructed one oven at the state penitentiary at Lansing, and this produced 262 tons of coke in 1908. All of the establishments but the 50-oven plant at Cokedale produced some coke in 1908.

The statistics of the manufacture of coke in this State in 1880, 1890, 1900, and from 1904 to 1908, are shown in the following table:

Statistics of the manufacture of coke in Kansas, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	2	6	0	4,800	3,070	$6,000	$1.95	64.0
1890	7	68	0	21,809	12,311	29,116	2.37	56.0
1900	9	91	0	10,303	5,948	14,985	2.52	57.7
1904	6	91	0	14,525	9,460	23,485	2.48	65.0
1905	6	91	0	6,504	4,425	13,818	3.12	68.0
1906	5	81	0	2,807	1,698	4,101	2.42	60.5
1907	6	83	0	11,392	6,274	19,837	3.16	55.0
1908	6	67	0	3,790	2,497	8,011	3.21	65.9

KENTUCKY.

Kentucky is the only one of the United States whose coal supplies are drawn from any two of the great fields. The eastern counties of the State are underlain by the coal measures of the Appalachian region, and the southern extremity of the eastern interior, or Illinois-Indiana field, is worked extensively in the western part of Kentucky. Coke has been made from coal mined in both the eastern and the western parts of the State, but although the coals of the eastern counties are in large part included among the high-grade coking coals of the Appalachian field and although little or no coke is made from the coals of the eastern interior field in Illinois or Indiana, all of the coke made in Kentucky in 1907 and 1908 came from the western portion of the State.

Of the 6 coking establishments in the State 4 were idle and only 2 made coke in 1908. In 1907 there were the same number of establishments, of which 4 were operated. The number of ovens (495) was the same in both years. Four hundred and forty-one ovens were operated in 1907, and only 175 in 1908. The production decreased from 67,068 short tons in 1907 to 37,827 short tons in 1908. The details of production in 1908 are included with those of other States in order not to divulge the statistics of individual plants.

The following table gives the statistics of production of coke in Kentucky in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in Kentucky, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	5	45	0	7,206	4,250	$12,250	$2.88	59.0
1890	9	175	103	24,372	12,343	22,191	1.80	51.0
1900	5	458	3	190,268	95,532	235,505	2.47	50.2
1904	7	499	0	140,139	64,112	138,226	2.15	45.7
1905	6	495	0	154,783	79,487	159,659	2.01	51.4
1906	6	462	0	148,448	74,064	169,846	2.29	49.9
1907	6	495	0	129,538	67,068	157,288	2.35	51.7
1908	6	495	0	(a)	37,827	(a)	(a)	(a)

a Included with other States having less than three producers.

MISSOURI.

Coke making in Missouri has never been much of an industry, and, as in Kansas, has been limited to the coking of a small quantity of Pittsburg (Kans.) slack, the coke being used at the zinc smelters in connection with which the ovens were operated. One of the two small plants with which the State has been credited during the last five years was abandoned in 1907, and the other one was idle in 1906, 1907, and 1908.

The statistics of production for a series of years have been as follows:

Statistics of the manufacture of coke in Missouri, 1887–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1887	1	4	0	5,400	2,970	$10,395	$3.50	55.0
1890	3	10	0	9,491	6,136	9,240	1.51	65.0
1900	3	10	0	3,775	2,087	5,268	2.52	55.3
1904	2	8	0	3,815	2,446	6,115	2.50	64.0
1905	2	6	0	2,551	1,580	4,072	2.58	61.9
1906	2	6	0	0	0	0	0	0
1907	1	5	0	0	0	0	0	0
1908	1	4	0	0	0	0	0	0

MONTANA.

There are 5 coke-making establishments in Montana, but only 1 of these made coke in 1908. The total production was 34,573 short tons, a decrease from 40,714 in 1907. The details of the production are included with other States. The coal used in the manufacture of coke in 1908 was 23,129 short tons of unwashed run-of-mine coal, and 36,139 tons of washed run-of-mine. The extent to which the coke has been benefited by washing the coal is shown by the fact that in 1905 the yield of coal in coke was less than 46 per cent; in 1906 it was 55.3 per cent; in 1907, when nearly all of the coal used was washed, it was 59 per cent, and in 1908 it was 58.3 per cent.

In the following table are given the statistics of production of coke in Montana in 1884, when the first production was reported, and in 1890, 1900, and since 1904:

Statistics of the manufacture of coke in Montana, 1884–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1884	3	5	12	165	75	$900	$12.00	46
1890	2	140	0	32,148	14,427	125,655	8.71	45
1900	3	342	111	108,710	54,731	337,079	6.16	50.3
1904	4	520	0	78,303	41,497	280,745	6.77	53
1905	4	555	100	68,777	31,482	211,351	6.71	45.8
1906	4	555	100	69,045	38,182	266,024	6.97	55.3
1907	5	567	15	68,948	40,714	295,174	7.25	59
1908	5	551	3	59,268	34,573	(a)	(a)	58.3

[a] Included with other States having less than three producers.

NEW MEXICO.

It was noted in the report for 1907 that New Mexico was assuming considerable importance as a coke producer. This statement is verified in 1908 by an increase in the production of coke in the Territory of 9,940 tons, or 3.56 per cent. There was only one other State in which an increased production in 1908 over 1907 was shown. The other State was Indiana, where a small production was made in 1908 from a new bank of ovens, the State not being credited with any production in recent years. The increase in New Mexico in coke production was due to the increased activities at the Stag Canyon Fuel Company's mines and ovens at Dawson. The production is disposed of to allied copper interests in Arizona, which insures a fairly steady outlet for the coke. The plant at Dawson is one of the best-equipped modern mining and coking plants in the United States. The ovens, although of the beehive type, are constructed with flues under the floors, and these flues connect with a large flue leading to the power plant. By this means the gases generated in the coking process are made to furnish not only the power required in the operation of the plant, but also to furnish steam heat to the office, stores, and other company buildings, and electric light for the entire mining town of Dawson. The plant has been fully described in a recent paper by Jo. E. Sheridan, territorial mine inspector, and presented before the American Institute of Mining Engineers. Although New Mexico's production of coke increased 9,440 tons, or 3.56 per cent, the value of the product decreased $13,473, or 1.6 per cent, and the average price per ton declined from $3.17 to $3.01. There are 4 establishments in the Territory, with a total of 1,016 ovens. One plant of 50 ovens was idle throughout the year. By the increase in the Territory's production in 1908, the year of general decrease, New Mexico advanced from fifteenth to tenth place in the rank of producing States and Territories. In 1907, the year of unusual activity and increased production, New Mexico showed the largest percentage of increase of all the important coke-producing States and Territories.

The statistics of production in 1882, 1890, 1900, and from 1904 to 1908 are shown in the following table:

Statistics of the manufacture of coke in New Mexico, 1882–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1882	2	0	12	1,500	1,000	$6,000	$6.00	66.0
1890	2	70	0	3,980	2,050	10,025	4.89	51.5
1900	2	126	0	74,261	44,774	130,251	2.91	60.3
1904	3	234	0	94,397	58,259	171,976	2.95	61.7
1905	3	258	498	148,469	89,638	253,229	2.83	60.4
1906	4	571	450	261,609	147,747	442,712	3.00	56.5
1907	4	896	125	446,140	265,125	840,253	3.17	59.4
1908	4	1,016	0	454,873	274,565	826,780	3.01	60.4

OHIO.

Although Ohio ranks fourth in importance among the coal-producing States, it has not developed much prominence as a coke producer. This is in part due to the fact that much of the coal mined in the State makes an excellent blast-furnace fuel in its raw state, and also to the proximity of the higher-grade coking coals of Pennsylvania and West Virginia. During 1905, 1906, and 1907, the coke production of the State showed material increase over previous years because of the operations of the Rothberg by-product recovery plant at Cleveland and of the United-Otto plant at Kokotto, near Cincinnati, the maximum production being reached in 1906, with a total of 293,994 short tons. There was a slight decrease in 1907 to 270,634 tons, and in sympathy with the general decrease in coke production in 1908 the output fell off in that year to 159,578 tons, a decrease of 111,056 tons, or 41.04 per cent. The value decreased slightly less in proportion, from $819,262 in 1907, to $491,982 in 1908, a loss of $327,280, or 39.95 per cent. The average price per ton advanced from $3.03 to $3.08. This advance in the average price per ton was not so much due to any accentuation in value, but to the greater proportion of retort-oven coke, which being sold at the place of consumption, brought a higher price at the ovens than the beehive coke shipped to distant markets. One of the coking establishments, consisting of 120 ovens, at Utley, has been permanently abandoned. This reduces the total number of plants in the State from 8 to 7, and the number of ovens from 600 to 481, there having been one establishment which added one oven to its equipment in 1908. In 1907 the construction of 50 new United-Otto ovens was begun at Kokotto, doubling the plant at that place, but the new ovens had not been completed at the close of 1908.

The statistics of the production of coke in Ohio in 1880, 1890, and 1900, and for the last five years, are shown in the following table:

Statistics of the manufacture of coke in Ohio, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	15	616	25	172,453	100,596	$255,905	$2.54	58.0
1890	13	443	1	126,921	74,633	218,090	2.92	59.0
1900	8	369	50	115,269	72,116	194,042	2.69	62.5
1904	8	539	14	165,487	109,284	337,606	3.09	66.0
1905	8	573	0	396,961	277,130	970,897	3.50	69.8
1906	8	575	0	437,567	293,994	1,013,248	3.45	67.2
1907	8	600	50	376,759	270,634	819,262	3.03	71.8
1908	7	[a] 481	[b] 50	237,448	159,578	491,982	3.08	67.2

[a] Includes 105 Rothberg and 50 United-Otto ovens. [b] United-Otto ovens.

The larger part of the coal used in coke making in Ohio is unwashed run-of-mine. In 1908 the coal charged into the ovens consisted of 180,458 tons of unwashed run-of-mine, 27,481 tons of washed run-of-mine, 6,244 tons of unwashed slack, and 23,265 tons of washed slack.

The character of the coal used in the manufacture of coke in Ohio in 1890, 1895, 1900, and from 1904 to 1908, is shown in the following table:

Character of coal used in the manufacture of coke in Ohio since 1890, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	34,729	0	54,473	37,719	126,921
1900	68,175	0	17,094	30,000	115,269
1904	140,915	0	7,249	17,323	165,487
1905	348,502	0	10,837	37,622	396,961
1906	356,540	0	38,737	42,290	437,567
1907	268,637	45,712	36,514	25,896	376,759
1908	180,458	27,481	6,244	23,265	237,448

OKLAHOMA.

Coke making in Oklahoma (Indian Territory) has decreased each year since 1905. This carries with it the conviction that the attempts to manufacture coke out of Oklahoma coal have not been attended with pronounced success. Of the 5 establishments in the State only 1 was operated in 1908, and 406 of the 486 ovens were idle. The total production in 1908 amounted to 2,944 tons, compared with 19,089 tons in 1907, 49,782 tons in 1906, and 54,781 tons in 1905. The details of production in 1908, because of there being but one producing plant, are included with other States.

The following table gives the statistics of the manufacture of coke in Oklahoma (Indian Territory) in 1880, 1890, 1900, and from 1904 to 1908:

Statistics of the manufacture of coke in Oklahoma (Indian Territory), 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	20	0	2,494	1,546	$4,638	$3.00	62.0
1890	1	80	0	13,278	6,639	21,577	3.25	50.0
1900	3	230	0	79,534	38,141	152,204	3.99	48.0
1904	5	286	0	98,847	44,808	209,165	4.67	45.3
1905	5	388	50	123,389	54,781	199,424	3.64	44.4
1906	5	490	0	95,296	49,782	204,205	4.10	52.2
1907	5	490	50	38,615	19,089	82,447	4.32	49.4
1908	5	486	50	(a)	2,944	(a)	(a)	(a)

a Included with other States having less than three producers.

PENNSYLVANIA.

In the manufacture of coke, as in the mining of coal, Pennsylvania stands supreme among the States, and for more than a quarter of a century, or practically since 1880, when the manufacture of coke assumed any importance as an industry, has contributed over 50 per cent of the total coke product of the United States. This supremacy was maintained in 1908, notwithstanding the pronounced decrease in production due to the business depression and the decline in the output of pig iron. In 1907 Pennsylvania produced 65.02 per cent of the total coke output of the United States; in 1908 Pennsylvania produced 59.58 per cent of the total. Until the last two years more than half of the total coke production of Pennsylvania has come from the celebrated Connellsville district, contained in Fayette and Westmoreland counties. In 1907, however, owing to the largely increased production of the Lower Connellsville or Klondike district, and not to any decrease in the Connellsville district proper, the percentage of the Connellsville district fell to a little less than 50 per cent. In 1908 the decrease in the Connellsville district was in greater proportion than that of the Lower Connellsville or Klondike district, and the percentage of production of the Connellsville district to the total fell off to 44.4 per cent. The Lower Connellsville district is located in Fayette County, and is separated from the Connellsville basin proper by the Greensburg anticline. The Upper Connellsville or Latrobe district is the northern extremity of the Connellsville trough or basin.

The combined production of these three districts represented 75 per cent of the total production of the State, and nearly 50 per cent of the total output of the United States.

The quantity of coke produced in Pennsylvania in 1908 was 15,511,634 short tons, out of a total for the United States of 26,033,518 short tons. In 1907 Pennsylvania produced 26,513,214 short tons out of a total of 40,779,564 tons. Compared with 1907 the coke production of Pennsylvania in 1908 showed a decrease of 11,001,580 short tons, or 41.5 per cent. As compared with 1906 the production in 1908 showed a decrease of 7,548,877 short tons, or 32.7 per cent. The years 1906 and 1907, however, were the years of plenty in the coal-mining and coke-producing industries, and can hardly be considered years of normal production. If, however, the production of Pennsylvania in 1908 is compared with the average of the five preceding years (1903–1907, inclusive) it is noted that the production still shows a decrease of 4,620,257 short tons, or 22.9 per cent. Compared with the average production for the eight years previous to 1908 (1900–1907, inclusive), the production shows a decrease of 2,597,188 short tons, or 14.3 per cent. The production in 1908 was the smallest since 1904.

Every coke-producing district in the State showed the effects of the business depression, and some of the districts, statistics for which in previous reports have been given separately, have had to be combined for 1908 because of the fact that nearly all of the establishments were idle throughout the year, which necessitated combining the statistics with other districts in order not to divulge statements of individual operations. In every respect conditions in 1908 were almost a direct contrast to those which prevailed in 1907. During 1907, until the effects of the financial troubles began to be felt, there was scarcely a time that the production was in excess of the demand; in 1908 the occasions were just as few when the supply was not in excess of the market requirements. The result of these conditions is exhibited in the proportionately larger decrease in the value of the coke as compared with the decrease in product.

The total value of the coke produced in Pennsylvania in 1908 was $32,569,621, against $67,638,024 in 1907, a decrease of $35,068,403, or 51.8 per cent. The decrease in tonnage was 41.5 per cent. The decrease in the value of the production in 1908 was greater than the total value of the entire coke output of Pennsylvania in 1904.

The average price per ton obtained for coke in Pennsylvania in 1908 was $2.10, as compared with $2.55 in 1907, $2.35 in 1906, and $2.05 in 1905. The only reason to be assigned for the fact that the price in 1908 was in excess of that of 1905 is that operators were able through contracts to maintain prices and thus prevent entire demoralization, and also to the fact that large quantities of coke produced in Pennsylvania are not placed upon the market but are used by the producers themselves or by allied interests, and the value placed upon the article is purely arbitrary.

The quantity of coal consumed in the manufacture of coke in Pennsylvania in 1908 was 23,215,964 short tons, valued at $23,250,885. This represents 19.81 per cent of the total production of bituminous coal in Pennsylvania during the year. In 1907 the consumption of coal in the manufacture of coke was 39,733,177 short tons, or 26.4 per cent of the State's total bituminous coal production, valued at $42,732,546. The much smaller percentage in the quantity of coal used for coke making in 1908 as compared with the two preceding years indicates that the decrease in the demand for coke by the iron furnaces was in greater proportion than from other consumers of fuel. The difference between the value of the coke and the value of the coal from which it was made in 1908 was $9,318,736, or 40.1 per cent; in 1907 the difference was $24,905,478, or 58.3 per cent.

The general decrease in coke production was also exhibited in the number of coke-making establishments, there being 1 less in 1908 than in 1907, although the number increased in the Connellsville district from 101 to 104, and the total number of ovens in the State increased from 51,364 to 52,606. The number of establishments in the Allegheny Mountain district decreased from 17 to 16, in the Greensburg district from 8 to 7, in the Pittsburg district from 10 to 9, and in the Clearfield-Center district from 7 to 6. Of the 252 establishments, 44 were idle, and of the 52,606 ovens 3,616 were out of blast throughout the year. The completed ovens include 934 United-Otto, 360 Semet-Solvay, 152 Newton-Chambers, 100 Belgian, 32 bank, 395 rectangular, and 80 longitudinal ovens.

The statistics of the production of coke in Pennsylvania for the years 1880, 1890, 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	124	9,501	836	4,347,558	2,821,384	$5,255,040	$1.86	65.0
1890	106	23,430	74	13,046,143	8,560,245	16,333,674	1.91	65.6
1900	177	32,548	2,310	20,239,966	13,357,295	29,692,258	2.22	66.0
1904	217	42,165	1,621	22,432,064	14,861,064	25,027,462	1.68	66.2
1905	226	42,608	2,384	31,030,345	20,573,736	42,253,178	2.05	66.3
1906	239	47,185	2,373	34,503,513	23,060,511	54,184,531	2.35	66.8
1907	253	51,364	1,337	39,733,177	26,513,214	67,638,024	2.55	66.7
1908	252	[a]52,606	[b]1,720	23,215,964	15,511,634	32,569,621	2.10	66.8

[a] Includes 934 United Otto, 360 Semet-Solvay, 152 Newton-Chambers, 159 rectangular, and 80 longitudinal ovens.
[b] Includes 695 rectangular and 60 longitudinal ovens.

The character of the coal used in the manufacture of coke in Pennsylvania in 1890, 1895, 1900, and from 1904 to 1908 has been as follows:

Character of coal used in the manufacture of coke in Pennsylvania since 1890, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	11,788,625	303,591	630,195	323,732	13,046,143
1895	13,618,376	34,728	440,869	117,594	14,211,567
1900	17,692,623	647,045	1,300,796	599,502	20,239,966
1904	19,447,395	697,771	1,340,474	946,424	22,432,064
1905	26,148,696	1,335,631	2,436,621	1,109,397	31,030,345
1906	27,471,566	3,972,712	1,584,152	1,475,083	34,503,513
1907	33,589,751	2,267,142	2,566,090	1,310,194	39,733,177
1908	18,691,073	1,718,944	1,062,478	1,743,469	23,215,964

RECTANGULAR OR BELGIAN OVENS.

During 1908 considerable development was made, particularly in the Connellsville district, in the construction of a new type of oven, known as the Belgian or rectangular oven. Mr. Albert Ladd Colby, consulting engineer, of South Bethlehem, Pa., has furnished the following list of companies that have constructed or have under construction ovens of this design.

The rectangular oven is not applicable to the recovery of by-products, nor does it give the yield in coke obtained in the retort or by-product oven. While more expensive in construction, it has many advantages in point of production and in economies of labor over the beehive oven. Its position as a permanent factor in the production of coke, especially in the Connellsville districts, will only be definitely determined after a longer run of the plants now in operation. All of these plants are located in the Connellsville district proper or in the Upper or Lower Connellsville district.

Rectangular or Belgian coke ovens.

Name of company.	Location of ovens.	Number of ovens.	Date put in operation, or date construction began.
W. J. Rainey Coke Co	Mount Braddock	a 12	Spring of 1906.
Do	do	38	Summer of 1908.
Connellsville Central Coke Co	New Salem	100	September, 1907.
Jones & Laughlin Steel Co	Pittsburg	a 10	Early in 1907.
F. A. Humphries Coal and Coke Co	Latrobe	40	August, 1908.
River Coal Co. (of the H. C. Frick Coke Co.)	Bridgeport	100	Began construction late in 1908.
Mount Hope Coal Co	Lynn	150	Do.
Union Connellsville Coke Co	Near Brownsville.	150	Contracted for in 1908; construction begun in February, 1909.
		600	

a Experimental.

In addition to the ovens included in the foregoing list, the Tower Hill Connellsville Coke Company reported to the Geological Survey

149 rectangular ovens completed and 595 in course of construction on December 31, 1908, and W. J. Rainey reported 186 ovens completed at Royal, but not put in blast.

PRODUCTION BY DISTRICTS.

In previous chapters of this series is has been customary to consider the production of coke in Pennsylvania according to certain well-defined districts. These divisions are based to some extent upon geographic boundaries, but also upon the quality of the coal mined and the coke produced. Each district has been more fully described in some of the preceding volumes, but the following brief statement regarding the territory included in the different coking districts is repeated here for the sake of convenience.

The Allegheny Mountain district includes the ovens along the line of the Pennsylvania Railroad from Gallitzin eastward over the crest of the Alleghenies to a point beyond Altoona. The Allegheny Valley district formerly included the coke works of Armstrong and Butler counties and one of those in Clarion County, the other ovens in the latter county being included in the Reynoldsville-Walston district. All but two of the Allegheny Valley plants have been abandoned, and the production previous to 1908 has been included in that of the Pittsburg district. During 1908 the plants were idle throughout the year. What was previously known as the Beaver district included the ovens in Beaver and Mercer counties, but all the ovens in Beaver County have been abandoned, those formerly operated by the Semet-Solvay Company in Mercer County have been abandoned, and the operations of the one establishment of United-Otto ovens at South Sharon are now also included in the Pittsburg district. The Blossburg and Broadtop districts embrace the Blossburg and Broadtop coal fields. The ovens of the Clearfield-Center district are chiefly in the two counties from which it derives its name. A few ovens constructed recently in Elk County have been included in the Clearfield-Center district. The Connellsville district is the well-known region of western Pennsylvania in Westmoreland and Fayette counties, extending from just south of Latrobe to Fairchance. The Lower Connellsville region is entirely in Fayette County and southwest of the Connellsville basin proper, from which it is separated by the Greensburg anticline. It embraces the recent developments in the vicinity of Uniontown, and is now the second producing district of the State. The Greensburg, Irwin, Pittsburg, and Reynoldsville-Walston districts include the ovens near the towns which have given the names to these districts. The Upper Connellsville district, sometimes called the Latrobe district, is near the town of Latrobe. The Semet-Solvay ovens at Chester, Steelton, and Lebanon, and the United-Otto ovens at Lebanon are in what has been designated as the Lebanon-Schuylkill district, the production of which has previously been combined with that of the Broadtop district. Owing to the number of establishments idle in several of the districts during 1908, the only ones for which separate statistics are published are: The Allegheny Mountain, Broadtop, Connellsville, Greensburg, Lower Connellsville, Pittsburg, Reynoldsville-Walston, and Upper Connellsville districts.

The statistics of the manufacture of coke in Pennsylvania, by districts, in 1907 and 1908 are presented in the following table:

Coke production in Pennsylvania in 1907 and 1908, by districts.

1907.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Allegheny Mountain.	17	a2,424	0	1,753,002	1,209,592	$3,564,117	$2.95	69
Allegheny Valley b...	2	50	0	....	....	....	....	....
Broadtop c...........	6	634	46	1,547,741	1,154,874	4,977,142	4.31	74.6
Clearfield-Center.....	7	706	0	115,388	74,187	191,378	2.58	64.3
Connellsville.........	101	d23,857	0	19,751,739	13,089,427	30,355,050	2.32	66.3
Greensburg..........	8	1,735	0	1,206,981	798,003	2,273,078	2.85	66.1
Irwin................	5	572	0	315,601	210,393	492,304	2.34	66.7
Lebanon and Schuylkill c...............	4	e482	0	....	....	....	....	....
Lower Connellsville..	62	12,264	1,068	9,150,693	6,310,900	15,758,049	2.50	69
Pittsburg f...........	10	g3,135	0	2,807,931	1,764,747	5,183,156	2.94	62.9
Reynoldsville - Walston.................	9	2,781	0	1,526,123	870,831	2,386,678	2.74	57.1
Upper Connellsville..	22	2,724	223	1,557,978	1,030,260	2,457,072	2.38	66.1
	253	51,364	1,337	39,733,177	26,513,214	67,638,024	2.55	66.7

1908.

District.	Establishments.	Built.	Building.	Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke per ton.	Yield of coal in coke (per cent).
Allegheny Mountain.	16	a2,394	99	1,208,221	859,648	$2,055,779	$2.39	71.1
Broadtop............	6	680	30	198,798	125,722	235,382	1.87	63.2
Connellsville.........	104	d24,071	118	10,238,665	6,880,951	14,025,422	2.04	67.2
Greensburg..........	7	1,690	60	1,119,391	694,032	1,489,303	2.15	62.0
Lower Connellsville..	62	h13,162	i1,203	6,156,553	4,252,222	7,796,860	1.83	69.1
Pittsburg.............	9	j3,110	150	1,742,119	1,103,413	2,592,403	2.35	63.3
Reynoldsville - Walston.................	9	2,781	0	1,198,938	655,312	1,649,541	2.50	54.7
Upper Connellsville..	22	2,906	60	779,468	514,525	897,631	1.74	66.0
Other districts k......	17	l1,812	0	573,811	425,809	1,827,300	4.29	74.2
	252	52,606	1,720	23,215,964	15,511,634	32,569,621	2.10	66.8

a Includes 372 United-Otto and 152 Newton-Chambers ovens.
b Production included in Pittsburg district.
c Production of Lebanon and Schuylkill valleys included in Broadtop district.
d Includes 110 Semet-Solvay ovens.
e Includes 250 Semet-Solvay and 232 United-Otto ovens.
f Includes production of ovens in Allegheny Valley district.
g Includes 330 United-Otto and 25 Semet-Solvay ovens.
h Includes 149 rectangular ovens.
i Includes 249 rectangular ovens.
j Includes 330 United-Otto and 10 rectangular ovens.
k Includes Allegheny Valley, Clearfield-Center, Irwin, and Lebanon and Schuylkill valleys districts.
l Includes 232 United-Otto and 250 Semet-Solvay ovens.

Allegheny Mountain district.—This district embraces the coke ovens located near Johnstown, Cambria County, and a few ovens in Somerset County. It also formerly included those lying along the line of the Pennsylvania Railroad in Indiana County. The plants in Cambria County include the United-Otto by-product ovens at Johnstown, operated in connection with the iron and steel works of the Cambria Steel Company. This plant, originally consisting of 60 ovens, was begun in 1895. Since then, however, it has been enlarged three times—100 ovens being added in March, 1899; 100 ovens more in September, 1904; and the third installment of 112 ovens being completed in February, 1907. The output of this district during 1908, like that of all the other coke-producing districts of Pennsylvania, showed the effects of the financial depression, the production declining from 1,209,592 short tons in 1907 to 859,648 short tons in 1908, a loss of 349,944 short tons, or 28.9 per cent. The value decreased in larger proportion, from $3,564,117 in 1907 to $2,055,779 in 1908, a difference of $1,508,338, or 42.3 per cent. This larger proportionate decrease in the value of the product was the result of the drop in prices, the average price per ton quoted for the year being $2.39, as compared with $2.95 in 1907, $2.85 in 1906, and $2.50 in 1905. The number of coke-making establishments in the district decreased by one, and the number of ovens from 2,424 in 1907 to 2,394 in 1908. There were, however, 99 ovens building at the close of the year, all of the beehive type. Of the 16 establishments, 2, with a total of 227 ovens, were idle throughout the year.

The statistics of the manufacture of coke in the Allegheny Mountain district in 1880, 1890, 1900, and from 1904 to 1908, have been as follows:

Statistics of the manufacture of coke in the Allegheny Mountain district of Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	8	291	0	201,345	127,525	$289,929	$2.27	63.0
1890	16	1,171	0	633,974	402,514	730,048	1.81	63.5
1900	14	1,341	0	876,440	557,184	1,260,441	2.26	63.6
1904	17	2,153	100	785,105	551,570	1,152,101	2.09	70.3
1905	17	2,245	142	1,406,540	967,042	2,421,799	2.50	68.7
1906	16	2,137	137	1,271,710	893,271	2,552,967	2.85	70.2
1907	17	2,424	0	1,753,002	1,209,592	3,564,117	2.95	69.0
1908	16	[a] 2,394	99	1,208,221	859,648	2,055,779	2.39	71.1

[a] Includes 372 United-Otto and 152 Newton-Chambers ovens.

Broadtop district.—The Broadtop district includes the coke ovens in Bedford and Huntingdon counties, coal for which is drawn from the Broadtop coal field. Although the number of establishments in the district did not change during 1908, the number of ovens was increased by 46, from 634 in 1907 to 680 in 1908, and there were 30 additional ovens building at the close of the year. In previous years it has been customary to add to the output of this district that of the Lebanon and Schuylkill valleys, comprising the United-Otto by-product ovens at Lebanon, and the Semet-Solvay operations at Lebanon, Chester, and Steelton, but this year the statistics are given for the Broadtop district itself, which accounts in part for the apparent enormous decline both in production and value. The production reported for 1908 amounted to 125,722 short tons, valued at $235,382, the average price being $1.87. It will be noted that this production shows but a slight increase over that for 1900, the production for that year amounting to 113,448 short tons, valued at $230,580, at an average price of $2.03 per ton. Of the 6 establishments reporting, 1, with a total of 18 ovens, was idle throughout the year. Another large establishment was operated but two weeks out of the year.

The statistics of the manufacture of coke in the Broadtop district in 1880, 1890, 1900, and for the last five years, have been as follows:

Statistics of the manufacture of coke in the Broadtop district, Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	5	188	105	92,894	51,130	$123,748	$2.40	55.0
1890	5	482	16	247,823	157,208	314,416	2.00	63.0
1900	5	532	0	179,088	113,448	230,580	2.03	63.0
1904 [a]	5	606	0	358,807	237,639	645,045	2.71	66.2
1905 [b]	5	614	0	687,954	483,198	1,544,966	3.20	70.2
1906 [b]	5	584	0	978,893	710,143	2,824,343	3.98	72.5
1907 [c]	6	634	46	1,547,741	1,154,874	4,977,142	4.31	74.6
1908	6	680	30	198,798	125,722	235,382	1.87	63.2

[a] Includes production and value of coke in by-product ovens at Lebanon and Chester.
[b] Includes production and value of coke in by-product ovens at Lebanon.
[c] Includes production and value of coke in by product ovens at Steelton, Lebanon, and Chester.

Clearfield-Center-Elk district.—Of the 6 establishments credited to this district (which obtains its name from the counties in which the ovens are located) 5 were idle, and the output of the 1 operating establishment has been added to that of other districts in order not to divulge individual operations. The production of this district has been steadily declining for some years, its maximum output of 212,286 short tons having occurred in 1890.

Statistics of the manufacture of coke in the Clearfield-Center-Elk district, Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	0	0	200	100	$200	$2.00	50.0
1890	7	701	0	331,104	212,286	391,957	1.85	64.0
1900	7	568	0	212,196	134,828	283,592	2.10	63.5
1904	9	828	0	61,564	35,931	79,746	2.22	58.4
1905	8	648	0	182,659	119,651	273,028	2.28	65.5
1906	7	738	0	91,822	56,634	162,722	2.87	61.6
1907	7	706	0	115,388	74,187	191,378	2.58	64.3
1908	6	706	0	(a)	(a)	(a)	(a)	(a)

[a] Included in other districts.

Connellsville district.—The Connellsville district of Pennsylvania is the largest coke-producing district in the world. The coal basin occupies a comparatively narrow synclinal trough, extending in a northeast-southwest direction nearly across the two counties of Fayette and Westmoreland, within the boundaries of which it is entirely contained. It lies a short distance east of the city of Pittsburg, and supplies the larger part of the fuel consumed in the iron and steel furnaces of Pittsburg and vicinity, the greatest iron-manufacturing center of the world. Large quantities of Connellsville coke are also shipped to distant points of consumption. This district, until 1903, produced from 40 to 50 per cent of the total coke output of the United States, the smaller percentage during the last four years being due to the largely increased production from the Lower Connellsville or Klondike region, which lies entirely within

Fayette County, and which is separated from the Connellsville basin proper by the Greensburg anticline. If to the Connellsville production is added that of the Lower Connellsville, the supremacy of the region has been more than maintained.

Connellsville coal is the ideal fuel for coking in beehive ovens, and it is probably to the success of the beehive practice in the Connellsville district that is due the prevalence of the beehive oven in coke manufacturing in the United States, manufacturers being led by the idea that because beehive coke manufactured from Connellsville coal is the standard for furnace and foundry use, other coal should also be coked in beehive ovens, whereas many coals are found to give more satisfactory results in retort ovens. Connellsville coke is considered by some ironmasters as without rival for blast-furnace use, and is undoubtedly the standard by which all other blast-furnace cokes are judged.

At the close of 1908 there were 24,071 ovens in the Connellsville district with 118 building, against 23,857 ovens built and no new ovens under construction at the close of 1907. All of the 24,071 ovens in the district at the close of 1908 were of the beehive type, except 110 Semet-Solvay ovens and 50 Mitchell rectangular ovens. The 24,071 ovens were distributed among 104 establishments, an increase of 3 establishments over 1907. Fourteen of the establishments, having 857 ovens, were idle during the year. One of the idle establishments consisted of 20 new ovens completed just before the end of 1908 but not put in blast.

The effect of the depression in the iron trade was nowhere more significantly illustrated than in the production of Connellsville coke. In 1908 the total production of coke in the Connellsville district amounted to 6,880,951 short tons, valued at $14,025,422, against 13,089,427 short tons, valued at $30,355,050, in 1907, the decrease in 1908 amounting to 6,208,476 short tons, or 47.4 per cent, in quantity, and $16,329,628, or 53.8 per cent, in value. The average price per ton declined from $2.32 in 1907 to $2.04 in 1908. The production of Connellsville coke in 1908 was only slightly more than in 1890, eighteen years before, when there were only 15,865 ovens in the district. The average production per active oven in 1908 was 296 short tons, compared with 553 short tons in 1907.

In the following table are presented the statistics of the manufacture of coke in the Connellsville district in 1880, 1890, 1900, and from 1904 to 1908:

Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
1880	67	7,211	731	3,367,856	2,205,946	$3,948,643	$1.79	65.5
1890	28	15,865	30	9,748,449	6,464,156	11,537,370	1.94	66.3
1900	98	20,981	686	14,946,659	10,020,907	22,383,432	2.23	67.0
1904	101	22,695	1,044	13,185,690	8,883,220	13,990,329	1.58	67.4
1905	100	22,033	200	16,980,341	11,365,077	22,315,361	1.96	66.9
1906	101	23,616	142	17,956,160	12,057,840	26,858,660	2.23	67.1
1907	101	23,857	0	19,751,739	13,089,427	30,355,050	2.32	66.3
1908	104	[a]24,071	118	10,238,665	6,880,951	14,025,422	2.04	67.2

[a] Includes 110 Semet-Solvay by-product ovens.

The following table, compiled by the Connellsville Courier, of Connellsville, Pa., shows the shipments of coke from the Connellsville region in 1907 and 1908, by months, in cars and tons, with the average number of cars shipped each working day in the month. These figures include coke made in the Upper and the Lower Connellsville districts as well as in the Connellsville district proper. The figures of production as reported to the Geological Survey both in 1907 and 1908 are somewhat in excess of the shipments as reported by the Courier. In 1907 the total production of the Connellsville district, including the Upper and the Lower Connellsville districts, as reported to the Survey, was 20,430,587 short tons, while the shipments as reported by the Courier were 19,029,058 short tons. In 1908 the production reported to the Survey was 11,647,698 short tons, and the shipments according to the Courier were 10,700,022 short tons.

Shipments of coke from the Connellsville region, including Upper and Lower Connellsville districts, in 1907 and 1908, by months.

Month.	1907.			1908.		
	Cars.	Daily average.	Short tons.	Cars.	Daily average.	Short tons.
January	62,240	2,305	1,698,475	25,632	949	742,096
February	59,272	2,470	1,625,783	27,041	1,081	810,436
March	61,999	2,384	1,701,342	28,664	1,102	841,059
April	62,585	2,407	1,708,590	26,314	1,012	772,915
May	65,929	2,442	1,787,611	25,567	948	759,813
June	61,518	2,461	1,677,488	26,904	1,034	772,367
July	63,577	2,355	1,741,612	30,066	1,113	856,843
August	65,262	2,417	1,787,190	32,938	1,266	952,492
September	59,637	2,386	1,650,207	33,646	1,294	975,606
October	64,656	2,395	1,805,307	35,252	1,305	1,030,552
November	41,412	1,593	1,167,796	34,665	1,386	995,807
December	23,670	910	677,657	41,533	1,597	1,190,036
	691,757	2,210	19,029,058	368,222	1,173	10,700,022

The monthly shipments of coke from this region in the years 1904 to 1908, as reported by the Courier, are given in the following table:

Monthly shipments of coke from the Connellsville region, 1904–1908, in short tons.

Month.	1904.	1905.	1906.	1907.	1908.
January	718,382	1,283,152	1,665,747	1,698,475	742,096
February	845,428	1,350,128	1,435,452	1,625,783	810,436
March	1,062 192	1,497,756	1,683,212	1,701,342	841,059
April	1,118,043	1,843,502	1,604,906	1,708,590	772,915
May	1,146,907	1,451,554	1,739,743	1,787,611	759,813
June	945,520	1,354,470	1,654,209	1,677,488	772,367
July	887,402	1,622,998	1,662,545	1,741,612	856,843
August	975,724	1,328,002	1,685,036	1,787,190	952,492
September	1,153,471	1,726,734	1,610,509	1,650,207	975,606
October	1,148,089	1,430,238	1,850,450	1,805,307	1,030,552
November	1,207,131	1,488,942	1,752,234	1,167,796	995,807
December	1,219,174	1,519,050	1,655,283	677,657	1,190,036
	12,427,463	17,896,526	19,999,326	19,029,058	10,700,022

The total shipments, in cars, for the last twenty-one years were as follows:

Total and daily average shipments, in cars, 1888–1908.

Year.	Daily average.	Total cars.	Year.	Daily average.	Total cars.	Year.	Daily average.	Total cars.
1888	905	282,441	1895	1,410	441,243	1902	1,986	624,198
1889	1,046	326,220	1896	920	289,137	1903	1,782	558,738
1890	1,147	355,070	1897	1,181	367,383	1904	1,623	510,759
1891	884	274,000	1898	1,415	441,249	1905	1,886	688,328
1892	1,106	347,012	1899	1,676	523,203	1906	2,385	745,274
1893	874	270,930	1900	1,619	504,410	1907	2,210	691,757
1894	900	281,677	1901	1,857	581,051	1908	1,173	368,222

The following table shows the prices for Connellsville furnace and foundry coke, by months, during the years 1904 to 1908. The prices quoted are those reported by The Iron Age, and are for strictly Connellsville coke. "Main line" and "outside" cokes are usually quoted from 15 to 20 cents below the Connellsville. It would appear from this table that the values for Connellsville furnace coke during 1908 were less than $2 per ton, although for foundry coke the average prices were in excess of that figure. The average price for all coke produced in the Connellsville district, obtained by dividing the value by the production, was $2.04 per ton, indicating that the proportion of foundry coke sold was somewhat above the average, or that some coke was sold, probably in small lots, at rates higher than the prices reported to The Iron Age.

Prices of Connellsville furnace and foundry coke, 1904–1908, by months.

Month.	Furnace.				
	1904.	1905.	1906.	1907.	1908.
January	$1.60 to $1.65	$2.10 to $3.00	$2.15 to $2.75	$3.50 to $3.75	$1.90 to $2.25
February	1.50 to 1.65	2.00 to 2.75	2.10 to 2.50	3.50 to 3.65	1.70 to 2.25
March	1.60 to 1.75	2.25 to 2.50	2.20 to 2.50	2.90 to 3.25	1.80 to 1.85
April	1.60 to 1.65	1.90 to 2.25	2.30 to 2.75	2.65 to 2.85	1.50 to 1.60
May	1.60 to 1.65	1.80 to 2.00	2.30 to 2.75	2.00 to 2.85	1.50 to 1.60
June	1.40 to 1.65	1.75 to 2.10	2.30 to 2.50	1.75 to 2.65	1.50 to 1.60
July	1.40 to 1.50	1.75 to 2.10	2.40 to 2.75	2.40 to 2.60	1.50 to 1.60
August	1.45 to 1.50	1.80 to 2.10	2.75 to 2.85	2.40 to 2.85	1.50 to 1.55
September	1.40 to 1.50	1.90 to 2.50	2.85 to 2.90	2.75 to 2.90	1.50 to 1.55
October	1.45 to 1.65	2.35 to 3.10	2.75 to 3.25	2.75 to 3.00	1.50 to 1.65
November	1.75 to 2.15	2.85 to 3.00	3.00 to 3.60	2.00 to 2.75	1.65 to 1.85
December	2.10 to 2.45	2.75 to 2.90	3.00 to 3.60	2.00 to 2.50	1.75 to 1.90

Month.	Foundry.				
	1904.	1905.	1906.	1907.	1908.
January	$2.10 to $2.50	$2.25 to $2.75	$2.75 to $3.50	$4.00 to $4.50	$2.00 to $2.65
February	2.10 to 2.25	2.50 to 3.00	2.50 to 3.00	3.75 to 4.50	2.40 to 2.75
March	2.10 to 2.50	2.75 to 3.25	2.75 to 3.25	3.50 to 4.00	2.10 to 2.40
April	2.15 to 2.50	2.65 to 3.00	2.90 to 3.10	3.25 to 3.75	1.85 to 2.25
May	2.00 to 2.15	2.50 to 2.75	2.65 to 3.10	2.75 to 3.25	2.00 to 2.25
June	1.80 to 2.00	2.35 to 2.65	2.65 to 2.75	3.00 to 3.25	2.00 to 2.25
July	1.75 to 1.85	2.25 to 2.50	2.75 to 3.00	3.00 to 3.25	2.00 to 2.25
August	1.75 to 1.85	2.25 to 2.50	3.00 to 3.25	3.00 to 3.75	1.90 to 2.25
September	1.75 to 2.00	2.40 to 3.00	3.25 to 3.50	3.15 to 3.50	1.90 to 2.00
October	1.80 to 2.25	2.75 to 3.50	3.25 to 4.00	3.25 to 3.40	2.00 to 2.25
November	2.00 to 2.50	3.50 to 4.00	3.75 to 4.50	2.50 to 3.00	2.15 to 2.25
December	2.25 to 2.50	3.40 to 4.00	3.75 to 4.50	2.50 to 2.75	2.15 to 2.25

Greensburg district.—The ovens in the Greensburg district are all located in the vicinity of Greensburg. At the close of 1908 there were 7 establishments in this district, a decrease of 1 from 1907, and the number of ovens in existence decreased from 1,735 in 1907 to 1,690 in 1908. There were 60 ovens under construction at the end of the year. Of the 7 establishments in the district 1, of 10 ovens, was idle throughout the year. The production for 1908 amounted to 694,032 short tons, valued at $1,489,303, as compared with 798,003 short tons, valued at $2,273,078 in 1907. The average price per ton declined from $2.85 in 1907 to $2.15 in 1908.

The statistics of the manufacture of coke in the Greensburg district, in 1889, 1890, 1900, and from 1904 to 1908, are given in the following table:

Statistics of the manufacture of coke in the Greensburg district, Pennsylvania, 1889–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1889	2	50	16	32,070	20,459	$21,523	$1.05	63.8
1890	2	58	0	44,000	30,261	44,290	1.46	68.7
1900	5	680	280	331,305	196,709	442,704	2.25	59.4
1904	7	1,332	0	511,303	314,954	551,228	1.75	61.6
1905	7	1,328	100	908,003	551,233	1,155,958	2.10	60.7
1906	8	1,428	260	1,118,227	678,817	1,641,473	2.42	60.7
1907	8	1,735	0	1,206,981	798,003	2,273,078	2.85	66.1
1908	7	1,690	60	1,119,391	694,032	1,489,303	2.15	62.0

Irwin district.—The Irwin district is of minor importance and includes a total of 572 ovens located near the town of Irwin, in Westmoreland County. Of the 5 establishments and 572 ovens, 4 establishments, having 472 ovens, were idle during 1908. The statistics of production for 1908 are therefore included with the Clearfield-Center and Lebanon and Schuylkill valleys districts.

The statistics of production for 1889, 1890, 1900, and from 1904 to 1907, have been as follows:

Statistics of the manufacture of coke in the Irwin district, Pennsylvania, 1889–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1889	4	696	0	373,913	243,448	$351,304	$1.44	65
1890	4	661	0	270,476	172,329	256,458	1.49	63.7
1900	5	697	0	93,647	61,630	153,743	2.49	65.8
1904	6	691	0	14,468	8,793	14,576	1.66	60.8
1905	5	680	27	258,039	164,601	325,746	1.98	63.8
1906	5	581	0	348,007	230,552	510,572	2.21	66.2
1907	5	572	0	315,601	210,393	492,304	2.34	66.7
1908	5	572	0	(a)	(a)	(a)	(a)	(a)

a Included in other districts.

Lower Connellsville district.—This district, sometimes called the "Klondike," is located in the western part of Fayette County, immediately west of the south end of the Connellsville basin, from which it is separated by the Greensburg anticline. Although but nine years old, having been opened in 1900, it ranks next to Connellsville among the coke-making districts in the United States, having in 1907 three times, and in 1908 more than four times, the output of the Flat Top district in Virginia and West Virginia, which until 1902 was the second coke-producing region in the United States. The development of this district surpasses all records in the United States, and the production up to 1907 increased with phenomenal rapidity. Following the abnormal conditions in 1904, the production of coke in Pennsylvania showed a decrease in every district except the Lower Connellsville. The year 1908, therefore, records the first time in the history of the district in which the production was less than in the preceding year. The output in 1908 amounted to 4,252,222 short tons, valued at $7,796,860, against 6,310,900 short tons, valued at $15,758,049, in 1907, a decrease of 2,058,678 short tons, or 32.6 per cent in quantity, and of $7,961,189, or 50.6 per cent in value. Even with this decrease the percentage of loss was less in the Lower Connellsville district than it was in either the Connellsville district proper or the Upper Connellsville district. At the close of 1908 there were 62 establishments, the same as in 1907. These included one establishment of 186 Mitchell ovens which were completed before the close of the year, but which, on account of the unfavorable market conditions, had not been put in blast. Of the 62 establishments 8, having a total of 660 ovens, were idle during the year. The total number of ovens in the district at the close of 1908 was 13,162, an increase of 898 over 1907. There were also 1,203 ovens in course of construction at the end of the year. The completed ovens included 100 Belgian and 149 rectangular ovens. There were 695 rectangular ovens among those under construction at the close of the year.

The record of the district in 1900, and from 1904 to 1908, has been as follows:

Statistics of the manufacture of coke in the Lower Connellsville district, Pennsylvania, 1900, and 1904–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1900	12	2,033	1,112	579,928	385,909	$792,886	$2.05	66.5
1904	34	6,570	250	4,229,755	2,887,456	4,623,133	1.60	68.2
1905	45	7,484	1,145	5,666,812	3,871,310	7,532,382	1.95	68.3
1906	53	9,708	1,502	7,465,205	5,188,135	12,046,889	2.32	69.4
1907	62	12,264	1,068	9,150,693	6,310,900	15,758,049	2.50	69.0
1908	62	[a] 13,162	[b] 1,203	6,156,553	4,252,222	7,796,860	1.83	69.1

[a] Includes 100 Belgian and 149 rectangular ovens. [b] Includes 695 rectangular ovens.

Lebanon Valley and Schuylkill districts.—All of the by-product ovens in the Lebanon and Schuylkill valleys, which include 120 Semet-Solvay ovens at Steelton, 40 at Chester, 90 Semet-Solvay ovens at Lebanon, and 232 Otto-Hoffman ovens at Lebanon, were operated during 1908, though with a materially reduced production as compared with 1907. The total production from this district was 350,724 short tons, as compared with 909,188 short tons produced in 1907. The details of production are included with the Allegheny Valley, Irwin, and Clearfield-Center districts.

Pittsburg district.—A large part of the production of the Pittsburg district is from slack coal obtained from the mines along the slack-water navigation of the Monongahela River and is brought to Pittsburg on barges. Some run-of-mine coal is also brought from the fourth pool of the Monongahela River at Pittsburg. The production of 120 Otto-Hoffman ovens at Glassport and of 210 United-Otto ovens at South Sharon is included in this district. The 25 Semet-Solvay ovens at Sharon, in Mercer County, which were also previously included in the Pittsburg district, have been dismantled. The 2 plants of 52 ovens credited to the Allegheny Valley district, the production of which has also been previously included with the Pittsburg district, have been taken out this year and included with the Clearfield-Center, Irwin, and Lebanon and Schuylkill valleys districts, the plants being idle throughout the year. This reduced the number of establishments in the Pittsburg district to 9, and the number of ovens to 3,110. Of these, 100 were idle throughout the year. There were, however, 150 building at the close of the year. The total production of the district amounted in 1908 to 1,103,413 short tons, valued at $2,592,403, a decrease as compared with the production of 1907 of 661,334 short tons, or 37.5 per cent in quantity, and of $2,590,753, or 50 per cent, in value. The average price per ton declined from $2.94 in 1907 to $2.35 in 1908.

The statistics of the manufacture of coke in the Pittsburg district in 1880, 1890, 1900, and from 1904 to 1908, are given in the following table:

Statistics of the manufacture of coke in the Pittsburg district, Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	21	534	0	194,393	105,974	$254,500	$2.40	55.0
1890	14	541	0	149,230	93,984	171,465	1.82	63.0
1900	8	1,641	0	862,610	570,678	1,418,382	2.48	66.1
1904 [a]	8	2,195	0	1,370,629	841,459	1,795,257	2.13	61.4
1905 [a]	8	2,226	380	2,317,159	1,463,774	3,599,436	2.46	63.2
1906 [a]	10	2,868	0	2,376,403	1,463,795	3,620,030	2.47	61.5
1907 [a]	12	3,185	0	2,807,931	1,764,747	5,183,156	2.94	62.9
1908	[b] 9	[c] 3,110	150	1,742,119	1,103,413	2,592,403	2.35	63.3

[a] Includes ovens and production in Allegheny Valley district.
[b] Includes 1 establishment in Mercer County and 1 in Beaver County.
[c] Includes 330 United-Otto ovens.

Reynoldsville-Walston district.—This district, in Jefferson and Clearfield counties, includes all of the ovens along the line of the Rochester and Pittsburg Railroad, as well as those of the low-grade division of the Allegheny Valley Railway and those connected with the mines of the New York Central and Hudson River Railroad. The number of establishments in the district in 1908 was 9, the same as in 1907. Of these, 2, having a total of 140 ovens, were idle throughout the year. The total number of ovens at the close of 1908 was 2,781, the same as in 1907. The production decreased from 870,831 short tons, valued at $2,386,678, in 1907, to 655,312 short tons, valued at $1,649,541, in 1908, a loss of 215,519 short tons, or 24.7 per cent, in quantity, and of $737,137, or 30.9 per cent, in value. The average price per ton declined from $2.74 to $2.50.

The following table gives the statistics of the manufacture of coke in the Reynoldsville-Walston district for 1880, 1890, 1900, and from 1904 to 1908, inclusive:

Statistics of the manufacture of coke in the Reynoldsville-Walston district, Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	3	117	0	45,055	28,090	$46,359	$1.65	62.0
1890	8	1,737	0	652,966	406,184	771,996	1.90	62.0
1900	7	2,010	0	1,115,923	625,553	1,347,869	2.15	56.0
1904	8	2,101	200	1,313,507	709,502	1,585,950	2.24	54.0
1905	8	2,303	200	1,463,680	831,904	1,638,934	1.97	56.8
1906	8	2,502	0	1,399,801	770,095	1,794,127	2.33	55.8
1907	9	2,781	0	1,526,123	870,831	2,386,678	2.74	57.1
1908	9	2,781	0	1,198,938	655,312	1,649,541	2.50	54.7

Upper Connellsville district.—This district includes that portion of the Connellsville trough or basin which lies north of a point a short distance south of the town of Latrobe, Westmoreland County. The coal of this district differs somewhat from that of the basin proper, so that, in addition to its geographic position, there is another reason for separating the production from that of the Connellsville district. The percentage of decrease in the Upper Connellsville district for 1908 as compared with 1907 was greater than in any of the other coke-producing districts of the State. The production in this district decreased a little over 50 per cent, from 1,030,260 short tons in 1907 to 514,525 short tons in 1908, while the value decreased 63.5 per cent, from $2,457,072 in 1907 to $897,631 in 1908. The average price per ton declined from $2.38 to $1.74. The number of establishments in the district in 1908 was the same as in the two preceding years, with an increase of 182 in the number of ovens in existence. Of the 22 establishments, 4, with a total of 74 ovens, were idle during the year.

The statistics of the manufacture of coke in the Upper Connellsville district in 1880, 1890, 1900, and from 1904 to 1908, are shown in the following table:

Statistics of the manufacture of coke in the Upper Connellsville district, Pennsylvania, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	8	757	0	319,927	229,433	$397,945	$1.73	72.0
1890	14	1,569	28	889,277	577,246	1,008,102	1.75	64.9
1900	14	1,999	0	1,042,170	690,449	1,378,629	2.00	66.2
1904	19	2,660	27	601,236	390,540	590,097	1.51	64.9
1905	19	2,434	30	1,159,158	755,946	1,445,568	1.91	65.2
1906	22	2,516	332	1,497,285	1,011,229	2,172,748	2.15	67.5
1907	22	2,724	223	1,557,978	1,030,260	2,457,072	2.38	66.1
1908	22	2,906	60	779,468	514,525	897,631	1.74	66.0

Other districts.—In order not to divulge the individual reports that were made to the Geological Survey, the statistics of the manufacture of coke in the Allegheny Valley, Clearfield-Center, Irwin, and Lebanon and Schuylkill Valley districts for 1908 have been combined, and are shown in the following table. Of the 17 establishments given, 11, with a total of 1,130 ovens, were idle throughout the year.

Statistics of the manufacture of coke in the Allegheny Valley, Clearfield-Center, Irwin, and Lebanon and Schuylkill Valley districts, 1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1908	17	1,812	0	573,811	425,809	$1,827,300	$4.29	74.2

TENNESSEE.

Coke making in Tennessee showed a larger percentage of decrease in 1908 as compared with 1907 than in any other of the important coke-producing States. There were only 2 States which showed a larger percentage of decrease, Kansas and Oklahoma, and the total production of these two States was only a little over 5,000 tons. The depression in the iron trade seems to have been particularly felt in Tennessee, and the production of coke in that State decreased from 467,499 short tons, valued at $1,592,225, in 1907, to 214,528 short tons, valued at $561,789, in 1908, a decrease of 252,971 short tons, or 54.11 per cent in quantity, and of $1,030,436, or 64.72 per cent in value. The total number of establishments in the State at the close of 1908 was 17, a decrease of one from 1907; and the total number of ovens decreased from 2,806 to 2,792. One plant of 72 ovens was abandoned in 1908, while 58 ovens were added to other plants. Of the 17 establishments in the State, 7 made coke, one of 20 ovens was under construction, and 9, with a total of 1,430 ovens, were idle.

The statistics of the manufacture of coke in Tennessee in the years 1880, 1890, 1900, and from 1904 to 1908 are shown in the following table:

Statistics of the manufacture of coke in Tennessee, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	6	656	68	217,656	130,609	$316,607	$2.42	60.0
1890	11	1,664	292	600,387	348,728	684,116	1.96	58.0
1900	14	2,107	340	854,789	475,432	1,269,555	2.67	55.6
1904	17	2,436	190	718,181	379,240	905,540	2.39	52.8
1905	16	2,615	60	862,320	468,092	1,184,442	2.53	54.3
1906	17	2,731	138	929,405	483,428	1,350,856	2.79	52.0
1907	18	2,806	80	825,221	467,499	1,592,225	3.41	56.6
1908	17	2,792	20	395,936	214,528	561,789	2.62	54.2

There were 395,936 tons of coal used in the manufacture of coke in Tennessee in 1908, of which 132,246 were unwashed and 263,690 washed. All of the unwashed slack used was at the state plant, operated in connection with the penitentiary at Petros.

The character of the coal used in the manufacture of coke in Tennessee in 1890, 1900, and since 1904, is shown in the following table:

Character of coal used in the manufacture of coke in Tennessee, 1890, 1900, and 1904–1908, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	255,359	0	273,028	72,000	600,387
1900	150,697	349,448	24,122	330,522	854,789
1904	1,471	302,943	60,784	352,983	718,181
1905	134,432	244,302	46,073	437,513	862,320
1906	81,825	509,532	142,843	195,205	929,405
1907	54,397	386,094	0	384,730	825,221
1908	29,668	250,120	102,578	13,570	395,936

UTAH.

As there is but one company in Utah engaged in the manufacture of coke, the statistics of production have been included with those of the State of Colorado, which adjoins Utah on the east. The coals of Utah which are used in the manufacture of coke are practically identical in character with those of western Colorado.

VIRGINIA.

All the coking coals of Virginia are contained within a few counties in the extreme southwestern portion of the State which lie within the coal fields of the Appalachian province. The development of this region began in 1883 with the completion of the New River division of the Norfolk and Western Railway, and for ten years the manufacture of coke, as well as the production of coal in Virginia, was almost entirely from Tazewell County. Ten years from the opening of the district, or in 1893, the Norfolk and Western Railway completed a branch up the Clinch Valley and opened up what is now the most important coking-coal district in Wise County. During 1906 and 1907 extensive developments in what is known as the Black Mountain field in Lee County followed the construction into that district of the Black Mountain Railroad, now operated jointly by the Southern Railway and the Louisville and Nashville Railroad. The first ovens in Lee County were reported as under construction in 1907, and an output of something over 50,000 tons was reported at Keokee in 1908. This district, a brief description of which is given in Bulletin 341,[a] promises to rival in development and production the rapid growth of Wise County. Notwithstanding the new production from Lee County in 1908, the total production of coke in the State decreased from 1,545,280 tons, valued at $3,765,733, in 1907 to 1,162,051 tons, valued at $2,121,980, in 1908, a decline of 383,229 tons, or 24.8 per cent, in quantity, and of $1,643,753, or 43.65 per cent, in value. The production in 1908 was the smallest since 1904. The average price per ton declined from $2.44 to $1.83. There were 19 establishments in the State at the close of 1908, the same as in 1907. Owing to the dismantling of a number of ovens at several of the plants, the total number of ovens decreased from 5,333 in 1907 to 4,853 in 1908. Five

[a] Contributions to economic geology for 1907, pt. 2: Bull. U. S. Geol. Survey No. 341, 1909, pp. 409–418.

of the 19 establishments and 751 of the ovens were idle during the year. The idle ovens include the 56 Newton-Chambers ovens at Pocahontas, which have not been operated during the last five or six years, and also include some ovens in establishments which operated only a portion of the year. The coke manufactured in Wise County, on the Clinch Valley branch of the Norfolk and Western Railway, and in the Black Mountain district in Lee County is the only coke made in Virginia from coal mined exclusively within the State. There are two plants in Virginia, one at Lowmoor and one at Covington, the coal for both of which is drawn from the mines in the New River district of West Virginia. The coal for the ovens at Pocahontas in Tazewell County is obtained from mines whose workings extend across the state boundary line into West Virginia and a part of this coal production should properly be credited to West Virginia. The openings of the mines, however, and the coke ovens, are in Tazewell County, and it is customary to credit the coal, as well as the coke, to Virginia.

The statistics of the manufacture of coke in Virginia in 1883, when the first operations were begun, and in 1890, 1900, and from 1904 to 1908, inclusive, are shown in the following table:

Statistics of the manufacture of coke in Virginia, 1883–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1883	1	200	0	39,000	25,340	$44,345	$1.75	65.0
1890	2	550	250	251,683	165,847	278,724	1.68	66.0
1900	7	2,331	300	1,083,827	685,156	1,464,556	2.14	63.2
1904	16	4,345	68	1,636,905	1,101,716	1,772,717	1.61	67.3
1905	16	4,549	0	2,184,369	1,499,481	2,869,452	1.91	68.6
1906	18	4,641	695	2,296,227	1,577,659	3,611,659	2.29	68.7
1907	19	5,333	50	2,264,720	1,545,280	3,765,733	2.44	68.2
1908	19	[a] 4,853	158	1,785,281	1,162,051	2,121,980	1.83	65.1

[a] Includes 56 Newton-Chambers by-product ovens.

All of the coal used in the manufacture of coke in Virginia in both 1907 and 1908 was unwashed. The small demand for coal during 1908 is shown by an increase of 167,236 tons in the quantity of run-of-mine coal charged into the ovens, while the quantity of slack coal decreased 646,675 tons, from 993,202 tons in 1907 to 346,527 tons in 1908.

The following table shows the character of the coal used in coke making in Virginia in 1890, 1900, and from 1904 to 1908:

Character of coal used in the manufacture of coke in Virginia, 1890–1908, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	98,215	0	153,468	0	251,683
1900	620,207	0	463,620	0	1,083,827
1904	1,213,226	44,222	379,457	0	1,636,905
1905	1,096,656	0	1,087,713	0	2,184,369
1906	1,014,299	228,347	1,053,581	0	2,296,227
1907	1,271,518	0	993,202	0	2,264,720
1908	1,438,754	0	346,527	0	1,785,281

WASHINGTON.

There are 6 coke-making establishments in Washington, 4 of which manufactured coke in 1908, while 2, with a total of 31 ovens, were idle. One of the active establishments having 25 ovens was a new construction and made coke for the first time in 1908. Washington is the only State west of the Rocky Mountains in which coking coals occur. The industry is not a large one when compared with the operations in some of the Eastern States, but is of interest as showing the availability of smelter and blast-furnace fuel for such industries in the Pacific coast States. All of the coking operations at present are in Pierce County, in the central part of the State, but recent tests made at the Geological Survey plant at Denver established the coking qualities of coal from the northern part of the Roslyn field in Kittitas County. The production of coke in Washington in 1908 amounted to 38,889 short tons, valued at $213,138, compared with 52,028 tons, valued at $293,019, reported in 1907. The average price per ton declined from $5.63 in 1907 to $5.48 in 1908. All of the coal used in the manufacture of coke in Washington in 1908 was washed run-of-mine.

The coke-making industry of Washington began in 1884, when 400 tons of coke were produced. The record since that time has been as follows:

Statistics of the manufacture of coke in Washington, 1884–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1884	1	0	0	700	400	$1,900	$4.75	57.5
1890	2	30	80	9,120	5,837	46,696	8.00	64.0
1900	2	90	0	54,310	33,387	160,165	4.80	61.5
1904	6	256	0	76,993	45,432	207,357	4.56	59.0
1905	5	216	0	85,715	53,137	251,717	4.74	62.0
1906	5	216	0	76,896	45,642	226,977	4.99	59.4
1907	5	216	0	85,860	52,028	293,019	5.63	60.6
1908	6	231	50	68,069	38,889	213,138	5.48	57.1

WEST VIRGINIA.

West Virginia ranks second among the States in the quantity of coke produced, though when the value of the product is considered Alabama leads West Virginia. In 1908 West Virginia's coke product exceeded that of Alabama's by 274,457 tons, while the value of Alabama's product exceeded that of West Virginia by $1,902,847. Although there is no question that the quality of the West Virginia coke is fully up to that of Alabama, the latter possesses the advantage of markets close at hand in the iron manufacturing industries of the State, while by far the greater part of West Virginia's output is shipped to furnaces outside the State's borders. The effects of these conditions are shown by the fact that while West Virginia's product in 1908 was worth an average of $2 per ton, that of the Alabama product averaged $3.04.

The production of coke in West Virginia in 1908 amounted to 2,637,123 short tons, valued at $5,267,054, against 4,112,896 short tons, valued at $9,717,130, in 1907. The decrease in 1908 from 1907 amounted to 1,475,773 tons, or 35.88 per cent in quantity, and to $4,450,076, or 45.8 per cent in value. The average price per ton declined from $2.36 to $2. The number of ovens increased from 19,688 to 20,124, although there was a decrease of 4 in the number of establishments, from 142 to 138. Three of the abandoned establishments, with a total of 104 ovens, were in the Upper Monongahela district. All of these had been idle for a number of years. Of the 138 establishments 34, with a total of 2,605 ovens, were idle. Of the 34 idle establishments 18 were in the Upper Monongahela district, 12 were in the New River district, 2 were in the Kanawha district, and 1 each was in the Flat Top and Upper Potomac districts.

In the following table will be found the statistics of the manufacture of coke in West Virginia in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in West Virginia, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	18	631	40	230,758	138,755	$318,797	$2.30	60
1890	55	4,060	334	1,395,266	833,377	1,524,746	1.83	60
1900	106	10,249	1,306	3,868,840	2,358,499	4,746,633	2.01	60.9
1904	137	16,929	1,319	3,543,338	2,283,086	3,757,850	1.65	64.4
1905	143	19,189	1,214	5,329,695	3,400,593	6,548,205	1.92	63.8
1906	141	19,714	353	5,822,619	3,713,514	8,192,956	2.21	63.8
1907	142	19,688	459	6,536,795	4,112,896	9,717,130	2.36	62.9
1908	138	[a]20,124	0	4,127,730	2,637,123	5,267,054	2.00	63.9

[a] Includes 120 Semet-Solvay ovens at Wheeling.

As shown in the following table, approximately 60 per cent of the coal used for coke making in West Virginia is slack, nearly all of which is used without being washed. Of the 4,127,730 tons of coal charged into the ovens in 1908, 3,901,093 tons were unwashed and 226,637 tons were washed. Of the unwashed 1,694,470 tons were run-of-mine and 2,206,623 tons were slack.

The character of the coal used in the manufacture of coke in West Virginia in 1890, 1900, and from 1904 to 1908, is shown in the following table:

Character of coal used in the manufacture of coke in West Virginia, 1890–1908, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	324,847	0	930,989	139,430	1,395,266
1900	509,960	8,000	3,140,064	210,816	3,868,840
1904	1,247,935	1,350	2,128,251	165,802	3,543,338
1905	1,445,099	1,950	3,577,793	304,853	5,329,695
1906	2,093,483	0	3,388,877	340,259	5,822,619
1907	2,451,811	27,067	3,874,817	183,100	6,536,795
1908	1,694,470	35,226	2,206,623	191,411	4,127,730

PRODUCTION BY DISTRICTS.

It has been customary in the preceding reports of this series to consider the coke production by the districts into which the State has been divided. These districts are known, respectively, as the

Upper Monongahela, the Upper Potomac, the Kanawha, the New River, and the Flat Top. The first two are in the northern part of the State and are named from the fact that they are drained by the headwaters of Monongahela and Potomac rivers. The other three districts are in the southern part of the State. The New River district includes the ovens along the line of the Chesapeake and Ohio Railway and its branches from Quinnimont to Hawks Nest, near which point the coals of the New River region go below water level. The Kanawha district embraces all of the ovens along Kanawha River and its tributaries from Mount Carbon to the western limit of the coal fields. The ovens of the Gauley Mountain Coal Company at Ansted are included in the New River district, although the Ansted coal belongs in reality to the Kanawha coal series and lies about 1,000 feet above the New River coals. The Flat Top region is drained by the upper portions of New, Guyandotte, and Big Sandy rivers, and includes the ovens in West Virginia which belong to the Pocahontas coal field. The Flat Top district is by far the most important and bears the same relation to the production of West Virginia that the Connellsville district bears to that of Pennsylvania. Since 1900 the statistics of production of the Flat Top district have included the new operations along Tug River lying west of and continuous with the Flat Top district. The output from this district averages something over 50 per cent of the total coke product of the State. The production in 1908 decreased in every district.

The statistics of the production of West Virginia by districts in 1907 and 1908 are shown in the following table:

Production of coke in West Virginia in 1907 and 1908.

1907.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Flat top [a]	55	11,613	50	3,436,902	2,193,064	$4,893,772	$2.23	63.8
Kanawha	12	1,660	202	739,724	451,043	1,168,888	2.59	61.0
New River	23	1,957	0	428,123	248,346	696,335	2.80	58.0
Upper Monongahela	40	[b] 2,983	107	1,107,659	698,345	1,738,464	2.49	63.0
Upper Potomac and Tygarts Valley	12	1,475	100	824,387	522,098	1,219,671	2.34	63.3
	142	19,688	459	6,536,795	4,112,896	9,717,130	2.36	62.9

1908.

District.	Establishments.	Built.	Building.	Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
Flat top [a]	54	11,936	0	2,627,775	1,715,314	$3,438,228	$2.00	65.3
Kanawha	12	1,807	0	373,750	222,205	443,729	2.00	59.5
New River	23	1,873	0	348,366	203,973	521,518	2.56	58.6
Upper Monongahela	37	[b] 3,008	0	442,346	279,541	475,355	1.70	63.2
Upper Potomac and Tygarts Valley	12	1,500	0	335,493	216,090	388,224	1.80	64.4
	138	20,124	0	4,127,730	2,637,123	5,267,054	2.00	63.9

[a] Includes Tug River district. [b] Includes 120 Semet-Solvay ovens.

Flat Top district.—Until the close of 1902 this district was, next to the Connellsville district of Pennsylvania, the most important coke-producing region of the United States, but the largely increased production of the Lower Connellsville or Klondike district of Pennsylvania in 1902 placed that district above the Flat Top as a coke producer. Like the coal of the Connellsville region, that of the Flat Top district of West Virginia produces a coke which makes an ideal blast-furnace fuel. Chemically, the Flat Top coke is superior to that of Connellsville, as it is lower in mineral content or ash, and it is regarded by some ironmasters as equal in physical properties to the Connellsville coke.

To the operations of the Flat Top district have been added those of the Tug River district immediately west, in which are located the ovens of the United States Coal and Coke Company. The combined production of the Flat Top and Tug River districts amounted in 1908 to 1,715,314 short tons, valued at $3,438,228, against 2,193,064 tons, valued at $4,893,772 in 1907. The Flat Top district should also really include the coal-mining and coke-making operations of Tazewell County, Va., and if the Tazewell County production be added, the total output of coke for the district in 1908 amounted to 1,811,822 tons.

The Flat Top district began producing in 1886. The output of the West Virginia portion of the district for 1890, and for that of the West Virginia Flat Top and Tug River districts in 1900, and from 1904 to 1908, has been as follows:

Statistics of the manufacture of coke in the Flat Top district of West Virginia, 1886–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1886	2	10	38	1,075	658	$1,316	$2.00	61.2
1890	17	1,584	252	566,118	325,576	571,239	1.75	57.5
1900 [a]	38	5,290	666	1,952,274	1,208,838	2,290,947	1.90	61.9
1904	53	10,023	684	2,024,055	1,320,314	1,928,871	1.46	65.2
1905	56	11,287	1,074	3,162,820	2,042,123	3,604,923	1.77	64.6
1906	56	11,872	200	2,985,931	1,912,595	4,000,986	2.09	64.1
1907	55	11,613	50	3,436,902	2,193,064	4,893,772	2.23	63.8
1908	54	11,936	0	2,627,775	1,715,314	3,438,228	2.00	65.3

[a] Includes establishments in the Tug River district since 1900.

New River district.—This district includes the ovens along the Chesapeake and Ohio Railway and New River from Quinnimont on the east to the junction of New and Gauley rivers on the west. The ovens at Ansted, on Gauley Mountain, are included in this district, although the coal belongs of right to the Kanawha coal series. The coals of the New River district are for the most part high-grade coking coals, and the coke is a good blast-furnace fuel. It is also a high-grade steaming coal, nearly smokeless in character, and the demand for it as a steam coal is probably responsible for the somewhat backward tendency shown by the coke production during the last few years. The number of ovens in the district has decreased each year since 1903, and although the number of establishments in 1908 was the same as in 1907, the number of ovens decreased from 1,957 to 1,873. There were no new ovens under construction at the close of the year. The production of the district decreased from 248,346 short tons, valued at $696,335, in 1907 to 203,973 tons, valued at $521,518, in 1908. The average price per ton declined from $2.80 to $2.56.

The statistics of the manufacture of coke in the New River district in 1880, 1890, 1900, and for the last five years, have been as follows:

Statistics of the manufacture of coke in the New River district, West Virginia, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	6	468	40	159,032	98,427	$239,977	$2.14	62.0
1890	12	773	4	275,458	174,295	377,847	2.17	63.0
1900	27	1,722	560	568,856	341,527	750,637	2.20	60.0
1904	26	2,156	18	387,265	233,014	439,521	1.89	60.2
1905	25	2,129	0	514,850	301,626	622,815	2.06	58.6
1906	25	2,039	0	394,365	240,474	658,729	2.74	60.9
1907	23	1,957	0	428,123	248,346	696,335	2.80	58.0
1908	23	1,873	0	348,366	203,973	521,518	2.56	58.6

Kanawha district.—The Kanawha district includes all of the ovens along the banks of Kanawha River from its formation by the junction of New and Gauley rivers to the western limits of the coal fields. It also includes the recent developments on the Virginian (Deepwater-Tidewater) Railway along lower Loup Creek, and the inclusion of this latter factor is responsible for the marked increases in production in 1905, 1906, and 1907. In general sympathy with the decreasing production in 1908, the output of the Kanawha district declined from 451,043 short tons in 1907 to 222,205 short tons in 1908. The value of the product decreased in much larger proportion, from $1,168,888 in 1907 to $443,729 in 1908. The average price per ton declined from $2.59 to $2. Of the 12 establishments in the district, 2, with a total of 200 ovens, were idle throughout the year.

The following table gives the statistics of the manufacture of coke in the Kanawha district in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in the Kanawha district, West Virginia, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	4	18	0	6,789	4,300	$9,890	$2.30	63.3
1890	6	474	0	182,340	104,076	196,583	1.89	57.0
1900	11	847	80	291,277	165,339	412,636	2.50	56.7
1904	14	1,112	600	152,517	92,014	142,858	1.55	60.3
1905	14	1,617	0	415,808	249,251	504,734	2.03	60.0
1906	12	1,605	50	582,260	358,903	860,514	2.40	61.6
1907	12	1,660	202	739,724	451,043	1,168,888	2.59	61.0
1908	12	1,807	0	373,750	222,205	443,729	2.00	59.5

Upper Monongahela district.—This district embraces coke ovens in the counties of Harrison, Marion, Monongalia, Preston, and Taylor, and derives its name from the fact that the region is drained by the headwaters of Monongahela River. It includes the well-known mining regions in the vicinity of Clarksburg and Fairmont, which are among the most important in the State, and also 120 Semet-Solvay ovens at Benwood, near Wheeling.

So far as the number of ovens and the total production in the district is concerned, the Upper Monongahela ranks next to the Flat Top in West Virginia, but in the proportion of idle establishments and idle ovens it ranks first. Of the 37 establishments, 18 were idle, and of 3,008 ovens, 984 were idle. The production in 1908 amounted to 279,541 short tons, valued at $475,355, against 698,345 short tons, valued at $1,738,464, in 1907. The average price per ton declined from $2.49 to $1.70.

The statistics of coke production in the Upper Monongahela district in 1880, 1890, 1900, and from 1904 to 1908, are shown in the following table:

Statistics of the manufacture of coke in the Upper Monongahela district, West Virginia, 1880–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	8	145	0	64,937	36,028	$68,930	$1.91	55.0
1890	18	1,051	50	276,367	167,459	260,574	1.56	60.0
1900	24	1,563	0	584,265	355,861	817,340	2.30	60.9
1904	37	2,348	17	478,513	328,820	749,305	2.28	68.7
1905	39	2,861	90	576,201	389,213	965,402	2.48	67.5
1906	37	2,873	50	1,028,258	659,427	1,412,215	2.14	64.1
1907	40	2,983	107	1,107,659	698,345	1,738,464	2.49	63.0
1908	37	[a]3,008	0	442,346	279,541	475,355	1.70	63.2

[a] Includes 120 Semet-Solvay ovens at Wheeling.

Upper Potomac and Tygarts Valley district.—The Upper Potomac district includes the ovens along the line of the West Virginia Central and Pittsburg Railroad, in the region drained by the upper waters of Potomac River. The statistics since 1902 include also the operations of some new ovens in Tygarts Valley, which is just below the Ohio-Potomac divide, but practically continuous with the Upper Potomac district. The number of establishments in this district in 1908 was 12, the same as in 1907. There was an increase of 25 in the number of ovens, from 1,475 to 1,500. The production decreased 306,008 short tons, or 58.61 per cent, from 522,098 short tons in 1907 to 216,090 tons in 1908, the production in the latter year being the smallest since 1900. The value declined $831,447, or 68.17 per cent, from $1,219,671 to $388,224, and the average price declined from $2.34 to $1.80. Of the 12 establishments in the district 1 was idle throughout the year.

The statistics of the manufacture of coke in the Upper Potomac and Tygarts Valley district in 1887, 1890, 1900, and from 1904 to 1908, are shown in the following table:

Statistics of the manufacture of coke in the Upper Potomac and Tygarts Valley district, West Virginia, 1887–1908.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1887	1	20	50	3,565	2,211	$4,422	$2.00	62.0
1890	2	178	28	94,983	61,971	118,503	1.91	65.0
1900	6	827	0	472,168	286,934	475,073	1.66	60.8
1904	7	1,290	0	500,988	308,924	497,295	1.61	61.7
1905	9	1,295	50	660,016	418,380	850,331	2.03	63.4
1906	11	1,325	53	831,805	542,115	1,260,512	2.33	65.1
1907	12	1,475	100	824,387	522,098	1,219,671	2.34	63.3
1908	12	1,500	0	335,493	216,090	388,224	1.80	64.4

OTHER STATES.

In the following table are presented the statistics of coke production in those States in which in 1908 there were one or two establishments in operation. In 1907 there were 7 States included, viz, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, and Wisconsin. The statistics for 1908 include also the details of production in Indiana, Kentucky, Montana, and Oklahoma, Indiana being returned to the list of coke-producing States through the operations of the United Fourth Vein Coal Company at Black Creek. Kentucky, Montana, and Oklahoma are included among the other States in 1908 because the number of idle establishments in these States reduced the producing plants to less than three. Notwithstanding the addition of 4 States to the statistics contained in this table, the combined production decreased from 2,528,739 short tons, valued at $10,302,269 in 1907, to 286,092 short tons, valued at $8,338,363, in 1908. Of the several States included in this statement, 6—Maryland, Michigan, Minnesota, New Jersey, New York, and Wisconsin—produced coke from coal mined in other States, and 1—Massachusetts—obtained its chief supply of coal from Nova Scotia, with smaller quantities from West Virginia. All of the ovens in Maryland, Massachusetts, Minnesota, New Jersey, New York, and Michigan are by-product retort ovens, and one of the two establishments in Wisconsin is also a by-product recovery plant.

The statistics of production in the States having less than three establishments since 1900 are shown in the following table:

Statistics of coke production from 1900 to 1908 in States having only one or two establishments.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1900	10	832	594	708,295	506,730	$1,454,029	$2.87	71.5
1901	11	862	609	793,187	564,191	1,607,476	2.849	71.0
1902	11	898	742	852,977	598,869	2,063,894	3.446	70.2
1903	17	1,308	760	1,306,707	932,428	3,228,064	3.46	71.3
1904	14	1,753	658	2,046,340	1,469,845	4,830,621	3.286	71.8
1905	12	1,666	145	2,222,723	1,660,857	5,500,337	3.31	74.7
1906	12	1,952	0	2,861,934	2,085,617	7,474,889	3.58	72.9
1907	11	1,878	0	3,415,723	2,528,739	10,302,269	4.07	74.0
1908	30	[a] 3,456	[b] 103	3,155,100	2,286,092	8,338,363	3.65	72.5

[a] Includes 350 Semet-Solvay, 1,018 United-Otto, and 282 Rothberg ovens.
[b] Includes 50 United-Otto ovens.

The large proportion of by-product coke made in the States included in this statement is responsible for the higher value of the product.

GAS, COKE, TAR, AND AMMONIA.

By Edward W. Parker.

INTRODUCTION.

In the report on the manufacture of coke the discussion is limited to the product which is obtained by the distillation or partial combustion of bituminous coal in ovens and which is used primarily for blast-furnace, foundry, or steel-works fuel. It does not include the coke product obtained in the manufacture of illuminating gas, commonly known as "gas-house coke." During the last fifteen years considerable progress has been made in the manufacture of coke in retort ovens, with the recovery of by-products, gas, tar, and ammonia, and the output of such establishments is included in the annual statistics of coke production. The future development of this branch of the industry depends largely upon the ability on the part of the operators to dispose of the by-products at remunerative prices. They come directly into competition with the products of gas-house retorts, and the situation thus created has developed a demand for information in respect to the total quantities produced and the values. The present chapter and the corresponding ones in preceding volumes have been prepared in response to inquiries received by the Geological Survey. It is not claimed that they treat directly of mineral resources, but they do embody information which is at least collateral, in that the contents pertain to the economic utilization of products of the mineral industry. The previous volumes of "Mineral Resources of the United States" in which chapters on the production of coke, gas, tar, and ammonia have been published are those for 1898, 1902, 1903, 1904, 1905, and 1907. The reports for 1905, 1907, and 1908 have also included the statistics of production of water gas, which were not considered in the earlier reports. The marked increase in the production of water gas as compared with that of coal gas is interesting. In 1905, 477 water-gas companies reported a production of 77,412,025,000 cubic feet; in 1908, 552 companies reported a production of 103,347,497,000 cubic feet. The number of coal-gas companies in 1905 was 529, and they reported a production of 40,454,215,000 cubic feet; in 1908, 506 companies reported 53,561,-813,000 cubic feet. Some companies produce both coal gas and water gas; others have changed over entirely from coal-gas to water-gas production.

PRODUCTION.

The total quantity of artificial gas produced in the United States in 1908 amounted to 156,909,310,000 cubic feet, valued at $133,571,-122. This total includes the gas manufactured at gas-house retorts, at water-gas works, and the surplus gas produced at by-product recovery coke plants. It does not include the quantity of gas lost or unaccounted for, made at coal and water gas works, nor the gas consumed in the regeneration of retort ovens. In 1907 the total production of all kinds of artificial gas amounted to 149,454,307,000 cubic feet, valued at $126,635,416, compared with which the production in 1908 showed an increase of 7,455,003,000 cubic feet in quantity and of $6,935,706 in value. The associated products in 1908 amounted to 6,253,125 tons of coke, valued at $21,507,045; 110,430,-663 gallons of tar, including 9,168,834 gallons of water-gas tar, valued at $2,766,700; 30,615,835 pounds of anhydrous ammonia (the ammonia liquor reported being reduced to its equivalent in NH_3), valued at $2,065,169; and 44,093,437 pounds of ammonium sulphate, valued at $1,322,807.

The total quantity of coal carbonized at coal-gas works and in by-product ovens in 1908 was 9,252,978 short tons, of which 5,699,058 tons, or 62 per cent, were consumed in by-product oven plants, and 3,553,920 tons, or 38 per cent, were used at gas works. In 1907 the total quantity of coal carbonized was 11,490,661 short tons, of which 7,460,587 short tons, or 65 per cent, were consumed at by-product coke works, and 4,030,074 tons, or 35 per cent, at gas works. From this it can be seen that the principal decrease in 1908 was in the quantity of coal used at retort-oven plants and was due to the prevailing business depression, which materially curtailed the demand for coke, the primary product of such establishments. Notwithstanding the decrease in the quantity of coal carbonized in the gas-house retorts, the quantity of coal gas produced and sold increased from 34,302,954,000 cubic feet in 1907 to 37,355,886,000 cubic feet in 1908, while the output of surplus gas at by-product coke plants decreased from 20,516,731,000 cubic feet in 1907 to 16,205,925,000 cubic feet in 1908. The coke produced at gas works decreased from 2,510,106 short tons in 1907 to 2,051,899 tons in 1908, and by-product coke decreased from 5,583,038 short tons to 4,201,226 tons. The quantity of water gas produced and sold in 1908 amounted to 103,347,497,000 cubic feet, valued at $96,343,221, against 94,634,-620,000 cubic feet, valued at $90,173,112, in 1907. The quantity of gas lost or wasted, which is tabulated in these reports as "Gas unaccounted for," amounted in 1908 to 10,272,562,000 cubic feet, of which 3,382,856,000 cubic feet were coal gas and 6,889,706,000 cubic feet were water gas.

The total quantity and value of the gas, coke, tar, and ammonia liquor (reduced to equivalent in NH_3), and of ammonium sulphate produced at gas works and in by-product ovens in 1903, 1904, 1905, 1907, and 1908 are shown in the following table:

Production of gas, coke, tar, and ammonia, and value thereof, at gas works and by-product coke ovens in the United States, 1903–1905 and 1907–1908.

	1903.		1904.	
	Quantity.	Value.	Quantity.	Value.
Gas sold........1,000 cubic feet..	31,049,462	$30,315,776	34,814,991	$32,090,998
Coke........short tons..	3,941,282	13,634,095	4,716,049	14,693,126
Tar........gallons..	62,964,393	2,199,969	69,498,085	2,114,421
Ammonia (reduced to NH_3)........pounds..	17,643,507	1,291,732	19,750,032	1,487,196
Ammonium sulphate........do....	12,400,032	389,028	28,225,210	771,995

	1905.		1907.	
	Quantity.	Value.	Quantity.	Value.
Gas sold........1,000 cubic feet..	40,454,215	$32,937,456	54,819,685	$36,462,304
Coke........short tons..	5,751,378	18,844,866	8,093,144	30,332,644
Tar........gallons..	80,022,043	2,176,944	103,577,760	2,651,527
Ammonia (reduced to NH_3)........pounds..	22,455,857	1,728,254	37,560,858	2,601,057
Ammonium sulphate........do....	38,663,682	997,452	48,882,237	1,525,472

	1908.	
	Quantity.	Value.
Gas sold........1,000 cubic feet..	53,561,811	$37,227,901
Coke........short tons..	6,253,125	21,507,045
Tar........gallons..	101,261,829	2,537,118
Ammonia (reduced to NH_3)........pounds..	30,615,835	2,065,169
Ammonium sulphate........do....	44,093,437	1,322,807

In the earlier reports on the production of gas, coke, tar, and ammonia, the statistics were limited to the operations of coal-gas works and retort-oven plants, the statistics of water-gas works being compiled for the first time in 1905. There are, therefore, no years previous to 1905 for which comparative statistics are available.

In the following table is presented a statement of the quantity of coal carbonized and the quantity of gas, coke, and tar produced at gas works and in by-product ovens in 1903, 1904, 1905, 1907, and 1908. No statistics of this character were compiled for 1906 and no separation by sources has been made of the ammonia produced in any of the years for which statistics have been compiled. As previously stated, in giving the production of gas in by-product ovens only the "surplus" gas is considered; that is, gas which is over and above that used in the process and which is either sold or used for other purposes than heating the ovens. As a usual thing the gases which come off in the earlier stages of the process, and which are richer in illuminants, are sold; the leaner gases are used for heating the ovens. The quantity of gas sold at gas works per ton of coal carbonized, in 1908, was 10,511 cubic feet, as compared with 2,844 cubic feet of surplus gas from retort ovens. In 1907 the gas works produced 8,512 cubic feet of gas per ton of coal and the retort ovens 2,750 cubic feet of surplus gas per ton of coal.

Coal consumed and gas, coke, and tar produced at coal-gas works and in by-product coke ovens in the United States, 1903–1908.

Kind of product.	Gas works.	By-product coke plants.	Total.
1903.			
Coal coked........short tons..	3,238,085	2,605,453	5,843,538
Coal gas produced and sold........1,000 cubic feet..	....	....	33,483,431
Coke produced and sold........short tons..	2,058,888	1,882,394	3,941,282
Tar produced and sold........gallons..	....	....	62,964,393
1904.			
Coal coked........short tons..	3,485,208	3,572,949	7,058,157
Coal gas produced and sold........1,000 cubic feet..	30,109,449	4,705,542	34,814,991
Coke produced and sold........short tons..	2,107,820	2,608,229	4,716,049
Tar produced and sold........gallons..	41,726,970	27,771,115	69,498,085
1905.			
Coal coked........short tons..	3,558,831	4,628,981	8,187,812
Coal gas produced and sold........1,000 cubic feet..	30,722,279	9,731,936	40,454,215
Coke produced and sold........short tons..	2,289,030	3,462,348	5,751,378
Tar produced and sold........gallons..	43,642,189	36,379,854	80,022,043
1907.			
Coal coked........short tons..	4,030,074	7,460,587	11,490,661
Coal gas produced and sold........1,000 cubic feet..	34,302,954	20,516,731	54,819,685
Coke produced and sold........short tons..	2,510,106	5,583,038	8,093,144
Tar produced and sold........gallons..	49,581,965	53,995,795	103,577,760
1908.			
Coal coked........short tons..	3,553,920	5,699,058	9,252,978
Coal gas produced and sold........1,000 cubic feet..	37,355,886	16,205,925	53,561,811
Coke produced and sold........short tons..	2,051,899	4,201,226	6,253,125
Tar produced and sold........gallons..	58,541,220	42,720,609	101,261,829

The effect of the increasing proportion of gas from by-product works is shown by the fact that although the production of gas increased something over 20,000,000,000 cubic feet, or 57 per cent, from 1904 to 1907, the value increased only $4,371,306, or about 14 per cent, while the quantity of coke produced increased from 4,716,049 to 8,093,144 short tons, a gain of 3,377,095 short tons, or 72 per cent, and the value of the coke production increased $15,639,518, or 106 per cent, the much lower price at which coke-oven gas is sold and the much higher quality of the by-product coke being responsible for these differences. Similarly, the value of the gas produced in 1908 increased while the quantity decreased, and the proportionately larger decrease in value than in quantity of the coke product was due to the larger falling off in the operations of the by-product ovens in that year. The average price for by-product coke in 1908 was $3.44 per ton, against $3.86 per ton in 1907. The average price for gas-house coke was $3.43 per ton in 1908 and $3.45 in 1907. The gas produced at by-product ovens is, however, sold at much lower rates than that from gas works, some of it as low as 9 or 10 cents per thousand cubic feet, and the larger proportion of this product is chiefly responsible for the apparent decrease in the price of gas in 1907 as compared with 1905, and for the apparent increase in the price in 1908 as compared with 1907. The average price for all coal gas sold shows an advance from 67 cents in 1907 to 70 cents in 1908.

PRODUCTION OF COAL GAS.

Returns to the Geological Survey covering the production of coal gas were received from 506 coal-gas and by-product coke works in 1908, and 516 companies reported in 1907. The 506 companies operating in 1908 reported a total production of 56,944,669,000 cubic feet of gas, of which 3,382,856,000 cubic feet were lost through leakage, fire, or otherwise, and reported as "unaccounted for." The net production sold, therefore, was 53,561,813,000 cubic feet, which was valued at $37,227,901, or an average of 70 cents per thousand cubic feet. In 1907 the quantity of gas sold was 54,819,687,000 cubic feet, valued at $36,462,304, an average of 67 cents per thousand feet. Compared with 1907, the net production in 1908 shows a decrease of 1,257,874,000 cubic feet, with a gain in value amounting to $765,597. As already explained, the comparative increase in value was due to the smaller proportion of by-product oven gas made in 1908.

Quantity and value of gas produced and sold at by-product coke plants and coal-gas works of the United States in 1907, by States.

State.	Number of establishments.	Quantity of coal carbonized.	Total quantity gas produced.	Gas sold for illuminating purposes.			Gas sold for fuel purposes.			Total gas sold.			Quantity of gas unaccounted for.
				Quantity.	Value.	Price per 1,000 cubic feet.	Quantity.	Value.	Price per 1,000 cubic feet.	Quantity.	Value.	Price per 1,000 cubic feet.	
		Short tons.	*1,000 cu. ft.*	*1,000 cu. ft.*			*1,000 cu. ft.*			*1,000 cu. ft.*			*1,000 cu. ft.*
Alabama	11	709,754	1,963,606	90,401	$96,342	$1.07	1,831,571	$398,786	$0.22	1,921,972	$495,128	$0.26	41,634
Arkansas	4	6,986	53,017	22,192	32,385	1.46	25,414	30,705	1.21	47,606	63,090	1.33	5,411
California	1	1,725	15,998	8,271	17,585	2.13	7,142	14,589	2.04	15,413	32,174	2.09	585
Oregon	3												
Colorado	7	74,192	738,556	232,259	239,714	1.03	412,583	397,020	.96	644,842	636,734	.99	93,714
Connecticut	7	73,317	679,104	399,795	411,780	1.03	238,759	248,107	1.04	638,554	659,887	1.03	40,550
Delaware	2												
District of Columbia	2	518,147	1,740,573	1,671,013	614,332	.37	17,609	19,631	1.11	1,688,622	633,963	.38	51,951
Maryland	6												
Florida	2												
Louisiana	1	12,050	89,257	32,454	52,090	1.61	50,872	67,213	1.32	83,326	119,303	1.43	5,931
Mississippi	6												
Georgia	8	67,083	600,439	241,573	274,931	1.14	326,949	337,326	1.03	568,522	612,257	1.08	31,917
Idaho	2												
Montana	2												
North Dakota	2	19,265	193,141	52,387	91,206	1.74	126,297	183,910	1.46	178,684	275,116	1.54	14,457
South Dakota	2												
Wyoming	1												
Illinois	44	767,280	3,732,356	2,284,590	1,237,641	.54	1,228,262	1,270,209	1.03	3,512,852	2,507,850	.71	219,504
Indiana	30	142,204	1,256,572	695,826	670,845	.96	461,800	452,636	.98	1,157,626	1,123,481	.97	98,946
Iowa	17	59,174	674,139	326,427	384,765	1.18	298,390	317,178	1.06	624,817	701,943	1.12	49,322
Kansas	3	14,493	138,017	55,230	71,346	1.29	65,745	87,410	1.33	120,975	158,756	1.31	17,042
Nebraska	3												
Kentucky	13	99,679	900,932	321,301	339,142	1.06	479,906	358,819	.75	801,207	697,961	.87	99,725
Maine	7	20,290	205,095	141,671	190,782	1.35	43,945	54,759	1.25	185,616	245,541	1.32	19,479
Massachusetts	42	998,629	5,880,445	5,106,582	3,300,911	.65	574,532	586,127	1.02	5,681,114	3,887,038	.68	199,331
Michigan	48	742,885	4,421,707	2,468,898	1,609,722	.65	1,674,805	1,452,066	.87	4,143,703	3,061,788	.74	278,004
Minnesota	9	205,519	1,215,976	637,931	462,695	.73	527,182	403,344	.76	1,165,113	866,039	.74	50,863
Missouri	15	197,244	1,736,649	710,869	730,734	1.03	876,737	711,864	.81	1,587,606	1,442,598	.91	149,043
Nevada	1												
New Mexico	1	11,792	116,395	26,524	49,834	1.88	63,399	66,221	1.04	89,923	116,055	1.29	26,472
Utah	2												
New Hampshire	5	21,000	205,489	140,870	182,027	1.29	48,519	65,112	1.34	189,389	247,139	1.30	16,100
Vermont	2												
New Jersey	16	422,883	2,168,051	1,061,595	783,051	.74	1,070,986	610,776	.57	2,132,581	1,393,827	.65	35,470
New York	52	1,439,268	8,267,143	4,950,945	4,325,590	.89	2,790,498	889,755	.32	7,741,443	5,215,345	.67	525,700
North Carolina	7	30,816	275,520	132,619	184,642	1.39	100,934	126,374	1.25	233,553	311,016	1.33	41,967
South Carolina	2												

Ohio	32	720,705	5,232,129	2,795,736	2,250,356	.80	1,724,839	1,015,887	.59	4,520,575	3,266,243	.72	711,554
Oklahoma	5	22,597	105,633	20,419	25,813	1.26	78,896	86,610	1.10	99,315	112,423	1.13	6,318
Pennsylvania	28	2,886,382	9,451,529	2,256,484	2,109,015	.93	7,040,531	946,801	.13	9,297,015	3,055,816	.33	154,514
Rhode Island	3	56,821	554,995	306,737	292,715	.95	223,625	214,630	.96	530,362	507, 45	.96	24,633
Tennessee	7	66,703	588,246	342,602	341,101	1.00	151,177	154,287	1.02	493,779	495,388	1.00	94,467
Texas	7	28,282	251,233	53,281	88,688	1.66	167,886	224,104	1.33	221,167	312,792	1.41	30,066
Virginia	13	66,075	621,242	372,355	405,149	1.09	147,640	173,935	1.18	519,995	579,084	1.11	101,247
Washington	9	58,172	548,868	233,455	300,138	1.29	281,913	374,856	1.33	515,368	674,994	1.31	33,500
West Virginia	3	223,287	569,796	109,765	82,478	.75	460,031	61,388	.13	569,796	143,866	.25	....
Wisconsin	21	705,902	3,050,700	1,853,717	869,878	.47	1,043,539	940,446	.91	2,897,256	1,810,324	.62	153,444
	516	11,490,661	58,242,548	30,156,774	23,119,423	.77	24,662,913	13,342,881	.54	54,819,687	36,462,304	.67	3,422,861

Quantity and value of gas produced and sold at by-product coke plants and coal-gas works of the United States in 1908, by States.

State.	Number of establishments.	Quantity of coal carbonized.	Total quantity gas produced.	Gas sold for illuminating purposes.			Gas sold for fuel purposes.			Total gas sold.			Quantity of gas unaccounted for.
				Quantity.	Value.	Price per 1,000 cubic feet.	Quantity.	Value.	Price per 1,000 cubic feet.	Quantity.	Value.	Price per 1,000 cubic feet.	
		Short tons.	*1,000 cu. ft.*	*1,000 cu. ft.*			*1,000 cu. ft.*			*1,000 cu. ft.*			*1,000 cu. ft.*
Alabama	12	725,345	2,080,280	99,525	$118,662	$1.19	1,917,295	$433,708	$0.23	2,016,820	$552,370	$0.27	63,460
Arkansas	4	6,998	63,102	22,583	32,915	1.46	32,789	41,495	1.27	55,372	74,410	1.34	7,730
California	1	1,700	13,847	6,344	13,280	2.09	6,432	13,240	2.06	12,776	26,520	2.08	1,071
Oregon	2												
Colorado	7	94,307	950,303	200,402	202,571	1.01	661,407	602,661	.91	861,809	805,232	.93	88,494
Connecticut	7	79,037	762,977	420,443	501,763	1.19	290,343	341,147	1.17	710,786	842,910	1.19	52,191
Delaware	2												
District of Columbia	2	445,250	1,632,663	1,484,474	567,083	.38	83,199	78,108	.94	1,567,673	645,191	.41	64,990
Maryland	7												
Florida	2												
Louisiana	1	13,729	104,207	30,208	45,113	1.49	61,341	79,470	1.30	91,549	124,583	1.36	12,658
Mississippi	6												
Georgia	9	72,357	681,293	309,311	341,239	1.10	339,665	353,212	1.04	648,976	694,451	1.07	32,317
Idaho	2												
Montana	2												
North Dakota	2	21,207	218,805	48,656	85,563	1.76	150,501	220,102	1.46	199,157	305,665	1.53	19,648
South Dakota	2												
Wyoming	1												
Illinois	45	663,999	3,896,481	2,399,196	1,268,604	.53	1,249,411	1,285,861	1.03	3,648,607	2,554,465	.70	247,874
Indiana	32	151,644	1,405,554	699,092	672,426	.96	599,481	571,288	.95	1,298,573	1,243,714	.96	106,981
Iowa	17	75,905	715,008	278,676	320,163	1.15	362,691	406,378	1.12	641,367	726,541	1.13	73,641
Kansas	2	13,464	128,478	51,660	62,974	1.22	63,293	82,511	1.30	114,953	145,485	1.27	13,525
Nebraska	4												
Kentucky	13	106,465	996,972	319,415	332,184	1.04	547,406	398,790	.73	866,821	730,974	.84	130,151
Maine	7	20,823	221,303	152,896	212,864	1.39	49,877	64,968	1.30	202,773	277,832	1.37	18,530
Massachusetts	41	998,277	6,159,518	5,157,464	3,398,047	.66	732,677	728,251	.99	5,890,141	4,126,298	.70	269,377
Michigan	47	706,301	4,744,748	2,637,794	1,767,700	.67	1,826,068	1,551,368	.85	4,463,862	3,319,068	.74	280,886
Minnesota	8	201,392	1,275,096	957,250	776,268	.81	227,026	238,648	1.05	1,184,276	1,014,916	.86	90,820
Missouri	16	180,056	1,758,100	679,813	701,069	1.03	938,048	773,320	.82	1,617,861	1,474,389	.91	140,239
New Hampshire	5	23,047	225,059	108,990	135,497	1.24	89,215	108,923	1.22	198,205	244,420	1.23	26,854
Vermont	2												
New Jersey	14	434,771	2,190,611	1,231,183	719,289	.58	937,556	576,644	.62	2,168,739	1,295,933	.60	21,872
New Mexico	1												
Oklahoma	4	25,671	250,423	45,114	61,167	1.36	178,739	175,092	.98	223,853	236,259	1.06	26,570
Utah	1												
New York	50	1,425,600	9,318,961	6,586,267	4,716,808	.72	2,450,394	890,514	.36	9,036,661	5,607,322	.62	282,300
North Carolina	7	31,612	300,120	130,340	187,181	1.44	124,564	149,473	1.20	254,904	336,654	1.32	45,216
South Carolina	2												

Ohio	27	525,272	4,543,232	2,606,741	1,811,447	.69	1,269,751	712,634	.56	3,876,492	2,524,081	.65	666,740
Pennsylvania	27	1,727,956	6,153,919	2,356,360	2,314,198	.98	3,683,135	496,369	.13	6,039,495	2,810,567	.47	114,424
Rhode Island	3	53,057	515,071	258,868	256,982	.99	210,111	208,577	.99	468,979	465,559	.99	46,092
Tennessee	7	68,615	637,100	300,970	306,891	1.01	299,080	301,665	1.01	600,050	608,556	1.01	37,050
Texas	8	30,461	284,650	53,717	98,362	1.83	185,534	240,218	1.29	239,251	338,580	1.42	45,399
Virginia	13	84,693	793,416	434,215	436,141	1.00	212,835	235,679	1.11	647,050	671,820	1.04	146,366
West Virginia	2												
Washington	9	65,866	582,148	239,261	299,006	1.25	288,337	372,188	1.29	527,598	671,194	1.27	54,550
Wisconsin	21	703,373	3,341,224	2,178,343	836,473	.38	1,008,041	895,469	.89	3,186,384	1,731,942	.54	154,840
	506	9,252,978	56,944,669	32,485,571	23,599,930	.73	21,076,242	13,627,971	.65	53,561,813	37,227,901	.70	3,382,856

In the preceding tables showing the production of coal gas, by States, an approximate separation is made of the gas sold for illuminating and for fuel purposes. It is impossible to secure an exact separation of the fuel and the illuminating gas, for although in many cases, in order to encourage the use of gas for cooking purposes, additional meters are installed and a lower price charged for such gas, there are just as many cases where the gas for both lighting and cooking purposes passes through the same meter and only rough estimates of the quantities used for the two purposes are obtainable. When the gas for cooking is passed through separate meters a lower price is charged therefor, although it is supplied from the same mains as the illuminating gas burned in the same houses. When gas is used in large quantities for power purposes separate meters are generally used, and this factor is more accurately determinable, but the quantities of gas which are being used for household purposes other than lighting and which are passed through the same meters are increasing rapidly every year, so that it is becoming more and more difficult to make exact separations.

According to the best information obtainable, the quantity of coal gas sold for illuminating purposes in 1908 was 32,485,571,000 cubic feet, valued at $23,599,930, an average of 73 cents per thousand cubic feet, while that sold for fuel purposes was 21,076,242,000 cubic feet, valued at $13,627,971, or 65 cents per thousand cubic feet. In 1907 the quantity of gas sold for illuminating purposes was 30,156,774,000 cubic feet, valued at $23,119,423, or 77 cents per thousand cubic feet, and the gas sold for fuel purposes was 24,662,913,000 cubic feet, valued at $13,342,881, or 54 cents per thousand. The higher price for the fuel gas in 1908 as compared with 1907 was due to the smaller proportion of coke-oven gas included in this item. In the report for 1907 it was shown that Pennsylvania had superseded New York in first place as a producer of bituminous-coal gas, this having been due to the operation of the by-product ovens at Steelton and Lebanon. In 1908, however, New York again assumed first place, owing to the marked decrease in the production of by-product coke in Pennsylvania, caused by the depression in the steel trade. In 1907 Pennsylvania's production of gas for fuel purposes was over 7,000,000,000 cubic feet. In 1908 it was slightly less than 3,700,000,000 cubic feet, a decrease of nearly 50 per cent. In 1908 New York consumed something over 9,000,000,000 cubic feet of coal gas, Pennsylvania a little over 6,000,000,000 cubic feet, and Massachusetts, which came third, a little less than 5,900,000,000 cubic feet. Michigan, because of the operation of the by-product ovens at Delray and Wyandotte, comes fourth, with Ohio fifth and Illinois sixth. It will be observed that in the States where the production of by-product ovens is an important factor the prices are much lower than in the States where the output is exclusively from coal-gas works. Competition with natural gas also controls prices to some extent. The influence of the gas from by-product ovens is particularly noticeable in Alabama, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Wisconsin.

In the manufacture and transportation of gas a considerable loss is necessarily entailed through leakage, fire, and other accidents, and of the total production of 56,944,669,000 cubic feet in 1908, 3,382,-

856,000 cubic feet, or 5.9 per cent, were reported as lost or unaccounted for. In 1907 the total production was 58,242,548,000 cubic feet, of which 3,422,861,000 cubic feet, or 5.9 per cent, were unaccounted for. The largest percentages of loss in 1908 were shown in the production of Virginia and West Virginia; the smallest percentages of loss were reported in New Jersey, Pennsylvania, and New York.

In the following table is shown the total quantity of gas produced in each State and Territory, arranged according to rank, in 1907 and 1908, with the quantity and percentage of gas sold and lost or unaccounted for. A part of the latter was used by the company producing it and is not an actual loss.

Rank of States in coal-gas production and the quantity sold and unaccounted for in 1907 and 1908, by States.

1907.

Rank.	State.	Total production.	Gas sold.		Gas unaccounted for.	
			Quantity.	Percentage.	Quantity.	Percentage.
		1,000 cu. ft.	*1,000 cu. ft.*		*1,000 cu. ft.*	
1	Pennsylvania	9,451,529	9,297,015	98.4	154,514	1.6
2	New York	8,267,143	7,741,443	93.6	525,700	6.4
3	Massachusetts	5,880,445	5,681,114	96.6	199,331	3.4
4	Ohio	5,232,129	4,520,575	86.4	711,554	13.6
5	Michigan	4,421,707	4,143,703	93.7	278,004	6.3
6	Illinois	3,732,356	3,512,852	94.1	219,504	5.9
7	Wisconsin	3,050,700	2,897,256	95.0	153,444	5.0
8	New Jersey	2,168,051	2,132,581	98.4	35,470	1.6
9	Alabama	1,963,606	1,921,972	97.9	41,634	2.1
10	Delaware, District of Columbia, and Maryland	1,740,573	1,688,622	97.0	51,951	3.0
11	Missouri	1,736,649	1,587,606	91.4	149,043	8.6
12	Indiana	1,256,572	1,157,626	92.1	98,946	7.9
13	Minnesota	1,215,976	1,165,113	95.8	50,863	4.2
14	Kentucky	900,932	801,207	88.9	99,725	11.1
15	Colorado	738,556	644,842	87.3	93,714	12.7
16	Connecticut	679,104	638,554	94.0	40,550	6.0
17	Iowa	674,139	624,817	92.7	49,322	7.3
18	Virginia	621,242	519,995	83.7	101,247	16.3
19	Georgia	600,439	568,522	94.7	31,917	5.3
20	Tennessee	588,246	493,779	83.9	94,467	16.1
21	West Virginia	569,796	569,796	100.0		
22	Rhode Island	554,995	530,362	95.6	24,633	4.4
23	Washington	548,868	515,368	93.9	33,500	6.1
24	North Carolina and South Carolina	275,520	233,553	84.8	41,967	15.2
25	Texas	251,233	221,167	88.0	30,066	12.0
26	New Hampshire and Vermont	205,489	189,389	92.2	16,100	7.8
27	Maine	205,095	185,616	90.5	19,479	9.5
28	Idaho, Montana, North Dakota, South Dakota, and Wyoming	193,141	178,684	92.5	14,457	7.5
29	Kansas and Nebraska	138,017	120,975	87.7	17,042	12.3
30	Nevada, New Mexico, and Utah	116,395	89,923	77.3	26,472	22.7
31	Oklahoma	105,633	99,315	94.0	6,318	6.0
32	Florida, Louisiana, and Mississippi	89,257	83,326	93.3	5,931	6.7
33	Arkansas	53,017	47,606	89.8	5,411	10.2
34	California and Oregon	15,998	15,413	96.3	585	3.7
		58,242,548	54,819,687	94.1	3,422,861	5.9

Rank of States in coal-gas production and the quantity sold and unaccounted for in 1907 and 1908, by States—Continued.

1908.

Rank.	State.	Total production.	Gas sold.		Gas unaccounted for.	
			Quantity.	Percentage.	Quantity.	Percentage.
		1,000 cu. ft.	*1,000 cu. ft.*		*1,000 cu. ft.*	
1	New York	9,318,961	9,036,661	97.0	282,300	3.0
2	Massachusetts	6,159,518	5,890,141	95.6	269,377	4.4
3	Pennsylvania	6,153,919	6,039,495	98.1	114,424	1.9
4	Michigan	4,744,748	4,463,862	94.1	280,886	5.9
5	Ohio	4,543,232	3,876,492	85.3	666,740	14.7
6	Illinois	3,896,481	3,648,607	93.6	247,874	6.4
7	Wisconsin	3,341,224	3,186,384	95.4	154,840	4.6
8	New Jersey	2,190,611	2,168,739	99.0	21,872	1.0
9	Alabama	2,080,280	2,016,820	96.9	63,460	3.1
10	Missouri	1,758,100	1,617,861	92.0	140,239	8.0
11	Delaware, District of Columbia, and Maryland	1,632,663	1,567,673	96.0	64,990	4.0
12	Indiana	1,405,554	1,298,573	92.4	106,981	7.6
13	Minnesota	1,275,096	1,184,276	92.9	90,820	7.1
14	Kentucky	996,972	866,821	86.9	130,151	13.1
15	Colorado	950,303	861,809	90.7	88,494	9.3
16	Virginia and West Virginia	793,416	647,050	81.6	146,366	18.4
17	Connecticut	762,977	710,786	93.2	52,191	6.8
18	Iowa	715,008	641,367	89.7	73,641	10.3
19	Georgia	681,293	648,976	95.3	32,317	4.7
20	Tennessee	637,100	600,050	94.2	37,050	5.8
21	Washington	582,148	527,598	90.6	54,550	9.4
22	Rhode Island	515,071	468,979	91.1	46,092	8.9
23	North Carolina and South Carolina	300,120	254,904	84.9	45,216	15.1
24	Texas	284,650	239,251	84.1	45,399	15.9
25	New Mexico, Oklahoma, and Utah	250,423	223,853	89.4	26,570	10.6
26	New Hampshire and Vermont	225,059	198,205	88.1	26,854	11.9
27	Maine	221,303	202,773	91.6	18,530	8.4
28	Idaho, Montana, North Dakota, South Dakota, and Wyoming	218,805	199,157	91.0	19,648	9.0
29	Kansas and Nebraska	128,478	114,953	89.5	13,525	10.5
30	Florida, Louisiana, and Mississippi	104,207	91,549	87.9	12,658	12.1
31	Arkansas	63,102	55,372	87.7	7,730	12.3
32	California and Oregon	13,847	12,776	92.3	1,071	7.7
		56,944,669	53,561,813	94.1	3,382,856	5.9

Up to the close of 1907 the quantity of coal gas used for fuel purposes had shown a considerably more rapid increase than the gas used for illuminating purposes. Part of this more rapid gain in fuel-gas production was due to the increasing output from by-product retort coke ovens, and part to the increasing popularity of gas for cooking and heating purposes. In 1908 a notable decrease is shown in the proportion of fuel gas consumed. This is attributable to nothing more nor less than the business depression which put at least one important bank of retort ovens entirely out of commission and reduced materially the production at most of the other plants. The output of gas from by-product retort ovens decreased over 4,300,000,000 cubic feet. The total quantity of gas sold for fuel purposes decreased about 3,600,000,000 cubic feet in 1908 as compared with 1907, and the proportion of the total product used for fuel purposes decreased from 45 per cent in 1907 to 39.3 per cent in 1908. The quantity of coal gas sold for illuminating purposes increased from a little over 30,000,000,000 cubic feet to nearly 32,500,000,000, and the proportion of illuminating gas to the total increased from 55 to 60.7 per cent. As compared with 1902, however, the proportion of gas used for fuel purposes shows an increase of practically 100 per cent in 1908. In 1902 the proportion of gas used for fuel purposes was 19.55 per cent, and in 1908 it was 39.3 per cent. In 1902 the total quantity of gas reported as consumed for fuel purposes was 5,678,000,000 cubic feet, and in 1907, when the maximum quantity was reported, it was 24,663,000,000 cubic feet.

The following table shows the total quantity of coal gas consumed in 1907 and 1908, with the quantity and percentage used for illuminating and for fuel purposes:

Quantity of illuminating and fuel coal gas sold in 1907 and 1908, by States.

1907.

State.	Total sales.	Illuminating.		Fuel.	
		Quantity.	Percentage.	Quantity.	Percentage.
	1,000 cu. ft.	*1,000 cu. ft.*		*1,000 cu. ft.*	
Alabama	1,921,972	90,401	4.7	1,831,571	95.3
Arkansas	47,606	22,192	46.6	25,414	53.4
California and Oregon	15,413	8,271	53.7	7,142	46.3
Colorado	644,842	232,259	36.0	412,583	64.0
Connecticut	638,554	399,795	62.6	238,759	37.4
Delaware, District of Columbia, and Maryland	1,688,622	1,671,013	99.0	17,609	1.0
Florida, Louisiana, and Mississippi	83,326	32,454	38.9	50,872	61.1
Georgia	568,522	241,573	42.5	326,949	57.5
Idaho, Montana, North Dakota, South Dakota, and Wyoming	178,684	52,387	29.3	126,297	70.7
Illinois	3,512,852	2,284,590	65.0	1,228,262	35.0
Indiana	1,157,626	695,826	60.1	461,800	39.9
Iowa	624,817	326,427	52.2	298,390	47.8
Kansas and Nebraska	120,975	55,230	45.7	65,745	54.3
Kentucky	801,207	321,301	40.1	479,906	59.9
Maine	185,616	141,671	76.3	43,945	23.7
Massachusetts	5,681,114	5,106,582	89.9	574,532	10.1
Michigan	4,143,703	2,468,898	59.6	1,674,805	40.4
Minnesota	1,165,113	637,931	54.8	527,182	45.2
Missouri	1,587,606	710,869	44.8	876,737	55.2
Nevada, New Mexico, and Utah	89,923	26,524	29.5	63,399	70.5
New Hampshire and Vermont	189,389	140,870	74.4	48,519	25.6
New Jersey	2,132,581	1,061,595	49.8	1,070,986	50.2
New York	7,741,443	4,950,945	64.0	2,790,498	36.0
North Carolina and South Carolina	233,553	132,619	56.8	100,934	43.2
Ohio	4,520,575	2,795,736	61.8	1,724,839	38.2
Oklahoma	99,315	20,419	20.6	78,896	79.4
Pennsylvania	9,297,015	2,256,484	24.3	7,040,531	75.7
Rhode Island	530,362	306,737	57.8	223,625	42.2
Tennessee	493,779	342,602	69.4	151,177	30.6
Texas	221,167	53,281	24.1	167,886	75.9
Virginia	519,995	372,355	71.6	147,640	28.4
Washington	515,368	233,455	45.3	281,913	54.7
West Virginia	569,796	109,765	19.3	460,031	80.7
Wisconsin	2,897,256	1,853,717	64.0	1,043,539	36.0
	54,819,687	30,156,774	55.0	24,662,913	45.0

1908.

Alabama	2,016,820	99,525	4.9	1,917,295	95.1
Arkansas	55,372	22,583	40.8	32,789	59.2
California and Oregon	12,776	6,344	49.7	6,432	50.3
Colorado	861,809	200,402	23.3	661,407	76.7
Connecticut	710,786	420,443	59.2	290,343	40.8
Delaware, District of Columbia, and Maryland	1,567,673	1,484,474	94.7	83,199	5.3
Florida, Louisiana, and Mississippi	91,549	30,208	33.0	61,341	67.0
Georgia	648,976	309,311	47.7	339,665	52.3
Idaho, Montana, North Dakota, South Dakota, and Wyoming	199,157	48,656	24.4	150,501	75.6
Illinois	3,648,607	2,399,196	65.8	1,249,411	34.2
Indiana	1,298,573	699,092	53.8	599,481	46.2
Iowa	641,367	278,676	43.5	362,691	56.5
Kansas and Nebraska	114,953	51,660	44.9	63,293	55.1
Kentucky	866,821	319,415	36.8	547,406	63.2
Maine	202,773	152,896	75.4	49,877	24.6

Quantity of illuminating and fuel coal gas sold in 1907 and 1908, by States—Cont'd.

1908—Continued.

State.	Total sales.	Illuminating.		Fuel.	
		Quantity.	Percentage.	Quantity.	Percentage.
	1,000 cu. ft.	*1,000 cu. ft.*		*1,000 cu. ft.*	
Massachusetts	5,890,141	5,157,464	87.6	732,677	12.4
Michigan	4,463,862	2,637,794	59.1	1,826,068	40.9
Minnesota	1,184,276	957,250	80.8	227,026	19.2
Missouri	1,617,861	679,813	42.0	938,048	58.0
New Hampshire and Vermont	198,205	108,990	55.0	89,215	45.0
New Jersey	2,168,739	1,231,183	56.8	937,556	43.2
New Mexico, Oklahoma, and Utah	223,853	45,114	20.2	178,739	79.8
New York	9,036,661	6,586,267	72.9	2,450,394	27.1
North Carolina and South Carolina	254,904	130,340	51.1	124,564	48.9
Ohio	3,876,492	2,606,741	67.2	1,269,751	32.8
Pennsylvania	6,039,495	2,356,360	39.0	3,683,135	61.0
Rhode Island	468,979	258,868	55.2	210,111	44.8
Tennessee	600,050	300,970	50.2	299,080	49.8
Texas	239,251	53,717	22.5	185,534	77.5
Virginia and West Virginia	647,050	434,215	67.1	212,835	32.9
Washington	527,598	239,261	45.3	288,337	54.7
Wisconsin	3,186,384	2,178,343	68.4	1,008,041	31.6
	53,561,813	32,485,571	60.7	21,076,242	39.3

PRODUCTION OF OIL AND WATER GAS.

Since the manufacture of coke in retort ovens assumed, in 1897, an importance sufficient to be considered an independent industry, the problems regarding the supply of and the demand for the by-products obtained have created a desire for statistical data on these products as produced at gas houses; and as no other bureau of the Federal Government was charged with that duty at that time the Geological Survey undertook the preparation of the special report on the production of gas, coke, tar, and ammonia in 1898, and since 1902 the statistics have been collected each year with the exception of 1906. Similarly the statistics of coal-gas production have created a desire for information as to the production of oil and water gas, and in response to the numerous requests this information has been collected for the reports for 1905, 1907, and 1908.

It is interesting to note that although the production of coal gas in 1908 was less than in 1907 the production of water gas showed a distinct increase. In fact, oil and water gas production has developed with marked rapidity in recent years, and a number of companies formerly producing coal gas have changed over to oil or water gas, in whole or in part. In 1907 there were 516 coal-gas companies which reported to the Geological Survey, and in 1908 there were 506, a decrease of 10, and in 1907 there were 13 less than in 1905. The number of oil and water gas companies reporting increased, however, from 477 in 1905 to 520 in 1907 and to 552 in 1908. In the quantity of oil and water gas produced there was an increase from 82,959,229,000 cubic feet in 1905 to 102,139,875,000 in 1907, and to 110,237,203,000 in 1908. Of the total production of oil and water gas in 1908 approximately 7,000,000,000 cubic feet were lost or unaccounted for, leaving 103,347,497,000 cubic feet as the net production sold. This was nearly double the quantity of coal gas sold in 1908. It is also to be noted that the values of oil and water gas are higher than those of coal gas, the average price for all of the oil and water gas sold in 1908 being 93 cents, against 70 cents for coal gas. A part of this is due to the larger proportion of oil and water gas sold for illuminating purposes and part to the inclusion in the coal gas of the product from by-product coke ovens, most of which is sold for fuel purposes, while the proportion sold for illuminating purposes is usually turned over to other distributing companies at a much lower price than that at which it reaches the consumer. About 75 per cent of the total quantity of oil and water gas produced in 1908 was sold for illuminating purposes and 25 per cent for fuel purposes.

The quantity and value of oil and water gas produced and sold in the United States in 1907 and 1908, by States and Territories, are shown in the following tables:

Quantity and value of oil and water gas produced and sold in the United States in 1907, by States.

State.	Number of establishments.	Total quantity of gas produced.	Gas sold for illuminating purposes. Quantity.	Gas sold for illuminating purposes. Value.	Gas sold for illuminating purposes. Price per 1,000 cubic feet.	Gas sold for fuel purposes. Quantity.	Gas sold for fuel purposes. Value.	Gas sold for fuel purposes. Price per 1,000 cubic feet.	Total gas sold. Quantity.	Total gas sold. Value.	Total gas sold. Price per 1,000 cubic feet.	Quantity of gas unaccounted for.
		1,000 cu. ft.	1,000 cu. ft.			1,000 cu. ft.			1,000 cu. ft.			1,000 cu. ft.
Alabama	3											
Louisiana	1	961,491	429,950	$525,841	$1.22	417,527	$494,835	$1.19	847,477	$1,020,676	$1.20	114,014
Mississippi	2											
Arizona	4	65,018	19,782	39,972	2.02	39,520	72,604	1.84	59,302	112,576	1.90	5,716
Arkansas	3	131,807	56,847	72,847	1.28	63,733	73,917	1.16	120,580	146,764	1.22	11,227
Oklahoma	1											
California	59	10,029,232	6,071,447	5,867,100	.97	2,144,496	1,975,306	.92	8,215,943	7,842,406	.95	1,813,289
Colorado	5	364,196	116,940	116,226	.99	209,449	201,107	.96	326,389	317,333	.97	37,807
Connecticut	19	2,111,965	1,370,735	1,469,683	1.07	641,824	655,908	1.02	2,012,559	2,125,591	1.06	99,406
Delaware	3											
District of Columbia	1	3,722,456	2,656,585	2,671,028	1.01	785,463	763,994	.97	3,442,048	3,435,022	1.00	280,408
Maryland	6											
Florida	8	211,418	107,600	184,641	1.72	86,418	123,653	1.43	194,018	308,294	1.59	17,400
Georgia	5	468,169	198,646	230,564	1.16	250,457	270,583	1.08	449,103	501,147	1.12	19,066
Illinois	27	11,487,449	6,870,318	5,932,773	.86	3,489,894	3,094,284	.89	10,360,212	9,027,057	.87	1,127,237
Indiana	20	1,508,740	832,168	787,995	.95	578,426	556,169	.96	1,410,594	1,344,164	.95	98,146
Iowa	29	1,226,951	547,352	605,824	1.11	598,733	640,687	1.07	1,146,085	1,246,511	1.09	80,866
Kansas	1	771,235	305,576	368,566	1.21	419,688	496,658	1.18	725,264	865,224	1.19	45,971
Nebraska	10											
Kentucky	6	304,743	128,392	136,821	1.07	139,248	100,400	.72	267,640	237,221	.89	37,103
Maine	3	125,472	85,933	108,269	1.26	31,742	39,209	1.24	117,675	147,478	1.25	7,797
Massachusetts	32	4,691,387	3,857,471	3,390,288	.88	663,870	640,078	.96	4,521,341	4,030,366	.89	170,046
Michigan	22	1,331,278	582,609	594,495	1.02	648,393	535,355	.83	1,231,002	1,129,850	.92	100,276
Minnesota	8	1,608,153	823,139	829,697	1.01	655,524	662,199	1.01	1,478,663	1,491,896	1.01	129,490
Missouri	9	2,886,699	1,121,748	1,131,800	1.01	1,485,145	1,155,315	.78	2,606,893	2,287,115	.88	279,806
Montana	2	32,468	14,110	27,050	1.92	15,257	28,668	1.88	29,367	55,718	1.90	3,101
North Dakota	3											
Nevada	1											
New Mexico	1	38,132	10,426	12,342	1.18	26,375	32,968	1.25	36,801	45,310	1.23	1,331
Utah	1											
New Hampshire	10	194,813	125,317	186,572	1.49	52,005	76,407	1.47	177,322	262,979	1.48	17,491
New Jersey	23	6,872,616	3,351,258	3,301,383	.99	2,763,107	2,725,922	.99	6,114,365	6,027,305	.99	758,251
New York	54	35,283,833	30,088,327	27,241,544	.91	3,541,777	3,323,302	.94	33,630,104	30,564,846	.91	1,653,729
North Carolina	6	129,258	70,685	102,505	1.45	48,916	64,179	1.31	119,601	166,684	1.39	9,657
South Carolina	2											
Ohio	13	752,601	412,018	389,695	.95	236,941	159,824	.67	648,959	549,519	.85	103,642
Oregon	2	973,410	426,183	448,266	1.05	539,169	557,612	1.03	965,352	1,005,878	1.04	8,058
Washington	4											

Pennsylvania	62	10,651,458	9,701,190	9,896,609	1.02	756,942	843,572	1.11	10,458,132	10,740,181	1.02	193,326
Rhode Island	6	1,065,390	629,638	601,677	.96	417,929	391,871	.94	1,047,567	993,548	.95	17,823
South Dakota	5	99,277	49,796	77,599	1.56	46,973	65,974	1.40	96,769	143,573	1.48	2,508
Tennessee	3	365,781	137,702	137,702	1.00	161,596	161,603	1.00	299,298	299,305	1.00	66,483
Texas	10	591,645	191,530	259,309	1.35	335,850	426,797	1.27	527,380	686,106	1.30	64,265
Vermont	7	115,613	47,655	63,977	1.34	65,711	87,155	1.33	113,366	151,132	1.33	2,247
Virginia	5	542,933	340,732	345,488	1.01	96,508	101,354	1.05	437,240	446,842	1.02	105,693
West Virginia	2											
Wisconsin	11	422,788	151,807	167,688	1.10	248,402	249,807	1.01	400,209	417,495	1.04	22,579
	520	102,139,875	71,931,612	68,323,836	.95	22,703,008	21,849,276	.96	94,634,620	90,173,112	.95	7,505,255

Quantity and value of oil and water gas produced and sold in the United States in 1908, by States.

State.	Number of establishments.	Total quantity of gas produced.	Gas sold for illuminating purposes.			Gas sold for fuel purposes.			Total gas sold.			Quantity of gas unaccounted for.
			Quantity.	Value.	Price per 1,000 cubic feet.	Quantity.	Value.	Price per 1,000 cubic feet.	Quantity.	Value.	Price per 1,000 cubic feet.	
		1,000 cu. ft.	*1,000 cu. ft.*			*1,000 cu. ft.*			*1,000 cu. ft.*			*1,000 cu. ft.*
Alabama	4	110,751	16,748	$19,552	$1.16	83,048	$96,663	$1.16	99,796	$116,215	$1.16	10,955
Arizona	6	79,658	18,821	36,431	1.94	50,554	93,182	1.84	69,375	129,613	1.87	10,283
Arkansas Oklahoma	3 1	106,056	46,755	60,951	1.30	47,925	62,629	1.31	94,680	123,580	1.31	11,376
California	61	10,623,330	5,404,197	5,204,785	.96	4,456,994	4,648,571	1.04	9,861,191	9,853,356	1.00	762,139
Colorado	5	263,130	50,518	48,016	.95	191,740	174,798	.92	242,258	222,814	.92	20,872
Connecticut	20	2,226,247	1,258,076	1,283,952	1.02	802,289	767,319	.96	2,060,365	2,051,271	1.00	165,882
Delaware	3	338,654	207,133	208,503	1.00	97,420	98,165	1.01	304,553	306,668	1.01	34,101
District of Columbia Maryland	2 6	3,689,883	2,483,454	2,484,509	1.00	940,463	935,676	.99	3,423,917	3,420,185	1.00	265,966
Florida	10	257,384	114,139	196,125	1.72	123,535	190,974	1.55	237,674	387,099	1.63	19,710
Georgia	5	410,755	179,469	201,070	1.12	229,331	256,882	1.12	408,800	457,952	1.12	1,955
Illinois	30	11,611,045	6,916,479	5,980,419	.86	3,556,139	3,164,859	.89	10,472,618	9,145,278	.88	1,138,427
Indiana	21	1,471,746	669,785	637,332	.95	668,204	630,052	.94	1,337,989	1,267,384	.95	133,757
Iowa	30	1,346,140	578,424	653,233	1.13	668,648	732,886	1.10	1,247,072	1,386,119	1.11	99,068
Kansas Nebraska	1 11	865,437	348,170	416,153	1.20	470,775	550,930	1.17	818,945	967,083	1.18	46,492
Kentucky Tennessee	6 2	703,834	330,709	336,843	1.02	248,206	197,941	.80	578,915	534,784	.92	124,919
Louisiana Mississippi	1 2	1,017,557	392,724	1,032,034	2.63	520,200	538,830	1.04	912,924	1,570,864	1.72	104,633
Maine	3	134,337	88,285	114,756	1.30	35,264	46,040	1.31	123,549	160,796	1.30	10,788
Massachusetts	34	5,135,351	4,100,519	3,571,597	.87	769,662	714,973	.93	4,870,181	4,286,570	.88	265,170
Michigan	22	1,323,095	571,644	583,389	1.02	665,187	549,791	.83	1,236,831	1,133,180	.92	86,264
Minnesota	9	1,737,636	1,286,998	1,297,160	1.01	287,446	298,983	1.04	1,574,444	1,596,143	1.01	163,192
Missouri	10	2,886,507	1,087,138	1,101,372	1.01	1,581,891	1,265,706	.80	2,669,029	2,367,078	.89	217,478
Montana North Dakota	1 3	31,746	11,166	20,129	1.80	18,058	30,441	1.69	29,224	50,570	1.73	2,522
Nevada New Mexico	3 1	36,446	6,200	14,170	2.29	25,321	49,593	1.96	31,521	63,763	2.02	4,925
New Hampshire	10	215,526	119,691	168,414	1.41	73,932	99,322	1.34	193,623	267,736	1.38	21,903
New Jersey	25	6,665,534	3,241,345	3,142,411	.97	3,186,822	3,105,072	.97	6,428,167	6,247,483	.97	237,367
New York	55	41,455,459	35,511,916	29,334,778	.83	3,762,431	3,565,075	.95	39,274,347	32,899,853	.84	2,181,112
North Carolina South Carolina	6 2	137,949	69,903	103,796	1.48	50,351	67,558	1.34	120,254	171,354	1.42	17,695
Ohio	13	375,678	218,034	213,228	.98	106,509	72,460	.68	324,543	285,688	.88	51,135
Oregon	3	868,520	313,550	288,189	.92	467,817	427,332	.91	781,367	715,521	.92	87,153

Pennsylvania	66	10,768,369	9,544,895	9,754,341	1.02	975,938	1,085,242	1.11	10,520,833	10,839,583	1.03	247,536
Rhode Island	6	1,155,538	629,811	641,284	1.02	428,854	427,920	1.00	1,058,665	1,069,204	1.01	96,873
South Dakota	6	109,267	49,186	66,498	1.35	53,259	69,725	1.31	102,445	136,223	1.33	6,822
Texas	11	671,360	286,206	364,749	1.27	306,458	389,983	1.27	592,664	754,732	1.27	78,696
Vermont	9	128,245	46,273	60,403	1.31	74,339	97,275	1.31	120,612	157,678	1.31	7,633
Virginia	6	568,113	336,715	336,532	1.00	134,593	132,977	.99	471,308	469,509	1.00	96,805
West Virginia	2											
Washington	4	420,385	190,532	202,844	1.06	194,811	209,093	1.07	385,343	411,937	1.07	35,042
Wisconsin	12	290,535	78,938	114,210	1.45	188,537	204,145	1.08	267,475	318,355	1.19	23,060
	552	110,237,203	76,804,546	70,294,158	.92	26,542,951	26,049,063	.98	103,347,497	96,343,221	.93	6,889,706

PRODUCTION OF COKE.

The total quantity of coke produced in the United States at by-product recovery coke ovens and at gas works, in 1908, was 6,253,125 short tons, valued at $21,507,045, against 8,093,144 short tons, valued at $30,332,644, in 1907. The decrease in the production of coke was 1,840,019 short tons, or 23 per cent, and in value it was $8,825,599, or 29 per cent. The greater part of the decrease in production was in the output from by-product ovens, the quantity of retort-oven coke decreasing from 5,583,038 short tons in 1907 to 4,201,226 short tons in 1908, a difference of 1,381,812 short tons. The quantity of coke produced at gas-house retorts decreased 458,207 short tons, from 2,510,106 tons in 1907 to 2,051,899 tons in 1908. The larger proportion of decrease shown in the production of retort-oven coke was responsible also for the greater percentage of decrease in the total value of the product, by-product coke being a metallurgical fuel and commanding in 1907 in the same market a much higher price than the gas-house product. The business depression in 1908 brought the price of retort-oven coke to within 1 cent of that of gas-house coke.

The average price for gas-house and retort-oven coke declined from $3.75 in 1907 to $3.44 in 1908. The total value of the 4,201,226 short tons of by-product coke included in the total production of 1908 was $14,465,429, an average of $3.44 per ton, and the value of the 2,051,899 short tons of gas-house coke was $7,041,616, an average of $3.43 per ton. In 1907 the average price of retort-oven coke was $3.86 per ton, and that of gas-house coke $3.45 per ton.

The total quantity of coal carbonized or coked at gas works and in by-product ovens in 1908 was 9,252,978 short tons, of which 5,699,058 tons were coked in by-product ovens and 3,553,920 tons were used at gas works. In 1907 the total quantity of coal carbonized at gas works and in by-product ovens was 11,490,661 short tons, of which 7,460,587 tons were coked in retort ovens and 4,030,074 tons were consumed at gas works. The smaller proportionate quantity of coal used in retort ovens in 1908 is exhibited in the decrease in the yield of coal in coke, the yield in 1907 being 70.7 per cent and in 1908, 63.9 per cent. The number of companies reporting a production of coke in 1908 was 14 less than in 1907, the number in the two years being, respectively, 481 and 467.

Many gas companies are engaged also in the electric-light business, and coke produced at the gas works, as well as a considerable quantity of tar, is used for firing in the electric-light plants. Other coal-gas producers are also producers of water gas, and the coke from the coal benches is used for firing the water-gas plant. Some coke is also used in the carbonization of coal at some of the gas works. This is to be noted in the cases where the companies did not report any coke produced. The total production as given is for the coke sold.

The following table gives the production of coke at gas works and in retort ovens, by States, arranged according to their rank in producing importance, in 1907 and 1908:

Rank of States in production of coke in gas works and by-product ovens in 1907 and 1908.

1907.

Rank.	State.	Number of establishments.	Quantity.	Value.	Value per ton.	Yield of coal in coke.
			Short tons.			*Per cent*
1	Pennsylvania	27	2,165,066	$8,311,285	$3.84	75.0
2	New York	47	978,057	3,859,398	3.95	68.5
3	Massachusetts	42	698,049	2,404,522	3.44	69.9
4	Wisconsin	21	534,040	2,572,896	4.82	75.7
5	Ohio	30	529,650	1,222,842	2.31	73.6
6	Michigan	46	527,276	2,076,151	3.94	71.1
7	Illinois	41	521,396	2,339,702	4.49	68.8
8	Alabama	10	486,603	1,482,717	3.05	68.6
9	Delaware, District of Columbia, and Maryland	8	364,477	1,558,085	4.27	70.8
10	New Jersey	14	307,844	915,169	2.97	73.0
11	Virginia and West Virginia	15	202,805	600,521	2.96	70.1
12	Minnesota	9	135,967	532,166	3.91	66.2
13	Missouri	14	114,748	421,566	3.67	58.2
14	Indiana	28	84,181	276,154	3.28	60.3
15	Kentucky	11	65,087	169,591	2.61	66.5
16	Colorado	7	48,552	183,705	3.78	65.4
17	Rhode Island	3	43,096	152,713	3.54	75.8
18	Connecticut	7	42,583	154,792	3.64	58.1
19	Georgia	8	41,776	142,346	3.41	62.3
20	Tennessee	6	40,043	125,793	3.14	60.4
21	Iowa	17	39,432	193,804	4.91	57.0
22	Washington	9	36,507	199,179	5.46	62.8
23	North Carolina and South Carolina	6	16,872	75,021	4.45	64.9
24	New Hampshire and Vermont	6	12,521	69,711	5.57	61.7
25	Texas	6	12,049	56,407	4.68	56.5
26	Maine	7	10,385	46,058	4.44	51.2
27	Idaho, Montana, North Dakota, South Dakota, and Wyoming	9	9,863	72,692	7.37	51.2
28	Florida, Louisiana, and Mississippi	8	6,483	26,497	4.09	61.8
29	Nevada, New Mexico, and Utah	4	5,678	31,753	5.59	48.2
30	Kansas and Nebraska	5	4,774	23,893	5.00	33.6
31	Arkansas	3	3,962	18,152	4.58	62.9
32	Oklahoma	4	2,411	11,296	4.69	25.1
33	Oregon	3	911	6,067	6.66	61.8
		481	8,093,144	30,332,644	3.75	70.7

1908.

Rank.	State.	Number of establishments.	Quantity.	Value.	Value per ton.	Yield of coal in coke.
1	Pennsylvania	24	1,286,371	$4,168,935	$3.24	73.9
2	New York	44	878,399	2,887,465	3.29	61.9
3	Massachusetts	40	613,169	2,005,005	3.27	61.6
4	Wisconsin	20	501,752	2,270,516	4.53	71.7
5	Illinois	44	500,451	2,107,167	4.21	65.2
6	Alabama	9	489,788	1,417,074	2.89	67.7
7	Michigan	47	438,866	1,694,362	3.86	62.1
8	Ohio	27	347,479	846,722	2.44	63.2
9	Delaware, District of Columbia, and Maryland	10	307,333	1,131,979	3.68	69.1
10	New Jersey	13	258,565	632,768	2.45	69.9
11	Missouri	16	107,831	375,705	3.48	59.9
12	Minnesota	8	90,664	362,676	4.00	45.0
13	Indiana	29	78,985	247,641	3.14	53.9
14	Kentucky	10	44,835	132,459	2.95	43.1
15	Connecticut	6	40,311	135,577	3.36	52.3
16	Iowa	16	37,041	176,078	4.75	50.8
17	Washington	8	32,622	164,346	5.04	50.9
18	Virginia and West Virginia	15	31,867	116,413	3.65	37.6
19	Colorado	6	26,788	79,978	2.99	30.6
20	Tennessee	5	25,390	87,458	3.44	38.6
21	Georgia	8	22,724	74,877	3.30	31.5
22	Rhode Island	3	20,633	84,882	4.11	38.9
23	North Carolina and South Carolina	7	14,121	39,688	2.81	51.1
24	New Hampshire and Vermont	7	12,699	69,967	5.51	55.1
25	New Mexico, Oklahoma, and Utah	6	12,667	35,068	2.77	49.3
26	Texas	6	8,733	39,714	4.55	39.8
27	Idaho, Montana, North Dakota, South Dakota, and Wyoming	8	8,375	53,832	6.43	44.5
28	Maine	7	5,330	25,690	4.82	25.6
29	Florida, Louisiana, and Mississippi	7	4,089	18,999	4.65	41.9
30	Arkansas	3	3,221	11,713	3.64	54.4
31	Kansas and Nebraska	5	1,667	9,692	5.81	12.9
32	California and Oregon	3	359	2,599	7.24	21.1
		467	6,253,125	21,507,045	3.44	63.9

PRODUCTION OF COAL TAR.

Coal tar, as the raw material from which is obtained creosoting oils, aniline dyes, and salts, and numerous organic chemical compounds and medicinal preparations, is of much more economic importance in some of the European countries than it is in the United States. This country is considerably in the rear, particularly when compared with Germany, in the development of chemical industries based on coal tar, the products of which are imported to the value of several million dollars each year. At the present time coal-tar manufacture in the United States is confined principally to the production of creosote and of tars and tar pitches suitable for roofing papers, paving materials, etc. With the continued development of the retort-oven coking industry, however, and an assured supply of coal tar, there is every reason to believe that chemical industries dependent on tar as a raw material will be established. The lack of such an outlet for one of the principal by-products of retort-oven coke manufacture is in part responsible for the fact that the construction of by-product oven plants has not been more energetically pushed in this country.

There were 471 companies which reported to the Geological Survey their production of coal tar in 1908, against 488 companies in 1907. The production decreased from 103,577,760 gallons, valued at $2,651,527, in 1907, to 101,261,829 gallons, valued at $2,537,118, in 1908. The average price per gallon decreased from 2.6 cents in 1907 to 2.5 cents in 1908. The price of the coal tar has shown a steadily declining tendency since 1893, when the average price reported to the Geological Survey was 3.49 cents per gallon. It dropped to 3.04 cents in 1904; to 2.72 cents in 1905; and reached its lowest price, 2.5 cents, in 1908.

The yield of tar per ton of coal consumed, in 1908, ranged from 4.14 gallons in Georgia, to 21.6 gallons in Missouri. The average price ranged in 1908 from 2.1 cents in Pennsylvania, New York, and Kentucky, to 10 cents in California and Oregon. The average yield of tar per ton of coal in the entire United States was 10.3 gallons in 1908 and 9.04 gallons in 1907.

The following table shows the production of coal tar in the United States in 1907 and 1908, arranged according to rank of States:

Rank of States in coal-tar production in 1907 and 1908.

1907.

Rank.	State.	Number of establishments.	Quantity.	Value.	Value per gallon.	Yield per ton of coal.
			Gallons.		*Cents.*	*Gallons.*
1	Pennsylvania	28	18,304,661	$412,127	2.3	6.34
2	New York	50	13,769,436	302,290	2.2	9.58
3	Massachusetts	41	10,659,792	299,219	2.8	10.72
4	Ohio	32	8,095,305	218,986	2.7	11.23
5	Michigan	44	8,038,584	173,599	2.2	10.86
6	Illinois	40	6,383,125	125,049	2.0	8.49
7	Alabama	11	5,898,064	177,879	3.0	8.31
8	Wisconsin	21	5,436,098	129,556	2.4	7.70
9	Delaware, District of Columbia, and Maryland	10	4,208,105	86,445	2.1	8.12
10	New Jersey	15	3,973,251	121,049	3.1	9.40
11	Missouri	14	3,870,388	90,452	2.3	19.63
12	Virginia and West Virginia	16	3,094,593	93,558	3.0	16.95
13	Minnesota	8	2,388,283	70,082	2.9	11.88
14	Indiana	29	1,498,434	36,049	2.4	10.71
15	Kentucky	11	976,622	22,577	2.3	9.98
16	Connecticut	7	886,359	32,114	3.6	12.09
17	Colorado	7	861,799	40,700	4.7	11.62
18	Iowa	18	759,317	18,906	2.5	10.98
19	Tennessee	7	754,135	27,233	3.6	11.31
20	Rhode Island	3	644,026	17,536	2.7	11.33
21	Georgia	8	635,889	18,738	2.9	9.48
22	Washington	9	634,491	44,804	7.1	10.91
23	Maine	7	295,034	11,349	3.8	14.54
24	North Carolina and South Carolina	7	291,871	11,792	4.0	10.53
25	New Hampshire and Vermont	5	235,324	11,388	4.8	11.94
26	Texas	7	225,394	12,707	5.6	7.97
27	Oklahoma	5	193,531	14,275	7.4	8.56
28	Idaho, Montana, North Dakota, and Wyoming	6	144,411	9,831	6.8	9.93
29	Nevada, New Mexico, and Utah	4	120,925	7,431	6.1	10.25
30	Kansas and Nebraska	5	113,522	4,082	3.6	7.99
31	Florida, Louisiana, and Mississippi	7	95,870	3,955	4.1	10.60
32	Arkansas	3	71,700	3,771	5.3	11.38
33	Oregon	3	19,421	1,998	10.3	13.17
		488	103,577,760	2,651,527	2.6	9.04

1908.

Rank.	State.	Number of establishments.	Quantity.	Value.	Value per gallon.	Yield per ton of coal.
1	Pennsylvania	25	18,720,845	$401,052	2.1	10.76
2	New York	48	14,688,079	315,664	2.1	10.33
3	Massachusetts	38	10,493,400	284,664	2.7	10.65
4	Michigan	42	7,834,757	182,571	2.3	11.45
5	Ohio	27	6,774,193	192,682	2.8	12.32
6	Illinois	45	6,248,695	140,199	2.2	8.13
7	Alabama	11	6,244,491	176,854	2.8	8.62
8	Wisconsin	18	5,557,537	135,311	2.4	8.01
9	Delaware, District of Columbia, and Maryland	11	4,129,124	91,804	2.2	9.27
10	New Jersey	13	4,127,126	123,662	3.0	9.52
11	Missouri	15	3,874,454	89,403	2.3	21.60
12	Minnesota	8	2,391,667	61,677	2.6	11.88
13	Indiana	30	1,587,817	40,395	2.5	10.76
14	Kentucky	11	1,397,492	29,676	2.1	13.39
15	Colorado	6	926,094	42,621	4.6	9.92
16	Virginia and West Virginia	15	924,805	24,503	2.6	10.92
17	Connecticut	6	819,317	29,011	3.5	10.62
18	Washington	9	668,005	36,295	5.4	10.14
19	Iowa	16	658,454	18,444	2.8	8.82
20	Tennessee	7	646,760	24,422	3.8	9.43
21	Rhode Island	3	628,968	16,843	2.7	11.85
22	Georgia	9	299,424	11,021	3.7	4.14
23	Maine	7	278,105	10,120	3.6	13.36
24	New Mexico, Oklahoma, and Utah	6	264,209	7,731	2.9	10.29
25	North Carolina and South Carolina	8	253,520	10,467	4.1	8.56
26	New Hampshire and Vermont	6	238,847	12,076	5.0	10.78
27	Kansas and Nebraska	6	202,384	5,617	2.8	15.03
28	Idaho, Montana, North Dakota, South Dakota, and Wyoming	7	128,170	8,455	6.6	8.49
29	Texas	6	101,580	5,788	5.7	4.63
30	Florida, Louisiana, and Mississippi	6	79,110	4,244	5.4	8.74
31	Arkansas	3	65,200	2,926	4.5	11.01
32	California and Oregon	3	9,200	920	10.0	5.41
		471	101,261,829	2,537,118	2.5	10.30

PRODUCTION OF OIL AND WATER GAS TAR.

The quantity of tar produced at oil and water gas works in 1908 amounted to 9,168,834 gallons, valued at $229,582, as against 14,414,017 gallons, valued at $342,041 in 1907. The decrease was largely in the quantity of tar sold. There is little demand for the product, and most of the tar is used for fuel at the works, no record being kept of the output. In addition to this item, there were over 5,500,000 gallons reported in 1908 as made and not sold or used. It is of interest to note, however, that an outlet for water-gas tar is developing—although in somewhat tardy advance—in the coal-briquetting industry. The United Gas Improvement Company, of Philadelphia, has installed a briquetting plant and reports satisfactory results in the use of water-gas pitch as a binding material. This plant was installed for the purpose of utilizing coke breeze produced at its gas works, and the briquets are afterwards used at its coal-gas works in the manufacture of water gas. The company has installed its own tar-distilling apparatus in order to procure a uniform quality of binder.

The following table gives approximately the quantity of tar produced at oil and water gas works and sold in the United States in 1907 and 1908, with the total value and the average price received at the works:

Quantity and value of tar produced and sold at water-gas and oil-gas works in the United States in 1907 and 1908.

1907.

State.	Total quantity.	Total value.	Price per gallon.
	Gallons.		*Cents.*
Arkansas, Florida, Louisiana, and Mississippi	440,563	$13,396	3.0
California and Washington	3,388,891	78,554	2.3
Connecticut and Massachusetts	2,142,476	58,914	2.7
Delaware, Maryland, and New Jersey	1,871,500	45,850	2.4
Georgia and South Carolina	34,439	2,262	6.6
Illinois, Indiana, and Ohio	132,300	2,675	2.0
Iowa	294,182	7,031	2.4
Minnesota and Wisconsin	664,457	21,699	3.2
Nebraska and South Dakota	454,314	11,205	2.4
Missouri	3,050	163	5.3
New Hampshire	58,120	777	1.3
New York	3,619,788	72,626	2.0
Pennsylvania	1,207,156	24,152	2.0
Texas	102,781	2,737	2.7
	14,414,017	342,041	2.4

1908.

State.	Total quantity.	Total value.	Price per gallon.
California and Washington	724,031	35,471	4.9
Connecticut, Massachusetts, and New Hampshire	2,364,190	58,540	2.5
Delaware and Maryland	137,917	2,072	1.5
Florida, Louisiana, Mississippi, and Texas	558,714	15,207	2.7
Georgia and South Carolina	22,800	1,061	4.7
Illinois	21,600	524	2.4
Indiana and Ohio	557,322	12,360	2.2
Iowa	361,760	7,505	2.1
Michigan, Minnesota, and Wisconsin	615,055	19,316	3.1
Missouri, Nebraska, and South Dakota	458,637	10,357	2.3
New Jersey	114,900	1,805	1.6
New York	2,894,727	58,620	2.0
Pennsylvania	337,181	6,744	2.0
	[a] 9,168,834	229,582	2.5

[a] In addition 5,559,199 gallons were reported as produced but not sold.

PRODUCTION OF AMMONIA.

About one-fifth of the establishments producing gas and coke from coal report the recovery of ammonia, the returns being either for ammoniacal liquor, anhydrous ammonia, or ammonium sulphate. In making the reports on the quantity of ammonia liquor produced, somewhat different methods are employed. Some companies reported the production in liquor ounces selling at a certain price per 100 liquor ounces of a specific strength; others reported the production in gallons, sales being made at a certain price per pound or by the ammonia (NH_3) contained; others reported the production in gallons of ammonia liquor at so much per gallon, according to the strength of the liquor. Then, again, the strength of the liquor is reported by some producers in ounces, by others in degrees Twaddell, and by still others in the percentage of anhydrous ammonia (NH_3).

In compiling the statistics for 1907 and 1908 separate statements have been prepared of the anhydrous ammonia produced, the quantity of ammonia liquor being reduced to its equivalent in NH_3. The ammonia liquor produced in 1908 was 62,463,709 gallons, equivalent to 15,347,354 pounds of anhydrous ammonia, against 54,065,541 gallons in 1907, equivalent to 20,993,863 pounds of anhydrous ammonia. The total quantity of anhydrous ammonia represented by the production in 1908 was 30,615,835 pounds, valued at $2,065,169, against 37,560,858 pounds, valued at $2,601,057, in 1907.

In the following table giving the production of ammoniacal liquor in 1907 and 1908 the returns are graded according to the strength of the liquor produced and not according to States. This method is employed in order to avoid disclosing the operations of individual producers. The production of ammonium sulphate in 1908 amounted to 44,093,437 pounds, valued at $1,322,807, as against 48,882,237 pounds, valued at $1,525,472 in 1907.

Production and value of ammoniacal liquor at gas and by-product coke works of the United States in 1907 and 1908.

1907.

Coal carbonized.	Quantity of ammonia liquor made and sold.	Strength of liquor.				Total value of ammonia liquor.
		In ounces.	Equivalent to anhydrous ammonia (NH_3).		Equivalent to sulphate of ammonia (ounces per gallon).	
			Ounces per gallon.	Total in pounds.		
Short tons.	*Gallons.*					
14,190	595,200	4.00	1.39	51,782	5.40	$1,905
45,237	1,998,820	4.74	1.65	206,004	6.40	10,422
49,396	1,612,560	5.00	1.74	175,366	6.75	7,820
255,563	8,511,300	5.37	1.87	993,694	7.25	36,532
163,915	2,667,712	6.00	2.09	347,969	8.10	15,348
155,230	5,964,915	6.06	2.11	785,878	8.18	59,649
35,179	1,175,265	6.50	2.26	166,080	8.77	6,596
33,569	1,241,076	7.00	2.44	188,876	9.45	9,304
190,375	4,309,565	8.00	2.78	749,595	10.80	54,558
239,511	8,656,112	8.17	2.84	1,537,542	11.03	57,996
85,847	3,458,725	8.18	2.85	615,221	11.04	227,238
36,466	827,643	8.45	2.94	152,079	11.41	10,950
36,440	331,074	10.00	3.48	71,988	13.50	3,234
10,527	143,911	10.20	3.55	91,743	13.77	1,655
20,541	157,006	12.00	4.18	40,969	16.20	2,465
238,238	2,468,749	16.00	5.57	858,815	21.60	40,990
8,809	10,080	24.00	8.35	5,261	32.40	252
42,463	186,302	30.00	10.44	121,562	40.51	14,281
9,932	19,425	32.00	11.13	13,513	43.18	1,098
26,124	391,539	36.00	12.52	306,380	48.58	9,124
130,525	664,290	40.00	13.92	577,933	54.01	40,265
11,623	25,767	44.00	15.31	24,656	59.40	1,972
8,969	18,928	46.00	16.00	18,928	62.08	1,230
3,536	2,481	46.20	16.07	2,452	62.35	78
28,344	104,221	48.00	16.70	108,781	64.80	5,961
18,184	26,417	51.60	17.95	29,637	69.65	2,569
52,655	74,388	52.00	18.09	84,104	70.19	5,323
31,931	18,023	56.00	19.48	21,944	75.58	1,344
3,200	7,000	56.40	19.62	8,584	76.13	601
15,125	11,942	57.00	19.83	14,801	76.94	1,433
5,200	5,600	58.36	20.30	7,105	78.76	179
618,926	1,742,502	60.00	20.87	2,272,876	80.98	186,528
139,285	377,167	61.84	21.51	507,054	83.46	40,564
5,775	15,982	62.00	21.57	21,546	83.69	1,293
68,858	1,676,761	64.00	22.27	2,333,842	86.41	17,482
6,435	11,155	65.80	22.89	15,958	88.81	1,277
16,275	474,084	67.00	23.31	690,681	90.44	55,254
96,157	305,470	67.08	23.34	445,593	90.56	37,875
66,969	178,605	71.00	24.70	275,722	95.84	25,918
632,191	459,922	71.40	24.84	714,029	96.38	65,603
4,477	9,339	72.00	25.05	14,621	97.19	514
150,165	3,048,510	78.00	27.14	5,183,535	105.30	53,226
44,072	80,008	80.00	27.83	139,164	107.98	10,270
3,856,429	54,065,541	....	....	20,993,863	....	1,128,176

Production and value of ammoniacal liquor at gas and by-product coke works of the United States in 1907 and 1908—Continued.

1908.

Coal carbonized.	Quantity of ammonia liquor made and sold.	Strength of liquor. In ounces.	Equivalent to anhydrous ammonia (NH_3). Ounces per gallon.	Equivalent to anhydrous ammonia (NH_3). Total in pounds.	Equivalent to sulphate of ammonia (ounces per gallon).	Total value of ammonia liquor.
Short tons.	*Gallons.*					
34,435	740,319	4.00	1.39	64,408	5.40	$2,882
49,100	2,210,346	4.63	1.61	222,554	6.25	11,257
47,186	1,230,000	5.00	1.74	133,763	6.75	5,599
199,143	8,294,567	5.57	1.94	1,003,643	7.51	36,927
89,562	4,594,036	5.86	2.04	585,452	7.91	21,371
73,152	1,957,695	5.89	2.05	250,707	7.95	10,033
199,005	4,920,959	6.00	2.09	641,876	8.10	37,768
153,047	6,164,902	6.04	2.10	809,529	8.15	63,190
34,115	1,120,967	6.50	2.26	197,088	8.77	6,971
4,136	91,992	7.00	2.44	14,000	9.45	1,003
195,902	4,080,408	8.00	2.78	709,736	10.80	60,979
80,808	3,236,618	8.02	2.79	564,385	10.83	20,605
10,235	178,975	8.32	2.90	32,383	11.23	1,619
383,801	14,896,888	8.41	2.93	2,724,268	11.35	99,809
51,333	990,376	9.00	3.13	193,804	12.15	8,062
11,056	171,504	10.09	3.51	37,624	13.62	1,183
9,520	110,000	14.00	4.87	33,488	18.90	1,100
260,760	3,047,198	16.00	5.57	1,064,044	21.60	47,456
6,500	6,699	24.00	8.35	3,496	32.40	155
24,453	32,057	30.00	10.44	20,917	40.51	1,030
4,182	8,920	34.00	11.83	6,595	45.90	330
18,152	26,764	36.00	12.52	20,943	48.58	4,506
18,850	33,522	37.68	13.11	27,467	50.87	2,086
18,101	47,312	38.00	13.22	39,091	51.29	3,294
24,699	48,792	40.00	13.92	42,449	54.01	4,260
2,290	6,816	44.00	15.31	6,522	59.40	243
7,637	15,000	46.00	16.00	15,000	62.08	983
31,759	146,653	48.00	16.70	153,072	64.80	10,793
11,810	26,800	49.52	17.23	28,860	66.85	2,204
4,440	8,976	50.56	17.59	9,868	68.25	610
55,646	112,546	52.00	18.09	127,248	70.19	8,266
5,380	6,529	54.00	18.79	7,667	72.91	531
27,739	139,562	56.00	19.48	169,917	75.58	13,355
29,557	60,617	58.00	20.18	76,453	78.30	2,428
238,878	502,226	60.00	20.87	655,094	80.98	41,765
15,145	37,780	60.56	21.07	49,751	81.75	2,985
17,677	79,062	61.24	21.31	105,301	82.68	6,325
157,792	469,469	62.04	21.58	633,196	83.73	50,656
66,594	774,687	64.00	22.27	1,064,226	86.41	27,002
31,212	45,246	64.95	22.60	63,910	87.69	4,910
48,369	214,153	66.00	22.96	307,309	89.08	18,020
4,162	6,500	66.56	23.16	9,409	89.86	590
15,800	474,600	67.00	23.31	690,559	90.44	55,245
111,539	350,717	68.84	23.95	524,980	92.93	46,667
7,000	1,220	69.24	24.09	1,837	93.47	426
67,925	165,036	70.00	24.35	251,164	94.48	26,014
626,792	230,271	70.28	24.45	351,883	94.87	33,218
14,819	28,383	72.00	25.05	44,437	97.19	1,714
117,030	319,644	80.00	27.83	555,981	107.98	45,207
3,718,225	62,463,709	....	....	15,347,354	....	853,632

The following table gives the production of ammonia, the liquor being reduced to its equivalent in NH_3, by States, certain States being combined in order to avoid disclosing individual returns:

Production of ammonia in 1907 and 1908, by States.

1907.

State.	Coal carbonized.	Anhydrous ammonia (NH_3) or its equivalent.
	Short tons.	*Pounds.*
Alabama and Georgia	731,228	1,064,567
Colorado, Utah, and Washington	88,967	94,373
Connecticut and Rhode Island	103,268	386,074
District of Columbia, Maryland [a], Virginia, and West Virginia	745,416	1,611,718
Illinois	662,795	1,320,429
Indiana, Iowa, and Missouri	243,157	889,255
Kentucky and Tennessee	127,504	443,222
Maine, New Hampshire, and Vermont	32,395	162,647
Massachusetts	917,119	1,282,664
Michigan	641,118	2,897,898
Minnesota and North Dakota	194,541	642,517
New Jersey	402,328	1,793,009
New York	1,371,191	2,985,854
Ohio	677,671	7,275,883
Pennsylvania	2,866,085	11,594,678
Wisconsin	656,863	3,116,070
Total	10,461,646	37,560,858
Quantity of ammonium sulphate produced and sold (pounds)	48,882,237	

1908.

State.	Coal carbonized.	Anhydrous ammonia (NH_3) or its equivalent.
Alabama and Georgia	740,794	1,171,757
Colorado, Utah, and Washington	134,766	379,089
Connecticut and Rhode Island	104,004	390,037
District of Columbia, Maryland [a], Virginia and West Virginia	462,267	422,124
Illinois	659,681	3,163,293
Indiana	84,902	285,267
Iowa and Missouri	179,888	844,646
Kentucky and Tennessee	120,363	482,593
Maine, New Hampshire, and Vermont	33,515	233,981
Massachusetts	908,580	1,184,240
Michigan	608,716	2,934,297
Minnesota and North Dakota	192,524	524,098
New Jersey	415,123	2,024,947
New York	1,354,963	4,541,153
Ohio	518,370	3,008,241
Pennsylvania	1,723,487	5,610,440
Wisconsin	650,483	3,415,632
Total	8,892,426	30,615,835
Quantity of ammonium sulphate produced and sold (pounds)	44,093,437	

[a] Production of Maryland reported as ammonium sulphate.

In the following table the total ammonia production in 1907 and 1908 has been reduced to its equivalent in NH_3 and sulphate:

Production of ammonia at gas and by-product coke works of the United States in 1907 and 1908.

	1907.	1908.
Coal, carbonized ... short tons	10,461,646	8,892,626
Anhydrous ammonia (NH_3), or its equivalent, produced and sold ... pounds	37,560,858	30,615,835
Equivalent to ammonium sulphate ... do	145,736,129	118,789,440
Ammonia produced and sold as sulphate ... do	48,882,237	44,093,437
Value received for anhydrous ammonia (NH_3) or its equivalent	$2,601,057	$2,065,169
Value received for ammonium sulphate	1,525,472	1,322,807
Total value received	4,126,529	3,387,976

AGGREGATE PRODUCTION AND VALUE.

In the following tables are given the quantity and value of the gas, tar, coke, and ammonia produced in the United States in 1907 and 1908, by States. The aggregate value of this production in 1908 was $64,660,040 as against $73,573,004 in 1907.

Production of coal gas and by-products in the United States in 1907 and 1908, by States.

1907.

State.	Coal gas produced and used for illuminating and fuel purposes.	By-products.			Gas unaccounted for.
		Tar.	Anhydrous ammonia, NH_3.	Coke.	
	1,000 cu. ft.	*Gallons.*	*Pounds.*	*Short tons.*	*1,000 cu. ft.*
Alabama	1,921,972	5,898,064	1,064,567	486,603	41,634
Georgia	568,522	635,889		41,776	31,917
Arkansas	47,606	71,700	....	3,962	5,411
California	15,413	....	....	....	585
Oregon		19,421	....	911	
Colorado	644,842	861,799		48,552	93,714
Washington	515,368	634,491	94,373	36,507	33,500
Utah					
Nevada	89,923	120,925	....	5,678	26,472
New Mexico			....		
Connecticut	638,554	886,359	386,074	42,583	40,550
Rhode Island	530,362	644,026		43,096	24,633
Delaware			....		
District of Columbia	1,688,622	4,208,105		364,477	51,951
Maryland					
Virginia	519,995		a1,611,718		101,247
West Virginia	569,796	3,094,593		202,805	....
Florida, Louisiana, and Mississippi	83,326	95,870	....	6,483	5,931
South Dakota		....	....		
Montana			....		
Idaho	178,684		....	9,863	14,457
Wyoming		144,411	....		
North Dakota					
Minnesota	1,165,113	2,388,283	642,517	135,967	50,863
Illinois	3,512,852	6,383,125	1,320,429	521,396	219,504
Indiana	1,157,626	1,498,434		84,181	98,946
Iowa	624,817	759,317	889,255	39,432	49,322
Missouri	1,587,606	3,870,388		114,748	149,043
Kansas and Nebraska	120,975	113,522	....	4,774	17,042
Kentucky	801,207	976,622	443,222	65,087	99,725
Tennessee	493,779	754,135		40,043	94,467
Maine	185,616	295,034	162,647	10,385	19,479
New Hampshire and Vermont	189,389	235,324		12,521	16,100
Massachusetts	5,631,114	10,659,792	1,282,664	698,049	199,331
Michigan	4,143,703	8,038,584	2,897,898	527,276	278,004
New Jersey	2,132,581	3,973,251	1,793,009	307,844	35,470
New York	7,741,443	13,769,436	2,985,854	978,057	525,700
North Carolina and South Carolina	233,553	291,871	....	16,872	41,967
Ohio	4,520,575	8,095,305	7,275,883	529,650	711,554
Oklahoma	99,315	193,531	....	2,411	6,318
Pennsylvania	9,297,015	18,304,661	11,594,678	2,165,066	154,514
Texas	221,167	225,394	....	12,049	30,066
Wisconsin	2,897,256	5,436,098	3,116,070	534,040	153,444
Total	54,819,687	103,577,760	37,560,858	8,093,144	3,422,861
Ammonium sulphate	....	....	48,882,237	....	....

a Production of Maryland reported as ammonium sulphate.

Production of coal gas and by-products in the United States in 1907 and 1908, by States—Continued.

1908.

State.	Coal gas produced and used for illuminating and fuel purposes.	By-products. Tar.	By-products. Anhydrous ammonia, NH_3.	By-products. Coke.	Gas unaccounted for.
	1,000 cu. ft.	*Gallons.*	*Pounds.*	*Short tons.*	*1,000 cu. ft.*
Alabama	2,016,820	6,244,491	1,171,757	489,788	63,460
Georgia	648,976	299,424		22,724	32,317
Arkansas	55,372	65,200	....	3,221	7,730
California and Oregon	12,776	9,200	....	359	1,071
Colorado	861,809	926,094		26,788	88,494
Washington	527,598	668,005	379,089	32,622	54,550
Utah					
New Mexico	223,853	264,209	....	12,667	26,570
Oklahoma			....		
Connecticut	710,786	819,317	390,037	40,311	52,191
Rhode Island	468,979	628,968		20,633	46,092
Delaware			....		
District of Columbia	1,567,673	4,129,124		307,333	64,990
Maryland			*a*422,124		
Virginia					
West Virginia	647,050	924,805		31,867	146,366
Florida, Louisiana, and Mississippi	91,549	79,110	....	4,089	12,658
Idaho			....		
Montana			....		
South Dakota	199,157	128,170	....	8,375	19,648
Wyoming			....		
North Dakota			524,098		
Minnesota	1,184,276	2,391,667		90,664	90,820
Illinois	3,648,607	6,248,695	3,163,293	500,451	247,874
Indiana	1,298,573	1,587,817	285,267	78,985	106,981
Iowa	641,367	658,454	844,646	37,041	73,641
Missouri	1,617,861	3,874,454		107,831	140,239
Kansas and Nebraska	114,953	202,384	....	1,667	13,525
Kentucky	866,821	1,397,492	482,593	44,835	130,151
Tennessee	600,050	646,760		25,390	37,050
Maine	202,773	278,105	233,981	5,330	18,530
New Hampshire and Vermont	198,205	238,847		12,699	26,854
Massachusetts	5,890,141	10,493,400	1,184,240	613,169	269,377
Michigan	4,463,862	7,834,757	2,934,297	438,866	280,886
New Jersey	2,168,739	4,127,126	2,024,947	258,565	21,872
New York	9,036,661	14,688,079	4,541,153	878,399	282,300
North Carolina and South Carolina	254,904	253,520	....	14,121	45,216
Ohio	3,876,492	6,774,193	3,008,241	347,479	666,740
Pennsylvania	6,039,495	18,720,845	5,610,440	1,286,371	114,424
Texas	239,251	101,580	....	8,733	45,399
Wisconsin	3,186,384	5,557,537	3,415,632	501,752	154,840
Total	53,561,813	101,261,829	30,615,835	6,253,125	3,382,856
Ammonium sulphate	....	....	44,093,437	....	....

a Production of Maryland reported as ammonium sulphate

Value of coal gas and by-products produced in the United States in 1907 and 1908, by States.

1907.

State.	Total value of illuminating and fuel coal gas.	Value of by-products. Tar.	Anhydrous ammonia, NH_3 (or its equivalent) and ammonium sulphate.	Coke.	Total.	Total value of all products.
Alabama	$495,128	$177,879	$403,580	$1,482,717	$2,225,260	$3,332,645
Georgia	612,257	18,738		142,346		
Arkansas	63,090	3,771	....	18,152	21,923	85,013
California	32,174	....	....	....	....	40,239
Oregon		1,998	....	6,067	8,065	
Colorado	636,734	40,700		183,705		
Washington	674,994	44,804	3,247	199,179		
Utah					510,819	1,938,602
Nevada	116,055	7,431	....	31,753		
New Mexico			....			
Connecticut	659,887	32,114	20,203	154,792	377,358	1,544,590
Rhode Island	507,345	17,536		152,713		
Delaware			....			
District of Columbia	633,963	86,445		1,558,085		
Maryland			348,557		2,687,166	4,044,079
Virginia	579,084	93,558		600,521		
West Virginia	143,866					
Florida, Louisiana, and Mississippi	119,303	3,955	....	26,497	30,452	149,755
South Dakota		....	....			
Montana			....			
Idaho	275,116	9,831	....	72,692	738,444	1,879,599
Wyoming			....			
North Dakota			53,673			
Minnesota	866,039	70,082		532,166		
Illinois	2,507,850	125,049	237,459	2,339,702	2,702,210	5,210,060
Indiana	1,123,481	36,049		276,154		
Iowa	701,943	18,906	70,045	193,804	1,106,976	4,374,998
Missouri	1,442,598	90,452		421,566		
Kansas and Nebraska	158,756	4,082	....	23,893	27,975	186,731
Kentucky	697,961	22,577	24,344	169,591	369,538	1,562,887
Tennessee	495,388	27,233		125,793		
Maine	245,541	11,349	5,025	46,058	143,531	636,211
New Hampshire and Vermont	247,139	11,388		69,711		
Massachusetts	3,887,038	299,219	435,373	2,404,522	3,139,114	7,026,152
Michigan	3,061,788	173,599	272,732	2,076,151	2,522,482	5,584,270
New Jersey	1,393,827	121,049	150,389	915,169	1,186,607	2,580,434
New York	5,215,345	302,290	639,675	3,859,398	4,801,363	10,016,708
North Carolina and South Carolina	311,016	11,792	....	75,021	86,813	397,829
Ohio	3,266,243	218,986	185,514	1,222,842	1,627,342	4,893,585
Oklahoma	112,423	14,275	....	11,296	25,571	137,994
Pennsylvania	3,055,816	412,127	1,011,150	8,311,285	9,734,562	12,790,378
Texas	312,792	12,707	....	56,407	69,114	381,906
Wisconsin	1,810,324	129,556	265,563	2,572,896	2,968,015	4,778,339
	36,462,304	2,651,527	4,126,529	30,332,644	37,110,700	73,573,004

Value of coal gas and by-products produced in the United States in 1907 and 1908, by States—Continued.

1908.

State.	Total value of illuminating and fuel coal gas.	Value of by-products.				Total value of all products.
		Tar.	Anhydrous ammonia, NH_3 (or its equivalent) and ammonium sulphate.	Coke.	Total.	
Alabama	$552,370	$176,854	$328,713	$1,417,074	$2,008,559	$3,255,360
Georgia	694,451	11,021		74,877		
Arkansas	74,410	2,926	....	11,713	14,639	89,049
California and Oregon	26,520	920	....	2,599	3,519	30,039
Colorado	805,232	42,621		79,978		
Washington	671,194	36,295	14,398	164,346		
Utah					380,437	2,093,122
New Mexico	236,259	7,731	....	35,068		
Oklahoma			....			
Connecticut	842,910	29,011	15,902	135,577	282,215	1,590,684
Rhode Island	465,559	16,843		84,882		
Delaware			....			
District of Columbia	645,191	91,804		1,131,979		
Maryland			221,758		1,586,457	2,903,468
Virginia						
West Virginia	671,820	24,503		116,413		
Florida, Louisiana, and Mississippi	124,583	4,244	....	18,999	23,243	147,826
Idaho			....			
Montana			....			
South Dakota	305,665	8,455	....	53,832		
Wyoming			....		533,251	1,853,832
North Dakota						
Minnesota	1,014,916	61,677	46,611	362,676		
Illinois	2,554,465	140,199	262,289	2,107,167	2,509,655	5,064,120
Indiana	1,243,714	40,395	12,272	247,641	300,308	1,544,022
Iowa	726,541	18,444	66,358	176,078	725,988	2,926,918
Missouri	1,474,389	89,403		375,705		
Kansas and Nebraska	145,485	5,617	....	9,692	15,309	160,794
Kentucky	730,974	29,676	22,189	132,459	296,204	1,635,734
Tennessee	608,556	24,422		87,458		
Maine	277,832	10,120	15,054	25,690	132,907	655,159
New Hampshire and Vermont	244,420	12,076		69,967		
Massachusetts	4,126,298	284,664	457,376	2,005,005	2,747,045	6,873,343
Michigan	3,319,068	182,571	250,515	1,694,362	2,127,448	5,446,516
New Jersey	1,295,933	123,662	170,064	632,768	926,494	2,222,427
New York	5,607,322	315,664	434,900	2,887,465	3,638,029	9,245,351
North Carolina and South Carolina	336,654	10,467	....	39,688	50,155	386,809
Ohio	2,524,081	192,682	163,913	846,722	1,203,317	3,727,398
Pennsylvania	2,810,567	401,052	599,808	4,168,935	5,169,795	7,980,362
Texas	338,580	5,788	....	39,714	45,502	384,082
Wisconsin	1,731,942	135,311	305,856	2,270,516	2,711,683	4,443,625
	37,227,901	2,537,118	3,387,976	21,507,045	27,432,139	64,660,040

IMPORTS OF COAL-TAR PRODUCTS.

A statement regarding the imports of coal-tar products is given in connection with the report on the production of coke in 1908 and is therefore not repeated in this chapter.

NATURAL GAS.

By B. Hill.

INTRODUCTION.

An examination of the table of production covering the period of these reports from 1882 to 1908 shows that the output of natural gas rose rapidly from a value of $215,000 in 1882 to $22,629,875 in 1888, fell gradually in the next eight years to $13,002,512 in 1896, a little more than doubled in five years to $27,066,077 in 1901, a little more than doubled again in the next six years to $54,222,399 in 1907, and, in spite of the financial difficulties beginning in 1907, increased slightly in 1908. This remarkable record seems to indicate that the production of natural gas has become one of the great established industries of the country, an indication borne out by the extension of the gas districts in the Appalachian field, by the development of the mid-Continent and Gulf fields, which has practically only begun, and by the systematic efforts being made to conserve the consumption of this most useful, convenient, and luxurious fuel. The industry evidently has a great future and will probably continue to expand as intelligent and conservative use, rather than the foolish waste of the past, becomes the governing factor.

The report shows that the approximate value of the natural gas produced from wells and consumed in the United States in 1908 was $54,640,374, being greater than that of any previous year. There was a slight decline in 1908 in the Eastern States, as compared with 1907, but this loss was more than made up by substantial gains in the States of the Middle West and South. A further examination of the tables for the last three years brings out at least three interesting facts: An increasing quantity of gas used for domestic purposes, a decreasing quantity consumed for industrial purposes, and an increased price for the gas. Important developments and features peculiar to the various States will be found on other pages of this report under their respective heads.

PRODUCTION AND CONSUMPTION.

The following tables present the statistics of production and consumption in detail:

The following table gives, by States, the total value of the natural gas produced in the entire country from 1882 to 1908, inclusive:

Approximate value of natural gas produced in the United States, 1882–1908, by States.

State.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
Pennsylvania	$75,000	$200,000	$1,100,000	$4,500,000	$9,000,000	$13,749,500	$19,282,375
New York	....	....	....	196,000	210,000	333,000	332,500
Ohio	....	....	....	100,000	400,000	1,000,000	1,500,000
West Virginia	....	....	....	40,000	60,000	120,000	120,000
Illinois	....	....	....	1,200	4,000	....	....
Indiana	....	....	....	....	300,000	600,000	1,320,000
Kansas	....	....	....	....	6,000	....	....
Missouri	....	....	....	....	....	....	....
California	....	....	....	....	....	....	....
Kentucky and Tennessee	....	....	....	....	....	....	....
Texas and Alabama	....	....	....	....	....	....	....
Arkansas and Wyoming	....	....	....	....	....	....	....
Utah	....	....	....	....	....	....	....
Colorado	....	....	....	....	....	....	....
South Dakota	....	....	....	....	....	....	....
Indian Territory and Oklahoma	....	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....	....
Other	140,000	275,000	360,000	20,000	32,000	15,000	75,000
	215,000	475,000	1,460,000	4,857,200	10,012,000	15,817,500	22,629,875

State.	1889.	1890.	1891.	1892.	1893.	1894.
Pennsylvania	$11,593,989	$9,551,025	$7,834,016	$7,376,281	$6,488,000	$6,279,000
New York	530,026	552,000	280,000	216,000	210,000	249,000
Ohio	5,215,669	4,684,300	3,076,325	2,136,000	1,510,000	1,276,100
West Virginia	12,000	5,400	35,000	70,500	123,000	395,000
Illinois	10,615	6,000	6,000	12,988	14,000	15,000
Indiana	2,075,702	2,302,500	3,942,500	4,716,000	5,718,000	5,437,000
Kansas	15,873	12,000	5,500	40,795	50,000	86,600
Missouri	35,687	10,500	1,500	3,775	2,100	4,500
California	12,680	33,000	30,000	55,000	62,000	60,350
Kentucky and Tennessee	2,580	30,000	38,993	43,175	68,500	89,200
Texas and Alabama	1,728	....	....	100	50	50
Arkansas and Wyoming	375	....	250	100	100	100
Utah	....	....	....	....	500	500
Colorado	....	....	....	....	....	12,000
South Dakota	....	....	....	....	....	....
Indian Territory and Oklahoma	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....
Other	1,600,175	1,606,000	250,000	200,000	100,000	50,000
	21,107,099	18,792,725	15,500,084	14,870,714	14,346,250	13,954,400

Approximate value of natural gas produced in the United States, 1882–1908, by States—Continued.

State.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Pennsylvania	$5,852,000	$5,528,610	$6,242,543	$6,806,742	$8,337,210	$10,215,412	$12,688,161
New York	241,530	256,000	200,076	229,078	294,593	335,367	293,232
Ohio	1,255,700	1,172,400	1,171,777	1,488,308	1,866,271	2,178,234	2,147,215
West Virginia	100,000	640,000	912,528	1,334,023	2,335,864	2,959,032	3,954,472
Illinois	7,500	6,375	5,000	2,498	2,067	1,700	1,825
Indiana	5,203,200	5,043,635	5,009,208	5,060,969	6,680,370	7,254,539	6,954,566
Kansas	112,400	124,750	105,700	174,640	332,592	356,900	659,173
Missouri	3,500	1,500	500	145	290	547	1,328
California	55,000	55,682	50,000	65,337	86,891	79,083	67,602
Kentucky and Tennessee	98,700	99,000	90,000	103,133	125,745	286,243	270,871
Texas and Alabama	20	....	....	765	8,000	20,000	18,577
Arkansas and Wyoming	100	60	40	....	....	....	....
Utah	20,000	20,000	15,050	7,875	....	....	....
Colorado	7,000	4,500	4,000	3,300	1,480	1,800	1,800
South Dakota	....	....	....	....	3,500	9,817	7,255
Indian Territory and Oklahoma							
Louisiana	....	....	....	....	....	....	....
Other	50,000	50,000	20,000	20,000	....	....	....
	13,006,650	13,002,512	13,826,422	15,296,813	20,074,873	23,698,674	27,066,077

State.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Pennsylvania	$14,352,183	$16,182,834	$18,139,914	$19,197,336	$18,558,245	$18,844,156	$19,104,944
New York	346,471	493,686	522,575	623,251	672,795	766,157	959,280
Ohio	2,355,458	4,479,040	5,315,564	5,721,462	7,145,809	8,718,562	8,244,835
West Virginia	5,390,181	6,882,359	8,114,249	10,075,804	13,735,343	16,670,962	14,837,130
Illinois	1,844	3,310	4,745	7,223	87,211	143,577	446,077
Indiana	7,081,344	6,098,364	4,342,409	3,094,134	1,750,715	1,572,605	1,312,507
Kansas	824,431	1,123,849	1,517,643	2,261,836	4,010,986	6,198,583	7,691,587
Missouri	2,154	7,070	6,285	7,390	7,210	17,010	22,592
California	120,648	104,521	114,195	133,696	134,560	168,397	307,652
Alabama	....	....	14,082	14,409			
Texas	14,953	13,851			150,695	178,276	236,837
Louisiana	....	....	....	1,500			
Kentucky	365,356	390,301	322,104	237,290	287,501	380,176	424,271
Tennessee	300	300	300	300	300	300	350
Arkansas and Wyoming	....	2,460	6,515	21,135	34,500	126,582	164,930
Colorado	1,900	14,140	14,300	20,752	22,800		
South Dakota	10,280	10,775	12,215	15,200	15,400	19,500	24,400
Oklahoma	360	1,000	49,665	130,137	259,862	417,221	860,159
North Dakota	....	....	....	....	....	235	2,480
Oregon	....	....	....	....	....	100	250
Iowa	....	....	....	....	....	....	93
	30,867,863	35,807,860	38,496,760	41,562,855	46,873,932	54,222,399	54,640,374

The following table shows the production and consumption of natural gas in 1907 and 1908, by States:

Quantity and value of natural gas produced and consumed in the United States in 1907 and 1908, by States.

1907.

State.	Produced.			Consumed.		
	Quantity, M cubic feet.	Cents per M cu. ft.	Value.	Quantity, M cubic feet.	Cents per M cu. ft.	Value.
Pennsylvania	135,516,015	13.9	$18,844,156	164,541,179	13.9	$22,917,547
West Virginia	122,687,236	13.6	16,670,962	54,170,520	6.9	3,757,977
Ohio	52,040,996	16.8	8,718,562	82,971,768	18.4	15,227,780
Kansas	76,707,165	8.1	6,198,583	76,758,560	8.1	6,208,862
Indiana	6,624,204	23.7	1,572,605	6,615,204	23.7	1,570,605
New York	3,287,974	23.3	766,157	11,857,754	26.1	3,098,533
Oklahoma	4,867,031	8.5	417,221	4,815,636	8.5	406,942
Kentucky	1,303,158	29.2	380,176	1,303,158	29.2	380,176
Alabama, Louisiana, Texas	1,287,734	13.8	178,276	1,287,734	13.8	178,276
California	230,344	73.1	168,397	230,344	73.1	168,397
Illinois	1,154,344	12.4	143,577	1,154,344	12.4	143,577
Arkansas, Colorado, Wyoming	766,988	16.5	126,582	766,988	16.5	126,582
North Dakota	940	25.0	235	940	25.0	235
Missouri	108,090	15.7	17,010	108,090	15.7	17,010
Tennessee	2,000	15.0	300	2,000	15.0	300
South Dakota	37,500	52.0	19,500	37,500	52.0	19,500
Oregon	400	25.0	100	400	25.0	100
	406,622,119	13.33	54,222,399	406,622,119	13.33	54,222,399

1908.

State.	Produced.			Consumed.		
	Quantity, M cubic feet.	Cents per M cu. ft.	Value.	Quantity, M cubic feet.	Cents per M cu. ft.	Value.
Pennsylvania	130,476,237	14.64	$19,104,944	147,790,097	13.99	$20,678,161
West Virginia	112,181,278	13.23	14,837,130	54,159,403	7.42	4,020,282
Ohio	47,442,393	17.38	8,244,835	79,906,919	18.98	15,166,434
Kansas	80,740,264	9.52	7,691,587	80,740,264	9.52	7,691,587
New York	3,842,402	24.97	959,280	12,085,891	27.15	3,281,312
Indiana	5,255,792	24.97	1,312,507	5,255,792	24.97	1,312,507
Oklahoma	11,924,574	7.21	860,159	11,924,574	7.21	860,159
Illinois	4,978,879	8.96	446,077	4,978,879	8.96	446,077
Kentucky	1,430,062	29.7	424,271	1,430,062	29.7	424,271
California	478,698	64.3	307,652	478,698	64.3	307,652
Alabama, Louisiana, Texas	1,752,372	13.5	236,837	1,752,372	13.5	236,837
Arkansas, Colorado, Wyoming	1,438,053	11.5	164,930	1,438,053	11.5	164,930
South Dakota	36,400	67.0	24,400	36,400	67.0	24,400
Missouri	152,280	14.8	22,592	152,280	14.8	22,592
North Dakota	7,960	31.2	2,480	7,960	31.2	2,480
Tennessee	2,200	15.9	350	2,200	15.9	350
Oregon	700	35.7	250	700	35.7	250
Iowa	186	50.0	93	186	50.0	93
	402,140,730	13.59	54,640,374	402,140,730	13.59	54,640,374

Distribution of natural gas consumed in the United States in 1907, by States, and total for 1906.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	344	295,115	3,812	44,840,748	24.2	$10,846,922
Ohio	468	380,489	5,476	41,970,198	24.4	10,228,979
Kansas [a]	196	149,327	1,605	16,484,812	20.0	3,288,783
West Virginia [b]	105	53,807	1,000	9,807,000	16.0	1,567,911
New York	208	83,805	155	10,466,829	27.9	2,918,817
Indiana	687	46,210	218	4,480,499	28.7	1,284,160
Oklahoma	107	11,038	277	1,262,808	19.3	244,050
Kentucky	38	19,279	239	1,028,898	31.5	324,368
Alabama	2	600	4			
Louisiana	5	3,000	38	343,261	30.7	105,272
Texas	8	1,250	6			
California	51	6,346	37	97,245	102.2	99,376
Illinois	128	2,126	61	344,304	22.7	78,284
Arkansas	6	3,899	35			
Colorado	3	1,091	21	185,405	40.5	75,182
Wyoming	4	6	3			
North Dakota	3	3	....	940	25.0	235
Missouri	26	259	12	41,340	25.0	10,335
Tennessee	4	1	1	400	25.0	100
South Dakota	13	529	5	22,500	53.8	12,100
Oregon	1	1	....	400	25.0	100
Total	2,407	1,058,181	13,005	131,377,587	23.66	31,084,974
Total for 1906	1,871	874,944	9,074	110,405,808	22.7	25,149,097

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	119,700,431	10.1	$12,070,625	164,541,179	13.9	$22,917,547
Ohio	41,001,570	12.2	4,998,801	82,971,768	18.4	15,227,780
Kansas [a]	60,273,748	4.8	2,920,079	76,758,560	8.1	6,208,862
West Virginia [b]	44,363,520	4.9	2,190,066	54,170,520	6.9	3,757,977
New York	1,390,925	12.9	179,716	11,857,754	26.1	3,098,533
Indiana	2,134,705	13.4	286,445	6,615,204	23.7	1,570,605
Oklahoma	3,552,828	4.6	162,892	4,815,636	8.5	406,942
Kentucky	274,260	20.3	55,808	1,303,158	29.2	380,176
Alabama						
Louisiana	944,473	7.7	73,004	1,287,734	13.8	178,276
Texas						
California	133,099	51.8	69,021	230,344	73.1	168,397
Illinois	810,040	8.1	65,293	1,154,344	12.4	143,577
Arkansas						
Colorado	581,583	8.8	51,400	766,988	16.5	126,582
Wyoming						
North Dakota	....	....	....	[c] 940	25.0	[c] 235
Missouri	66,750	10.0	6,675	108,090	15.7	17,010
Tennessee	1,600	12.5	200	2,000	15.0	300
South Dakota	15,000	49.3	7,400	37,500	52.0	19,500
Oregon	....	....	....	[c] 400	25.0	[c] 100
Total	275,244,532	8.4	23,137,425	406,622,119	13.33	54,222,399
Total for 1906	278,436,754	7.8	21,724,835	388,842,562	12.1	46,873,932

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.
[c] Estimated.

Distribution of natural gas consumed in the United States in 1908, by States.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	695	307,585	4,577	42,202,868	24.0	$10,141,517
Ohio	1,053	427,276	3,621	43,848,494	25.1	10,999,202
Kansas [a]	235	168,855	1,162	23,140,099	20.1	4,647,157
West Virginia [b]	162	63,228	1,225	10,688,856	16.5	1,764,547
New York	263	91,391	213	10,856,613	28.6	3,105,585
Indiana	861	42,054	216	3,957,133	28.0	1,108,001
Oklahoma	155	17,567	356	2,562,201	17.6	451,906
Illinois	219	7,377	204	1,050,252	18.5	194,859
Kentucky	57	21,778	42	1,194,661	33.2	396,179
California	51	6,623	188	144,103	97.5	140,567
Alabama	3	642	1			
Louisiana	6	4,400	57	472,320	28.1	132,950
Texas	24	1,225	18			
Arkansas	6	4,199	42			
Colorado	5	901	3	381,986	26.1	99,599
Wyoming	7	21	3			
South Dakota	28	362	28	26,000	73.5	19,100
Missouri	31	505	5	55,100	22.7	12,499
North Dakota	8	12	2	1,960	50.0	980
Tennessee	4	2	1	600	25.0	150
Oregon	3	2	1	300	50.0	150
Iowa	7	3	....	186	50.0	93
	3,883	1,166,008	11,965	140,583,732	23.6	33,215,041

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	105,587,229	10.0	$10,536,644	147,790,097	13.99	$20,678,161
Ohio	36,058,425	11.6	4,167,232	79,906,919	18.98	15,166,434
Kansas [a]	57,600,165	5.3	3,044,430	80,740,264	9.52	7,691,587
West Virginia [b]	43,470,547	5.2	2,255,735	54,159,403	7.42	4,020,282
New York	1,229,278	14.3	175,727	12,085,891	27.15	3,281,31
Indiana	1,298,659	15.7	204,506	5,255,792	24.97	1,312,507
Oklahoma	9,362,373	4.4	408,253	11,924,574	7.21	860,159
Illinois	3,928,627	6.4	251,218	4,978,879	8.96	446,077
Kentucky	235,401	11.9	28,092	1,430,062	29.7	424,27
California	334,595	49.9	167,085	478,698	64.3	307,65
Alabama						
Louisiana	1,280,052	8.1	103,887	1,752,372	13.5	236,83
Texas						
Arkansas						
Colorado	1,056,067	6.2	65,331	1,438,053	11.5	164,93
Wyoming						
South Dakota	10,400	51.0	5,300	36,400	67.0	24,40
Missouri	97,180	10.4	10,093	152,280	14.8	22,59
North Dakota	6,000	25.0	1,500	7,960	31.2	2,48
Tennessee	1,600	12.5	200	2,200	15.9	35
Oregon	400	25.0	100	700	35.7	25
Iowa	....	....	....	186	50.0	9
	261,556,998	8.19	21,425,333	402,140,730	13.59	54,640,37

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.

Value of natural gas consumed in the United States, 1903–1908, by States.

State.	1903.	1904.	1905.	1906.	1907.	1908.
Pennsylvania	$16,060,196	$17,205,804	$19,237,218	$21,085,077	$22,917,547	$20,678,161
Ohio	7,200,867	9,393,843	10,396,633	12,652,520	15,227,780	15,166,434
Kansas	1,123,849	1,517,643	2,265,945	4,030,776	[b] 6,208,862	[b] 7,691,587
Missouri	7,070	6,285	7,390		17,010	22,592
West Virginia	3,125,061	3,383,515	3,586,608	3,720,440	[c] 3,757,977	[c] 4,020,282
New York	1,944,667	2,222,980	2,434,894	2,654,115	3,098,533	3,281,312
Indiana	[a] 5,915,367	[a] 4,282,409	[a] 3,056,634	[a] 1,750,755	1,570,605	1,312,507
Kentucky	280,426	268,264	237,290	287,501	380,176	424,271
Oklahoma	1,000	49,665	126,028	247,282	406,942	860,159
Alabama	....	14,082	14,409	150,695	178,276	236,837
Texas	13,851					
Louisiana	....	....	1,500			
California	104,521	114,195	133,696	134,560	168,397	307,652
Illinois	3,310	4,745	7,223	87,211	143,577	446,077
Arkansas	2,460	6,515	21,135	34,500	126,582	164,930
Wyoming						
Colorado	14,140	14,300	20,752	22,800		
South Dakota	10,775	12,215	15,200	15,400	19,500	24,400
Tennessee	300	300	300	300	300	350
North Dakota	....	....	....	....	235	2,480
Oregon	....	....	....	....	100	250
Iowa	....	....	....	....	....	93
	35,807,860	38,496,760	41,562,855	46,873,932	54,222,399	54,640,374

[a] A portion of this was consumed in Chicago, Ill.
[b] Includes value of gas piped from Kansas to Missouri.
[c] Includes value of gas piped from West Virginia to Maryland.

COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following tables give the value of natural gas and of petroleum and their combined value in 1907 and 1908, by States, arranged in the order of the value of the combined production:

Value of the natural gas and petroleum produced in 1907 and 1908, and their combined value, by States.

1907.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
Pennsylvania	$18,844,156	$17,579,706	$36,423,862
West Virginia	16,670,962	15,852,428	32,523,390
Kansas	6,198,583	18,478,658	25,094,462
Oklahoma	417,221		
Ohio	8,718,562	14,769,888	23,488,450
Illinois	143,577	16,432,947	16,576,524
California	168,397	14,699,956	14,868,353
Alabama	178,276	....	14,643,172
Louisiana		4,063,033	
Texas		10,401,863	
Indiana	1,572,605	4,536,930	6,109,535
New York	766,157	2,127,748	2,893,905
Kentucky	380,176	862,396	1,242,872
Tennessee	300		
Arkansas	126,582	272,813	421,278
Colorado			
Wyoming		21,883	
Utah	....		
Michigan	....	6,500	23,510
Missouri	17,010		
North Dakota	19,500	....	19,500
South Dakota	235	....	235
Oregon	100	....	100
	54,222,399	120,106,749	174,329,148

Value of the natural gas and petroleum produced in 1907 and 1908, and their combined value, by States—Continued.

1908.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
Pennsylvania	$19,104,944	$16,881,194	$35,986,138
West Virginia	14,837,130	16,911,865	31,748,995
California	307,652	23,433,502	23,741,154
Illinois	446,077	22,648,881	23,094,958
Ohio	8,244,835	14,178,502	22,423,337
Oklahoma	860,159	17,694,843	18,555,002
Texas		6,700,708	
Louisiana	236,837	4,131,173	11,068,718
Alabama		....	
Kansas	7,691,587	746,695	8,438,282
Indiana	1,312,507	3,203,883	4,516,390
New York	959,280	2,071,533	3,030,813
Kentucky	424,271	706,811	1,131,082
Arkansas		....	
Colorado	164,930	346,403	
Wyoming			584,190
Missouri	22,592	50,265	
Michigan			
Utah	....		
South Dakota	24,400	....	24,400
North Dakota	2,480	....	2,480
Tennessee	350	....	350
Oregon	250	....	250
Iowa	93	....	93
	54,640,374	129,706,258	184,346,632

WELL RECORD.

The following table gives the record of natural gas wells in 1908, by States:

Record of natural gas wells in 1908, by States.

State.	Productive Dec. 31, 1907.	Drilled in 1908.			Abandoned in 1908.	Productive Dec. 31, 1908.
		Gas.	Dry.	Total.		
Alabama	9	2	....	2	....	11
Arkansas	54	2	....	2	....	56
California	53	5	....	5	1	57
Colorado	3	....	....	....	....	3
Illinois	283	121	42	163	26	378
Indiana	3,386	187	41	228	350	3,223
Iowa	8	....	....	....	....	8
Kansas	1,760	403	208	611	246	1,917
Kentucky	179	19	23	42	7	191
Louisiana	30	5	10	15	3	32
Missouri	[a] 78	16	3	19	7	[a] 87
New York	1,049	68	19	87	20	1,097
North Dakota	8	7	1	8	1	14
Ohio	2,942	398	124	522	167	3,17
Oklahoma	344	73	40	113	43	37
Oregon	2	1	....	1	....	[illegible]
Pennsylvania	8,051	571	147	718	269	8,35
South Dakota	22	9	....	9	1	3
Tennessee	4	....	....	....	....	
Texas	23	6	8	14	1	2
West Virginia	2,169	253	80	333	99	2,32
Wyoming	11	2	....	2	....	1
	20,468	2,148	746	2,894	1,241	21,37

[a] Includes some wells which produce both oil and gas.

ACREAGE CONTROLLED BY NATURAL GAS COMPANIES.

The following table shows the number of acres of land held by natural gas companies in 1907 and 1908 and whether the acreage was owned in fee or leased:

Acreage controlled by natural gas companies in 1907 and 1908, by States.

State.	1907.			1908.		
	In fee.	Leased.	Total.	In fee.	Leased.	Total.
Alabama	70	30,000	30,070	570	25,000	25,570
Arkansas	2,100	140,148	142,248	3,800	134,103	137,903
California	646	....	646	342	800	1,142
Colorado	....	4	4	....	78	78
Illinois	....	47,250	47,250	....	60,648	60,648
Indiana	23,547	121,161	144,708	23,029	117,130	140,159
Kansas	22,543	664,370	686,913	32,879	628,112	660,991
Kentucky	256	64,162	64,418	308	72,029	72,337
Louisiana	500	39,000	39,500	3,466	8,005	11,471
Missouri	1,491	40,535	42,026	1,831	25,535	27,366
New York	3,238	122,575	125,813	3,670	151,877	155,547
North Dakota	....	....	....	....	23,000	23,000
Ohio	11,855	849,436	861,291	7,287	860,508	867,795
Oklahoma	7,808	742,157	749,965	11,017	933,739	944,756
Pennsylvania	334,454	1,419,808	1,754,262	350,075	1,508,809	1,858,884
Texas	....	28,112	28,112	155	31,455	31,610
West Virginia	38,126	2,039,743	2,077,869	41,683	2,249,552	2,291,235
Wyoming	250	2,390	2,640	250	2,990	3,240
	446,884	6,350,851	6,797,735	480,362	6,833,370	7,313,732

NATURAL-GAS INDUSTRY BY STATES.

PENNSYLVANIA.

The report shows that Pennsylvania not only leads all States in the value of its gas production in 1908 but also in the combined value of its natural gas and petroleum production.

The statistics of the natural-gas industry, as given in the table of distribution, show that the value of the gas consumed in this State in 1908 was $20,678,161, as compared with $22,917,547 in 1907, a decrease of $2,239,386. This decrease was due to a falling off in consumption, the quantity decreasing from 164,541,179,000 cubic feet in 1907 to 147,790,097,000 cubic feet in 1908; the average price per thousand cubic feet was 13.99 cents in 1908, as against 13.9 cents in 1907, a slight advance. It will be noted that the greater decline was in gas utilized for industrial purposes, the quantity and value decreasing from 119,700,431,000 cubic feet, valued at $12,070,625, in 1907, to 105,587,229,000 cubic feet, valued at $10,536,644, in 1908, this decline being partly due to lessened demand for gas as a result of the general depression in business which so largely affected the manufacturing districts of this State in 1908. In some instances wells, owned by manufacturing establishments which were idle, were closed all year. In the domestic consumption of gas in 1908 there was a decline of 2,637,880,000 cubic feet in quantity and $705,405 in value, as compared with 1907.

The estimated quantity and value of the gas produced in this State in 1908 were 130,476,237,000 cubic feet, valued at $19,104,944, as compared with 135,516,015,000 cubic feet, valued at $18,844,156 in 1907, a decrease in quantity of 5,039,778,000 cubic feet and an increase in value of $260,788.

The average price received per 1,000 cubic feet for all gas produced in the State advanced from 13.9 cents in 1907 to 14.64 cents in 1908. The average price of gas per 1,000 cubic feet consumed in the State varied from 2½ cents at the wells, the lowest price paid for gas for manufacturing, to 32 cents, the highest price for domestic gas, the average price of all gas for industrial purposes being 10 cents and for domestic purposes 24 cents.

During the year 1908 a total of 718 wells was completed in Pennsylvania, of which 571 were productive wells and 147 were dry holes. Although some very good wells were drilled in the gas fields of this State in 1908, no very important developments have been reported. Three good gassers, with a rock pressure varying from 400 to 460 pounds, were brought in in Pleasant Valley Township, Potter County. From several districts come reports of decreased pressure and failing gas supply.

Record of natural-gas industry in Pennsylvania, 1897–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	176	$6,242,543	[a] 201,059	1,124	$5,392,661	314	96	2,467
1898	232	6,806,742	[a] 213,410	1,021	6,064,477	373	74	2,840
1899	281	8,337,210	[a] 232,060	1,236	7,926,970	467	104	3,303
1900	266	10,215,412	[a] 229,730	1,296	9,812,615	513	142	3,776
1901	296	12,688,161	[a] 326,912	1,743	11,785,996	660	143	4,436
1902	379	14,352,183	185,678	2,448	13,942,783	775	232	5,211
1903	414	16,182,834	214,432	2,834	16,060,196	699	126	5,910
1904	414	18,139,914	238,481	2,929	17,205,804	701	174	6,352
1905	351	19,197,336	257,416	2,845	19,237,218	765	168	6,56[illegible]
1906	309	18,558,245	273,184	3,307	21,085,077	603	153	7,30[illegible]
1907	344	18,844,156	295,115	3,812	22,917,547	769	180	8,05[illegible]
1908	[b] 695	19,104,944	307,585	4,577	20,678,161	571	147	[c] 8,35[illegible]

[a] Number of fires supplied.
[b] Includes 123 companies producing gas from oil wells only; also includes 216 producers having shallow wells in Erie county for their own domestic consumption.
[c] Includes 350 shallow wells in Erie county.

Depth and gas pressure of wells in Pennsylvania, 1906 to 1908, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1906.	1907.	1908.
Allegheny	1,530–2,800	1– 380	7– 400	1–[illegible]
Armstrong	800–3,384	7– 900	6– 800	2–[illegible]
Beaver	1,000	....	4	....
Butler	824–2,600	22– 700	15– 625	15–[illegible]
Clarion	600–2,600	6– 450	3– 700	15–[illegible]
Elk	1,400–3,200	50– 990	49– 960	50–[illegible]
Crawford	600– 900	25– 100	10– 200	
Erie	300–1,500			
Fayette and Somerset	1,700–2,660	28– 300	100– 550	200–[illegible]
Forest	700–2,600	6– 90	75– 250	85–[illegible]
Greene	1,400–3,200	80– 350	80–1,200	70–[illegible]
Indiana	1,100–1,500	....	....	....
Jefferson	1,800–2,715	70– 800	200– 500	325–[illegible]
McKean	750–2,665	18– 880	20– 450	15–[illegible]
Mercer	1,100–1,500	30– 150	....	....
Potter	750–2,200	125– 400	40– 360	100[illegible]
Tioga	730–1,400	....	350	
Venango	787–2,100	90– 200	70– 150	40[illegible]
Warren	600–2,050	20– 100	10– 60	14[illegible]
Washington	606–3,304	30–1,300	15– 100	5[illegible]
Westmoreland	1,800–3,300	80– 100	25	1[illegible]

NEW YORK.

The returns received from producers in New York show that the quantity and value of natural gas produced in this State increased from 3,287,974,000 cubic feet, valued at $766,157, in 1907, to 3,842,402,000 cubic feet, valued at $959,280, in 1908, an increase of 594,428,000 cubic feet and of $193,123. The number of domestic consumers increased from 83,805 in 1907 to 91,391 in 1908. It will be observed that only about one-third of the gas consumed in New York is produced in the State, the difference between the consumption and the production being the quantity of gas piped into the State from Pennsylvania, upon whose gas fields the consumers of New York are so largely dependent for their supply. During the year 1908 the total consumption of gas in New York amounted to 12,085,891,000 cubic feet, valued at $3,281,312, as compared with 11,857,754,000 cubic feet, valued at $3,098,533, in 1907, an increase of 228,137,000 cubic feet and of $182,779.

The greater portion of the gas consumed in this State is utilized for domestic purposes, and that supplied for industrial purposes is used mostly for power plants, gas engines, and boilers.

A total of 87 wells was completed in the State in 1908, of which 68 were producers of gas and 19 were dry holes, the number of productive gas wells at the close of the year being 1,097.

The average price of gas per 1,000 cubic feet in 1908 was 27.15 cents, or 1.05 cents more than in 1907, when the price was 26.1 cents.

Record of natural-gas industry in New York, 1897–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	41	$200,076	[a] 55,086	80	$874,617	33	7	359
1898	62	229,078	[a] 68,662	103	1,006,567	63	9	422
1899	84	294,593	[a] 76,544	121	1,236,007	36	7	447
1900	89	335,367	[a] 89,837	138	1,456,286	57	11	504
1901	114	293,232	[a] 95,161	98	1,694,925	53	14	557
1902	116	346,471	50,536	215	1,723,709	69	8	626
1903	144	493,686	57,935	208	1,944,667	75	11	700
1904	153	522,575	67,203	451	2,222,980	78	12	744
1905	148	623,251	67,848	447	2,434,894	89	17	839
1906	143	672,795	74,538	95	2,654,115	64	14	919
1907	208	766,157	83,805	155	3,098,533	61	13	1,049
1908	[b] 263	959,280	91,391	213	3,281,312	68	19	1,097

[a] Number of fires supplied.
[b] Includes 48 companies which produced gas from oil wells only.

Depth and gas pressure of wells in New York, 1906–1908, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1906.	1907.	1908.
Allegany	600–1,700	30–250	10–150	10–200
Cattaraugus	400–2,300	20– 90	5– 85	4–150
Chautauqua	150–2,471	5–650	1–800	1–800
Erie	360–2,980	56–400	40–585	25–500
Niagara	550		....	150
Genesee	1,150–1,850	....	300–580	600
Livingston	345–1,800	5– 10	10	1–350
Onondaga	1,000–3,000	100–350	100	100–350
Ontario	700–2,300	10–600	65–425	65–510
Seneca	1,450–1,550			
Oswego	700–1,200	4–400	....	....
Schuyler	1,400	100–435	100–435	15–100
Yates	1,200–1,900			
Steuben	279– 850	70–300	....	25
Wyoming	1,638–1,800	120–200	140–200	100–200

WEST VIRGINIA.

West Virginia ranks second in quantity and value of natural gas produced in the United States in 1908, as well as second in the combined value of its natural gas and petroleum production.

It is not possible to give accurately the quantity and value of the gas produced in West Virginia, since gas is piped through the same line as gas from another State; hence only approximate figures can be given. The returns received indicate that there was a decline in the production of gas in West Virginia in 1908 as compared with 1907, there being a falling off in the quantity of gas piped out of the State. The decline is noticeable in the quantity of gas consumed for manufacturing purposes, which was due in part to a decreased demand caused by the depression in business in the industrial districts of Ohio and Pennsylvania. There is also a constantly increasing demand for gas for domestic purposes. A larger proportion of the gas was piped to cities and towns in northern Ohio and consumed for domestic purposes in 1908 than in previous years.

The construction of the new pipe line from the gas fields of this State to Cincinnati, Ohio, was the most important work undertaken in 1908 in connection with the natural-gas industry of West Virginia. This new line extends in a westerly and northwesterly direction, beginning at Culloden, W. Va., and running through the northeasterly part of Kentucky, just south of Ohio River, and comprises 33 miles of 18-inch pipe from Culloden to Big Sandy River and 126 miles of 20-inch pipe from that point to and through the city of Covington Ky., where it terminates at present in two 12-inch pipes crossing the suspension bridge into the city of Cincinnati. The main pipe is wrought steel, $\frac{3}{8}$ inch and $\frac{5}{16}$ inch thick; the size given above is outside diameter. In addition to the main line, there are 25 miles o 8-inch and 12-inch field lines running directly south from the 18-incl line into the Lincoln County and Wayne County gas fields of southwestern West Virginia, and about as many more miles of smaller fiel line piping connecting the various gas wells. The capacity of th pipe line at point of delivery is 70,000,000 cubic feet of gas per da This line is the property of the Cincinnati Gas Transportation Con pany and is leased to the Columbia Gas and Electric Company. Th new line was completed and in operation July 1, 1909, on which date gas was being supplied to the cities of Cincinnati, Ohio, and Covington, Ky.

The consumption of gas in West Virginia and Maryland amounted to 54,159,403,000 cubic feet, valued at $4,020,282, in 1908, as compared with 54,170,520,000 cubic feet, valued at $3,757,977, in 1907, a reduction of 11,117,000 cubic feet in quantity and a gain of $262,305 in value. Of this total consumption 10,688,856,000 cubic feet, valued at $1,764,547, were used for domestic purposes, and 43,470,547,000 cubic feet, valued at $2,255,735, were used for manufacturing and other industrial purposes. Of the quantity consumed for industrial purposes, approximately 10,411,444,000 cubic feet, valued at $250,365, almost equaling in quantity the gas utilized for domestic purposes, were consumed in the manufacture of carbon black in this State in 1908. Gas was also used for iron, glass, and brick manufacturing.

The price of gas per 1,000 cubic feet in 1908 ranged from 1½ cents at the wells to 26½ cents, the highest price received for gas used for domestic purposes, the average for the year being 7.42 cents, as compared with 6.9 cents in 1907. The average price per 1,000 cubic feet received for gas consumed for domestic purposes was 16½ cents and for industrial purposes 5.2 cents.

It will be observed that the quantity and value of gas produced in West Virginia and consumed in Maryland are included with the figures showing the consumption of gas in West Virginia, as there is but one company piping gas from West Virginia to Maryland and the figures must not be disclosed. During the year 1908 gas produced in West Virginia was supplied to the cities of Cumberland, Lonaconing, Frostburg, Eckhart, McCoole, Barton, and other small towns in Allegany County, Md.

There were 333 wells completed in West Virginia in 1908, of which 253 were gas wells and 80 were dry holes, and 99 gas wells were abandoned, the total of productive gas wells in this State at the close of 1908 being 2,323. Reports from the older gas fields state that the pressure is slowly diminishing and that it is becoming necessary to develop new fields to maintain the supply.

Record of natural-gas industry in West Virginia, 1897–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	12	$912,528	[a] 30,015	393	$791,192	47	1	196
1898	19	1,334,023	[a] 28,652	125	914,969	32	4	227
1899	30	2,335,864	[a] 38,137	305	1,310,675	78	6	300
1900	34	2,959,032	[a] 45,943	184	1,530,378	129	6	428
1901	44	3,954,472	[a] 55,808	266	2,244,758	177	8	604
1902	79	5,390,181	29,357	877	2,473,174	142	37	745
1903	88	6,882,359	36,179	1,122	3,125,061	242	43	987
1904	90	8,114,249	44,563	1,005	3,383,515	292	33	1,274
1905	76	10,075,804	45,588	1,417	3,586,608	385	28	1,579
1906	67	13,735,343	51,281	913	3,720,440	263	23	1,831
1907	105	16,670,962	53,807	1,000	[c] 3,757,977	377	59	2,169
1908	[b] 162	14,837,130	63,228	1,225	[c] 4,020,282	253	80	2,323

[a] Number of fires supplied.
[b] Includes 24 companies which produced gas from oil wells only.
[c] Includes gas consumed in Maryland.

Depth and gas pressure of wells in West Virginia, 1906 to 1908, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1906.	1907.	1908.
Braxton	2,250-2,350			
Clay	1,650-1,800	....	250-900	250-500
Taylor	2,100			
Brooke	1,300-1,700	....	100	30-600
Cabell	900-2,325	350- 650	300-625	230-650
Calhoun	1,470-4,000	300	200-600	25-400
Doddridge	1,700-2,980	100- 900	180-620	70-580
Gilmer	1,280-2,873	465	....	....
Hancock	800-1,400	80- 90	15-300	1-220
Harrison	800-3,049	325-1,000	105-975	150-800
Kanawha	1,500-1,700	....	....	....
Lewis	1,510-2,700	200- 900	250-900	275-750
Lincoln	1,200-2,400	....	500	585
Marion	2,300-3,100	400- 750	300-350	100-700
Marshall	1,400-2,900	....	....	160-300
Monongalia	1,400-3,106	150- 500	140-450	40-400
Pleasants	1,200-1,985	....	50-300	200-350
Ritchie	1,700-2,200	....	....	25-670
Roane	1,472-2,350	....	340	500-700
Tyler	1,650-2,700	80	160-550	40-340
Upshur	2,300	....	....	....
Wetzel	2,068-3,172	42- 50	125-242	65-300
Wirt	700-1,600	60- 530	20-530	30-500
Wood	1,200-1,500	....	....	40-150

KENTUCKY.

The report shows that the value of natural gas produced from wells in Kentucky is increasing, the total value for 1908 having been $424,271, as compared with $380,176 in 1907 and with $287,501 in 1906. Most of the gas produced in this State is used for domestic purposes; considerable gas, however, is produced from oil and gas wells in Wayne County and is consumed in the oil fields for development and operating purposes.

The natural-gas wells of Kentucky are located in Breckenridge, Clay, Floyd, Hardin, Jefferson, Knox, Logan, Martin, Meade, Menifee, Powell, Shelby, Wayne, and Wolfe counties. A few gas wells have been drilled in Christian and Warren counties, but their product has not been used. The wells of Hardin and Jefferson counties are shallow and their supply is almost exhausted, the presence of water causing the abandonment of many wells. Wells in Meade County have declined greatly and are still declining. Some wells have been drilled in Logan County, the product of which was used at Diamond Springs in 1908, but preparations are being made to lay a pipe line to Lewisburg to supply that town and Russellville. The Cumberland Gas Company, having wells in Knox and Wayne counties, which has been supplying gas to domestic consumers in Barboursville, is installing a plant in Monticello. During the year 1908 a total of 19 productive gas wells and 23 dry holes was drilled in Kentucky, and 7 gas wells were abandoned, the total number of productive gas wells being 191 at the close of the year, of which 41 were closed in.

Record of natural-gas industry in Kentucky, 1906 to 1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	45	$287,501	17,216	18	$287,501	......	......	166
1907	38	380,176	19,279	239	380,176	31	14	179
1908	57	424,271	21,778	42	424,271	19	23	191

OHIO.

Ohio was second to Pennsylvania in the number of industries supplied with natural gas in 1908, but first in the number of domestic consumers. Ohio produced in 1908 little more than one-half the gas consumed in the State, her consumers being dependent upon the gas fields of Pennsylvania and West Virginia for a portion of their supply, the larger part of which was piped from the gas fields of West Virginia. It is estimated that the production of natural gas in Ohio in 1908 amounted to 47,442,393,000 cubic feet, valued at $8,244,835, as compared with 52,040,996,000 cubic feet, valued at $8,718,562, in 1907, a decrease in 1908 of 4,598,603,000 cubic feet and of $473,727.

The table of distribution shows that the quantity of gas consumed in Ohio fell from 82,971,768,000 cubic feet in 1907 to 79,906,916,000 cubic feet in 1908, a reduction of 3,064,852,000 cubic feet in quantity, and a decrease in value of only $61,346, or from $15,227,780 in 1907 to $15,166,434 in 1908. It will be noted that there was a marked increase in quantity and value of gas sold for domestic purposes in 1908 as compared with 1907, and a corresponding decrease in quantity and value of gas sold for industrial purposes. This was brought about partly by the industrial depression, which restricted consumption, and by the piping of gas through the new line from the West Virginia gas fields to Cleveland and other cities and towns in northern Ohio, where millions of feet of gas were delivered for consumption, most of which was supplied for domestic purposes. The quantity of gas consumed for domestic purposes in Ohio in 1908 was 43,848,494,000 cubic feet, valued at $10,999,202, as against 41,970,198,000 cubic feet, valued at $10,228,989, in 1907, an increase of 1,878,296,000 cubic feet and of $770,223. The quantity of gas supplied for industrial and manufacturing consumption was 36,058,425,000 cubic feet, valued at $4,167,232, in 1908, as compared with 41,001,570,000 cubic feet, valued at $4,998,801, in 1907, a decrease of 5,043,145,000 cubic and of $831,569.

The price of gas per 1,000 cubic feet in Ohio in 1908 ranged from 4 cents at the well, the lowest, to 50 cents, the highest price paid for gas supplied for domestic purposes, the average price of all gas for the year being 18.98 cents, as compared with 18.4 cents in 1907. The average price of gas consumed for domestic purposes advanced from 24.4 cents in 1907 to 25.1 cents in 1908, while the average price of gas consumed for manufacturing and industrial purposes decreased from 12.2 cents in 1907 to 11.6 cents in 1908.

A total of 398 gas wells and 124 dry holes were drilled, and 167 gas wells were abandoned in 1908, the total number of productive gas wells at the close of the year being 3,173. These figures include a total of 901 shallow wells in Ashtabula, Cuyahoga, Lake, and Lorain counties, 26 of which were drilled in 1908. These wells supplied 979 domestic consumers, the value of the gas consumed being estimated at $56,220. Little need be said regarding these wells, which have no commercial value, most of them being drilled on the properties of the owners, for their own domestic use, and few of them producing more than sufficient gas for one dwelling.

Some good wells which will do much to supply the needs of consumers were completed in 1908 in the gas fields of Ohio. In the Roseville field 2 wells were drilled, with pressure ranging from 350 to 400 pounds. In the Clinton sand of Knox and Licking counties, at depths varying from 2,250 to 3,200 feet, several wells were drilled in 1908, with pressures ranging from 250 to 525 pounds, one especially good well in Knox County at a depth of 2,600 feet having a pressure of 900 pounds. In the Homer and Sugar Grove gas fields it is reported that the rock pressure is diminishing rapidly, owing to the installation of gas pumps, and that the supply is decreasing proportionately. In the Homer field rock pressure in 1908 was from 110 to 600 pounds, an average, as indicated by 165 wells, equal to 263 pounds; in 1907 the rock pressure was from 115 to 555 pounds, and the average for 131 wells was 265 pounds. In the Sugar Grove field rock pressure in 1908 was from 45 to 300 pounds, an average, as indicated by 74 wells, equal to 108 pounds; in 1907 the rock pressure was from 27 to 558 pounds and the average for 74 wells was 117 pounds. In 1908 gas developments were in progress in Jefferson County, and at a depth of 600 to 700 feet some gas wells were drilled, with a pressure of 150 to 230 pounds.

Record of natural gas industry in Ohio, 1897–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	157	$1,171,777	[a] 85,368	183	$1,506,454	88	51	729
1898	237	1,488,308	[a] 68,211	349	2,250,706	120	12	806
1899	359	1,866,271	[a] 77,787	691	3,207,286	134	17	929
1900	281	2,178,234	[a] 135,743	1,092	3,823,209	97	19	990
1901	305	2,147,215	[a] 149,709	949	4,119,059	113	35	1,099
1902	451	2,355,458	120,127	786	4,785,766	266	40	1,343
1903	515	4,479,040	197,710	1,786	7,200,867	290	62	1,523
1904	453	5,315,564	232,557	1,136	9,393,843	334	49	1,661
1905	425	5,721,462	274,585	2,955	10,396,633	342	58	1,705
1906	409	7,145,809	310,175	3,316	12,652,520	337	51	[b] 1,977
1907	468	8,718,562	380,489	5,476	15,227,780	431	90	2,942
1908	[c] 1,053	8,244,835	427,276	3,621	15,166,434	398	124	[d] 3,173

[a] Number of fires supplied.
[b] Exclusive of complete report of shallow wells.
[c] Includes 83 producers which supplied gas from oil wells only; also 735 producers in Ashtabula, Lake, Lorain, and Cuyahoga counties having shallow wells for their own domestic purposes.
[d] Includes 901 shallow wells located in Ashtabula, Lake, Lorain, and Cuyahoga counties.

Depth and gas pressure of wells in Ohio, 1906 to 1908, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1906.	1907.	1908.
Allen	1,200–1,260	25– 100	200	....
Ashtabula	600–2,030	....	....	3– 300
Athens	600–1,200	50– 350	100	30– 250
Auglaize	1,110–1,220	....	5– 250	5– 225
Belmont	1,200–1,824	150	200– 275	5– 100
Carroll	1,259–1,434	....	200– 375	200– 350
Columbiana	650– 900	90– 225	70– 240	30– 275
Cuyahoga	500–1,300	....	....	90
Darke	960–1,300	....	75– 103	30
Fairfield	1,900–2,500	15– 300	40– 130	5– 150
Guernsey	1,050–1,300	250	400	300– 450
Hancock	1,100–1,400	2– 250	85	3– 5
Hardin	1,260–1,460	250	....	16– 150
Harrison	703–1,600	100– 300	40– 200	5– 125
Hocking	2,300	500– 600	....	....
Holmes	700–1,000	210	215	180– 205
Jefferson	600–2,026	200– 300	240	150– 495
Knox	590–3,000	50– 940	110– 400	140– 900
Lake	500–1,400	....	....	100
Licking	2,100–2,850	300– 500	200– 750	100– 730
Logan	1,460	25	40	....
Lorain	338–1,150	....	....	0– 120
Lucas	1,165–1,550	0– 90	1– 90	1– 80
Medina	300–1,300	....	....	20– 75
Mercer	1,096–1,400	20– 43	2– 40	2– 250
Monroe	1,200–2,000	136	400	200– 500
Morgan	250–1,450	30– 500	15– 500	20– 450
Muskingum	1,060–1,300	....	400– 425	350– 400
Noble	1,650–1,750	....	....	550
Ottawa	1,250–1,600	50– 420	50– 420	20– 400
Perry	1,200–2,500	....	350– 700	75– 85
Richland	2,550	1,000–1,260	1,100	500–1,000
Sandusky	470–1,400	30– 150	30– 75	20– 200
Seneca	400–1,460	....	15– 140	2– 150
Trumbull	370– 388	....	....	75
Van Wert	1,200–1,270	75– 200	....	175
Vinton and Jackson	520– 800	....	300	275– 325
Warren	275–1,000	....	....	40– 50
Washington	700–2,600	80– 640	75– 350	15– 550
Wood	1,200–1,400	10– 60	20	....

INDIANA.

As shown by the table of distribution the production of gas in Indiana is slowly decreasing, the quantity declining from 6,615,204,000 cubic feet, valued at $1,570,605, in 1907, to 5,255,792,000 cubic feet, valued at $1,312,507, in 1908, a reduction of 1,359,412,000 cubic feet and of $258,098. Of the estimated total production in 1908, there were 3,957,133,000 cubic feet, valued at $1,108,001, with an average price of 28 cents per 1,000, utilized for domestic purposes, and 1,298,659,000 cubic feet, valued at $204,506, consumed for industrial purposes. Of the total quantity supplied to industrial establishments, it is estimated that 723,208,000 cubic feet, valued at $105,708, were consumed by glass, tile, foundry, and chemical works, and that 575,451,000 cubic feet, valued at $98,798, were consumed for generating power, for gas engines, for elevators, pumping stations, electric light plants, laundries, etc.

The scarcity and failure of gas has been detrimental to the oil operators of this State, who depended so largely upon this fuel for the operation of their plants. In 1908 many oil wells were shut in during the winter months, when pressure is at its lowest, for lack of gas, and some leases were abandoned altogether. Some attempts were made to revive old gas wells by drilling deeper, and many new wells were drilled in old gas fields, but no important developments have been reported. A few good gas wells were drilled in Pike County at a depth of 1,137 to 1,208 feet, with 250 to 525 pounds pressure, but these, for lack of a market, have not been put to use except for development purposes on the leases. A few new wells in Sullivan County have a pressure of 295 pounds. It is reported that since factories have ceased to use gas for fuel, pressure seems to be increasing slightly in some of the old gas wells.

It appears from the following table that the number of gas producers in Indiana increased from 687 in 1907 to 861 in 1908. This is accounted for by the fact that more complete returns have been received; also that several of the large gas companies have either abandoned the wells they formerly operated, or sold them to the farmers upon whose lands the wells are located. Each of the wells is thus reported as a separate producer in 1908. Many of these wells produce sufficient gas for one or more dwellings. Another feature in this connection is that 560 of the total 861 producers reporting in 1908 have but one well each.

In the year 1908 a total of 187 productive gas wells was drilled and 41 dry holes, and 350 gas wells were abandoned, the total being 3,223 productive gas wells at the close of the year. Of this total number Decatur County had 338 wells; Delaware County, 330; Shelby County, 150; and Rush County, 377.

In most of the cities of Indiana gas rates have advanced, but in the country districts, where gas is sold at flat rates, prices have changed little if any. The lowest price charged for gas per 1,000 cubic feet, to be used for domestic purposes, was 12½ cents, a small quantity being supplied at this price. In Decatur County 15 cents per 1,000 cubic feet was the prevailing price; in Rush and Shelby counties the price ranged from 15 to 25 cents; in other counties of the State prices were from 20 cents to $1.25.

Record of natural gas industry in Indiana, 1897–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	452	$5,009,208	[a] 214,750	935	$3,945,307	419	66	2,881
1898	533	5,060,969	[a] 173,454	1,867	4,682,401	706	111	3,325
1899	571	6,680,370	[a] 181,440	1,741	5,833,370	838	109	3,909
1900	670	7,254,539	[a] 181,751	2,751	6,412,307	861	156	4,546
1901	656	6,954,566	[a] 153,869	2,570	6,276,119	985	208	4,572
1902	929	7,081,344	101,481	3,282	6,710,080	1,331	205	5,820
1903	924	6,098,364	90,118	1,020	5,915,367	895	242	5,514
1904	846	4,342,409	84,862	390	4,282,409	706	153	4,684
1905	740	3,094,134	63,194	231	3,056,634	252	74	3,650
1906	578	1,750,715	47,368	156	1,750,755	159	46	3,523
1907	687	1,572,605	46,210	218	1,570,605	185	56	3,386
1908	[b] 861	1,312,507	42,054	216	1,312,507	187	41	3,223

[a] Number of fires supplied. [b] Includes 38 companies which produced gas from oil wells only.

Depth and gas pressure of wells in Indiana, 1906 to 1908, by counties.

County	Depth, in feet.	Pressure, in pounds.		
		1906.	1907.	1908.
Bartholomew	864– 990	25–150	5– 150	100–150
Blackford	940–1,080	1– 5	1– 65	2– 60
Clark	128– 244			10– 27
Daviess, Martin	400– 600	4– 15	8– 25	5– 50
Decatur	725–1,000	30–340	15– 335	10–335
Delaware	728–1,200	1– 35	1– 40	75
Grant	900–1,100	a 15	a b240	45
Hamilton	800–1,200	10–200	10– 175	10–190
Hancock	700–1,100	5–200	5– 140	5–250
Harrison	320– 404	30	60	40
Henry	800–1,100	10–200	15– 120	5–270
Howard	860–1,100	20–200	25– 250	3–240
Jay	900–1,417	190	160	60
Jefferson	1,360			8– 10
Madison	800–1,000	½– 50	1– 200	1–150
Miami	900– 975	70–100	20– 60	20–100
Marion, Ripley	980–1,000		60– 190	
Pike	1,137–1,208			250–525
Randolph	900–1,140	25–275	5– 260	1–220
Rush	780–1,035	40–350	25– 350	10–350
Shelby	750–1,000	60–330	45– 350	25–330
Sullivan	721– 730		295	295
Tipton	750–1,100	45–215	40– 200	10–180
Wayne	800–1,150	70– 75	50– 80	50–250

[a] Run on vacuum. [b] New.

ILLINOIS.

The estimated production of natural gas in Illinois amounted in 1908 to 4,978,879,000 cubic feet, valued at $446,077, as compared with 1,154,344,000 cubic feet, valued at $143,577, in 1907, an increase in 1908 of 3,824,535,000 cubic feet, or 331 per cent, in quantity, and of $302,500, or 210 per cent, in value, being a larger gain than that of any other State. As a producer of crude petroleum Illinios ranked second in 1908, and also showed the greatest gain in production over 1907. Referring to the table of distribution it will be noted that nearly four times as much gas was consumed for industrial as for domestic purposes. Considerable gas was produced in this State from oil wells and consumed on the leases for development and operating purposes in 1908.

The deep wells of Illinois, which produce gas in commercial quantities, are located in Clark, Crawford, Cumberland, and Lawrence counties, their product being supplied to consumers in the following-named towns: Annapolis, Birds, Casey, Flat Rock, Hutsonville, Lawrenceville, Martinsville, Marshall, Oblong, Palestine, Pinkstaff, and Robinson. Sumner is being piped and will be supplied with gas from Lawrence County. Domestic consumers in Heyworth are supplied with gas from wells in McLean County. During 1908 gas was piped from wells in Crawford County to the city of Vincennes, Ind., where it was supplied to domestic and industrial consumers.

In 1908 a total of 121 productive gas wells and 42 dry holes were drilled in Illinois, and 26 gas wells were abandoned, the number of productive gas wells at the close of the year being 378; of this number 189 were located in Clark, Crawford, Cumberland, Lawrence, and McLean counties. The depth at which gas is found in Crawford

County wells varies from 600 to 625 feet, with a pressure of about 25 pounds, to from 868 to 1,550 feet, with a pressure of 100 to 400 pounds. In Clark County gas is found at a depth of 447 to 500 feet, and pressure varies from 65 to 100 pounds. In Cumberland County the depth of gas wells is from 468 to 575 feet and the pressure varies from 27 to 38 pounds. In Lawrence County gas is found at a depth of 1,500 to 1,652 feet with a pressure of 100 to 500 pounds.

In Bureau, Champaign, Dewitt, Lee, Logan, and Pike counties there was at the close of 1908 a total of 189 shallow gas wells, comprising one-half the wells of the State. The product of these wells is mainly consumed for domestic purposes by the owners, the flow not being sufficient for commercial use; the total value of the gas produced from these wells and consumed in 1908 is estimated at $14,470.

Record of natural gas industry in Illinois, 1906–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	66	$87,211	1,429	2	$87,211	......	......	200
1907	128	143,577	2,126	61	143,577	94	41	283
1908	219	446,077	a 7,377	a 204	a 446,077	121	42	378

a Includes number of consumers and value of gas consumed in Vincennes, Ind.

KANSAS.

The value of the natural gas produced in Kansas in 1908 exceeded that of any previous year. Since a large proportion of the gas supplied to consumers is not metered but is sold at flat rates, it is impossible to give accurately the quantity of gas consumed; but from the best estimates that could be made the following table shows that 80,740,264,000 cubic feet of gas, valued at $7,691,587, were produced, as compared with 76,707,165,000 cubic feet, valued at $6,198,583, in 1907, a gain in 1908 of 4,033,099,000 cubic feet and of $1,493,004.

The largest producer of natural gas in Kansas is the Kansas Natural Gas Company, which pipes a portion of its gas to Missouri, where it is delivered to consumers for domestic and industrial purposes in the cities and towns of that State. To increase the pressure of the gas in its transportation from this State to Missouri gas compressor stations have been erected at Scipio, Petrolia, and Grabham, Kans. As this company is the only producer which pipes gas from Kansas to Missouri, the number of consumers and the quantity and value of the gas consumed in Missouri are included with the figures given for Kansas.

1905 Reference to the table of distribution in 1908 will show tha
1906
1907 ...40,099,000 cubic feet of gas, valued at $4,647,157, were supplie
1908 ...8,855 domestic consumers in 1908, as compared with 16,484, cubic feet, valued at $3,288,783, supplied to 149,327 domesti
a Number of ...s in 1907, an increase in 1908 of 6,655,287,000 cubic feet, o and of 19,528 consumers. The quantity of gas consume ...turing purposes was almost two and one-half times mor

than the quantity consumed for domestic purposes, but the value of the gas consumed was only two-thirds as much. Large quantities of gas, to which they owe their existence, are consumed by the zinc smelting, cement, and brick industries of this State. It is estimated that 17,383,476,000 cubic feet of gas, valued at $516,968, were consumed by smelters alone, and that not less than 16,087,276,000 cubic feet, valued at $525,468, were consumed by cement, brick, and glass works.

The average price per 1,000 cubic feet of gas supplied to consumers in Kansas in 1908 was 9.52 cents, as compared with 8.1 cents in 1907. Large quantities of gas are sold by producers in this State to gas companies and to manufacturing establishments at very low rates, the price ranging from 1¾ cents to 3 cents per 1,000 cubic feet at the wells.

Although no reports have been received of the discovery of new gas fields in this State in 1908, the old gas fields have been extended by the drilling of many new wells. During the year 611 wells were drilled, of which 403 were gas producers and 208 were dry holes, the number of productive gas wells being 1,917 at the close of the year. Reports received from producers indicate that the pressure in the old gas fields of Allen, Neosho, and Wilson counties is decreasing and that some wells are giving out rapidly; in Montgomery County the gas pumps are having a marked effect on the rock pressure of some of the wells.

An analysis of the gas produced in the Butler County gas field, Kansas, is as follows:

Analysis of natural gas from Butler County, Kans., in 1908.

C_2H_4	0.77
CH_4	79.10
C_2H_6	7.44
Helium	.25
N_2	12.44
	100.00

Record of natural-gas industry in Kansas, 1897–1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers. Domestic.	Number of consumers. Industrial.	Value.	Drilled. Gas.	Drilled. Dry.	Productive Dec. 31.
1897	10	$105,700	a 3,956	20	$105,700	16	8	90
1898	29	174,640	a 6,186	44	174,640	34	18	121
1899	31	332,592	a 10,071	71	332,592	44	22	160
1900	32	356,900	a 9,703	65	356,900	54	15	209
1901	48	659,173	a 10,227	72	659,173	71	35	276
1902	80	824,431	13,488	91	824,431	144	63	404
1903	120	1,123,849	15,918	143	1,123,849	295	66	666
1904	190	1,517,643	27,204	298	1,517,643	378	135	1,029
1905	171	2,261,836	46,852	601	2,265,945	340	157	1,142
1906	130	4,010,986	79,270	990	b 4,023,566	331	99	1,495
1907	196	6,198,583	149,327	1,605	b 6,208,862	361	163	1,760
1908	c 235	7,691,587	168,855	1,162	b 7,691,587	403	208	1,917

a Number of fires supplied.
b Includes gas taken from Kansas and consumed in Missouri.
c Includes 23 producers using gas from oil wells.

Depth and gas pressure of wells in Kansas, 1906 to 1908, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1906.	1907.	1908.
Allen	600–1,300	40–400	10–300	5–300
Anderson	240– 700	65–240	43–200	65–237
Bourbon	200– 350	5– 60	50	50
Chase	150– 300	....	48–100	6–150
Crawford, Cowley	150– 800	30–100	25–150	20– 26
Chautauqua	325–1,300	75–320	50–280	50–260
Douglas, Johnson	335– 670	150–180	60–230	5–170
Elk	500–1,278	290	10–300	100–215
Butler, Greenwood, Woodson	365–1,435	80–390	75–450	40–640
Labette	450–1,000	250–285	80–200	80–208
Linn	200– 600	25–185	9–175	10–175
Franklin, Miami	245– 670	70– 75	20–225	20–260
Montgomery	258–1,500	100–650	25–530	40–530
Neosho	500–1,000	90–300	40–225	50–250
Wilson	225–1,150	135–400	70–395	50–395
Wyandotte	500– 600	....	175	160–198

MISSOURI.

There has been no change in the situation of the natural-gas industry in this State since the report for 1907. Considerable prospecting was carried on in 1908 in various parts of the State with the hope of finding oil or gas, but no discoveries of importance were reported. The gas wells of Missouri are located in Bates, Cass, Clay, and Jackson counties, and are all shallow wells ranging from 125 to 416 feet in depth. Some wells at a depth of 350 to 800 feet produce both oil and gas, the gas being utilized for both domestic and industrial purposes. The estimated value of the natural gas produced from wells in this State and consumed in 1908 amounted to $22,592, as compared with $17,010 in 1907. As stated elsewhere in this report, Missouri receives its chief supply of gas from Kansas. The Kansas Natural Gas Company pipes large quantities of gas from the Kansas gas fields to cities and towns in Missouri, where it is utilized for domestic consumption, and also for industrial purposes by the concentrating plants of the lead and zinc mines, which use it largely under boilers and in gas engines.

OKLAHOMA.

Although Oklahoma was first in the production of crude petroleum in 1907 and 1908, it ranked fifth in the production of natural gas in 1908 and seventh in value of the gas product. It is estimated that Oklahoma produced 11,924,574,000 cubic feet of gas, valued at $860,159 in 1908, this being more than twice the production and value in 1907, when the production was 4,867,031,000 cubic feet, and the value $417,221. The greater part of the gas consumed in this State in 1908 was utilized for industrial purposes, the price being very low and ranging from 1½ to 15 cents per 1,000 cubic feet. Considerable gas was used by smelters, cement works, and for brick manufacture, also for developing and operating purposes in the oil fields. Gas was used extensively for domestic purposes in this

State, the approximate value of the gas thus consumed in 1908 being $451,906, nearly twice as much as the value in 1907.

The number of wells drilled in Oklahoma in 1908 was 113, of which 73 were gas producers and 40 were dry holes. At the close of 1908 there was a total of 374 gas wells in this State, of which 100 wells, capable of producing hundreds of millions of cubic feet of gas, were shut in, awaiting a market, most of these wells having been developed unintentionally by producers in their search for petroleum. On account of the existence of State laws prohibiting the piping of gas out of the State the development of the gas industry of Oklahoma has been retarded or restricted, there not being sufficient market for the product within the State. With the announcement as this report goes to press of the removal of these restrictions by the United States court important and extensive developments may soon be looked for. Gas and pipe-line companies will begin laying pipes to pipe the gas to cities within economic distance of the gas fields, and there will no doubt be considerable activity in drilling, the results of which promise to make Oklahoma one of the great gas-producing States.

Record of natural-gas industry in Oklahoma in 1906, 1907, and 1908.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	50	$259,862	8,391	202	$247,282	81	33	239
1907	107	417,221	11,038	277	406,942	99	41	[a] 344
1908	[b] 155	860,159	17,567	356	860,159	73	40	[c] 374

[a] Includes 87 wells "shut in" in 1907.
[b] Includes 40 companies using gas from oil wells only.
[c] Includes 100 wells "shut in" in 1908.

ALABAMA.

The only gas wells in Alabama from which gas has been produced commercially are located near Huntsville, Madison County. This gas has been used in conjunction with manufactured gas and supplied to domestic consumers in Huntsville. The first well was drilled in Hazel Green Township in 1902, following indications consisting of bubbling of natural gas through water in ordinary dug wells. A dozen wells drilled to a depth of about 300 feet produced a moderate quantity of gas, but finally these wells were mostly drowned out by water, not salty, but having an odor of sulphur. The same indications led to drilling in West Huntsville, where several wells averaging 300 feet in depth gave enough gas for West Huntsville. A deep well was started, but at a depth of 700 feet had considerable trouble; the well was then shot with dynamite, which drowned out surrounding wells with water. Enough gas is being obtained to supply West Huntsville. The water is being pumped from the 700-foot well by a gas engine worked by natural gas from the well. A deep well is now being drilled in West Huntsville, and has reached a depth of 1,050 feet. At 600 feet considerable gas was struck in a sandy limestone under some shaly limestone; then a comparatively black shale was struck, which contains enough carbonaceous matter to ignite in the flame of a match. Under that, at 800 feet, a heavy flow of gas was struck, which was packed off. In several wells drilled in this locality traces of green oil and of amber oil containing paraffin were found. About 5 miles northeast of the Hazel Green wells is a shale outcrop which is oily and burns. The gas of this district has little odor, no sulphur odor, and burns with a rather pale flame.

In 1908 a shallow gas well was drilled in Walker County, about 1 mile from Jasper. It is reported to have considerable pressure, but has been plugged for future use. Two wells 1 mile from Mobile, at a depth of 1,500 feet, have been giving off gas for several years, but the product has never been used.

ARKANSAS.

The only gas field so far developed in Arkansas is the Fort Smith gas field of Sebastian County, where 56 productive gas wells have been completed, 2 of which were drilled in 1908. This gas field covers an area of about 36 square miles. The gas wells vary in depth from 1,125 to 3,175 feet. Seven productive gas sands have been found at 735 to 3,100 feet, averaging 100 feet in thickness. One advantage which the Fort Smith gas field has over some other gas fields is the absence of water. The gas is dry and contains no sulphur. The pressure varies from 100 to 315 pounds and holds out well. The rock pressure decreases when wells are used, but returns nearly to the original pressure after the wells are rested.

Two companies are furnishing gas to consumers in this State, the towns of Fort Smith, Mansfield, Van Buren, and Huntington being supplied with this fuel for domestic and industrial purposes.

Efforts are being made to find oil or gas in Pope County. A second well is being drilled, and at a depth of 2,100 feet considerable gas was struck.

Figures giving the quantity and value of gas produced in Arkansas in 1908 have been included with those of Colorado and Wyoming.

LOUISIANA.

The gas field of Louisiana, known as the "Caddo gas field," is located in Caddo Parish, in the northwestern part of the State. It is considered one of the important oil-producing sections of the South, and it will probably develop into the greatest gas field in the United States, if not in the world. When this gas field was opened in 1905–6, a tremendous pressure was developed in some of the wells and several blow-outs occurred. As no attempt was made to stop the flow, millions of cubic feet of this most useful and valuable fuel have since been going to waste daily. With a view to conserve this great natural resource of the country and to prevent the waste of natural gas now chargeable to the Caddo gas field, the Secretary of the Interior, in 1908, by the President's order, withdrew from entry all the public lands, embracing some 6,500 acres, in the petroleum and natural-gas fields of northwestern Louisiana. This action was taken pending a careful investigation and survey of the Caddo oil field, which is now in progress, by G. D. Harris, state geologist of Louisiana, in cooperation with the United States Geological Survey.

The total value of the natural gas produced from wells in Louisiana and consumed in 1908 is estimated at $174,718. This gas was supplied to consumers in Shreveport, Texarkana, Mooringsport, Blanchard, Caddo, Dixie, Belcher, and Bosier City for domestic and industrial purposes; in addition, large quantities were consumed for drilling and operating purposes in the Caddo oil field.

There were 32 gas wells in Louisiana at the close of 1908, 5 of which were drilled in during the year. With the exception of five wells in Lafourche Parish, all these wells are located in the Caddo gas field. The depth of the gas wells in the Caddo field varies from 800 to 2,300 feet. At a depth of 800 to 860 feet the pressure is from 200 to 300 pounds; at a depth of 1,000 to 1,200 feet the pressure is from 425 to 450 pounds; and at a depth of 2,200 feet the pressure is 900 pounds. Reports state there was no reduction of pressure in the Caddo gas field during the year 1908 except in two gas wells which are located within 1 mile of two wild wells, where the rock pressure has been reduced 100 pounds since the wells were first drilled.

TEXAS.

Considerable prospecting was carried on in Texas in 1908 with the hope of finding oil or gas, but no large gas wells have been reported. Two gas wells were completed at Bryan Heights, Brazoria County, at a depth of 780 feet, but have not been put to use. Two gas wells 1,560 feet in depth were drilled in Clay County, the product being used to supply domestic consumers in Petrolia and for drilling and pumping in the field. A gas well 1,390 feet in depth was completed in Coleman County, the estimated flow per day being 1,000,000 cubic feet. Drilling has been in progress 9 miles southeast of Marshall, Harrison County, in 1908, where a well is down 1,950 feet, with good indications for gas. A gas well was completed near East Laredo, Webb County, at a depth of 1,002 feet, which has a capacity of 2,000,000 cubic feet daily and a pressure of 275 pounds, but the gas has not been used. The chief source of the natural gas supply of Texas is from wells in the Navarro County field, from which 1,200 domestic consumers in Corsicana were supplied with gas in 1908. Considerable gas is produced in the oil fields of Texas and used for development and operating purposes. The pumping in the Navarro oil field is done chiefly by gas engines, the greater part of the gas used being from the casing head and obtained from the wells when they are being pumped for oil.

SOUTH DAKOTA.

Natural gas was used more extensively in South Dakota in 1908 than in previous years, the value of the gas consumed in 1908 amounting to $24,400, a total of 362 domestic and 28 industrial consumers being supplied. The greater part of the gas was consumed in Pierre, where gas has been in commercial use for several years. With the exception of the cities of Pierre and Fort Pierre, the gas from the wells is used for heating and lighting purposes on the ranches where they are located.

All the gas consumed in this State is produced from artesian wells in Hughes, Stanley, Sully, and Walworth counties, the last-named county having but one well, located near Akaska, from which gas was used to heat and light a house in 1908. A large well was in process of drilling at Akaska at the close of 1908. Artesian wells have been reported at Le Beau, but so far as could be learned the gas product has not been utilized. There was in use at the close of 1908 a total of 30 artesian wells in this State, 9 of which were drilled in 1908. In addition to these, there are several artesian wells from which the gas was not utilized in 1908. The wells vary in depth from 1,200 to 1,844 feet.

COLORADO.

The gas production of Colorado in 1908 was chiefly from one well near Boulder, the product of which is used in conjunction with manufactured gas to supply consumers in the town of Boulder. This well is maintaining its pressure, which varies from 50 to 200 pounds, according to the demand on the supply pipes. No petroleum accompanies the gas. Some gas is produced from oil wells in the Boulder and Florence oil fields and is consumed in the field for development and operating purposes. The product of a gas well in Las Animas County is being used to supply a dwelling on a ranch. The Colorado Springs Oil and Gas Company is drilling for oil in El Paso County and has reached a depth of 2,000 feet, finding small pockets of gas only. The Montrose and San Jose Oil and Gas Company has been drilling 1½ miles from Montrose, Montrose County, and has an artesian well, some oil and gas coming up with the water. Drilling was discontinued at a depth of 1,225 feet.

WYOMING.

Little can be added to what has been given in previous reports regarding the gas production of Wyoming. A small quantity of gas was consumed in this State in 1908, the statistics of which have been included with those of Colorado and Arkansas.

Two gas wells have been drilled in the Grey Bull district, Bighorn County, at a depth of 801 and 900 feet, respectively, but their product has not been utilized. The Montana and Wyoming Oil Company has completed three oil wells in the Garland district of Bighorn County, which produced considerable gas in 1908, the gas being utilized for operating purposes. In the Douglas district of Converse County a small quantity of gas was consumed for domestic and industrial purposes in 1908.

CALIFORNIA.

The total value of natural gas consumed in California in 1908 was $307,652, as compared with $168,397 in 1907. This increase was principally due to the increased use of gas produced from oil wells. The oil wells in the Santa Maria field produce considerable gas, reports indicating that the wells of this field produce more gas than those of any other oil field of the State. The town of Santa Maria is supplied and the town of Orcutt is lighted, and domestic consumers, machine shops, and power plants in the town are supplied with gas from this field, besides large quantities used in the operation of gas engines and under boilers in the field. There are no dry gas wells in this field, but the gas is separated from the oil in gas traps. It is estimated that the total value of the gas produced from oil wells and consumed in California in 1908 was $166,170.

No new gas fields were reported. At the close of the year 1908 there was a total of 57 gas wells in California, 5 of which were completed in the past year.

From the table of distribution of gas in 1908 it will be noted that the value of the gas supplied to domestic consumers in California was $140,567, and to industrial consumers, $167,085. The following towns were wholly or partly supplied with gas in 1908: Sacramento, Stockton, Summerland, Santa Maria, Orcutt, Oxnard, Santa Paula, Ventura, Hueneme, Suisun, Fairfield, and Cement.

NORTH DAKOTA.

The natural gas of North Dakota is produced from wells in Bottineau and Lamoure counties.

In Bottineau County the gas field is being developed by the Great Northern Oil, Gas, and Pipe-Line Company. A total of eight gas wells has been drilled near Westhope, ranging from 170 to 204 feet in depth and with a pressure of about 55 pounds. Gas from this field was supplied to a few domestic consumers and was also used for drilling purposes in 1908. A well is now being drilled into the Dakota sandstone in the hope of striking a heavy flow of gas. A well drilled 1 mile from Minot produces 3,000,000 cubic feet or more of gas per day, but the gas will not burn, analysis showing it is almost pure nitrogen. A report on the Bottineau gas field by John G. Barry will appear in the Fifth Biennial Report of the North Dakota Geological Survey.

The gas of Lamoure County is produced from artesian wells, which are from 1,150 to 1,450 feet in depth. At the close of 1908 gas was being used from six wells, one partly supplying gas for power and heat for an electric light plant in the village of Edgeley, the others being used for domestic purposes by the owners of the wells.

OREGON.

Gas from two artesian wells at a depth of 215 and 237 feet, respectively, in Malheur County, Oreg., was consumed for domestic purposes by the owners of the wells in 1908. The Ontario Oil and Gas Company struck considerable gas at a depth of 2,260 feet in a well near Ontario, which is being drilled for oil. The pressure is said to be 200 pounds. Six other wells were in process of drilling in this county at the close of 1908, two of which had reached a depth of more than 2,000 feet.

A well is drilling in Jackson County and has reached a depth of 150 feet.

IOWA.

A few shallow wells, not exceeding 125 feet in depth, located near Letts and Wapello, Louisa County, produced a small quantity of gas in 1908, which was consumed in a country school and a few farm houses for heating and lighting purposes. It is reported that one gas well in this locality was used eight years for heating and lighting a dwelling.

Two wells drilled near Bagley, Guthrie County, in 1908, developed some gas pressure at a depth of 750 feet.

NEW MEXICO.

In 1908 a well was drilled near Dayton, Eddy County, N. Mex., and at a depth of 1,020 feet gas was struck, which is reported to have a pressure of 250 pounds. The product has not been utilized.

CANADA.

The preliminary report of the Canadian Department of Mines for 1908 states that natural gas was produced in the counties of Welland, Haldimand, Norfolk, Kent, Essex, and Bruce, in Ontario, and at Medicine Hat, Alberta; the sales from the Ontario fields constituted over 95 per cent of the total. The total receipts for gas sold in 1908 show an increase of about 24 per cent over the receipts of 1907, and are now larger than at any time since the gas was first used.

Ontario.—The following statistics regarding the production of natural gas in Ontario, Canada, have been furnished by the Ontario Bureau of Mines, Toronto:

Statistics of natural-gas production in the Province of Ontario, Canada, 1902–1908.

Year.	Producing wells.	Miles of gas pipe.	Workmen employed.	Value of gas product.	Wages for labor.
1902	169	369	107	$195,992	$55,618
1903	210	312	138	196,535	79,945
1904	176	231	....	253,524	53,674
1905	273	462½	130	[a] 316,476	88,865
1906	332	550	108	533,446	64,968
1907	582	810	191	746,499	110,832
1908	656	850	152	988,616	106,786

[a] In addition, gas valued at $33,000 was produced from 12 wells at Medicine Hat, Alberta, Canada.

The natural gas produced in Canada was valued at $815,032 in 1907 and at $1,012,060[a] in 1908.

IMPORTS.

The imports of natural gas for consumption during the last six years have been as follows:

Value of natural gas imported for consumption, 1903–1908.

1903	$32,802
1904	34,828
1905	49,237
1906	$36,906
1907	32,107
1908	22,003

No exports of natural gas during 1907 and 1908 were reported.

[a] Subject to revision.

PETROLEUM.

By David T. Day.

INTRODUCTION.

Production and value.—The great gain in production of petroleum in 1907 over 1906 required such a drain on all the great pools and developed so large a stock of unused crude oil that a further increase in 1908 was not probable as a matter either of trade requirements or of available petroleum resources. As the year 1908 went on, unprecedented floods in May and June, and again in November, brought disaster to the pipe lines of Oklahoma; and these storms also left a record of over 100 oil tanks destroyed by lightning. In the eastern fields, on the other hand, the severe drought seriously interfered with well drilling. The decline in production in the Glenn pool and in various Texas and Louisiana pools increased the likelihood of a total smaller than in 1907. Nevertheless, the actual record of the year shows a total beyond all records, 179,572,479 barrels,[a] compared with 166,095,335 barrels in 1907, or 8.11 per cent increase. The total value was proportionately great, viz, $129,706,258, as against $120,106,749 in 1907. The price of the product in California increased, and it remained steady in other fields, except in the Gulf field, where a comparatively groundless fear of overproduction from the new Markham and Goose Creek districts caused depression.

The increases came from the steady growth in Illinois and California. Neither field showed phenomenal development. California responded to the higher prices consistent with depleted stocks, and Illinois showed the continued effect of the great investments of 1907 in this new territory.

The year, however, had its sensations. They came in midsummer. On July 2 a large gusher was drilled in at Goose Creek, Harris County, Tex., and three days later a gusher of the Spindle Top type came in at Markham, in Matagorda County. This turned the attention of the oil producers in the Gulf field significantly farther south.

July 4, 1908, proved memorable in three widely separated regions. At Anse la Butte, La., a large gusher, known as "Lake No. 9," was drilled in. On the same day the Pearsons opened in Mexico a well that assumed the proportions of a volcano and made a new world's record for an outburst of oil and water. On the same day also the Oil City well at Tustanowicz produced the record spouter for the Galicia field in Austria.

---

[a] The barrel used in this report, unless otherwise specified, is the United States standard barrel containing 42 Winchester gallons.

Oklahoma led all the States in production, with a total of 45,798,765 barrels, an increase of 5.23 per cent over 1907; California was a close second, with 44,854,737 barrels, an increase of 12.85 per cent over 1907; but Illinois made the greatest gain, rising from 24,281,973 barrels in 1907 to 33,685,106 barrels in 1908, a gain of 9,403,133 barrels, or 38.72 per cent. Colorado, Louisiana, Michigan, Missouri, Utah, Wyoming, and West Virginia also showed gains in production. The declines were in Indiana, where it was nearly 36 per cent; Kansas, 25 per cent; Ohio, 11 per cent; Texas, 9 per cent; Pennsylvania, nearly 6 per cent; New York, 4.3 per cent; and Kentucky, 11 per cent.

The increased activity in the three great fields—California, Oklahoma, and Illinois—was the dominant feature of the situation rather than the discovery and opening of any considerable new fields. The principal new field to gain prominence was the Caddo pool in northwestern Louisiana. The hoped-for increase in production from the Markham and Goose Creek fields in Texas did not materialize, and the total from the State showed a decline in spite of the increased production in the Humble pool. In the Appalachian field 7,115 new wells were drilled, of which 5,292 were producers, with a total initial production of 55,002 barrels. In the Lima-Indiana region 1,250 new wells were drilled, of which 1,088 were producers. In the new Illinois field 3,574 wells were drilled, of which 3,019 were producers, with an average initial production of 26 barrels a well. In the Mid-Continent field 3,490 wells were drilled, of which 2,587 were producers of oil, 471 were producers of gas, and 432 were dry; the initial production of the producing wells averaged 83.7 barrels. In the Gulf field only 819 new wells were drilled, 606 being producers and showing an initial production of 297 barrels. In California 617 wells were drilled, of which 594 were productive; and in other parts of the country 44 wells were drilled, yielding 24 new producers. From the total of 13,210 productive wells drilled the average initial production was 42.9 barrels.

The average price of petroleum for the entire country in 1908 remained identical with that in 1907, but there were considerable variations of an important character in individual States. The most notable of these was the increase in price in California from 37 cents a barrel in 1907 to 52¼ cents a barrel in 1908. The Gulf States, Louisiana and Texas, showed a decline in value from a little over 80 cents to 60 cents. The Appalachian oil showed a slight increase in value, from $1.73 in 1907 to $1.76 in 1908.

On the whole, prices were remarkably steady considering the notable increase over the large production of 1907.

Stocks.—The elasticity of the American oil trade is shown by the fact that stocks did not increase as much as might have been expected from the great production. The preparations of the year before led to better ability to transport the product to points of consumption.

ACKNOWLEDGMENTS.

In preparing this report much valuable information has been obtained from the Oil Investors' Journal; the Oil, Paint, and Drug Reporter; the Oil City Derrick; the Petroleum Gazette; and especially from the various pipe-line companies of the United States.

Many items have also been obtained in cooperation with Dr. H. Foster Bain, director of the Geological Survey of Illinois; Prof. G. D. Harris, state geologist of Louisiana; Prof. E. Haworth, state geologist of Kansas; and Messrs. Robert Anderson, Ralph Arnold, M. J. Munn, W. J. Reed, A. C. Veatch, and C. W. Washburne, of the United States Geological Survey. Credit should be given the Oil City Derrick for well-record tables for Pennsylvania and New York, Ohio, Indiana, West Virginia, Illinois, Kentucky, Kansas, and Oklahoma; and to the Oil Investors' Journal for well-record tables for Texas and Louisiana.

PRODUCTION.

During the year 1908 a study was made[a] of the stock of petroleum in the known fields of the United States, and from this estimated total supply the probable duration of the oil fields was calculated from the present increasing rate of production. It was shown that in each nine years as much petroleum was produced as in all preceding years. The enormous production of the last two years is at a still greater rate than that required to keep up this ratio of increase; in fact, the production of the last eight years is almost equal to all the preceding product since the beginning of the industry. In all nearly two billion barrels have been produced in forty-nine years, worth one and three-fourths billion dollars. This is more than half the value of all our gold and more than the entire value of our silver produced in twice as many years. The value of the petroleum in 1908 exceeded the value of the gold and silver combined by over two million dollars.

The statement of production by States is given in the following table:

Total quantity and value of crude petroleum produced in the United States and the average price per barrel in 1907 and 1908, by States.

State.	1907.			1908.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
	Barrels.			*Barrels.*		
California	39,748,375	$14,699,956	$0.370	44,854,737	$23,433,502	$0.5225
Colorado	331,851	272,813	.822	379,653	346,403	.913
Illinois	24,281,973	16,432,947	.677	33,685,106	22,648,881	.672
Indiana	5,128,037	4,536,930	.885	3,283,629	3,203,883	.976
Kansas	2,409,521	965,134	.401	1,801,781	746,695	.414
Kentucky Tennessee[b]	820,844	862,396	1.051	727,767	706,811	.971
Louisiana	5,000,221	4,063,033	.813	6,835,130	4,131,173	.604
Michigan Missouri	4,000	6,500	1.625	15,246	22,345	1.466
New York	1,212,300	2,127,748	1.755	1,160,128	2,071,533	1.7856
Ohio	12,207,448	14,769,888	1.210	10,858,797	14,178,502	1.306
Oklahoma	43,524,128	17,513,524	.402	45,798,765	17,694,843	.386
Pennsylvania	9,999,306	17,579,706	1.758	9,424,325	16,881,194	1.7912
Texas	12,322,696	10,401,863	.844	11,206,464	6,700,708	.598
Utah Wyoming	9,339	21,883	2.343	17,775	27,920	1.57
West Virginia	9,095,296	15,852,428	1.743	9,523,176	16,911,865	1.776
	166,095,335	120,106,749	.723	179,572,479	129,706,258	.722

[a] Report of the National Conservation Commission. Petroleum was the sixth largest contributor to our mineral wealth and furnished about one-sixteenth of the entire value.
[b] No production in Tennessee recorded in 1908.

The increase or decrease in the production by States, as well as the percentage of increase or decrease in 1908 compared with 1907, are shown in the following table. The striking features were the increases in quantity and in percentage in California and Illinois, and also the great percentage of decline in Indiana and Kansas.

Total production of crude petroleum and percentage of increase or decrease, by States, in 1908, as compared with 1907, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1907.	1908.			Increase.	Decrease.
California	39,748,375	44,854,737	5,106,362	....	12.85	....
Colorado	331,851	379,653	47,802	....	14.40	....
Illinois	24,281,973	33,685,106	9,403,133	....	38.72	....
Indiana	5,128,037	3,283,629	....	1,844,408	....	35.97
Kansas	2,409,521	1,801,781	....	607,740	....	25.22
Kentucky, Tennessee [a]	820,844	727,767	....	93,077	....	11.34
Louisiana	5,000,221	6,835,130	1,834,909	....	36.70	....
Michigan, Missouri	4,000	15,246	11,246	....	281.15	....
New York	1,212,300	1,160,128	....	52,172	....	4.30
Ohio	12,207,448	10,858,797	....	1,348,651	....	11.05
Oklahoma	43,524,128	45,798,765	2,274,637	....	5.23	....
Pennsylvania	9,999,306	9,424,325	....	574,981	....	5.75
Texas	12,322,696	11,206,464	....	1,116,232	....	9.06
Utah, Wyoming	9,339	17,775	8,436	....	90.33	....
West Virginia	9,095,296	9,523,176	427,880	....	4.70	....
	166,095,335	179,572,479	13,477,144	....	8.114	....

[a] No production in Tennessee recorded in 1908.

RANK OF PRODUCING STATES.

QUANTITY.

It is a noteworthy fact that, as predicted in the last report, the rank of the oil-producing States as regards quantity produced in 1908 remained practically the same as in 1907. This has not happened before since the western fields became a factor in the situation. While the rank of the States remained unchanged, the rate of increase in California was so much greater than in the ranking State—Oklahoma—that California came within less than a million barrels of first place, and the increased rate of production still continues in 1909. California's product in 1908 exceeded the product of Oklahoma in 1907. In percentage of increase Illinois exceeded either of the other great producers.

Rank of petroleum-producing States and Territories, with quantity produced and percentage of each in 1907 and 1908, in barrels.

1907.				1908.			
State.	Rank.	Quantity.	Percentage.	State.	Rank.	Quantity.	Percentage.
Oklahoma	1	43,524,128	26.20	Oklahoma	1	45,798,765	25.50
California	2	39,748,375	23.93	California	2	44,854,737	24.98
Illinois	3	24,281,973	14.62	Illinois	3	33,685,106	18.76
Texas	4	12,322,696	7.42	Texas	4	11,206,464	6.24
Ohio	5	12,207,448	7.35	Ohio	5	10,858,797	6.05
Pennsylvania	6	9,999,306	6.02	West Virginia	6	9,523,176	5.30
West Virginia	7	9,095,296	5.48	Pennsylvania	7	9,424,325	5.25
Indiana	8	5,128,037	3.09	Louisiana	8	6,835,130	3.80
Louisiana	9	5,000,221	3.01	Indiana	9	3,283,629	1.83
Kansas	10	2,409,521	1.45	Kansas	10	1,801,781	1.00
New York	11	1,212,300	.73	New York	11	1,160,128	.65
Kentucky Tennessee	12	820,844	.49	Kentucky Tennessee [a]	12	727,767	.41
Colorado	13	331,851	.20	Colorado	13	379,653	.21
Utah Wyoming	14	9,339	.01	Utah Wyoming	14	17,775	.02
Michigan Missouri	15	4,000		Michigan Missouri	15	15,246	
		166,095,335	100.00			179,572,479	100.00

[a] No production in Tennessee recorded in 1908.

VALUE.

Although second in quantity, California's total returns from the crude-oil product exceeded those of any other State and amounted to $23,433,502. This is the greatest total for any State, certainly in recent years. There was an average increase in price from 37 cents per barrel in 1907 to 52¼ cents in 1908. The increase will probably continue in 1909. With no change in price the total value of Illinois oil rose to $22,648,881, giving the State second place in this respect, while third in quantity, changing places with Oklahoma. Pennsylvania's total value fell from first place in 1907 to fifth in 1908.

Rank of petroleum-producing States and Territories, with value of production and percentage of each, in 1907 and 1908.

1907.				1908.			
State.	Rank.	Value.	Percentage.	State.	Rank.	Value.	Percentage.
Pennsylvania	1	$17,579,706	14.64	California	1	$23,433,502	18.08
Oklahoma	2	17,513,524	14.58	Illinois	2	22,648,881	17.46
Illinois	3	16,432,947	13.68	Oklahoma	3	17,694,843	13.64
West Virginia	4	15,852,428	13.20	West Virginia	4	16,911,865	13.04
Ohio	5	14,769,888	12.30	Pennsylvania	5	16,881,194	13.01
California	6	14,699,956	12.24	Ohio	6	14,178,502	10.93
Texas	7	10,401,863	8.66	Texas	7	6,700,708	5.17
Indiana	8	4,536,930	3.78	Louisiana	8	4,131,173	3.19
Louisiana	9	4,063,033	3.38	Indiana	9	3,203,883	2.47
New York	10	2,127,748	1.77	New York	10	2,071,533	1.59
Kansas	11	965,134	.80	Kansas	11	746,695	.57
Kentucky Tennessee	12	862,396	.72	Kentucky Tennessee [a]	12	706,811	.54
Colorado	13	272,813	.23	Colorado	13	346,403	.27
Utah Wyoming Michigan Missouri	14	28,383	.02	Utah Wyoming Michigan Missouri	14	50,265	.04
		120,106,749	100.00			129,706,258	100.00

[a] No production in Tennessee recorded in 1908.

PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES FROM 1859 TO 1908, INCLUSIVE.

In the following table will be found a statement of the production of crude petroleum from each State of the United States from the year 1859 to and including the production of the year 1908:

Production of crude petroleum in the United States, 1859–1908, by years and by States, in barrels of 42 gallons.

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.
1859	2,000							
1860	500,000							
1861	2,113,609							
1862	3,056,690							
1863	2,611,309							
1864	2,116,109							
1865	2,497,700							
1866	3,597,700							
1867	3,347,300							
1868	3,646,117							
1869	4,215,000							
1870	5,260,745							
1871	5,205,234							
1872	6,293,194							
1873	9,893,786							
1874	10,926,945							
1875	8,787,514							
1876	8,968,906	31,763	120,000	12,000				
1877	13,135,475	29,888	172,000	13,000				
1878	15,163,462	38,179	180,000	15,227				
1879	19,685,176	29,112	180,000	19,858				
1880	26,027,631	38,940	179,000	40,552				
1881	27,376,509	33,867	151,000	99,862				
1882	30,053,500	39,761	128,000	128,636				
1883	23,128,389	47,632	126,000	142,857	4,755			
1884	23,772,209	90,081	90,000	262,000	4,148			
1885	20,776,041	661,580	91,000	325,000	5,164			
1886	25,798,000	1,782,970	102,000	377,145	4,726			
1887	22,356,193	5,022,632	145,000	678,572	4,791	76,295		
1888	16,488,668	10,010,868	119,448	690,333	5,096	297,612		
1889	21,487,435	12,471,466	544,113	303,220	5,400	316,476	33,375	1,460
1890	28,458,208	16,124,656	492,578	307,360	6,000	368,842	63,496	900
1891	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634	675
1892	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	698,068	521
1893	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293	400
1894	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666	300
1895	19,144,390	19,545,233	8,120,125	1,208,482	1,500	438,232	4,386,132	200
1896	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732	250
1897	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356	500
1898	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907	360
1899	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182	360
1900	14,559,127	22,362,730	16,195,675	4,324,484	62,259	317,385	4,874,392	200
1901	13,831,996	21,648,083	14,177,126	8,786,330	137,259	460,520	5,757,086	250
1902	13,183,610	21,014,231	13,513,345	13,984,268	185,331	396,901	7,480,896	200
1903	12,518,134	20,480,286	12,899,395	24,382,472	554,286	483,925	9,186,411	
1904	12,239,026	18,876,631	12,644,686	29,649,434	998,284	501,763	11,339,124	
1905	11,554,777	16,346,660	11,578,110	33,427,473	1,217,337	376,238	10,964,247	181,084
1906	11,500,410	14,787,763	10,120,935	33,098,598	1,213,548	327,582	7,673,477	4,397,050
1907	11,211,606	12,207,448	9,095,296	39,748,375	820,844	331,851	5,128,037	24,281,973
1908	10,584,453	10,858,797	9,523,176	44,854,737	[a] 727,767	379,653	3,283,629	33,685,106
	698,009,862	377,108,902	194,562,894	246,820,562	6,004,345	9,253,938	93,411,140	62,551,789

[a] No production in Tennessee recorded in 1908.

Production of crude petroleum in the United States, 1859–1908, by years and by States, in barrels of 42 gallons—Continued.

Year.	Kansas.	Texas.	Missouri.	Oklahoma.	Wyoming.	Louisiana.	United States.	Total value.
1859	......	......	......	......	......	......	2,000	$32,000
1860	......	......	......	......	......	......	500,000	4,800,000
1861	......	......	......	......	......	......	2,113,609	1,035,668
1862	......	......	......	......	......	......	3,056,690	3,209,525
1863	......	......	......	......	......	......	2,611,309	8,225,663
1864	......	......	......	......	......	......	2,116,109	20,896,576
1865	......	......	......	......	......	......	2,497,700	16,459,853
1866	......	......	......	......	......	......	3,597,700	13,455,398
1867	......	......	......	......	......	......	3,347,300	8,066,993
1868	......	......	......	......	......	......	3,646,117	13,217,174
1869	......	......	......	......	......	......	4,215,000	23,730,450
1870	......	......	......	......	......	......	5,260,745	20,503,754
1871	......	......	......	......	......	......	5,205,234	22,591,180
1872	......	......	......	......	......	......	6,293,194	21,440,503
1873	......	......	......	......	......	......	9,893,786	18,100,464
1874	......	......	......	......	......	......	10,926,945	12,647,527
1875	......	......	......	......	......	......	8,787,514	7,368,133
1876	......	......	......	......	......	......	9,132,669	22,982,822
1877	......	......	......	......	......	......	13,350,363	31,788,566
1878	......	......	......	......	......	......	15,396,868	18,044,520
1879	......	......	......	......	......	......	19,914,146	17,210,708
1880	......	......	......	......	......	......	26,286,123	24,600,638
1881	......	......	......	......	......	......	27,661,238	23,512,051
1882	......	......	......	......	......	......	30,349,897	23,631,165
1883	......	......	......	......	......	......	23,449,633	25,740,252
1884	......	......	......	......	......	......	24,218,438	20,476,924
1885	......	......	......	......	......	......	21,858,785	19,193,694
1886	......	......	......	......	......	......	28,064,841	20,028,457
1887	......	......	......	......	......	......	28,283,483	18,856,606
1888	......	......	......	......	......	......	27,612,025	17,950,353
1889	500	48	20	......	......	......	35,163,513	26,963,340
1890	1,200	54	278	......	......	......	45,823,572	35,365,105
1891	1,400	54	25	30	......	......	54,292,655	30,526,553
1892	5,000	45	10	80	......	......	50,514,657	25,906,463
1893	18,000	50	50	10	......	......	48,431,066	28,932,326
1894	40,000	60	8	130	2,369	......	49,344,516	35,522,095
1895	44,430	50	10	37	3,455	......	52,892,276	57,691,279
1896	113,571	1,450	43	170	2,878	......	60,960,361	58,518,709
1897	81,098	65,975	19	625	3,650	......	60,475,516	40,929,611
1898	71,980	546,070	10	......	5,475	......	55,364,233	44,193,359
1899	69,700	669,013	132	......	5,560	......	57,070,850	64,603,904
1900	74,714	836,039	[a] 1,602	6,472	5,450	......	63,620,529	75,752,691
1901	179,151	4,393,658	[b] 2,335	10,000	5,400	......	69,389,194	66,417,335
1902	331,749	18,083,658	[a] 757	37,100	6,253	548,617	88,766,916	71,178,910
1903	932,214	17,955,572	[a] 3,000	138,911	8,960	917,771	100,461,337	94,694,050
1904	4,250,779	22,241,413	[a] 2,572	1,366,748	11,542	2,958,958	117,080,960	101,175,455
1905	[c] 12,013,495	28,136,189	[a] 3,100	([d])	8,454	8,910,416	134,717,580	84,157,399
1906	[c] 21,718,648	12,567,897	[a] 3,500	([d])	[e] 7,000	9,077,528	126,493,936	92,444,735
1907	2,409,521	12,322,696	[a] 4,000	43,524,128	[f] 9,339	5,000,221	166,095,335	120,106,749
1908	1,801,781	11,206,464	[a] 15,246	45,798,765	[f] 17,775	6,835,130	179,572,479	129,706,258
	44,158,931	129,026,455	36,717	90,883,206	103,560	34,248,641	1,986,180,942	1,784,583,943

[a] Includes the production of Michigan.
[b] Includes production of Michigan and small production in Oklahoma.
[c] Includes production of Oklahoma.
[d] Included with Kansas.
[e] Estimated.
[f] Includes the production of Utah.

CONSUMPTION OF FUEL OIL BY RAILROADS IN 1908.

The railroads of the United States on which oil-burning engines were used in 1908 were the same as in 1907, with the addition of the Chicago, Rock Island and Pacific Railway, operating in Kansas and Oklahoma. The consumption of fuel oil by all railroads of the country in 1908 aggregated 16,889,070 barrels, as compared with 18,855,691 barrels in 1907, a decrease of 1,966,621 barrels. The estimated mileage covered by oil-burning engines on these roads was 64,347,357 miles in 1908, an average of 3.81 miles per barrel of oil consumed. The total length of line operated by the use of fuel oil in 1908 was 15,474 miles, as against 13,593 miles in 1907. A small quantity of fuel oil was consumed by a few railroads for kindling locomotives and for shop purposes. Although much of the fuel oil consumed is crude oil, a considerable quantity is residuum, which is a product of the refinery after the lighter products have been extracted.

The following are the names of the railroad companies which used fuel oil on their lines in 1908: The Sunset lines of California, Texas, and Louisiana; the Houston and Texas Central Railroad Company, and the Houston and Shreveport Railroad Company, of Texas; the Kansas City Southern Railway Company, of Texas and Louisiana; the International and Great Northern Railroad Company, of Texas; the San Pedro, Los Angeles and Salt Lake Railroad Company; the Santa Fe lines; the Gulf and Interstate Railway Company, of Texas; the Chicago, Rock Island and Pacific Railway Company, of Kansas and Oklahoma; the Frisco lines of Kansas, Missouri, Oklahoma, and Texas; the St. Louis, Brownsville and Mexico Railway Company, of Texas; the Trinity and Brazos Valley Railway, of Texas.

OIL FIELDS OF THE UNITED STATES.

A general description of the oil fields of the United States is repeated here from the petroleum report for 1907. This description still applies to the known oil fields, and the changes in relative importance of the several districts will be referred to in the detailed account of each State.

Briefly described these fields are:

Appalachian field.—The oils of the Appalachian field are practically free from sulphur and asphalt, are rich in paraffin wax, and yield the largest percentage of gasoline and illuminating oils. The field extends from western New York in a general southwesterly direction along the western side of the Allegheny Mountains, through Pennsylvania, eastern Ohio, West Virginia, into Kentucky and Tennessee. In the latter States the quality of the oil varies so markedly within short distances that the product frequently resembles the sulphur oils of the Lima-Indiana field.

Lima-Indiana field.—The Lima-Indiana field yields oil with sufficient sulphur to require special treatment for its elimination. Like the Appalachian oil it yields paraffin wax. The field includes the northwestern part of Ohio and a strip in the middle of Indiana. The Illinois field is no longer included.

Illinois field.—It was stated in the report for 1906 that there was doubt as to the advisability of including the Illinois field with the Lima-Indiana, because the oil is produced from a different geologic horizon. The examination of the oil confirms the necessity of making this a separate field. The oil contains less sulphur, much of it being refined without special treatment. On the other hand, some of it contains asphalt as well as paraffin. The oils vary within wide limits in gravity and distillation products. The oil comes chiefly from a narrow field in southeastern Illinois near the Indiana line, though much drilling is in progress over the State by which small isolated pools have been developed.

Mid-Continent field.—The oils of the Mid-Continent field show considerable variation. Many contain both asphalt and paraffin, especially in Kansas. The field includes southeastern Kansas, Oklahoma, and northern Texas.

Gulf field.—Geographically this field includes all oils in Texas and Louisiana. The oils near the Gulf contain considerable quantities of sulphur, much of which is in the form of sulphuretted hydrogen and easily removed by steam before refining or use as fuel. Their location makes them well suited for fuel oils, especially for export. They also yield valuable lubricating oils, and the gasoline derived from them is acceptable as a substitute for turpentine. The oils of northern Texas, notably from Corsicana, are lighter and contain less sulphur. Statistically the Corsicana region has been split off from the Gulf field and combined for industrial distinction with the Mid-Continent field.

California field.—The California oils are generally characterized by much asphalt and little or no paraffin, but in the future a division of the field will be required on account of the increased yield of oils of lighter grade from the Santa Maria district, and probably from the Monterey district also, and the suitability of these oils for the increased demand for refining.

Other fields.—Small quantities of oil have been produced for many years in Wyoming, Colorado, Missouri, and Michigan. The map of the occurrence of oil indicates its presence in several other States—Arkansas, Montana, Washington, Oregon, Idaho, and Nevada. During 1907 a small field of heavy oil was developed in southwestern Utah, and promising developments are in progress in San Juan County, in southeastern Utah. Of all these, Wyoming gives most promise for the future.

FIELD INVESTIGATIONS IN 1908 AND 1909.

Bulletin 381 gives an account of the field investigations in 1908 concerning the occurrence of petroleum. Ralph Arnold and Robert Anderson continued investigation in California, especially in the Coalinga field. J. A. Taff and W. J. Reed began an extensive investigation of the Mid-Continent oil field, working especially in the southern portion of Oklahoma. G. H. Ashley, with M. J. Munn, studied the oil conditions in the Foxburg quadrangle and elsewhere in Pennsylvania. A. C. Veatch made a preliminary examination of the oil pools at Belle Isle and other localities in southern Louisiana; and G. D. Harris, state geologist of Louisiana, in cooperation with the United States Geological Survey, began a survey of the Caddo oil field. In Colorado, C. W. Washburne, in mapping the coal beds of the Florence field, studied the oils of that section and also examined the oils in the Boulder field. J. P. Dunlop visited Oklahoma and Kansas and made a systematic collection of samples from all the oil pools of the Mid-Continent field for analysis in the Washington office. A similar collection was made by Mr. Arnold in the California field for analysis by Irving Allen. At the Johns Hopkins University experiments were continued through the year by J. Elliott Gilpin and Marshall P. Cram on the fractionation of petroleum by fuller's earth; and at Bowdoin College an examination was begun, mainly of the quantity of petroleum found in various clays comprising the cap rocks of oil sands.

For the field season of 1909 the following petroleum investigations are projected: Robert Anderson will continue the examination of the California oil field in the Kern County, Sunset, Midway, and McKittrick districts. M. J. Munn will begin a comprehensive study of the petroleums of the Appalachian system. J. A. Taff and W. J. Reed will continue the mapping of the Oklahoma and Kansas fields. C. W. Washburne will complete the examination of the Florence and Boulder fields in Colorado, and will also make a reconnaissance in eastern Oregon. G. D. Harris will continue the survey of the Caddo oil field.

In cooperation with the Geological Survey of West Virginia, representative samples of petroleum from all the pools will be analyzed in the Washington office. Similar analyses will be made of the oils of Kentucky, Tennessee, Texas, New Mexico, and Louisiana.

The experiments as to the diffusion of oils through fuller's earth and the conditions of oil in various cap rocks will be continued at the Johns Hopkins University, Baltimore, and at Bowdoin College, Maine. The technologic branch of the Survey will continue the examination of the fuel value of California crude oils and various petroleum products and their applicability to internal-combustion engines and the analysis of crude petroleum from California. This branch will also cooperate with the international commission for the standardizing of petroleum tests.

SURVEY PUBLICATIONS, 1901–1909, ON THE OIL FIELDS OF THE UNITED STATES.

As the result of the field work of 1908 and of earlier investigations the following publications have been made by the Geological Survey:

PROFESSIONAL PAPERS.

56. Geography and geology of a portion of southwestern Wyoming, with speci[al] reference to coal and oil, by A. C. Veatch. 1907. 178 pp. 26 pls.
65. Geology and underground waters of the northern Black Hills region, by N. [H.] Darton. 1909. 106 pp., 24 pls.

BULLETINS.

184. Oil and gas fields of the western interior and northern Texas coal measures a[nd] of the Upper Cretaceous and Tertiary of the western Gulf coast, by George [I.] Adams. 1901. 64 pp., 10 pls.
198. The Berea grit oil sand in the Cadiz quadrangle, Ohio, by W. T. Griswold. 190[2]. 43 pp., 1 pl.

[a]212. Oil fields of the Texas-Louisiana Gulf coastal plain, by C. W. Hayes and Willi[am] Kennedy. 1903. 174 pp., 11 pls. 20c.

[a]213. Contributions to economic geology, 1902; S. F. Emmons and C. W. Hay[es], geologists in charge. 1903. 449 pp. 25c.
    The petroleum fields of California, by George H. Eldridge, p. 306.
    The Boulder, Colo., oil field, by N. M. Fenneman, p. 322.
    Asphalt, oil, and gas in southwestern Indiana, by Myron L. Ful[ler], p. 333.
    Structural work during 1901 and 1902 in the eastern oil fields, by W. [T.] Griswold, p. 336.
    Oil fields of the Texas-Louisiana Gulf coastal plain, by C. W. Ha[yes], p. 345.

[a] This mark indicates that the Geological Survey's stock of the paper is exhausted. Many of the pa[pers] marked in this way may, however, be purchased from the Superintendent of Documents, Washing[ton], D. C., at the prices indicated.

[a]225. Contributions to economic geology, 1903; S. F. Emmons and C. W. Hayes, geologists in charge. 1904. 527 pp., 1 pl. 35c.
Petroleum fields of Alaska and the Bering River coal field, by G. C. Martin, p. 365.
Structure of the Boulder oil field, Colorado, with records for the year 1903, by N. M. Fenneman, p. 383.
Oil and gas fields of eastern Greene County, Pa., by Ralph W. Stone, p. 396.

[a]238. Economic geology of the Iola quadrangle, Kansas, by G. I. Adams, Erasmus Haworth, and W. R. Crane. 1904. 83 pp., 11 pls. 25c.

250. The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. 1905. 64 pp., 7 pls.

256. Mineral resources of the Elders Ridge quadrangle, Pennsylvania, by R. W. Stone. 1905. 86 pp., 12 pls.

[a]259. Report on progress of investigations of mineral resources of Alaska in 1904, by A. H. Brooks and others. 1905. 196 pp., 3 pls. 15c.

[a]260. Contributions to economic geology, 1904; by S. F. Emmons, and C. W. Hayes, geologists in charge. 1905. 620 pp., 4 pls. 40c.
The Florence, Colo., oil field, by N. M. Fenneman, p. 436.
Notes on the geology of the Muscogee oil field, Oklahoma, by J. A. Taff and M. K. Shaler, p. 441.
Oil and gas in the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth, p. 446.
Oil fields of the Texas-Louisiana Gulf coast, by N. M. Fenneman, p. 459.
Oil and asphalt prospects in Salt Lake basin, Utah, by J. M. Boutwell, p. 468.

264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp.

265. Geology of the Boulder district, Colorado, by N. M. Fenneman. 1905. 101 pp., 5 pls.

279. Mineral resources of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts. 1906. 198 pp., 11 pls.

282. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman. 1906. 146 pp., 11 pls.

[a]285. Contributions to economic geology, 1905; S. F. Emmons, and E. C. Eckel, geologists in charge. 1906. 506 pp., 13 pls. 60c.
The Salt Lake oil field near Los Angeles, Cal., by Ralph Arnold, p. 357.
The Nineveh and Gordon oil sands in western Greene County, Pa., by F. G. Clapp, p. 362.

286. Economic geology of the Beaver quadrangle, Pennsylvania, by L. H. Woolsey. 1906. 132 pp., 8 pls.

296. Economic geology of the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth. 1906. 74 pp., 6 pls.

[a]298. Record of deep-well drilling for 1905, by Myron L. Fuller and Samuel Sanford. 1906. 299 pp. 25c.

304. Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. 1907. 110 pp., 3 pls.

[a]309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by G. H. Eldridge and Ralph Arnold. 1907. 266 pp., 41 pls. 80c.

[a]314. Report on progress of investigations of mineral resources of Alaska in 1906, by A. H. Brooks and others. 1907. 235 pp., 4 pls. 30c.

[a]317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907. 69 pp., 2 pls. 15c.

[a]318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 1907. 196 pp., 13 pls. 75c.

321. Geology and oil resources of the Summerland district, Santa Barbara County, Cal., by Ralph Arnold. 1907. 91 pp., 20 pls.

322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907. 161 pp., 26 pls. 50c.

335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C. Martin. 1908. 141 pp., 10 pls.

---

[a] This mark indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers marked in this way may, however, be purchased from the superintendent of documents, Washington, D. C., at the prices indicated.

340. Contributions to economic geology, 1907, Part I: Metals and nonmetals except fuels. C. W. Hayes, and Waldemar Lindgren, geologists in charge. 1908. 482 pp., 6 pls.

Petroleum and natural gas—California: Contra Costa County, Miner ranch field, by Ralph Arnold. Utah: Southern Utah oil field, by G. B. Richardson. Wyoming: Bighorn basin gas fields, by C. W. Washburne; Uinta County, Labarge oil field, by A. R. Schultz, pp. 339–374.

346. Structure of the Berea oil sand in the Flushing quadrangle, Ohio, by W. T. Griswold. 1908. 30 pp., 2 pls.

350. Geology of the Rangely oil district, Colorado, with a section on the water supply, by H. S. Gale. 1908. 60 pp., 4 pls.

[a]357. Preliminary report on the Coalinga oil district in Fresno and Kings counties, Cal., by Ralph Arnold and Robert Anderson. 1908. 142 pp., 2 pls. 20c.

364. Geology and mineral resources of the Laramie basin, Wyoming, by N. H. Darton and C. E. Siebenthal. 1908. 81 pp., 8 pls.

365. The fractionation of crude petroleum by capillary diffusion, by J. E. Gilpin and M. P. Cram. 1908. 33 pp.

394. Papers on the conservation of mineral resources. 1909. 214 pp., 12 pls.

In preparation.

381. Contributions to economic geology, 1908, Part II; Marius R. Campbell, geologist in charge. Chapter D, papers on petroleum and natural gas:

Geology and oil prospects of the Reno region, Nevada, by R. Anderson.

Two areas of oil prospecting in Lyon County, Nevada, by R. Anderson.

Analyses of crude petroleum in Oklahoma and Kansas, by D. T. Day.

Madill oil pool, Oklahoma, by J. A. Taff and W. J. Reed.

The Florence oil field, Colorado, by C. W. Washburne.

Development in the Boulder oil field, Colorado, by C. W. Washburne.

398. Geology and oil resources of the Coalinga district, California, final report, by Ralph Arnold and Robert Anderson.

401. Relations between local magnetic disturbances and the genesis of petroleum, by Geo. F. Becker.

WATER-SUPPLY PAPER.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls.

FOLIOS OF THE GEOLOGIC ATLAS OF THE UNITED STATES CONCERNING PETROLEUM AND NATURAL GAS FIELDS, 1897–1908.

40. Wartburg, Tenn., by A. Keith. 1897.
53. Standingstone, Tenn., by M. R. Campbell. 1899.
72. Charleston, W. Va., by M. R. Campbell. 1901.
76. Austin, Tex., by R. T. Hill and T. W. Vaughan. 1902.
82. Masontown-Uniontown, Pa., by M. R. Campbell. 1902.
92. Gaines, Pa.-N. Y., by M. L. Fuller and W. C. Alden. 1903.
105. Patoka, Ind.-Ill., by M. L. Fuller and F. G. Clapp. 1904.
107. Newcastle, Wyo.-S. Dak. by N. H. Darton, 1904.
115. Kittanning, Pa., by C. Butts and F. Leverett. 1904.
121. Waynesburg, Pa., by R. W. Stone. 1905.
123. Elders Ridge, Pa., by R. W. Stone. 1905.
125. Rural Valley, Pa., by C. Butts. 1905.
132. Muscogee, Okla., by J. A. Taff. 1906.
134. Beaver, Pa., by L. H. Woolsey. 1906.
135. Nepesta, Colo., by C. A. Fisher. 1906.
144. Amity, Pa., by F. G. Clapp. 1907.
146. Rogersville, Pa., by F. G. Clapp. 1907.
[b]148. Joplin district, Mo.-Kans., by W. S. T. Smith and C. E. Siebenthal. 1907.
159. Independence, Kans., by F. C. Schrader. 1908.
163. Santa Cruz, Cal., by J. C. Branner, J. F. Newsome, and R. Arnold, 1909.

In preparation. Sewickley, Pa., by M. J. Munn, Warren, Pa.-N. Y., by C. Butts.

---

[a] This mark indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers marked in this way may, however, be purchased from the superintendent of documents, Washington, D. C., at the prices iddicated.

[b] The price of folio No. 148 is 50 cents. The other folios named are sold at 25 cents each.

PRODUCTION BY FIELDS.

In the following tables is given the production of crude petroleum in the United States for the years 1903 to 1908, inclusive, by fields:

Production of petroleum in the United States, 1903–1908, by fields, in barrels.

Field.	1903.	1904.	1905.	1906.	1907.	1908.
Appalachian	31,558,248	31,408,567	29,366,960	27,741,472	25,342,137	24,945,517
Lima-Indiana	24,080,264	24,689,184	22,294,171	17,554,661	13,121,094	10,032,305
Illinois	....	....	181,084	4,397,050	24,281,973	33,685,106
Mid-Continent	1,573,085	6,186,629	12,535,777	22,838,553	46,846,267	48,323,810
Gulf	18,371,383	24,631,269	36,526,323	20,527,520	16,410,299	17,318,330
California	24,382,472	29,649,434	33,427,473	33,098,598	39,748,375	44,854,737
Other	495,885	515,877	385,792	336,082	345,190	412,674
	100,461,337	117,080,960	134,717,580	126,493,936	166,095,335	179,572,479

Percentages of total crude petroleum produced in the several fields, 1903–1908.

Field.	1903.	1904.	1905.	1906.	1907.	1908.
Appalachian	31.41	26.83	21.80	21.93	15.26	13.89
Lima-Indiana	23.97	21.09	16.55	13.88	7.90	5.59
Illinois	....	....	.14	3.47	14.62	18.76
Mid-Continent	1.57	5.28	.30	18.05	28.20	26.91
Gulf	18.29	21.03	27.11	16.23	9.88	9.64
California	24.27	25.33	24.81	26.17	23.93	24.98
Other	.49	.44	.29	.27	.21	.23
	100.00	100.00	100.00	100.00	100.00	100.00

Production of petroleum in the United States in 1907 and 1908, by fields, showing increase or decrease, in barrels.

Field.	Production.		Increase.	Decrease.	Percentage.	
	1907.	1908.			Increase.	Decrease.
Appalachian	25,342,137	24,945,517	....	396,620	....	1.57
Lima-Indiana	13,121,094	10,032,305	....	3,088,789	....	23.54
Illinois	24,281,973	33,685,106	9,403,133	....	38.72	....
Mid-Continent	46,846,267	48,323,810	1,477,543	....	3.15	....
Gulf	16,410,299	17,318,330	908,031	....	5.53	....
California	39,748,375	44,854,737	5,106,362	....	12.85	....
Other	345,190	412,674	67,484	....	19.55	....
	166,095,335	179,572,479	13,477,144	....	8.114	....

Quantity, total value, and price per barrel received at wells for crude petroleum produced in the United States in 1907 and 1908, by fields, in barrels.

Field.	1907.			1908.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Appalachian	25,342,137	$43,766,686	$1.727	24,945,517	$43,888,020	$1.759
Lima-Indiana	13,121,094	11,962,410	.912	10,032,305	10,065,768	1.003
Illinois	24,281,973	16,432,947	.677	33,685,106	22,648,881	.672
Mid-Continent	46,846,267	19,200,235	.4098	48,323,810	18,920,610	.392
Gulf	16,410,299	13,743,319	.837	17,318,330	10,352,809	.598
California	39,748,375	14,699,956	.3698	44,854,737	23,433,502	.5225
Other	345,190	301,196	.8725	412,674	396,668	.961
	166,095,335	120,106,749	.723	179,572,479	129,706,258	.722

Deliveries of crude petroleum in the United States and purposes for which shipped in 1908, by fields, in barrels.

Field.	Total deliveries in 1908.	Delivered for—		
		Refining.	Fuel.	Other purposes.
Appalachian	56,024,209	55,994,334		a 29,875
Lima-Indiana	14,722,866	14,713,817	4,363	b 4,686
Illinois	21,323,331	20,728,953	168,533	b 425,845
Kansas and Oklahoma	37,642,168	33,860,532	1,521,694	c 2,259,942
Louisiana	6,929,685	1,108,074	5,797,334	a 24,277
Texas	11,267,838	3,479,530	7,786,095	a 2,213
California	45,139,888	d 17,559,556	d 25,080,332	b 2,500,000
Other	409,224	397,314	11,910	
Total in 1908	193,459,209	147,842,110	40,370,261	5,246,838
Total in 1907	172,014,023	136,870,109	32,653,110	2,490,804

a Lubricating.
b For making gas.
c Railroad shipments can not be divided.
d Estimated.

STOCKS.

The following table gives the stocks of crude petroleum in the United States in 1908, by fields:

Stocks, runs, and deliveries of crude petroleum in the United States in 1908, by fields, in barrels.

Field.	Gross stocks December 31, 1907.	Runs from wells sold in 1908.	Deliveries in 1908.	Gross stocks December 31, 1908.
Appalachian	6,537,239	24,945,517	56,024,209	8,675,818
Lima-Indiana	6,700,526	10,032,305	14,722,866	6,411,272
Illinois	15,848,035	33,685,106	21,323,331	25,637,397
Kansas and Oklahoma	a 38,605,538	47,600,546	37,642,168	b 47,382,185
Louisiana	392,841	6,835,130	6,929,685	307,962
Texas	c 2,141,897	11,206,464	11,267,838	d 2,649,009
California	e 2,054,845	44,854,737	45,139,888	f 1,769,694
Other	1,000	412,674	409,224	4,450
Total in 1908	72,281,921	179,572,479	193,459,209	92,837,787
Total in 1907		166,095,335	172,014,023	

a In addition it is estimated that 6,650,000 barrels were held in producers' storage and refiners' reserve.
b In addition it is estimated that 7,500,000 barrels were held in producers' storage and refiners' reserve.
c In addition it is estimated that 1,200,000 barrels were held in producers' storage and refiners' reserve.
d In addition to this some oil was held in producers' storage and refiners' reserve.
e Field stock held by producers and do not include stocks held by pipe-line companies, which amounted to not less than 4,000,000 barrels.
f Field stocks held by producers and do not include stocks held by pipe-line companies.

In the following tables are given the grades of all stocks of crude petroleum held in the oil fields of the United States at the close of 1908, and the grades of stocks of crude oil held by the eastern pipe lines at the close of each month of the same year.

Grades of all stocks of crude petroleum held in the United States December 31, 1908, by fields, in barrels.

Kind of oil.	Quantity.	Kind of oil.	Quantity.
Pennsylvania	3,829,124	Texas	2,649,009
Lima	3,824,582	California	1,769,694
Illinois	29,209,660	Other	4,450
Kentucky	312,390		
Kansas and Oklahoma	50,930,916		92,837,787
Louisiana	307,962		

Grades of gross stocks of crude petroleum held by the eastern pipe lines at the close of each month in 1908, in barrels.

Month.	Pennsylvania.	Lima.	Kentucky.	Kansas.	Illinois.	Total.
January						12,835,198
February	3,036,059	4,699,795	310,771	2,815,878	2,086,609	12,949,112
March	3,074,634	4,567,612	334,913	2,615,961	2,919,608	13,512,728
April	3,092,554	4,653,599	324,724	2,571,254	3,189,075	13,831,206
May	3,262,774	4,279,366	307,149	2,954,770	2,912,737	13,716,796
June	3,556,125	4,151,247	224,035	2,777,811	3,049,094	13,758,312
July	3,561,856	4,110,690	278,550	2,960,789	3,452,404	14,364,289
August	3,566,999	3,709,929	302,363	3,525,776	3,203,173	14,308,240
September	3,476,693	3,547,627	254,684	4,114,869	2,726,598	14,120,471
October	3,209,015	3,481,262	298,708	4,251,463	2,852,588	14,093,036
November	3,052,538	3,612,152	290,982	3,859,430	3,297,260	14,112,362
December	3,306,894	3,619,819	311,590	3,548,731	3,572,263	14,359,297

WELL RECORD.

The following table gives the well record for the United States for 1908, by fields:

Well record in the United States in 1908, by fields.

Field.	Wells completed.				Initial production.	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian	5,292		1,823	7,115	55,002	10.4
Pennsylvania and New York	3,403		757	4,160	9,904	2.91
Southeastern Ohio	837		571	1,408	14,331	17.1
West Virginia	917		430	1,347	28,325	30.9
Kentucky	135		65	200	2,442	18.1
Lima-Indiana	1,088		162	1,250	11,979	11.01
Lima, Ohio	768		80	848	8,721	11.4
Indiana	320		82	402	3,258	10.2
Mid-Continent	2,587	471	432	3,490	216,486	83.7
Kansas	72	367	127	566	1,159	16.1
Oklahoma	2,458	102	284	2,844	214,152	87.1
Northern Texas	57	2	21	80	1,175	20.6
Illinois	3,019		555	3,574	78,960	26.2
Gulf	606	14	199	819	178,427	296.9
Coastal Texas	452	8	143	603	74,252	166.1
Louisiana	154	6	56	216	104,175	676.4
California	594		23	617		
Colorado	13		12	25		
Other	11		8	19		
	13,210	485	3,214	16,909	540,854	42.9

APPALACHIAN OIL FIELD.

The geographic limits of this field and the characteristics of the oils may be found in the preceding report, Mineral Resources of the United States for 1907. The minor developments during 1908 will be recorded under the individual States.

PRODUCTION.

The following table gives the production of petroleum in the Appalachian oil field during the year 1908, by States and months:

Production of the Appalachian oil field, by States and months, in 1908, in barrels.

Month.	Pennsylvania.	New York.	Ohio.	West Virginia.	Kentucky.	Total.
January	782,683	98,776	329,444	697,040	60,781	1,968,724
February	718,905	87,119	307,351	700,103	60,168	1,873,646
March	835,990	99,948	339,520	770,689	59,336	2,105,483
April	803,590	100,511	326,388	779,089	63,283	2,072,861
May	805,930	97,365	328,061	823,144	65,927	2,120,427
June	819,020	99,954	332,950	870,289	60,127	2,182,340
July	806,003	99,338	342,434	864,877	60,150	2,172,802
August	781,988	95,754	344,627	815,242	60,533	2,098,144
September	786,963	96,299	373,637	803,139	60,137	2,120,175
October	781,001	98,556	372,768	795,539	55,385	2,103,249
November	710,246	89,345	339,400	739,605	59,643	1,938,239
December	792,006	97,163	373,541	864,420	62,297	2,189,427
	9,424,325	1,160,128	4,110,121	9,523,176	727,767	24,945,517

The production of petroleum in the Appalachian oil field from 1859 to 1908, inclusive, is given in the following table:

Production of petroleum in the Appalachian field, 1859–1908, in barrels.

Year.	Production.	Per cent of total production.	Increase (+) or decrease (−) from previous year.	Yearly average price per barrel.[a]	Year.	Production.	Per cent of total production.	Increase (+) or decrease (−) from previous year.	Yearly average price per barrel.[a]
1859	2,000	100			1884	23,956,438	98.92	+ 649,662	$0.83½
1860	500,000	100	+ 498,000	$9.59	1885	21,533,785	98.51	−2,422,653	.87⅞
1861	2,113,609	100	+1,613,609	.49	1886	26,549,827	94.60	+5,016,042	.71¼
1862	3,056,690	100	+ 943,081	1.05	1887	22,878,241	80.90	−3,671,586	.66¾
1863	2,611,309	100	+ 445,381	3.15	1888	16,941,397	61.36	−5,936,844	.87⅝
1864	2,116,109	100	− 495,200	8.06	1889	22,355,225	63.57	+5,413,828	.94⅛
1865	2,497,700	100	+ 381,591	6.59	1890	30,073,307	65.63	+7,718,082	.86¾
1866	3,597,700	100	+1,100,000	3.74	1891	35,848,777	66.03	+5,775,470	.67
1867	3,347,300	100	− 250,400	2.41	1892	33,432,377	66.19	−2,416,400	.55⅝
1868	3,646,117	100	+ 298,817	3.62½	1893	31,365,890	64.76	−2,066,487	.64
1869	4,215,000	100	+ 568,883	5.63¾	1894	30,783,424	62.38	− 582,466	.83⅞
1870	5,260,745	100	+1,045,745	3.86	1895	30,960,639	58.54	+ 177,215	1.35⅞
1871	5,205,234	100	− 55,511	4.34	1896	33,971,902	55.73	+3,010,263	1.17⅞
1872	6,293,194	100	+1,087,960	3.64	1897	35,230,271	58.25	+1,258,369	.78⅝
1873	9,893,786	100	+3,600,592	1.83	1898	31,717,425	57.29	−3,512,846	.91⅛
1874	10,926,945	100	+1,033,159	1.17	1899	33,068,356	57.94	+1,350,931	1.29⅜
1875	8,787,514	100	−2,139,431	1.35	1900	36,295,433	57.05	+3,227,077	1.35¼
1876	9,120,669	99.87	+ 333,155	2.56¼	1901	33,618,171	48.45	−2,677,262	1.21
1877	13,337,363	99.90	+4,216,694	2.42	1902	32,018,787	36.07	−1,599,384	1.23¾
1878	15,381,641	99.90	+2,044,278	1.19	1903	31,558,248	31.41	− 460,539	1.59
1879	19,894,288	99.90	+4,512,647	.85⅞	1904	31,408,567	26.83	− 149,681	1.62¾
1880	26,245,571	99.85	+6,351,283	.94½	1905	29,366,960	21.80	−2,041,607	1.39⅜
1881	27,561,376	99.64	+1,315,805	.85⅞	1906	27,741,472	21.93	−1,625,488	1.59¾
1882	30,221,261	99.58	+2,659,885	.78⅛	1907	25,342,137	15.26	−2,399,335	1.74½
1883	23,306,776	99.39	−6,914,485	1.05¾	1908	24,945,517	13.89	− 396,620	1.78

[a] Price of oil of "Pennsylvania" grade as given by Seep Purchasing Agency.

In the following table is given the production of the Appalachian field, by States, from 1900 to 1908, inclusive:

Production of petroleum in the Appalachian field, 1900–1908, by States, in barrels.

Year.	Pennsylvania and New York.	West Virginia.	Southeastern Ohio.	Kentucky and Tennessee.	Total.
1900	14,559,127	16,195,675	5,478,372	62,259	36,295,433
1901	13,831,996	14,177,126	5,471,790	137,259	33,618,171
1902	13,183,610	13,513,345	5,136,501	185,331	32,018,787
1903	12,518,134	12,899,395	5,586,433	554,286	31,558,248
1904	12,239,026	12,644,686	5,526,571	998,284	31,408,567
1905	11,554,777	11,578,110	5,016,736	1,217,337	29,366,960
1906	11,500,410	10,120,935	4,906,579	1,213,548	27,741,472
1907	11,211,606	9,095,296	4,214,391	820,844	25,342,137
1908	10,584,453	9,523,095	4,110,121	[a] 727,767	24,945,517

[a] No production in Tennessee recorded in 1908.

In the following table is shown the production of the Appalachian field, by States, in the years 1907 and 1908, with the increase and decrease for each State and the percentage of increase or decrease as compared with the previous year:

Production of petroleum in the Appalachian field in 1907 and 1908, by States, showing increase or decrease, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1907.	1908.			Increase.	Decrease.
Pennsylvania	9,999,306	9,424,325		574,981		5.75
New York	1,212,300	1,160,128		52,172		4.30
Southeastern Ohio	4,214,391	4,110,121		104,270		2.47
West Virginia	9,095,296	9,523,176	427,880		4.70	
Kentucky and Tennessee [a]	820,844	727,767		93,077		11.34
	25,342,137	24,945,517		396,620		1.57

[a] No production in Tennessee recorded in 1908.

In the following table are given the quantity, value, and price per barrel of the oil produced in the Appalachian field during the years 1907 and 1908, by States:

Quantity and value at wells of crude petroleum produced in the Appalachian field in 1907 and 1908, by States.

State.	1907.			1908.		
	Quantity in barrels.	Value.	Price per barrel.	Quantity in barrels.	Value.	Price per barrel.
Pennsylvania	9,999,306	$17,579,706	$1.758	9,424,325	$16,881,194	$1.7912
New York	1,212,300	2,127,748	1.755	1,160,128	2,071,533	1.7856
Southeastern Ohio	4,214,391	7,344,408	1.743	4,110,121	7,316,617	1.78
West Virginia	9,095,296	15,852,428	1.743	9,523,176	16,911,865	1.776
Kentucky and Tennessee [a]	820,844	862,396	1.0506	727,767	706,811	.971
	25,342,137	43,766,686	1.727	24,945,517	43,888,020	1.759

[a] No production in Tennessee recorded in 1908.

Production and value of crude petroleum in the Appalachian field, 1905–1908, in barrels.

Year.	Pennsylvania.		New York.		Macksburg, Ohio.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	10,437,195	$14,653,278	1,117,582	$1,557,630	5,016,736	$6,992,885
1906	10,256,893	16,596,943	1,243,517	1,995,377	4,906,579	7,839,359
1907	9,999,306	17,579,706	1,212,300	2,127,748	4,214,391	7,344,408
1908	9,424,325	16,881,194	1,160,128	2,071,533	4,110,121	7,316,617

Year.	Kentucky-Tennessee.		West Virginia.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	1,217,337	$943,211	11,578,110	$16,132,631	29,366,960	$40,279,635
1906	1,213,548	1,031,629	10,120,935	16,170,293	27,741,472	43,633,601
1907	820,844	862,396	9,095,296	15,852,428	25,342,137	43,766,686
1908	[a] 727,767	706,811	9,523,176	16,911,865	24,945,517	43,888,020

[a] No production in Tennessee recorded in 1908.

In the two following tables is given the production of crude petroleum in the Appalachian field from 1903 to 1908, in the first by months and in the second by days:

Production of crude petroleum in the Appalachian oil field, 1903–1908, by months and years, in barrels.

Month.	1903.	1904.	1905.	1906.	1907.	1908.
January	2,726,634	2,377,630	2,368,186	2,346,346	2,064,855	1,968,724
February	2,353,281	2,294,922	2,207,659	2,070,728	1,938,474	1,873,646
March	2,759,807	2,719,887	2,685,538	2,397,601	2,186,092	2,105,483
April	2,691,431	2,599,224	2,445,161	2,326,650	2,169,518	2,072,861
May	2,681,586	2,743,881	2,685,829	2,473,788	2,254,810	2,120,427
June	2,731,722	2,700,030	2,570,383	2,383,010	2,082,385	2,182,340
July	2,758,308	2,697,037	2,434,710	2,406,191	2,245,920	2,172,802
August	2,628,708	2,822,017	2,523,737	2,437,028	2,155,226	2,098,144
September	2,633,513	2,668,124	2,358,897	2,198,899	2,021,582	2,120,175
October	2,664,422	2,606,321	2,376,013	2,329,121	2,138,189	2,103,249
November	2,374,373	2,558,764	2,268,847	2,180,492	1,947,011	1,938,239
December	2,554,463	2,620,730	2,442,000	2,191,618	2,138,075	2,189,427
	31,558,248	31,408,567	29,366,960	27,741,472	25,342,137	24,945,517

Average daily production of crude petroleum in the Appalachian oil field each month, 1903–1908, by months and years, in barrels.

Month.	1903.	1904.	1905.	1906.	1907.	1908.
January	87,956	76,698	76,393	75,689	66,608	63,507
February	84,046	79,135	78,845	73,955	69,231	64,608
March	89,026	87,738	86,630	77,342	70,519	67,919
April	89,714	86,641	81,505	77,555	72,317	69,095
May	86,503	88,512	86,640	79,798	72,736	68,401
June	91,057	90,001	85,679	79,434	69,413	72,745
July	88,978	87,001	78,539	77,619	72,449	70,090
August	84,797	91,033	81,411	78,614	69,523	67,682
September	87,784	88,937	78,630	73,297	67,386	70,673
October	85,949	84,075	76,646	75,133	68,974	67,847
November	79,146	85,292	75,628	72,683	64,903	64,608
December	82,402	84,540	78,774	70,697	68,970	70,627
Average	86,461	85,816	80,457	76,004	69,430	68,157

PIPE-LINE STATISTICS IN THE APPALACHIAN FIELD.

In the following tables are given the pipe-line runs for the principal lines in this field, together with their deliveries for each month in 1908, and the stocks held by these lines at the close of each month for the same period:

Pipe-line runs in the Appalachian oil field in 1908, by lines and months, in barrels.

Month.	National Transit.	Eureka.	Southwest.	Tidewater.	Producers and Refiners.	Emery.
January	366,177	645,129	158,196	128,527	191,268	25,256
February	327,206	653,764	147,943	115,486	185,632	22,797
March	396,514	720,842	163,368	133,671	194,222	26,642
April	376,564	732,707	163,473	129,321	187,825	24,922
May	383,287	774,165	154,530	131,714	189,390	27,016
June	381,717	819,325	168,820	133,320	190,452	26,708
July	377,111	793,790	162,103	133,509	210,144	25,032
August	360,509	742,102	157,423	127,257	214,559	26,910
September	367,183	725,236	159,272	129,597	214,288	26,623
October	368,430	715,915	152,794	126,127	220,984	26,139
November	333,201	662,332	138,606	118,543	203,933	24,443
December	368,358	784,679	159,416	132,097	224,778	26,740
	4,406,257	8,769,986	1,885,944	1,539,169	2,427,475	309,228

Month.	Cumberland.	New York Transit.	Buckeye Macksburg.	Other pipe lines.	Franklin.	Total.
January	56,713	25,146	234,908	134,350	3,054	1,968,724
February	57,248	19,980	218,873	122,068	2,649	1,873,646
March	56,560	23,053	248,815	137,779	4,017	2,105,483
April	59,849	24,509	234,870	134,697	4,124	2,072,861
May	62,918	22,385	238,016	133,189	3,817	2,120,427
June	57,353	24,040	243,285	133,414	3,906	2,182,340
July	57,223	22,926	250,726	136,713	3,525	2,172,802
August	57,930	23,075	251,438	133,447	3,494	2,098,144
September	57,303	21,705	285,435	130,309	3,224	2,120,175
October	52,820	23,188	287,365	126,076	3,411	2,103,249
November	57,579	21,524	265,270	109,221	3,587	1,938,239
December	59,922	22,182	285,283	122,418	3,554	2,189,427
	693,418	273,713	3,044,284	1,553,681	42,362	24,945,517

Pipe-line deliveries in the Appalachian oil field in 1908, by lines and months, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.
January	1,514,521	68,746	96,853	3,853	566,827	126,568	1,513,920
February	1,391,418	65,919	82,353	3,104	514,600	148,532	1,397,082
March	1,510,459	64,312	86,597	2,620	497,362	87,748	1,522,594
April	1,476,270	120,470	64,461	2,933	622,684	183,604	1,480,139
May	1 576,938	119,091	73,326	4,275	569,641	176,136	1,567,719
June	1,667,487	120,527	78,467	6,393	597,732	118,517	1,553,816
July	1,762,187	104,527	27,767	5,568	544,691	173,548	1,742,409
August	1,659,673	129,860	41,812	4,224	654,020	159,641	1,620,289
September	1,679,767	117,562	72,857	1,005	619,297	152,471	1,467,456
October	1,798,209	122,913	73,067	857	636,651	150,881	1,291,536
November	1,669,513	118,119	80,546	1,541	538,418	140,576	1,390,346
December	1,649,801	119,387	76,324	2,511	593,283	174,587	1,536,016
	19,356,243	1,271,433	854,430	38,884	6,955,206	1,792,809	18,083,322

Pipe-line deliveries in the Appalachian oil field in 1908, by lines and months, in barrels—Continued.

Month.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other pipe lines.[a]	Total.
January	258,948	235,351	24,313	1,403	4,082	134,104	4,549,489
February	188,192	194,960	23,534	535	....	134,100	4,144,329
March	262,279	184,743	27,658	694	50	134,104	4,381,220
April	304,049	199,806	24,261	185	6	134,104	4,612,972
May	291,247	186,474	24,523	154	6	134,104	4,723,634
June	262,875	199,821	28,158	4,103	....	134,104	4,772,000
July	281,997	219,146	25,774	6,447	104	134,104	5,028,269
August	272,429	197,957	25,370	5,367	36	134,104	4,904,782
September	338,412	191,092	27,732	6,283	507	134,104	4,808,545
October	296,862	189,569	25,662	3,687	5,006	134,104	4,729,004
November	252,792	210,149	24,512	1,426	4,653	134,104	4,566,695
December	249,493	223,403	26,953	5,388	12,019	134,105	4,803,270
	3,259,575	2,432,471	308,450	35,672	26,469	1,609,245	56,024,209

[a] Averaged.

Gross stocks held by pipe lines in the Appalachian oil field at close of each month in 1908, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.
January	1,016,826	810,731	1,147,491	155,029	479,616	88,823	877,918
February	952,702	810,459	1,201,211	170,640	576,461	76,012	835,113
March	1,095,449	1,013,303	1,154,246	169,359	636,103	142,099	819,821
April	1,126,761	910,029	1,111,621	186,097	627,458	97,096	975,292
May	1,138,356	922,359	1,206,056	203,548	718,201	81,352	1,149,328
June	1,185,784	991,931	1,342,705	163,527	727,245	122,255	1,278,706
July	1,207,914	1,238,886	1,326,239	175,958	847,664	115,998	1,270,566
August	1,218,706	952,914	1,387,875	188,444	841,765	123,159	1,453,965
September	1,230,275	1,027,871	1,273,193	195,497	856,997	124,946	1,499,437
October	1,129,438	989,521	1,180,886	206,184	827,695	128,287	1,770,419
November	1,063,627	929,269	1,118,591	232,398	843,731	126,812	1,866,011
December	1,083,595	925,744	1,339,048	208,315	785,563	104,866	1,736,045

Month.	Northern.	Producers and Refiners.	Emery.	United States.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	753,475	224,555	13,599	74,194	255,250	32,414	....	....
February	820,532	215,226	12,862	61,794	244,893	34,491	....	....
March	837,355	224,706	11,845	69,788	256,072	37,873	....	....
April	894,970	212,725	12,507	77,980	248,884	41,354	....	....
May	998,147	215,641	15,000	98,872	255,154	44,556	....	....
June	866,873	206,272	13,550	116,950	266,684	47,884	....	....
July	878,134	197,269	12,808	83,967	242,979	50,844	....	....
August	880,390	213,871	14,348	121,527	250,272	53,757	....	....
September	974,102	237,068	13,238	116,203	239,611	55,971	....	....
October	1,046,208	268,483	13,715	118,763	253,253	53,903	....	....
November	1,176,549	262,267	13,647	145,540	253,465	52,307	....	....
December	1,307,417	263,643	13,435	127,785	257,332	53,288	469,742	8,675,818

PRICES OF APPALACHIAN OIL.

The following table shows the range of prices paid by the Seep Purchasing Agency for the different grades of Appalachian oil in 1907 and 1908:

Range of prices paid by the Seep Purchasing Agency for light crude petroleum produced in the New York, Ohio, Pennsylvania, and West Virginia oil regions during 1907 and 1908, per barrel of 42 gallons.

Date.	Tiona, Pa.	Pennsylvania.	Second sand, Pa.	Corning, Ohio.	Newcastle, Ohio.	Butler and Richland.	Cabell, W. Va.
1907.							
January 1	1.68	1.58	1.58	1.10	1.35	1.78	1.18
February 11	1.73	1.63	1.63	1.12	1.37	1.78	1.20
March 9	1.78	1.68	1.68	1.14	1.39	1.78	1.22
March 13	1.78	1.78	1.78	1.14	1.39	1.78	1.22
April 12	1.78	1.78	1.78	1.14	1.22	1.78	1.22
June 1	1.78	1.78	1.78	1.14	1.22	1.78	1.32
1908.							
January 1	1.78	1.78	1.78	1.14	1.22	1.78	1.32

In the following table is given the average price per month of the different light oils of New York, Pennsylvania, Ohio, and West Virginia during the years 1907 and 1908:

Average monthly prices of Appalachian crude petroleum in 1907 and 1908, per barrel.

Month.	Tiona, Pa.	Pennsylvania.	Butler and Richland.	Corning, Ohio.	Newcastle, Ohio.	Cabell, W. Va.
1907.						
January	1.68	1.58	1.78	1.10	1.35	1.18
February	1.71¼	1.61¼	1.78	1.11¼	1.36¼	1.19¼
March	1.76⅝	1.72⅞	1.78	1.13½	1.38½	1.21½
April	1.78	1.78	1.78	1.14	1.28½	1.22
May	1.78	1.78	1.78	1.14	1.22	1.22
June	1.78	1.78	1.78	1.14	1.22	1.32
July	1.78	1.78	1.78	1.14	1.22	1.32
August	1.78	1.78	1.78	1.14	1.22	1.32
September	1.78	1.78	1.78	1.14	1.22	1.32
October	1.78	1.78	1.78	1.14	1.22	1.32
November	1.78	1.78	1.78	1.14	1.22	1.32
December	1.78	1.78	1.78	1.14	1.22	1.32
Average	1.76½	1.74½	1.78	1.13⅜	1.26¼	1.27¼
1908.						
Average	1.78	1.78	1.78	1.14	1.22	1.32

The average monthly and yearly prices per barrel of the crude petroleum in the Appalachian field for the years 1902–1908 are given in the following table:

Monthly and yearly average prices of pipe-line certificates of Pennsylvania crude petroleum at wells in daily market, 1902–1908, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
1902	$1.15	$1.15	$1.15	$1.17½	$1.20	$1.20⅜	$1.22	$1.22	$1.22	$1.28⅛	$1.38¼	$1.49	$1.23¾
1903	1.52½	1.50	1.50	1.51	1.51½	1.50	1.52½	1.56	1.57¼	1.68½	1.78¾	1.88⅜	1.59
1904	1.85	1.82	1.72⅛	1.65½	1.62	1.58⅝	1.52	1.50	1.53¾	1.56	1.58¾	1.57	1.62¾
1905	1.43⅛	1.39	1.38¼	1.32¾	1.28¾	1.27	1.27	1.27	1.35⅜	1.57½	1.59	1.58	1.39⅜
1906	1.58	1.58	1.58	1.60⅜	1.64	1.64	1.63⅝	1.58	1.58	1.58	1.58	1.58	1.59¾
1907	1.58	1.61¼	1.72⅞	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.74½
1908	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78

The following table shows the range of prices of Pennsylvania crude oil each year since 1859:

Highest and lowest prices of Pennsylvania crude petroleum each year, 1859–1908, per barrel.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
1859	September	$20.00	December	$20.00
1860	January	20.00	do	2.00
1861	do	1.75	do	.10
1862	December	2.50	January	.10
1863	do	4.00	do	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	do	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	do	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.82½
1874	February	2.25	do	.62½
1875	do	1.82½	January	.75
1876	December	4.23¾	do	1.47½
1877	January	3.69⅜	June	1.53¾
1878	February	1.87½	September	.78¾
1879	December	1.28¾	June	.63⅛
1880	June	1.24⅜	April	.71¼
1881	September	1.01¼	July	.72½
1882	November	1.37	do	.49¼
1883	June	1.24¾	January	.83¼
1884	January	1.15⅝	June	.51¼
1885	October	1.12⅝	January	.68
1886	January	.92¼	August	.59¾
1887	December	.90	July	.54
1888	March	1.00	June	.71⅜
1889	November	1.12½	April	.79½
1890	January	1.07⅝	December	.60¾
1891	February	.81⅜	August	.50
1892	January	.64⅛	October	.50
1893	December	.80	January	.52⅞
1894	do	.95¾	do	.78½
1895	April	2.60	do	.95¼
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	do	1.66	February	1.13
1900	January	1.68	November	1.05
1901	January, September	1.45	May	.80
1902	December	1.54	January, February, March	1.15
1903	do	1.90	January, February, March, April, May, June, July.	1.50
1904	January	1.85	July, December	1.50
1905	October	1.61	May	1.27
1906	April, May, June, July	1.64	January, February, March, April, August, September, October, November, December.	1.58
1907	March to December, inclusive.	1.78	January	1.58
1908	No change	1.78	No change	1.78

PENNSYLVANIA AND NEW YORK.

Pennsylvania and New York followed the expected course of gradual decline, checked here and there by the opening of small pools in abandoned or condemned territory. For example: In the old Thorn Creek field, Butler County, Pa., Henry N. Hoffman drilled a well on a site where a derrick had been located years ago, but where no drilling had ever been done. Hoffman's well flowed about 50 barrels a day and excited much drilling activity over the entire area. Schaffner & Co. brought in a second gusher. The field did not prove large, but it is typical of the many small finds in oil territory that helped to check the decline. In September the Kehr well was drilled on Watson's Flats about one-half mile north of the original Drake well, and produced 700 barrels a week, declining later to 10 barrels a day. Much drilling was done in October as a result of this find.

The month of November showed a first-sand development southwest of Chapmansville. Another was opened south of Sunville, a third southeast of Wallaceville, and still another developed between Wallaceville and Chapmansville—all in Venango County, Pa. The oil is dark, but of good quality, its gravity being about 44° B.

PRODUCTION.

The following table shows the production of crude petroleum in Pennsylvania and New York in 1906, 1907, and 1908, by months:

Production of crude petroleum in Pennsylvania and New York in 1906, 1907, and 1908, by months, in barrels.

Month.	Pennsylvania.			New York.		
	1906.	1907.	1908.	1906.	1907.	1908.
January	863,084	824,081	782,683	103,492	100,887	98,776
February	745,599	742,149	718,905	94,432	89,502	87,119
March	860,932	874,478	835,990	103,077	105,662	99,948
April	871,464	847,748	803,590	101,492	102,975	100,511
May	910,711	875,529	805,930	110,492	107,406	97,365
June	884,651	826,192	819,020	105,964	98,809	99,954
July	871,792	900,025	806,003	105,837	106,231	99,338
August	887,274	842,609	781,988	109,169	102,093	95,754
September	822,898	799,053	786,963	101,130	98,236	96,299
October	881,790	852,446	781,001	106,621	103,308	98,556
November	836,245	779,009	710,246	103,749	96,772	89,345
December	820,453	835,987	792,006	98,062	100,419	97,163
	10,256,893	9,999,306	9,424,325	1,243,517	1,212,300	1,160,128

In the following table are shown the quantity and value of crude petroleum produced in Pennsylvania and New York from 1904 to 1908, inclusive:

Quantity and value of crude petroleum in Pennsylvania and New York, 1904–1908, in barrels.

Year.	Pennsylvania.			New York.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
1904	11,125,762	$18,222,242	$1.638	1,113,264	$1,811,837	$1.6275
1905	10,437,195	14,653,278	1.404	1,117,582	1,557,630	1.394
1906	10,256,893	16,596,943	1.618	1,243,517	1,995,377	1.605
1907	9,999,306	17,579,706	1.758	1,212,300	2,127,748	1.755
1908	9,424,325	16,881,194	1.7912	1,160,128	2,071,533	1.7856

WELL RECORD.

The following tables give the well records for Pennsylvania and New York from 1904 to 1908, inclusive:

Number of wells completed in the Pennsylvania and New York oil fields, 1904–1908, by districts.

District.	Completed.					Dry.					Productive.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Bradford	297	292	332	305	359	48	56	35	37	44	249	236	297	268	315
Allegany	683	626	635	581	473	72	78	73	89	66	611	548	562	492	407
Middle	603	509	674	563	620	104	119	123	136	89	499	390	551	427	531
Venango and Clarion	1,540	1,396	1,905	1,997	1,841	216	216	253	217	201	1,324	1,180	1,652	1,780	1,640
Butler and Armstrong	515	449	475	435	520	160	162	161	164	204	355	287	314	271	316
Southwest Pennsylvania	619	449	451	451	347	232	210	161	205	153	387	239	290	246	194
	4,257	3,721	4,472	4,332	4,160	832	841	806	848	757	3,425	2,880	3,666	3,484	3,403

Number of wells completed in the Pennsylvania and New York oil fields, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	215	184	244	346	380	431	429	401	439	433	445	310	4,257
1905	234	143	179	293	322	351	337	326	387	373	420	356	3,721
1906	322	286	246	279	430	457	455	439	412	416	392	338	4,472
1907	272	201	218	293	405	431	436	432	447	453	429	315	4,332
1908	241	146	207	324	337	428	417	414	455	434	405	352	4,160

Number of dry holes drilled in the Pennsylvania and New York oil fields, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	50	48	50	69	55	97	59	85	75	102	79	63	832
1905	55	39	56	81	69	78	82	72	92	73	77	67	841
1906	64	60	42	54	64	64	79	76	75	73	82	73	806
1907	58	43	51	62	67	85	87	90	88	75	74	68	848
1908	65	27	56	59	48	76	61	72	76	61	86	70	757

Total and average initial daily production of new wells in the Pennsylvania and New York oil fields, 1904–1908, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Bradford	854	888	867	632	874	3.43	3.76	2.92	2.36	2.77
Allegany	1,988	1,531	1,547	1,147	806	3.25	2.79	2.75	2.33	1.98
Middle	2,012	1,115	1,833	1,378	1,257	4.03	2.86	3.33	3.23	2.37
Venango and Clarion	3,641	3,004	5,717	5,779	4,052	2.75	2.54	3.46	3.25	2.47
Butler and Armstrong	2,026	2,938	1,688	1,579	1,532	5.71	10.24	5.37	5.83	4.85
Southwest Pennsylvania	5,302	2,313	4,770	2,636	1,383	13.70	9.68	16.45	10.71	7.13
	15,823	11,789	16,422	13,151	9,904	4.62	4.09	4.48	3.77	2.91

Total initial daily production of new wells in the Pennsylvania and New York oil fields, 1904–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	851	900	1,254	1,482	1,422	1,844	1,641	1,423	1,701	1,107	1,314	884	15,823
1905	780	417	459	723	1,709	1,314	923	970	1,093	1,223	1,192	986	11,789
1906	1,046	1,058	957	1,488	1,537	2,156	1,612	1,400	1,551	1,282	1,268	1,067	16,422
1907	1,024	802	753	1,134	1,060	1,176	1,822	961	1,156	1,187	1,256	820	13,151
1908	523	396	476	746	816	960	1,119	1,114	1,013	1,029	964	748	9,904

WEST VIRGINIA.

In West Virginia there is much undrilled territory in the southwestern part of the field, and the developments by experienced companies went ahead systematically. The results were all that were expected. Brooke and Ritchie counties were the localities of most active development. The Follansbee and Hollidays Cove pools in Brooke County gave the most of the new production, yielding about 6,000 barrels per day in June, 1908, but declining steadily until the end of the year. The Hollidays Cove pool proved the steadier of the two in its output.

PRODUCTION.

In the following table is given the production of crude petroleum in West Virginia in the years 1905 to 1908, by months:

Total production of crude petroleum in West Virginia, 1905–1908, by months, in barrels.

Month.	1905.	1906.	1907.	1908.
January	940,709	832,628	687,251	697,040
February	923,632	752,399	695,616	700,103
March	1,093,107	897,277	771,814	770,689
April	970,540	833,514	770,274	779,089
May	1,078,884	923,039	821,554	823,144
June	1,026,569	872,138	747,071	870,289
July	952,919	917,879	812,437	864,877
August	996,356	906,522	785,620	815,242
September	911,583	777,682	734,077	803,139
October	901,944	833,781	765,671	795,539
November	859,791	762,915	696,694	739,605
December	922,076	811,161	807,217	864,420
	11,578,110	10,120,935	9,095,296	9,523,176

The quantity and value of crude petroleum produced in West Virginia from 1902 to 1908, inclusive, are shown in the following table:

Quantity and value of crude petroleum produced in West Virginia, 1902–1908.

Year.	Regular crude.			Lubricating crude.			Total.		
	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.
1902	13,498,685	$17,006,469	$1.26	14,660	$33,848	$2.31	13,513 345	$17,040,317	$1.261
1903	12,893,079	20,499,996	1.59	6,316	16,536	2.62	12,899,395	20,516,532	1.59
1904	12,636,253	20,557,556	1.627	8,433	26,225	3.11	12,644,686	20,583,781	1.628
1905	11,573,545	16,117,816	1.393	4,565	14,815	3.25	11,578,110	16,132,631	1.393
1906	10,111,647	16,138,811	1.596	9,288	31,482	3.39	10,120,935	16,170,293	1.598
1907	9,089,839	15,834,714	1.74	5,457	17,714	3.25	9,095,296	15,852,428	1.743
1908	9,519,875	16,902,968	1.775	3,301	8,897	2.70	9,523,176	16,911,865	1.776

WELL RECORD.

The following tables give the well records for West Virginia from 1904 to 1908, inclusive:

Number of wells completed in West Virginia, 1904-1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	172	168	182	217	188	224	193	241	212	195	157	145	2,294
1905	124	141	147	154	156	137	143	117	148	126	138	133	1,664
1906	113	136	116	109	108	102	119	147	110	129	117	128	1,434
1907	84	90	98	124	135	112	104	142	112	99	104	110	1,314
1908	89	101	85	98	115	113	119	136	134	117	124	116	1,347

Number of dry holes drilled in West Virginia, 1894-1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	57	45	55	77	61	69	53	73	63	81	48	60	742
1905	46	58	58	53	54	54	54	46	67	61	59	70	680
1906	37	58	36	37	38	31	43	56	33	42	48	49	508
1907	35	36	39	54	54	39	36	48	36	38	37	40	492
1908	42	30	33	39	29	29	33	43	25	40	48	39	430

Total initial daily production of new wells in West Virginia, 1894-1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1904	2,591	3,348	3,018	3,737	2,893	4,106	3,135	4,092	2,858	2,139	3,331	3,061	38,309	3,192
1905	2,324	2,002	2,843	1,907	1,846	2,338	1,715	1,147	1,970	1,012	1,738	898	21,740	1,812
1906	888	1,166	1,930	1,844	1,813	2,101	3,378	2,311	2,075	1,630	1,655	1,744	22,535	1,878
1907	688	1,369	2,042	2,024	2,136	1,488	3,401	1,992	1,798	811	1,027	1,563	20,339	1,695
1908	2,185	2,298	1,423	2,033	3,310	3,853	2,682	2,473	2,498	1,912	1,661	1,997	28,325	2,360

KENTUCKY AND TENNESSEE.

The greater portion of the crude petroleum produced in the State of Kentucky in 1908 was from wells located in Wayne County, the production in this county amounting to about 460,000 barrels. Wolfe County was next in rank, producing in 1908 about 118,000 barrels. The next county in point of production was Bath, with a production of 70,000 barrels. Other producing counties in the State in 1908 were Clinton, Estill, Whitley, Cumberland, Floyd, Barren, and Logan.

PRODUCTION AND PRICES.

In the following table is given the production of crude petroleum in Kentucky and Tennessee, by months, from 1905 to 1908, inclusive:

Production of crude petroleum in Kentucky and Tennessee, by months, 1905–1908, in barrels.

Month.	1905.	1906.	1907.	1908.
January	77,569	115,317	77,034	60,781
February	71,355	101,084	67,939	60,168
March	103,315	109,351	78,438	59,336
April	100,508	103,690	73,467	63,283
May	114,702	102,224	72,728	65,927
June	118,181	106,005	64,120	60,127
July	117,452	106,708	66,940	60,150
August	109,562	106,936	66,131	60,533
September	106,469	96,561	66,493	60,137
October	101,559	94,385	65,142	55,385
November	93,817	88,483	60,860	59,643
December	102,848	82,804	61,552	62,297
	1,217,337	1,213,548	820,844	[a] 727,767

[a] No production in Tennessee recorded in 1908.

In the following table are given the dates of change and the changes in prices of the different grades of petroleum produced in Kentucky and Tennessee during the years 1906, 1907, and 1908:

Fluctuations in prices, per barrel, of Kentucky and Tennessee[a] crude petroleum in 1906, 1907, and 1908.

1906.			1907.			1908.		
Date.	White-house, Somerset, Lacy, Barboursville (light).	Barboursville (heavy), Ragland.	Date.	White-house, Somerset, Lacy, Barboursville (light).	Barboursville (heavy), Ragland.	Date.	White-house, Somerset, Lacy, Barboursville (light).	Barboursville (heavy), Ragland.
January 1	$0.89	$0.49	January 1	$0.85	$0.55	January 1	$1.00	$0.75
April 13	.89	.49	January 5	.85	.60	June 17	1.00	.70
April 25	.91	.62	February 11	.87	.60	July 3	1.00	.65
July 28	.89	.60	March 9	.89	.62			
August 2	.87	.60	March 20	1.04	.62			
August 28	.85	.55	March 29	1.20	.62			
			April 24	1.20	.70			
			June 1	1.20	.75			
			October 29	1.10	.75			
			November 12	1.00	.75			

[a] No production recorded in Tennessee in 1908.

In the following table are given the average monthly prices of Kentucky and Tennessee crude petroleum, per barrel of 42 gallons, in the years, 1905 to 1908, inclusive:

Average monthly prices, per barrel, of Kentucky and Tennessee[a] crude petroleum in 1905–1908.

Month.	1905.	1906.	1907.	1908.	1905.	1906.	1907.	1908.
	White-house, Somerset, Lacy.	White-house, Somerset, Lacy.	White-house, Somerset, Lacy.	White-house, Somerset, Lacy.	Ragland.	Ragland.	Ragland.	Ragland.
January	$0.84⅜	$0.89	$0.85	$1.00	$0.55⅞	$0.49	$0.59⅜	$0.75
February	.80	.89	.86¼	1.00	.53	.49	.60	.75
March	.80	.89	.95½	1.00	.53	.49	.61½	.75
April	.78	.89⅜	1.20	1.00	.51¼	.51⅝	.63⅞	.75
May	.75⅞	.91	1.20	1.00	.49⅞	.62	.70	.75
June	.75	.91	1.20	1.00	.49	.62	.75	.72¾
July	.75	.90¾	1.20	1.00	.49	.61¾	.75	.65⅜
August	.75	.86¾	1.20	1.00	.49	.59¼	.75	.65
September	.78⅜	.85	1.20	1.00	.49	.55	.75	.65
October	.87½	.85	1.18⅞	1.00	.49	.55	.75	.65
November	.89¾	.85	1.03½	1.00	.49	.55	.75	.65
December	.89	.85	1.00	1.00	.49	.55	.75	.65
Average	.80⅔	.88	1.09⅛	1.00	.50½	.55¼	.70	.69⅞

[a] No production recorded in Tennessee in 1908.

WELL RECORD.

In the following tables are given the well records for Kentucky and Tennessee from 1904 to 1908, inclusive:

Number of wells completed in Kentucky and Tennessee, 1904-1908, by counties.

County.	Completed.					Dry.					Productive.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Barren	10	.....	.....	.....	.....	8	.....	.....	.....	.....	2	.....	.....	.....	.....
Bath and Rowan	22	2	.....	4	3	12	.....	.....	4	.....	10	2	.....	.....	3
Cumberland	96	15	1	.....	.....	54	7	1	.....	.....	42	8	.....	.....	.....
Estill	17	7	3	5	.....	6	2	.....	1	.....	11	5	3	4	.....
Fentress	.....	1	1	.....	.....	.....	.....	1	.....	.....	.....	1	.....	.....	.....
Floyd	13	1	.....	.....	1	8	.....	.....	.....	1	5	1	.....	.....	.....
Knox	.....	2	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
Wayne	347	283	232	177	175	80	63	70	62	59	267	220	162	115	116
Whitley	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....
Wolfe	8	88	100	26	21	2	14	12	7	5	6	74	88	19	16
Other	87	.....	.....	1	.....	69	.....	.....	1	.....	a18	.....	.....	.....	.....
	603	399	337	213	200	239	88	84	75	65	364	311	253	138	135

a Gas wells.

Number of wells completed in Kentucky and Tennessee, 1904-1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	22	49	35	50	51	49	67	59	37	54	51	51	a 603
1905	25	36	37	36	44	37	28	37	26	38	27	28	399
1906	32	33	25	36	43	26	34	29	23	21	15	20	337
1907	14	13	17	19	18	18	15	19	23	21	21	15	213
1908	13	15	20	16	21	18	18	17	15	20	11	16	200

a Includes 28 not reported by months.

Number of dry holes drilled in Kentucky and Tennessee, 1904-1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	6	28	10	28	12	20	28	26	10	22	22	27	239
1905	6	10	9	6	13	6	7	7	5	8	4	7	88
1906	7	8	4	10	14	6	8	3	8	6	3	7	84
1907	5	3	9	4	6	4	4	7	8	8	9	8	75
1908	5	5	7	8	5	6	5	6	6	5	2	5	65

Total and average initial daily production of new wells in Kentucky and Tennessee, 1904-1908, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Barren	5	....	....	....	....	2.5	....	....	....	....
Bath and Rowan	47	7	....	....	14	4.7	3.5	....	....	4.7
Cumberland	3,660	455	....	....	....	87.1	56.9	....	....	....
Estill	40	42	38	40	....	36.3	8.4	12.7	10	....
Fentress	....	5	....	....	....	....	5.0	....	....	....
Floyd	51	....	....	....	....	10.2	....	....	....	....
Knox										
Wayne	9,763	6,469	4,569	2,121	2,167	36.6	29.4	28.2	18.4	18.7
Whitley	30	....	....	....	....	10.0	....	....	....	....
Wolfe	100	2,250	1,238	250	261	16.7	30.4	14.1	13.2	16.3
Other	(a)	....	....	....	....	....	....	....	....	....
	13,696	9,228	5,845	2,411	2,442	39.6	29.7	23.1	17.5	18.1

a Not reported.

Total initial daily production of new wells in Kentucky and Tennessee, 1904–1908, by months, in barrels.

Year.	Jan	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	213	249	584	1,255	1,904	485	895	869	514	507	2,315	2,780	a13,696
1905	483	365	768	694	1,231	1,520	690	895	806	718	628	430	9,228
1906	465	440	502	678	385	993	706	728	415	158	155	220	5,845
1907	110	151	250	310	141	169	141	121	348	225	225	220	2,411
1908	200	195	378	127	265	151	199	196	195	242	147	147	2,442

a Includes 1,096 not reported by months.

OHIO.

Eastern Ohio followed the course of Pennsylvania. Interest was shown in the wells completed in June in the Mingo pool, Jefferson County, Ohio, which is an extension of the Follansbee pool, Brooke County, W. Va. These wells were still producing at the end of the year.

The oil pools of the Lima district in western Ohio and in Indiana showed the greatest proportionate decline in the country. This was due to inactivity among the oil producers, induced by a better field for capital in Illinois.

PRODUCTION.

In the following table is given the production of crude petroleum in Ohio, by months and districts, for the year 1908:

Total production of crude petroleum in Ohio in 1908, by months and districts, in barrels.

Month.	Lima.	Southeastern Ohio.	Mecca-Belden	Total.
January	637,509	329,429	....	966,953
February	539,704	307,336	....	847,055
March	599,087	339,505	....	938,607
April	591,502	326,373	....	917,890
May	581,022	328,046	....	909,083
June	567,055	332,935	....	900,005
July	571,066	342,419	....	913,500
August	543,369	344,606	....	887,996
September	526,669	373,622	....	900,306
October	544,576	372,753	....	917,344
November	500,578	339,385	....	839,978
December	546,539	373,526	....	920,080
	6,748,676	4,109,935	186	10,858,797

The total quantity and value of crude petroleum produced in Ohio from 1900 to 1908, inclusive, by districts, are shown in the following table:

Total quantity and value of crude petroleum produced in Ohio, 1900–1908, in barrels.

Year.	Lima district.		Southeastern Ohio district.		Mecca-Belden district.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	16,884,358	$16,673,304	5,476,089	$7,406,734	2,283	$11,563	22,362,730	$24,091,601
1901	16,176,293	13,911,612	5,470,850	6,619,342	940	2,617	21,648,083	20,533,571
1902	15,877,730	14,284,072	5,136,366	6,471,821	135	1,466	21,014,231	20,757,359
1903	14,893,853	17,351,339	5,585,858	8,881,514	575	1,668	20,480,286	26,234,521
1904	13,350,060	14,735,129	5,526,146	8,993,803	425	1,583	18,876,631	23,730,515
1905	11,329,924	10,061,992	5,016,646	6,991,950	90	935	16,346,660	17,054,877
1906	9,881,184	9,157,641	4,906,399	7,838,387	180	972	14,787,763	16,997,000
1907	7,993,057	7,425,480	4,214,298	7,343,943	93	465	12,207,448	14,769,888
1908	6,748,676	6,861,885	4,109,935	7,315,667	186	950	10,858,797	14,178,502

WELL RECORD.

In the following tables are given the well records for the Southeastern Ohio oil field from 1904 to 1908, inclusive:

Number of wells completed in southeastern Ohio oil field, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1904	160	152	169	180	202	238	229	220	217	174	217	150	2,308
1905	120	99	154	133	160	147	158	164	152	145	162	135	1,729
1906	105	145	122	105	151	173	152	181	139	133	108	147	1,661
1907	104	56	68	93	122	142	131	129	117	151	119	114	1,346
1908	76	74	68	76	103	117	111	138	162	142	167	174	1,408

Number of dry holes drilled in southeastern Ohio oil field, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	51	55	65	57	69	78	92	73	73	77	76	43	809
1905	45	40	69	62	67	61	62	63	55	40	56	42	662
1906	32	51	53	46	47	68	54	67	49	57	45	61	630
1907	35	26	31	34	47	51	60	51	52	53	45	36	521
1908	25	33	30	32	44	50	49	45	67	55	59	82	571

Total initial daily production of new wells in southeastern Ohio oil field, 1904–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1904	1,478	1,073	1,354	1,379	1,832	1,340	1,957	2,025	1,652	1,067	1,446	1,012	17,615	1,468
1905	1,176	595	671	801	1,300	822	855	1,077	1,378	1,397	1,437	1,564	13,073	1,089
1906	847	1,026	1,019	751	1,102	1,022	1,226	1,982	2,179	716	692	852	13,414	1,118
1907	802	170	185	436	697	765	617	850	584	555	641	608	6,910	576
1908	675	347	172	541	798	1,050	625	1,649	2,774	2,413	2,113	1,174	14,331	1,194

LIMA-INDIANA OIL FIELD.

This field, embracing northwestern Ohio and the State of Indiana, obtains its oil from the Trenton limestone. Sulphur is characteristic of this as of other limestone oils.

PRODUCTION OF LIMA-INDIANA FIELD.

In the following table will be found the production of the Lima-Indiana field, by States and months, for the year 1908:

Production of crude petroleum in the Lima-Indiana oil field in 1908, by months, in barrels.

Month.	Lima, Ohio.	Indiana.	Total.
January	637,509	323,620	961,129
February	539,704	262,189	801,893
March	599,087	296,478	895,565
April	591,502	302,416	893,918
May	581,022	302,290	883,312
June	567,055	292,156	859,211
July	571,066	289,040	860,106
August	543,369	269,667	813,036
September	526,669	259,162	785,831
October	544,576	241,468	786,044
November	500,578	219,348	719,926
December	546,539	225,795	772,334
	6,748,676	3,283,629	10,032,305

In the following table will be found the production of the Lima-Indiana field from 1902 to 1908, inclusive, with its percentage of the total production of the United States, the increase or decrease made each year, and the percentage of increase or decrease:

Production of petroleum in the Lima-Indiana field, 1902–1908.

Year.	Production, in barrels.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1902	23,358,826	26.31	1,425,197		6.50	
1903	24,080,264	23.97	721,438		3.09	
1904	24,689,184	21.09	608,920		2.53	
1905	22,294,171	16.55		2,395,013		9.70
1906	17,554,661	13.88		4,739,510		21.26
1907	13,121,094	7.90		4,433,567		25.26
1908	10,032,305	5.59		3,088,789		23.54

Production and value of crude petroleum in the Lima-Indiana field, 1905–1908, in barrels.

Year.	North Lima, Ohio.		South Lima, Ohio.	
	Quantity.	Value.	Quantity.	Value.
1905	6,931,635	$6,290,459	4,398,289	$3,771,533
1906	6,859,669	6,479,607	3,021,515	2,678,034
1907	6,399,917	6,016,238	1,593,140	1,409,242
1908	5,430,124	5,574,400	1,318,552	1,287,485

Year.	Indiana.		Total.	
	Quantity.	Value.	Quantity.	Value.
1905	10,964,247	$9,404,909	22,294,171	$19,466,901
1906	7,673,477	6,770,066	17,554,661	15,927,707
1907	5,128,037	4,536,930	13,121,094	11,962,410
1908	3,283,629	3,203,883	10,032,305	10,065,768

PIPE-LINE RUNS AND DELIVERIES AND STOCKS IN LIMA-INDIANA OIL FIELD.

In the following tables are given the pipe-line runs, deliveries, and stocks on hand in the Lima-Indiana field in 1908:

Pipe-line runs in the Lima-Indiana oil field in 1908, by months, in barrels.

Month.	Buckeye Pipe Line.	Other Ohio.	Indiana Pipe Line.	Other Indiana.	Total.
January	420,688	216,821	277,177	46,443	961,129
February	353,413	186,291	226,467	35,722	801,893
March	393,135	205,952	250,796	45,682	895,565
April	383,447	208,055	256,447	45,969	893,918
May	391,016	190,006	258,939	43,351	883,312
June	376,998	190,057	249,191	42,965	859,211
July	380,217	190,849	247,965	41,075	860,106
August	361,881	181,488	228,492	41,175	813,036
September	351,222	175,447	222,212	36,950	785,831
October	363,180	181,396	204,155	37,313	786,044
November	334,399	166,179	190,536	28,812	719,926
December	369,475	177,064	195,948	29,847	772,334
	4,479,071	2,269,605	2,808,325	475,304	10,032,305

Pipe-line deliveries of crude petroleum in the Lima-Indiana oil field in 1908, by months, in barrels.

Month.	Buckeye Pipe Line.	Indiana Pipe Line.	Other.[a]	Total.
January	392,393	751,288	229,125	1,372,806
February	341,766	633,643	229,125	1,204,534
March	301,243	598,739	229,125	1,129,107
April	269,971	576,984	229,125	1,076,080
May	255,228	716,305	229,125	1,200,658
June	347,446	723,580	229,125	1,300,151
July	280,012	753,084	229,125	1,262,221
August	314,885	520,410	229,125	1,064,420
September	319,889	658,829	229,125	1,207,843
October	326,498	712,690	229,127	1,268,315
November	334,120	802,870	229,127	1,366,117
December	366,365	675,121	229,128	1,270,614
	3,849,816	8,123,543	2,749,507	14,722,866

[a] Averaged.

Gross stocks of crude petroleum in the Lima-Indiana oil field in 1908, by months, in barrels.

Month.	Buckeye Pipe Line.	Indiana Pipe Line.	Other.	Total.
January	5,844,355	1,093,336		
February	5,696,742	1,274,465		
March	5,796,112	1,286,470		
April	6,137,301	1,212,485		
May	5,562,258	1,152,524		
June	5,222,839	1,252,991		
July	5,568,934	1,196,973		
August	5,560,976	1,100,028		
September	5,265,084	1,066,949		
October	5,082,788	1,077,396		
November	5,009,237	1,071,218		
December	5,133,711	1,072,798	204,763	6,411,272

PRICES OF CRUDE PETROLEUM IN LIMA-INDIANA FIELD.

In the following table are given the fluctuations in prices for the various grades of Lima and Indiana oil in 1906, 1907, and 1908. The dates are those on which changes in prices were made.

Fluctuations in prices of Lima (Ohio) and Indiana crude petroleum in 1906, 1907, and 1908, per barrel.

1906.			1907.			1908.		
Date.	North Lima.	South Lima and Indiana.	Date.	North Lima.	South Lima and Indiana.	Date.	North Lima.	South Lima and Indiana.
January 1	$0.94	$0.89	January 1	$0.90	$0.85	January 1	$0.94	$0.89
April 13	.96	.91	February 11	.92	.87	February 13	.99	.94
April 25	.98	.93	March 9	.94	.89	February 26	1.04	.99
July 28	.96	.91						
August 2	.94	.89						
August 15	.92	.87						
August 28	.90	.85						

In the following table are given the average monthly prices of Lima (Ohio) and Indiana crude petroleum, per barrel of 42 gallons each, in the years 1906 to 1908:

Average monthly prices of Ohio and Indiana crude petroleum in 1906, 1907, and 1908, per barrel.

Month.	1906.		1907.			1908.		
	North Lima.	South Lima and Indiana.	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.
January	$0.94	$0.89	$0.90	$0.85	$0.64	$0.94	$0.89	$0.68
February	.94	.89	.91¼	.86¼	.65¼	.97¾	.92¾	.68
March	.94	.89	.93½	.88½	.67½	1.04	.99	.68
April	.95⅝	.90⅝	.94	.89	.68	1.04	.99	.68
May	.98	.93	.94	.89	.68	1.04	.99	.68
June	.98	.93	.94	.89	.68	1.04	.99	.68
July	.97¾	.92¾	.94	.89	.68	1.04	.99	.68
August	.92¾	.87¾	.94	.89	.68	1.04	.99	.68
September	.90	.85	.94	.89	.68	1.04	.99	.68
October	.90	.85	.94	.89	.68	1.04	.99	.68
November	.90	.85	.94	.89	.68	1.04	.99	.68
December	.90	.85	.94	.89	.68	1.04	.99	.68
Average	.93⅝	.88⅝	.93⅜	.88⅜	.67⅜	1.02⅝	.97⅝	.68
Average of North Lima, South Lima and Indiana	.91⅛		.90⅞			1.00⅛		

In the following table will be found the highest, lowest, and average prices of Lima (Ohio) oil for the last six years:

Highest, lowest, and average prices of Lima (Ohio) crude petroleum, 1903–1908, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average.
1903	[a] $1.38	[b] $1.06	$1.16½	1906	[a] $0.98	[b] $0.85	$0.91⅛
1904	[a] 1.36	[b] .95	1.10⅜	1907	[a] .94	[b] .85	.90⅞
1905	[a] 1.01	[b] .81	.88¾	1908	[a] 1.04	[b] .89	1.00⅛

[a] North Lima. [b] South Lima.

WELL RECORD.

In the following tables are given the well records for the Lima (Ohio) oil field from 1904 to 1908, inclusive:

Number of wells completed in the Lima (Ohio) district, 1904–1908, by counties.

County.	Completed.					Dry.					Productive.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Allen	495	160	115	34	61	23	9	10	4	1	472	151	105	30	60
Auglaize	73	51	23	8	8	5	8	6	3	.....	68	43	17	5	8
Darke	.....	6	.....	.....	.....	.....	4	.....	.....	.....	.....	2	.....	.....	.....
Hancock	489	142	161	121	92	28	14	17	20	9	461	128	144	101	83
Hardin	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Lucas	122	59	59	40	34	9	5	6	3	4	113	54	53	37	30
Marion	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Mercer	174	100	74	21	8	17	7	5	2	1	157	93	69	19	7
Ottawa	63	80	100	57	44	11	7	19	4	2	52	73	81	53	42
Paulding	.....	2	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....
Putnam	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....
Sandusky	409	279	290	212	162	16	11	13	24	12	393	268	277	188	150
Seneca	71	83	93	41	81	6	13	6	6	21	65	70	87	35	60
Van Wert	218	74	67	42	108	20	12	11	11	4	198	62	56	31	104
Wood	895	470	471	258	229	56	47	36	28	17	839	423	435	230	212
Wyandot	120	70	61	60	19	32	11	8	22	7	88	59	53	38	12
Miscellaneous	.....	.....	35	12	2	.....	.....	25	9	2	.....	.....	10	3	.....
	3,131	1,578	1,549	906	848	223	151	162	136	80	2,908	1,427	1,387	770	768

Number of wells completed in the Lima (Ohio) district, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	322	186	248	246	243	320	284	345	271	242	208	216	3,131
1905	180	107	94	139	126	122	125	109	111	142	172	151	1,578
1906	137	140	131	143	147	162	132	153	135	113	81	75	1,549
1907	69	44	86	84	76	84	92	82	81	71	75	62	906
1908	60	26	46	49	62	66	88	88	98	95	84	86	848

Number of dry holes drilled in the Lima (Ohio) district, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	20	22	12	13	30	30	16	25	9	19	15	12	223
1905	14	6	8	12	18	10	17	10	4	15	24	13	151
1906	18	16	15	20	12	13	17	15	10	8	10	8	162
1907	14	6	13	26	8	10	10	7	8	13	8	13	136
1908	8	2	9	6	6	7	9	3	10	6	5	9	80

Total and average initial daily production of new wells in the Lima (Ohio) district, 1904–1908, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Allen	6,035	2,239	1,098	284	694	12.8	14.8	10.5	9.5	11.6
Auglaize	718	448	85	22	75	10.6	10.4	5.0	4.4	9.4
Darke	......	7	......	......	......	......	3.5	......	......	......
Hancock	5,160	1,730	1,687	1,090	1,042	11.2	13.5	11.7	10.8	12.6
Hardin	......	......	......	......	......	......	......	......	......	......
Lucas	1,150	862	567	433	327	10.2	16.0	10.7	11.7	10.9
Marion	......	......	......	......	......	......	......	......	......	......
Mercer	1,853	1,237	1,026	220	55	11.8	13.3	14.9	11.6	7.9
Ottawa	653	678	663	479	336	12.6	9.3	8.2	9.0	8.0
Paulding	......	10	......	......	......	......	10.0	......	......	......
Putnam	13	......	......	......	......	6.5	......	......	......	......
Sandusky	3,500	2,001	1,672	1,061	822	8.9	7.5	6.0	5.6	5.5
Seneca	254	456	410	664	800	3.9	6.5	4.7	19.0	13.3
Van Wert	2,341	692	746	361	1,268	11.8	11.2	13.3	11.6	12.2
Wood	8,864	4,582	4,621	2,128	3,067	10.6	10.8	10.6	9.2	14.5
Wyandot	874	787	1,758	1,087	235	9.9	13.3	33.2	28.6	19.6
Miscellaneous	......	......	158	23	......	......	......	15.8	7.7	......
	31,415	15,729	14,491	7,852	8,721	10.8	11.0	10.4	10.2	11.4

Total initial daily production of new wells in the Lima (Ohio) district, 1904–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	3,283	2,029	2,238	2,781	2,424	3,437	3,196	3,480	2,393	2,319	1,577	2,258	31,415
1905	1,789	950	753	964	1,199	1,545	1,141	1,048	1,564	1,688	1,620	1,468	15,729
1906	1,241	1,160	1,132	1,068	1,421	1,625	1,198	1,636	1,018	1,165	764	1,063	14,491
1907	460	523	849	699	687	593	698	575	653	1,012	527	576	7,852
1908	886	267	338	499	452	464	680	862	944	1,443	990	896	8,721

INDIANA.

PRODUCTION.

In the following table are shown the output and value of the oil produced in the State of Indiana during the years 1906, 1907, and 1908:

Production and value of petroleum in Indiana in 1906, 1907, and 1908, by kinds, in barrels.

Kind.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Trenton rock	7,665,408	$6,760,890	5,119,039	$4,526,893	3,279,266	$3,199,257
Corniferous rock	8,069	9,176	8,998	10,037	4,363	4,626
	7,673,477	6,770,066	5,128,037	4,536,930	3,283,629	3,203,883

In the following table will be found a statement of the production of petroleum in Indiana from 1902 to 1908:

Production of petroleum in Indiana, 1902–1908, in barrels.

Year.	Quantity.	Total value at wells of all oil produced, excluding pipeage.	Price per barrel.
1902	7,480,896	$6,526,622	$0.87
1903	9,186,411	10,474,127	1.14
1904	11,339,124	12,235,674	1.08
1905	10,964,247	9,404,909	.858
1906	7,673,477	6,770,066	.882
1907	5,128,037	4,536,930	.8847
1908	3,283,629	3,203,883	.976

WELL RECORD.

In the following tables are given the well records for Indiana from 1904 to 1908, inclusive:

Number of wells completed in Indiana, 1904–1908, by counties.

County.	Completed.					Dry.					Productive.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Adams	262	94	48	32	15	25	11	4	3	2	237	83	44	29	13
Blackford	222	65	64	22	40	21	10	9	3	9	201	55	55	19	31
Brown		1					1								
Clinton		2					2								
Delaware	952	653	180	65	29	121	83	39	16	14	831	570	141	49	15
Gibson	42	32	48	21	10	17	1	8	4	3	25	31	40	17	7
Grant	1,068	403	236	115	90	91	34	20	12	7	977	369	216	103	83
Hamilton		3										3			
Henry		3					3								
Huntington	332	161	123	48	17	8	2	2	2	2	324	159	121	46	15
Jay	329	204	205	152	107	52	33	27	30	25	277	171	178	122	82
Madison	50	55	3	5	2	15	25	1	2		35	30	2	3	2
Miami	8	7				3	1				5	6			
Randolph	113	80	26	3	5	27	34	8	1	1	86	46	18	2	4
Wabash	1	1				1						1			
Wells	387	158	235	122	70	19	4	11	2	4	368	154	224	120	66
Miscellaneous			26	73	17			11	53	15			15	20	2
	3,766	1,922	1,194	658	402	400	244	140	128	82	3,366	1,678	1,054	530	320

Number of wells completed in Indiana, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	235	157	240	209	305	397	399	388	380	389	321	346	3,766
1905	195	133	150	187	200	160	164	149	131	111	168	174	1,922
1906	137	96	89	71	115	148	126	108	99	75	71	59	1,194
1907	50	42	69	50	57	77	61	59	45	58	47	43	658
1908	35	23	31	21	29	35	35	39	47	38	33	36	402

Number of dry holes drilled in Indiana, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	15	8	26	28	46	44	52	43	35	36	27	40	400
1905	15	16	13	25	38	19	24	21	15	15	20	23	244
1906	10	12	8	5	15	18	11	10	13	18	17	3	140
1907	7	12	14	12	12	16	10	13	6	9	7	10	128
1908	12	9	7	5	7	7	7	7	1	6	5	9	82

Total and average initial daily production of new wells in Indiana, 1904–1908, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Adams	3,106	791	441	171	177	13.1	9.5	10.0	5.9	13.6
Blackford	1,960	404	695	140	264	9.8	7.3	12.6	7.4	8.5
Brown										
Clinton										
Delaware	36,877	18,608	4,774	715	312	44.4	32.6	33.8	14.6	20.8
Gibson	164	324	795	304	75	6.6	10.5	19.9	17.9	10.7
Grant	10,901	3,949	1,742	770	749	11.2	10.7	8.1	7.5	9.0
Hamilton		45					15.0			
Henry										
Huntington	5,887	3,079	1,650	485	154	18.2	19.4	13.6	10.5	10.3
Jay	4,747	2,713	2,742	1,362	900	17.1	15.9	15.4	11.2	11.0
Madison	367	471	30	50	15	10.5	15.7	15.0	16.7	7.5
Miami	32	50				6.4	8.3			
Randolph	3,719	1,693	608	25	35	43.2	36.8	33.8	12.5	8.8
Wabash		6					6.0			
Wells	4,392	1,754	2,109	1,067	537	11.9	11.4	9.4	8.9	8.1
Miscellaneous			253	308	40			16.9	15.4	20.0
	72,152	33,887	15,839	5,397	3,258	21.4	20.2	15.0	10.2	10.2

Total initial daily production of new wells in Indiana, 1904–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	3,328	2,081	3,544	3,033	4,571	6,626	7,879	8,637	8,972	9,846	6,775	6,860	72,152
1905	4,736	2,111	2,746	3,344	3,016	3,467	2,395	2,213	2,361	2,689	2,536	2,273	33,887
1906	1,836	1,192	1,019	992	1,602	2,168	2,373	1,637	1,049	666	737	568	15,839
1907	438	256	566	380	625	655	427	454	313	513	418	352	5,397
1908	258	135	225	144	262	335	201	322	563	301	241	271	3,258

ILLINOIS OIL FIELD.[a]

The gain in number of barrels was greatest in Illinois. During the last half of 1907 the rate of production was more than twice as great as in the first half, and this increase continued throughout 1908, with a gain of fully 33 per cent in the product, or over 8,000,000 barrels beyond the output in 1907.

Most persistent wild-catting was carried on in many parts of the State, but only a few pools of importance were opened, and the production came chiefly from the pools that had been fairly well defined in the previous year in Clark, Crawford, and Lawrence counties.

Much interest was shown by the discovery of oil in what is known as the Centralia pool. Here oil was found after a shot in a coal mine at Junction City, north of Centralia. The oil was found in sandstone, where a fault blocked an entry about 650 feet from the surface. This caused the drilling of a well half a mile west of the mine, where petroleum of about 31° B. gravity was struck at 600 feet from the surface.

About 200 miles of the pipe line from Stoy, Ill., to Rixford, Pa., has been completed.

PRODUCTION.

The total production, by months, for the last four years is given in the following table:

Production of crude petroleum in Illinois, 1905–1908, by months, in barrels.

Month.	1905.	1906.	1907.	1908.
January		55,680	781,812	2,703,973
February		65,208	956,399	2,572,115
March		19,352	1,547,323	2,825,491
April		102,862	1,874,465	3,249,690
May		267,746	2,138,918	3,223,515
June	6,521	410,655	1,879,362	3,081,848
July	17,306	610,401	2,422,192	2,693,288
August	23,827	778,464	2,446,042	2,808,667
September	26,586	722,168	2,605,663	2,675,385
October	27,589	463,819	2,863,812	2,709,913
November	34,611	350,985	2,510,146	2,479,202
December	44,644	549,710	2,255,839	2,662,019
	181,084	4,397,050	24,281,973	33,685,106

Production and value of crude petroleum in Illinois, 1905–1908, in barrels.

Year.	Ohio Oil Company.	Other lines.	Total quantity.	Total value.
1905	156,503	24,581	181,084	$116,561
1906	4,385,471	11,579	4,397,050	3,274,818
1907	23,733,790	548,183	24,281,973	16,432,947
1908	31,972,634	1,712,472	33,685,106	22,648,881

[a] For description of the Illinois field see Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 373.

PIPE-LINE RUNS AND DELIVERIES AND STOCKS.

The following table shows the runs of the Ohio Oil Company during the years 1905 to 1908, and deliveries and stocks in 1907 and 1908, by months:

Pipe-line runs of the Ohio Oil Company in Illinois, 1905–1908, by months, in barrels.

Month.	Pipe-line runs.			
	1905.	1906.	1907	1908.
January	....	55,680	752,671	2,497,359
February	....	65,208	918,620	2,464,914
March	....	19,352	1,494,598	2,591,911
April	....	102,862	1,823,025	3,089,417
May	....	267,746	2,094,195	3,084,816
June	5,489	410,655	1,830,634	2,965,786
July	9,208	610,401	2,376,281	2,579,977
August	15,092	778,464	2,398,895	2,690,931
September	19,592	722,168	2,560,593	2,555,871
October	26,444	463,819	2,818,032	2,582,561
November	34,766	350,985	2,464,981	2,356,386
December	45,912	538,131	2,201,265	2,512,705
	156,503	4,385,471	23,733,790	31,972,634

Deliveries and stocks in 1907–1908, by months, in barrels.

Month.	Deliveries.		Stock.	
	1907.	1908.	1907.	1908.
January	142,001	1,720,631	2,509,598	14,129,954
February	401,344	1,882,978	3,040,111	15,069,278
March	444,078	1,010,459	4,117,635	15,975,633
April	385,432	1,476,192	5,528,759	17,420,534
May	563,585	1,869,461	7,117,033	19,077,020
June	551,502	1,846,947	8,448,344	20,456,387
July	1,395,238	2,012,288	9,387,999	21,036,143
August	1,440,640	1,774,354	10,355,000	22,267,197
September	1,105,589	1,488,283	12,557,522	23,485,690
October	1,590,566	1,394,983	13,724,691	24,396,787
November	1,815,964	1,284,304	14,275,036	24,905,168
December	848,450	1,789,158	15,751,305	25,252,468
	10,684,389	19,550,038	....	....

PRICES.

In the following table are given the prices paid for Illinois crude petroleum at wells in Illinois from 1905 to 1908, inclusive:

Average monthly prices of Illinois crude petroleum, 1905 to 1908, per barrel.

Month.	1905.	1906.	1907.	1908.	
				Light.	Under 30°.
January	....	$0.79	$0.64	$0.68	$0.60
February	....	.79	.65¼	.68	.60
March	....	.79	.67½	.68	.60
April	....	.80⅝	.68	.68	.60
May	....	.83	.68	.68	.60
June	$0.60	.83	.68	.68	.60
July	.60	.82¾	.68	.68	.60
August	.60	.71⅞	.68	.68	.60
September	.61	.64	.68	.68	.60
October	.64	.64	.68	.68	.60
November	.66	.64	.68	.68	.60
December	.70	.64	.68	.68	.60
Average	.644	.745	.67⅜	.68	.60

WELL RECORD.

In the following tables are given the well records for Illinois from 1906 to 1908, inclusive:

Number of wells completed in Illinois, 1906–1908, by counties.

County.	Completed.			Dry holes.			Productive.		
	1906.	1907.	1908.	1906.	1907.	1908.	1906.	1907.	1908.
Clark	1,337	1,176	385	164	201	87	1,173	975	298
Coles	65	56	9	14	11	1	51	45	8
Crawford	1,060	2,840	2,322	164	376	336	896	2,464	1,986
Cumberland	558	152	42	53	13	11	505	139	31
Edgar	37	25	9	16	14	2	21	11	7
Lawrence	176	691	762	33	70	78	143	621	684
Miscellaneous	50	48	45	46	43	40	4	5	5
	3,283	4,988	3,574	490	728	555	2,793	4,260	3,019

Number of wells completed in Illinois, 1906–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	......	......	......	108	253	359	435	496	449	453	376	354	3,283
1907	253	356	351	387	493	639	521	461	400	363	430	334	4,988
1908	303	157	187	197	264	390	474	417	344	290	273	278	3,574

Number of dry holes drilled in Illinois, 1906–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	......	......	......	20	37	41	69	82	69	47	64	61	490
1907	41	55	60	40	64	75	72	45	62	82	80	52	728
1908	55	22	37	33	35	54	65	55	49	51	47	52	555

Total and average initial daily production of new wells in Illinois, 1906–1908, by counties, in barrels.

County.	Total initial production.			Average initial production per well.		
	1906.	1907.	1908.	1906.	1907.	1908.
Clark	31,060	20,385	6,953	26.5	20.9	23.3
Coles	279	314	122	5.5	7.0	15.3
Crawford	59,204	84,163	46,694	66.1	34.2	23.5
Cumberland	15,115	3,612	303	29.9	26.0	9.8
Edgar	101	118	45	4.8	10.7	6.4
Lawrence	7,230	30,543	24,793	50.6	49.2	36.2
Miscellaneous	23	28	50	5.8	5.6	10.0
	113,012	139,163	78,960	40.5	32.7	26.2

Total initial daily production of new wells in Illinois, 1904–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	....	....	....	3,736	8,137	17,148	15,262	22,432	9,705	14,039	10,611	11,942	113,012
1907	9,433	9,842	10,392	11,083	13,329	18,807	17,375	11,240	10,967	8,157	9,780	8,758	139,163
1908	6,144	3,329	4,133	4,285	6,628	9,856	9,475	8,322	7,848	6,091	6,242	6,607	78,960

The following table shows the quantity of crude petroleum shipped by railroad from the Illinois oil field, 1906 to 1908, by months:

Shipments of crude petroleum by railroad in tank cars from Illinois oil field, in pounds and equivalent in barrels, 1906–1908, by months.

Month.	1906.[a]		1907.[b]		1908.[c]	
	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.
January	18,083,407	60,134	2,607,940	8,701	27,369,575	91,807
February	15,444,464	51,358	4,361,996	14,598	21,191,859	71,170
March	4,814,239	16,009	7,158,170	23,947	39,352,395	132,300
April	10,687,154	35,539	12,609,699	42,249	35,198,236	118,074
May	48,151,478	160,121	47,076,459	158,227	25,177,339	84,290
June	107,669,378	358,039	49,701,853	166,644	36,566,990	122,317
July	155,158,474	515,956	96,137,954	322,622	32,087,310	107,688
August	160,831,482	534,821	66,661,072	223,134	20,912,433	70,171
September	110,852,921	368,625	21,203,105	70,555	24,771,903	83,042
October	48,881,173	162,547	17,055,726	56,570	30,427,564	102,163
November	14,659,266	48,747	16,831,726	56,080	41,096,712	138,147
December	9,275,053	30,843	19,952,993	66,692	37,751,352	126,967
	704,508,489	2,342,739	361,358,693	1,210,019	371,903,668	1,248,136

[a] Calculations are made on the basis of 7.16 pounds to the gallon. Shipments were made from Bridgeport, Oilfield, and Stoy. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore and Ohio, the Cincinnati, Hamilton and Dayton, and the Indianapolis Southern.

[b] Calculations made according to specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel. Shipments were made from Duncansville, Lawrenceville, Stoy, Robinson, Bridgeport, Oilfield, and Casey. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore and Ohio, the Cincinnati, Hamilton and Dayton, the Indianapolis Southern, and the Cleveland, Cincinnati, Chicago and St. Louis.

[c] Calculations made according to specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel. Shipments were made from Duncansville, Lawrenceville, Stoy, Robinson, Bridgeport, Sparta, and Casey. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore and Ohio, the Illinois Southern, the Indianapolis Southern, and the Cleveland, Cincinnati, Chicago and St. Louis.

MID-CONTINENT FIELD.[a]

Production held its own in the Mid-Continent field and increased slightly in spite of the expected decline in Kansas. The decline in the Glenn pool, in Oklahoma, which was marked in 1907, was checked by increased drilling, by cleaning out and shooting many wells, by the extension of the pool to the north, and by the development at several widely separated points of an additional sand at greater depth (2,200 to 2,350 feet), which is fairly productive and yields oil of good quality. The Muskogee field also developed a pool between the "old town" pool and the new pool. This third pool affords oil of such unusually high quality as to encourage much new drilling, which proved fairly satisfactory.

A series of heavy rain storms caused a flood on May 24, which washed out both the Gulf and the Texas pipe lines where they cross Red River. On the following day the 8-inch emergency pipe line of the Gulf Company also went out, and it was late in June before these companies were again pumping their usual amounts. The continued flood condition was disastrous to development work for a long period, especially in the lower Creek country. The Prairie Oil and Gas Company continued pumping, as the storm center was to the south of its line.

Late in December a gusher of 1,400 barrels per day was completed in the Morris field. The usual excitement following such discoveries has been sustained by subsequent work. Drilling was also encouraged by the completion of a branch pipe line to the field by the Gulf Company.

[a] For description of Mid-Continent field, see Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 380.

The great development of Oklahoma was in the northern extension of the Alluwe and Coodys Bluff field, constituting the Shallow Sand region. Here the oil sands are usually reached at less than 700 feet and fairly good supplies of oil are sometimes obtained at less than 400 feet. The low cost of these wells has stimulated drilling and results have been good. Pipe-line facilities here and at Bartlesville have been insufficient and the oil producers' petition to the governor for relief led to an arrangement with the Prairie Oil and Gas Company, by which eventually 32 miles of 8-inch pipe were laid from the Kansas state line to the Shallow Sand pool, and a short line of 4-inch pipe was laid into the Hogshooter pool, so that most of the oil is cared for.

In Kansas more wells were abandoned than new ones were drilled. The prices for crude oil were low, and many wells were not remunerative. Refinery projects are growing satisfactorily in Kansas and Oklahoma.

During the fiscal year ended June 30, 1908, there were 7,797 leases submitted to the Interior Department for consideration. Only 516 were left pending at the end of the year. Up to that time a total of 17,727 mineral leases, almost entirely oil leases, had been filed. Of these, 10,525 had been approved, some of which have since been canceled, and 6,137 disapproved. On April 20, 1908, the Interior Department modified the leasing regulations to a considerable extent, making the minimum royalty 12½ per cent for oil, instead of 10 per cent, and the term of lease for adult citizens five years and so long thereafter as oil or gas may be found in paying quantities. The royalties collected by the United States Indian agent during the fiscal year 1908 on account of oil and gas amounted to $1,692,627. The leases in the Osage Reservation covered 680,000 acres. The royalties arising from oil and gas operations are placed to the credit of the tribe. On June 30, 1908, there were 867 oil wells and 74 producing gas wells in the Osage Reservation.

Unusual activity was evident in Kansas and Oklahoma in the erection of small refining plants, many of them for the purpose of taking off light products from petroleum and selling the residuum for fuel oil or for use on roads.

PRODUCTION.

In the following tables are shown the production and value of petroleum in the Mid-Continent field since 1889:

Production of crude petroleum in the Mid-Continent oil field, 1889–1908, by States, in barrels.

Year.	Kansas.	Oklahoma.	Northern Texas.[a]	Total.
1889 to 1895	110,530	287	....	110,817
1896	113,571	170	1,400	115,141
1897	81,098	625	65,925	147,648
1898	71,980	....	544,620	616,600
1899	69,700	....	668,483	738,183
1900	74,714	6,472	[b] 836,039	917,225
1901	179,151	10,000	[b] 800,545	989,696
1902	331,749	37,100	617,871	986,720
1903	932,214	138,911	501,960	1,573,085
1904	4,250,779	1,366,748	569,102	6,186,629
1905	[c] 12,013,495	(d)	520,282	12,533,777
1906	[c] 21,718,648	(d)	1,117,905	22,836,553
1907	2,409,521	43,524,128	912,618	46,846,267
1908	1,801,781	45,798,765	723,264	48,323,810

[a] Includes counties of Navarro, Jack, and McLennan.
[b] Includes a small production in southern Texas.
[c] Includes the production of Oklahoma.
[d] Included in Kansas production.

In the following table is shown the total production of crude petroleum from the Mid-Continent field from 1889 to 1908, inclusive, with its percentage of the total production of the United States, and the quantity and percentage of increase and decrease each year:

Production of crude petroleum in the Mid-Continent field, 1889–1908, in barrels.

Year.	Production.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1889	500					
1890	1,200		700		140.00	
1891	1,430		230		19.17	
1892	5,080		3,650		255,24	
1893	18,010	0.04	12,930		254.53	
1894	40,130	0.08	22,120		122.82	
1895	44,467	0.08	4,337		10.81	
1896	115,141	0.19	70,674		158.93	
1897	147,648	0.24	32,507		28.23	
1898	616,600	1.11	468,952		317.62	
1899	738,183	1.29	121,583		19.72	
1900	917,225	1.44	179,042		24.25	
1901	989,696	1.43	72,471		7.90	
1902	986,720	1.12		2,976		0.30
1903	1,573,085	1.57	586,365		59.42	
1904	6,186,629	5.28	4,613,544		293.28	
1905	12,533,777	9.30	6,347,148		102.60	
1906	22,836,553	18.05	10,302,776		82.20	
1907	46,846,267	28.20	24,009,714		105.14	
1908	48,323,810	26.91	1,477,543		3.15	

Production and value of crude petroleum in the Mid-Continent field, 1905–1908, by States, in barrels.

Year.	Kansas and Oklahoma.		Northern Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	12,013,495	$6,546,398	520,282	$361,604	12,533,777	$6,908,002
1906	21,718,648	9,615,198	1,117,905	740,542	22,836,553	10,355,740
1907	45,933,649	18,478,658	912,618	721,577	46,846,267	19,200,235
1908	47,600,546	18,441,538	723,264	479,072	48,323,810	18,920,610

WELL RECORD.

The following table gives the well record in the Mid-Continent field for 1908:

Well record in Mid-Continent field in 1908, by districts.

District.	Wells completed.				Abandoned.
	Total.	Oil.	Gas.	Dry.	
Northern Texas:					
Corsicana	6	5		1	8
Powell	46	32		14	13
Henrietta	28	20	2	6	7
South Bosque					
	80	57	2	21	28
Kansas	566	72	367	127	
Oklahoma	2,844	2,458	102	284	
Grand total	3,490	2,587	471	432	

KANSAS AND OKLAHOMA PRODUCTION.

Production of crude petroleum in Kansas and Oklahoma in 1907 and 1908, by months, in barrels.

Month	1907.			1908.		
	Pipe-line runs.	Shipments of crude by rail and consumption by refineries and fuel users.	Total.	Pipe-line runs.	Shipments of crude by rail and consumption by refineries and fuel users.	Total.
January	2,358,104	83,865	2,441,969	3,903,357	227,489	4,130,846
February	2,364,531	91,531	2,456,062	3,741,224	226,250	3,967,474
March	3,080,436	100,299	3,180,735	4,102,989	244,766	4,347,755
April	3,614,650	103,852	3,718,502	3,951,697	250,519	4,202,216
May	3,747,039	105,043	3,852,082	3,328,552	341,458	3,670,010
June	3,822,064	106,690	3,928,754	2,870,823	314,630	3,185,453
July	3,890,672	110,618	4,001,290	3,847,671	356,567	4,204,238
August	4,131,984	118,206	4,250,190	3,709,025	366,952	4,075,977
September	4,198,671	110,661	4,309,332	3,542,924	300,393	3,843,317
October	4,841,057	117,272	4,958,329	3,773,919	306,211	4,080,130
November	4,451,984	107,410	4,559,394	3,565,177	266,336	3,831,513
December	4,149,149	127,861	4,277,010	3,786,836	274,781	4,061,617
	44,650,341	[a]1,283,308	45,933,649	44,124,194	[a]3,476,352	47,600,546
Total in 1906	21,194,156	524,492	21,718,648	....	....	....

[a] Quantity run to refineries averaged.

PRICES.

In the following tables are given the prices paid by the Prairie Oil and Gas Company for crude oils of different grades in Kansas and Oklahoma during 1906, 1907, and 1908; also the average monthly price during these years:

Range of prices paid for petroleum by the Prairie Oil and Gas Company in Kansas and Oklahoma in 1906, 1907, and 1908, per barrel.

Date.	32° and above.	Heavy.	Date.	32° and above.	31½° to 32°.	31° to 31½°.	30½° to 31°.	30° to 30½°.	Heavy.
1906.			1907.						
January 1	$0.52	$0.35	January 1	$0.39	$0.36	$0.33	$0.30	$0.27	$0.26
July 28	.50	.35	February 11	.40	.37	.34	.31	.28	.27
August 2	.48	.35	March 9	.41	.38	.35	.32	.29	.28
August 9	.45	.32							
August 15	.42	.29	1908.						
August 28	.39	.26	January 1	.41	.38	.35	.32	.29	.28

Average monthly price of Kansas and Oklahoma crude petroleum, per barrel of 42 gallons, 1906–1908, by months.

Month.	1906.		1907.		1908.			
					Kansas.		Oklahoma.	
	32° and above.	Heavy.	32° and above.	Heavy.	Light.	Heavy.	Light.	Heavy.
January	$0.52	$0.35	$0.39	$0.26	$0.41	$0.308	$0.41	$0.325
February	.52	.35	.39⅝	.26⅝	.41	.306	.41	.324
March	.52	.35	.40¾	.27¾	.41	.297	.41	.326
April	.52	.35	.41	.28	.41	.302	.41	.321
May	.52	.35	.41	.28	.41	.308	.41	.320
June	.52	.35	.41	.28	.41	.297	.41	.320
July	.51¾	.35	.41	.28	.41	.307	.41	.317
August	.43¾	.30¾	.41	.28	.41	.312	.41	.322
September	.39	.26	.41	.28	.41	.300	.41	.322
October	.39	.26	.41	.28	.41	.310	.41	.326
November	.39	.26	.41	.28	.41	.303	.41	.326
December	.39	.26	.41	.28	.41	.302	.41	.312
Average	.47	.31⅝	.40¾	.27¾	.41	.304	.41	.322

KANSAS.

Production.—The following table gives the production and sales of crude petroleum in Kansas in 1907 and 1908:

Production of crude petroleum in Kansas in 1907 and 1908, in barrels.

	1907.	1908.
Quantity piped from wells in Kansas to refineries	449,211	492,966
Rail shipments in Kansas	263,881	149,056
Estimated quantity piped from other wells in Kansas and sold	1,696,429	1,159,759
Total sales in Kansas	2,409,521	1,801,781
Total value	$965,134	$746,695

The following table by counties shows the result of an individual canvass of the producers in Kansas as to the actual value received for their oil. The total value, $748,018, is only $1,323 above the value derived from the average of the pipe line returns, or 0.17 per cent.

Prices for oil in various counties ranged from 60 to 36.4 cents per barrel.

Production and value of the petroleum in Kansas, by counties, in 1908.

County.	Quantity (barrels).	Value.	Average price per barrel.
Allen	135,026	$50,216	$0.372
Chautauqua	858,964	368,839	.429
Coffey Labette	20,375	8,330	.409
Elk	16,682	9,995	.599
Franklin	76,456	31,064	.406
Miami	21,338	8,629	.404
Montgomery	360,998	131,512	.364
Neosho	214,886	99,922	.465
Wilson	97,056	39,511	.407
	1,801,781	748,018	.415

Well record.—The following tables give the well records for Kansas from 1904 to 1908, inclusive:

Number of wells completed in Kansas, 1904–1908, by counties.

County.	Completed.					Dry.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Allen	441	13	2	45	192	63	3	......	2	37
Anderson	......	......	......	......	9	......	......	......	......	......
Bourbon	......	......	16	......	......	......	......	2	......	......
Chautauqua	630	235	156	47	24	64	29	25	10	3
Elk	......	16	2	......	......	......	4	1	......	......
Franklin	......	63	72	16	2	......	4	8	6	1
Labette	32	1	4	......	......	1	1	......	......	......
Miami	97	246	38	10	6	13	32	8	2	......
Montgomery	828	233	169	56	97	113	40	21	4	17
Neosho	519	155	165	112	118	65	31	36	18	34
Wilson	211	76	81	57	87	41	16	26	10	21
Woodson	24	......	......	......	......	4	......	......	......	......
Miscellaneous	......	239	74	25	31	......	51	24	12	14
	2,782	1,277	779	368	566	364	211	151	64	127

County.	Gas.				Productive.				
	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Allen	3	2	37	133	378	7	......	6	22
Anderson	......	......	......	9	......	......	......	......	......
Bourbon	......	6	......	......	......	......	8	......	......
Chautauqua	15	6	17	5	566	191	125	20	16
Elk	3	......	......	......	......	9	1	......	......
Franklin	4	1	1	......	......	55	63	9	1
Labette	......	3	......	......	31	......	1	......	......
Miami	17	5	3	6	84	197	25	5	......
Montgomery	89	88	31	79	715	104	60	21	1
Neosho	27	61	87	54	454	97	68	7	30
Wilson	24	48	47	66	170	36	7	......	......
Woodson	......	......	......	......	20	......	......	......	......
Miscellaneous	67	42	13	15	......	121	8	......	2
	249	262	236	367	2,418	817	366	68	72

Number of wells completed in Kansas, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	227	234	234	212	203	221	189	152	191	230	325	364	2,782
1905	92	88	174	178	144	130	85	76	59	79	87	85	1,277
1906	81	64	63	64	94	73	75	77	49	50	39	50	779
1907	37	18	40	24	14	22	24	35	34	32	35	53	368
1908	37	45	48	32	47	59	45	31	53	62	54	53	566

Number of dry holes drilled in Kansas, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	......	......	38	26	42	23	23	28	26	32	68	58	364
1905	14	16	18	33	29	28	18	9	7	15	12	12	211
1906	12	14	15	16	13	14	15	18	11	9	5	9	151
1907	10	3	4	5	3	4	2	6	4	8	7	8	64
1908	16	7	9	5	8	19	7	5	14	17	8	12	127

Number of gas wells drilled in Kansas, 1905–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	......	9	28	34	44	33	5	21	5	16	26	28	249
1906	18	23	15	24	23	15	15	27	22	19	27	34	262
1907	21	9	24	13	6	14	19	25	25	18	23	39	236
1908	19	33	37	22	32	32	27	17	36	41	36	35	367

Total and average initial daily production of new wells in Kansas, 1905–1908, by counties, in barrels.

County.	Total initial production.				Average initial production per well.			
	1905.	1906.	1907.	1908.	1905.	1906.	1907.	1908.
Allen	75	....	89	365	10.7	....	14.8	16.6
Anderson	....	....	....	....	....	....	....	....
Bourbon	....	135	....	....	....	16.9	....	....
Chautauqua	5,865	2,920	358	305	30.7	23.4	17.9	19.1
Elk	124	10	....	....	13.8	10.0	....	....
Franklin	773	597	95	8	14.1	9.5	10.6	8.0
Labette	....	10	....	....	....	10.0	....	....
Miami	1,725	203	41	....	8.7	8.1	8.2	....
Montgomery	2,373	854	213	15	22.8	14.2	10.1	15.0
Neosho	1,143	802	90	446	11.8	11.8	12.9	14.9
Wilson	440	105	....	....	12.2	15.0	....	....
Woodson	....	....	....	....	....	....	....	....
Miscellaneous	2,033	125	....	20	16.8	15.6	....	10.0
	14,551	5,761	886	1,159	17.7	15.7	13.0	16.1

Total initial daily production of new wells in Kansas, 1905–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	1,951	1,194	2,028	1,880	1,319	1,358	1,016	684	730	745	783	863	14,551
1906	946	528	528	442	722	765	637	472	252	272	85	112	5,761
1907	73	60	127	80	88	50	35	40	85	75	73	100	886
1908	65	100	40	85	105	120	170	138	55	80	96	105	1,159

OKLAHOMA.

Production.—The following table shows the production and sales of crude petroleum in Oklahoma in 1907 and 1908:

Production of crude petroleum in Oklahoma in 1907 and 1908, in barrels.

	1907.	1908.
Estimated quantity shipped from Glenn pool and sold	19,926,995	20,494,313
Quantity piped from wells in Oklahoma to refineries	373,372	714,684
Estimated quantity piped from other wells in Oklahoma and sold	23,048,806	24,297,739
Rail shipments (outside Glenn pool) in Oklahoma	174,955	292,029
Total sales in Oklahoma	43,524,128	45,798,765
Total value	$17,513,524	$17,694,843

In Osage County, Okla., there are approximately 100 oil-producing properties. In the following table is given a statement of the quantity of crude petroleum produced by the Indian Territory Illuminating Oil Company and its sublessees from wells in Osage County, Okla., from 1903 to 1908, inclusive.

Production of crude petroleum by the Indian Territory Illuminating Oil Company and its sublessees from January 1, 1903, to December 31, 1908.

	Barrels.		Barrels.
1903	56,905	1906	5,219,106
1904	652,479	1907	5,143,971
1905	3,421,478	1908	4,961,147

Of the total runs from Osage County in 1908 the Prairie Oil and Gas Company received 4,915,042 barrels, the Uncle Sam Refining Company 41,176 barrels, the Superior Refining Company 4,531 barrels, the Liquid Gas Company 395 barrels, and 3 barrels were sold for fuel. The total value was $2,026,411, one-eighth of which was royalty interest of the Osage Nation, or 620,143 barrels, valued at $253,301.

In the following table is shown the number of wells drilled in Osage County by the Indian Territory Illuminating Oil Company and its sublessees from 1903 to 1908, inclusive:

Oil and gas wells in Osage County, 1903–1908.

Total wells completed to—	Completed.	Productive.	Gas.	Dry.
January 1, 1903	30	17	2	11
December 31, 1904	361	243	21	97
June 10, 1905	544	355	34	155
December 31, 1905	704	462	45	197
June 10, 1906	862	569	55	238
December 31, 1906	1,080	716	66	298
June 30, 1907	1,155	779	67	309
December 31, 1907	1,277	837	71	369
December 31, 1908	1,422	936	78	408

It will be seen from this table that 145 wells were drilled in 1908, of which 39 were dry, 99 were oil, and 7 were gas wells. Under the column marked "dry" are included oil and gas wells that have been exhausted and abandoned in addition to the wells that were dry when drilled.

Estimated production and sales of crude petroleum from Glenn pool in 1907 and 1908, by months, in barrels.

Month.	1907.	1908.	Month.	1907.	1908.
January	385,939	1,796,461	August	2,003,607	1,770,819
February	572,414	1,897,054	September	2,309,205	1,639,252
March	1,084,636	2,098,411	October	2,441,622	1,832,033
April	1,716,079	1,968,761	November	1,971,595	1,404,234
May	1,923,262	1,630,111	December	1,625,127	1,491,998
June	1,971,122	1,051,045			
July	1,922,387	1,914,134		19,926,995	20,494,313

Well record.—The following tables give the well records for Oklahoma from 1904 to 1908, inclusive:

Number of wells completed in Oklahoma, 1904–1908, by districts.

District.	Completed.					Dry.					Gas.					Productive.				
	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.	1904.	1905.	1906.	1907.	1908.
Cherokee, deep	...	.....	.....	941	690	...	...	...	65	53	...	...	...	61	32	...	.....	.....	815	605
Bartlesville	...	273	790	.....	.....	...	33	123	...	...	...	15	61	...	...	...	225	606	.....	.....
Cherokee, shallow	...	.....	.....	1,537	1,281	...	...	...	120	94	...	...	...	14	7	...	.....	.....	1,403	1,180
Alluwe	...	165	441	.....	.....	...	4	25	...	...	...	1	7	...	...	...	160	409	.....	.....
Chelsea	...	244	400	.....	.....	...	20	44	...	...	...	6	8	...	...	...	218	348	.....	.....
Coodys Bluff	...	280	549	.....	.....	...	8	28	...	...	...	10	11	...	...	...	262	510	.....	.....
Creek	...	151	211	1,225	683	...	33	41	97	106	...	21	35	38	52	...	97	135	1,090	525
Oklahoma	...	334	107	36	.....	...	47	50	12	...	...	10	19	8	...	...	277	38	16	.....
Cleveland	...	.....	.....	.....	22	...	...	...	...	7	...	...	...	...	1	...	.....	.....	.....	14
Osage	361	482	262	184	153	97	107	30	15	16	21	16	17	15	8	243	359	215	154	129
Miscellaneous	...	581	19	33	15	...	101	7	9	8	...	19	5	12	2	...	461	7	12	5
	361	2,510	2,779	3,956	2,844	97	353	348	318	284	21	98	163	148	102	243	2,059	2,268	3,490	2,458

Number of wells completed in Oklahoma, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	361
1905	59	79	174	211	231	172	195	237	221	246	305	380	2,510
1906	310	285	217	258	404	337	218	222	142	110	96	180	2,779
1907	153	174	249	404	356	362	399	364	439	464	351	241	3,956
1908	194	162	165	194	229	208	224	282	246	263	325	352	2,844

Number of dry holes drilled in Oklahoma, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	97
1905	13	14	33	45	39	30	30	30	26	23	39	31	353
1906	35	41	29	25	39	40	29	32	19	30	9	20	348
1907	13	15	17	24	27	32	43	32	33	31	31	20	318
1908	23	11	21	24	22	25	18	38	28	21	25	28	284

Number of gas wells drilled in Oklahoma, 1904–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
1905	.....	4	3	8	6	14	9	17	6	10	15	6	98
1906	9	17	12	16	19	24	7	14	17	10	4	14	163
1907	9	14	13	12	16	12	13	10	10	16	14	9	148
1908	16	8	8	9	7	5	7	8	11	3	13	7	102

Total and average initial daily production of new wells in Oklahoma, 1905–1908, by districts, in barrels.

District.	Total initial production.				Average initial production per well.			
	1905.	1906.	1907.	1908.	1905.	1906.	1907.	1908.
Cherokee, deep	....	....	74,824	36,561	....	....	91.8	60.4
Bartlesville	14,780	44,367	....	....	65.7	73.2	....	....
Cherokee, shallow	....	....	64,490	80,923	....	....	45.9	68.6
Alluwe	5,116	13,749	....	....	31.9	33.6	....	....
Chelsea	3,960	6,828	....	....	18.1	19.6	....	....
Coodys Bluff	7,160	22,845	....	....	27.3	44.8	....	....
Creek	3,108	51,728	303,005	76,722	32.0	383.2	277.9	146.1
Oklahoma	23,178	1,562	534	....	83.7	41.1	33.4	....
Cleveland	....	....	....	455	....	....	....	32.5
Osage	36,423	20,047	16,355	19,377	101.5	93.2	106.2	150.2
Miscellaneous	17,665	160	654	114	38.3	22.9	54.5	22.8
	111,390	161,286	459,862	214,152	54.1	71.1	131.7	87.1

Total initial daily production of new wells in Oklahoma, 1905–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	4,982	4,395	7,636	8,340	8,415	8,665	13,737	10,905	8,918	9,207	11,285	14,905	111,390
1906	13,038	11,485	8,755	13,516	15,844	15,012	12,240	17,398	9,635	8,608	14,495	21,260	161,286
1907	17,700	21,829	29,063	36,690	52,157	47,697	44,683	40,166	55,371	46,643	41,608	26,255	459,862
1908	16,475	17,550	10,865	13,018	16,045	15,860	14,695	18,834	17,198	24,915	25,377	23,320	214,152

GULF OIL FIELD.

On account of the similarity in the oils and the conditions of their occurrence, and in the trade in the products, the oils of Louisiana and Texas near the Gulf of Mexico have been grouped together in the statistical tables which follow. The field was described in the report previous to this,[a] and the developments since that issue are given under each State.

PRODUCTION.

In the following table is given the production of the Gulf field for the years 1907 and 1908, by months:

Production of crude petroleum in the Gulf field in 1907 and 1908, by months, in barrels.

Month.	1907.			1908.		
	Coastal Texas.	Louisiana.	Total.	Coastal Texas.	Louisiana.	Total.
January	876,816	589,200	1,466,016	896,547	632,885	1,529,432
February	888,161	434,465	1,322,626	852,059	478,636	1,330,695
March	1,124,648	380,863	1,505,511	977,296	580,666	1,557,962
April	1,115,721	294,777	1,410,498	842,737	627,248	1,469,985
May	1,005,233	251,962	1,257,195	873,944	648,644	1,522,588
June	935,933	227,960	1,163,893	823,940	609,156	1,433,096
July	903,816	365,032	1,268,848	855,277	623,780	1,479,057
August	933,839	469,208	1,403,047	841,738	587,234	1,428,972
September	873,213	428,392	1,301,605	813,771	557,690	1,371,461
October	871,852	326,679	1,198,531	881,792	540,534	1,422,326
November	895,759	587,294	1,483,053	877,074	502,463	1,379,537
December	985,087	644,389	1,629,476	947,025	446,194	1,393,219
	11,410,078	5,000,221	16,410,299	10,483,200	6,835,130	17,318,330

[a] For brief description, see Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 393.

Production of crude petroleum in the Gulf field, 1889–1908, by States, in barrels.

Year.	Coastal Texas.	Louisiana.	Total.
1889 to 1900	2,441		2,441
1901	3,593,113		3,593,113
1902	17,465,787	548,617	18,014,404
1903	17,453,612	917,771	18,371,383
1904	21,672,311	2,958,958	24,631,269
1905	27,615,907	8,910,416	36,526,323
1906	11,449,992	9,077,528	20,527,520
1907	11,410,078	5,000,221	16,410,299
1908	10,483,200	6,835,130	17,318,330

Production and value of crude petroleum produced in the Gulf field, 1905–1908, in barrels.

Year.	Coastal Texas.		Louisiana.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	27,615,907	$7,190,658	8,910,416	$1,601,325	36,526,323	$8,791,983
1906	11,449,992	5,825,036	9,077,528	3,557,838	20,527,520	9,382,874
1907	11,410,078	9,680,286	5,000,221	4,063,033	16,410,299	13,743,319
1908	10,483,200	6,221,636	6,835,130	4,131,173	17,318,330	10,352,809

In the following table is shown the production of crude petroleum in the Gulf field from 1889 to 1908 with its percentage of the total of the United States, the increase or decrease each year, and the percentage of increase or decrease:

Production of crude petroleum in the Gulf field, 1889–1908, in barrels.

Year.	Production.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1889	48					
1890	54		6		12.50	
1891	54					
1892	45			9		16.67
1893	50		5		11.11	
1894	60		10		20.00	
1895	50			10		16.67
1896	50					
1897	50					
1898	1,450		1,400		2,800.00	
1899	530			920		63.45
1900	0			530		100.00
1901	3,593,113	5.18	3,593,113			
1902	18,014,404	20.29	14,421,291		401.36	
1903	18,371,383	18.29	356,979		1.98	
1904	24,631,269	21.03	6,259,886		34.07	
1905	36,526,323	27.11	11,895,054		48.29	
1906	20,527,520	16.23		15,998,803		43.80
1907	16,410,299	9.88		4,117,221		20.05
1908	17,318,330	9.64	908,031		5.53	

WELL RECORD.

In the following table will be found the number of wells completed in 1908 in the different districts of the Gulf field. Most of the well-record information of the Gulf field is compiled from the statistics of field operations published monthly by the Oil Investors' Journal, of Beaumont, Tex.

Well record in Gulf field in 1908.

District.	Wells completed.				Abandoned.
	Total.	Oil.	Gas.	Dry.	
Coastal Texas	603	452	8	143	269
Louisiana	216	154	6	56	50
Total, 1908	819	606	14	199	319
Total, 1907	1,004	735	24	245	307
Total, 1906	746	507	....	239	293

TEXAS.

PRODUCTION.

The decline of 1907 in Texas continued, in spite of the new finds south of the developed fields.

On June 2 a well was brought in at Goose Creek, Harris County, 25 miles east of Houston. It was drilled by a syndicate of Houston people after various unsuccessful attempts had been made to find oil there during the last few years. The well flowed intermittently at the rate of 30 barrels an hour until shut in the next day. The sand was found at a depth of 1,600 feet. The gravity of the oil is 18° B. The location is favorable for marketing oil and the gusher led to much drilling during the remainder of the year, most of which proved very disappointing.

On June 5 another remarkable strike was made 6½ miles northwest of Markham, a town of 1,000 inhabitants in Matagorda County, about 110 miles west and south of Houston. The well was drilled by the Hardy Oil Company, and is known as Hardy No. 1. It is 1,370 feet deep to a fine sand, such as characterizes the Jennings field. The oil is reported as having a gravity of 22° B. The Hardy No. 1 flowed 1,500 to 2,000 barrels on the first day, and was then shut in while storage was provided. In six months it declined to 150 barrels daily. Gas seepages are common for 10 miles northeast and southwest of Markham, and led to the drilling of this well. In spite of the bad weather during June, great excitement prevailed and many wells were started on leases of other companies. Most of them, however, proved dry or salt. Meanwhile the new strike depressed the prices of crude oil in Texas before any of the new oil was marketed. The gas encountered between 600 and 700 feet has frequently proved unmanageable and has led to blow-outs. At the end of 1908 the Oil Investors' Journal reported 15 wells in the Markham field, of which 4 are producers and 11 are dry or blow-outs.

The Humble pool developed many good producers and did more than any other region to check the decline in the State's production. In July a 3,000-barrel well was brought in by the Sun Company on the Bailey & West tract. In August the W. S. Farish No. 20 and No. 21, on the Hargreaves lease, came in with 1,400 and 1,200 barrels, respectively. Altogether, during the year there were completed 8 wells having an initial production of over 1,000 barrels each, 28 of over 500 barrels each, and 48 of 200 barrels or more each. Developments in the later part of the year were more active than at any time since 1905. In November water appeared on the east side of the pool and gradually worked its way over to the west. Spindle Top showed the only other increase in Texas.

Wild-catting was active at many points in the State. Heavy oil in small quantity was found at Palestine, Anderson County. A good showing was also obtained at a depth of 1,867 feet at Cross Timbers, 7 miles from Houston. At Henrietta, Clay County, the Clay County Oil Company drilled Lochridge No. 4, which pumped 150 barrels from a depth of 740 feet. The oil is extremely light. In Brazoria County the only commercial wells are located at Hoskins Mound, the production in 1908 remaining about the same as in 1907. Drilling operations were carried on in this county at West Columbia, but no wells were discovered which would produce oil in paying quantities. Developments are still in progress. The Piedras Pintas district, Duval County, has not been extended, but considerable leasing is in progress. The production in 1908 declined slightly as compared with that of 1907. No new developments have been reported from the Mission field, Bexar County, but production shows a small increase in 1908 over that of 1907. The wells of South Bosque, McLennan County, showed little change, production remaining about the same in 1908 as in 1907. The crude oil is consumed locally for fuel purposes.

Production of crude petroleum in northern and coastal Texas in 1907 and 1908, by months, in barrels.

Month.	1907.			1908.		
	Northern Texas.	Coastal Texas.	Total.	Northern Texas.	Coastal Texas.	Total.
January	95,270	876,816	972,086	74,374	896,547	970,921
February	90,527	888,161	978,688	76,391	852,059	928,450
March	96,188	1,124,648	1,220,836	61,731	977,296	1,039,027
April	86,311	1,115,721	1,202,032	59,656	842,737	902,393
May	84,333	1,005,233	1,089,566	58,230	873,944	932,174
June	82,297	935,933	1,018,230	60,464	823,940	884,404
July	67,552	903,816	971,368	56,875	855,277	912,152
August	66,805	933,839	1,000,644	58,493	841,738	900,231
September	60,229	873,213	933,442	58,642	813,771	872,413
October	62,059	871,852	933,911	53,115	881,792	934,907
November	55,656	895,759	951,415	52,313	877,074	929,387
December	65,391	985,087	1,050,478	52,980	947,025	1,000,005
	912,618	11,410,078	12,322,696	723,264	10,483,200	11,206,464

Production and value of crude petroleum produced in northern and coastal Texas, 1905–1908, in barrels.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	520,282	$361,604	27,615,907	$7,190,658	28,136,189	$7,552,262
1906	1,117,905	740,542	11,449,992	5,825,036	12,567,897	6,565,578
1907	912,618	721,577	11,410,078	9,680,286	12,322,696	10,401,863
1908	723,264	479,072	10,483,200	6,221,636	11,206,464	6,700,708

In the two following tables will be found the production of crude petroleum in Texas, by districts and months, for the years 1907 and 1908:

Production of crude petroleum in Texas, 1907–8, by districts and months, in barrels.

1907.

Month.	Spindle Top.	Sour Lake.	Batson.	Saratoga.	Corsicana.	Powell.
January	113,293	176,808	186,128	192,680	27,469	61,349
February	112,010	193,891	172,808	219,918	21,562	59,985
March	174,956	247,062	225,097	225,219	21,455	64,379
April	158,949	238,690	169,640	210,693	21,087	59,601
May	142,085	213,612	200,382	168,557	18,230	60,018
June	135,845	184,683	206,216	165,989	17,464	58,405
July	134,190	200,226	173,173	164,874	15,282	45,681
August	132,431	214,056	181,660	154,774	17,165	42,008
September	122,676	196,877	155,007	148,186	14,158	38,145
October	121,829	165,934	156,730	164,994	16,598	37,454
November	153,586	162,553	168,888	156,167	13,438	34,569
December	198,093	159,548	168,724	158,877	22,403	35,303
	1,699,943	2,353,940	2,164,453	2,130,928	226,311	596,897

Month.	Humble.	Matagorda and Hoskins Mound.	Henrietta.	Dayton.	Other.	Total.
January	189,138	3,739	6,240	15,024	218	972,086
February	180,307	427	8,668	8,794	318	978,688
March	237,217	1,593	9,992	13,498	368	1,220,836
April	326,013	948	5,211	10,782	418	1,202,032
May	270,547	2,080	5,613	7,964	478	1,089,566
June	230,581	779	5,916	10,640	1,712	1,018,230
July	217,812	1,683	6,077	10,658	1,712	971,368
August	239,483	100	7,120	10,135	1,712	1,000,644
September	240,895	564	7,414	7,808	1,712	933,442
October	254,865	444	7,245	5,343	2,475	933,911
November	249,619	300	6,877	2,933	2,485	951,415
December	293,163	610	6,887	4,459	2,411	1,050,478
	2,929,640	13,267	83,260	108,038	[a] 16,019	12,322,696

[a] Includes production of Mission, Piedras Pintas, South Bosque, and Jack County districts.

1908.

Month.	Spindle Top.	Sour Lake.	Batson.	Saratoga.	Powell.	Corsicana.
January	160,067	143,352	147,131	153,010	42,189	25,670
February	145,873	150,325	147,108	151,283	43,423	26,179
March	182,460	163,071	159,143	195,176	38,681	15,620
April	166,581	137,548	132,413	153,558	36,998	15,443
May	173,803	130,205	144,212	141,602	37,065	14,730
June	141,384	125,942	128,580	134,927	36,888	16,694
July	145,751	125,613	136,086	120,504	35,456	14,953
August	130,871	128,342	131,100	126,866	33,249	16,783
September	120,649	119,726	116,224	118,946	34,861	16,158
October	126,620	124,821	120,291	117,286	28,849	16,766
November	126,060	119,417	115,553	108,023	26,935	16,089
December	127,418	126,698	115,729	113,605	27,065	16,032
	1,747,537	1,595,060	1,593,570	1,634,786	421,659	211,117

Month.	Dayton.	Humble.	Henrietta.	Goose Creek and Matagorda County.	Other.[a]	Total.
January	2,564	287,773	6,103	140	2,922	970,921
February	3,298	251,885	6,377	140	2,559	928,450
March	3,553	272,043	7,018	140	2,122	1,039,027
April	3,262	248,531	6,803	140	1,116	902,393
May	2,625	280,847	6,023	140	922	932,174
June	2,117	288,546	6,470	1,934	922	884,404
July	2,823	312,065	6,154	10,525	2,222	912,152
August	5,374	304,367	8,149	14,305	825	900,231
September	2,980	311,429	7,311	23,307	822	872,413
October	4,242	375,957	7,188	12,065	822	934,907
November	3,711	394,765	8,977	7,035	2,822	929,387
December	3,352	450,313	9,390	7,769	2,634	1,000,005
	39,901	3,778,521	85,963	77,640	20,710	11,206,464

[a] Includes Hoskins Mound, South Bosque, Mission, Piedras Pintas, and miscellaneous counties.

The production of petroleum in Texas from 1896 to 1908, inclusive, has been as follows:

Production of crude petroleum in Texas, 1896–1908, by districts, in barrels.

Year.	Corsicana.	Powell.	Spindle Top.	Sour Lake.	Saratoga.	Batson.
1896	1,450					
1897	65,975					
1898	544,620					
1899	668,483					
1900	829,560	6,479				
1901	763,424	37,121	3,593,113			
1902	571,059	46,812	17,420,949	44,838		
1903	401,817	100,143	8,600,905	8,848,159		4,518
1904	374,318	129,329	3,433,842	6,442,357	739,239	10,904,737
1905	311,554	132,866	1,652,780	3,362,153	3,125,028	3,774,841
1906	332,622	673,221	1,077,492	2,156,010	2,182,057	2,289,507
1907	226,311	596,897	1,699,943	2,353,940	2,130,928	2,164,453
1908	211,117	421,659	1,747,537	1,595,060	1,634,786	1,593,570

Year.	Dayton.	Matagorda County.	Henrietta.	Humble.	Other.	Total.
1896						1,450
1897						65,975
1898					1,450	546,070
1899					530	669,013
1900						836,039
1901						4,393,658
1902						18,083,658
1903					30	17,955,572
1904		151,936	65,455		200	22,241,413
1905	60,294	46,471	75,592	15,594,310	300	28,136,189
1906	92,850	3,600	111,072	3,571,445	78,021	12,567,897
1907	108,038	1,573	83,260	2,929,640	27,713	12,322,696
1908	39,901	62,640	85,963	3,778,521	35,710	11,206,464

The following table gives a statement of the production and value of crude petroleum at wells in Texas in 1907 and 1908, by districts:

Production and value of petroleum in Texas in 1907 and 1908, by districts, in barrels.

District.	1907.			1908.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Spindle Top	1,699,943	$1,521,304	$0.895	1,747,537	$1,030,403	$0.589
Sour Lake	2,353,940	1,944,343	.826	1,595,060	982,769	.616
Saratoga	2,130,928	1,742,913	.818	1,634,786	989,167	.605
Corsicana	226,311	228,845	1.011	211,117	153,489	.727
Powell	596,897	407,186	.682	421,659	274,536	.651
Batson	2,164,453	1,913,875	.884	1,593,570	885,965	.556
Humble	2,929,640	2,456,892	.839	3,778,521	2,269,341	.60
Dayton	108,038	80,559	.746	39,901	19,818	.497
Henrietta	83,260	78,946	.948	85,963	46,947	.546
Matagorda	[a] 13,267	10,811	.815	[b] 77,640	33,267	.429
Other	16,019	16,189	1.011	20,710	15,006	.725
	12,322,696	10,401,863	.844	11,206,464	6,700,708	.598

[a] Includes the production of Hoskins Mound.

[b] Includes the production of Goose Creek.

PRICES.

Average monthly prices of crude petroleum per barrel of 42 gallons at wells in the Texas field in the years 1907 and 1908 were as follows:

Average monthly prices of crude petroleum in Texas in 1907 and 1908.

Month.	Spindle Top.		Sour Lake.		Humble.		Batson.	
	1907.	1908.	1907.	1908.	1907.	1908.	1907.	1908.
January	\$0.72–\$0.78	\$0.71 –\$0.791	\$0.65½–\$0.76	\$0.69 –\$0.92	\$0.62–\$0.77	\$0.68 –\$0.9128	\$0.72–\$0.75	\$0.66–\$0.84
February	.78– .80	.70 – .7168	.72 – .80	.70 – .8071	.69– .80	.725 – .8929	.77– .80	.68– .73
March	.81– .85	.69 – .7126	.74 – .85	.70 – .725	.74– .90	.69 – .8688	.80– .85	.67– .71
April	.83– .87½	.64 – .6869	.79 – .90	.64 – .725	.76– .90	.66 – .869	.81– .85	.63
May	.83– .89	.57 – .646	.79 – .90	.57 – .725	.76– .91	.60 – .725	.82– .90	.53– .58
June	.85– .93	.48 – .5684	.79 – .90	.51 – .725	.76– .94	.51 – .725	.81– .93	.47– .51
July	.88– .95	.4076– .43	.80 – .93	.43 – .6878	.80– .95	.43 – .4818	.88– .93	.40
August	.93– .97	.44 – .45	.88 – .93	.44 – .45	.81– .99	.4397– .45	.92– .93	.40– .43
September	.94– .97	.4622– .50	.89 – .97	.4399– .47	.81– .97	.4356– .50	.92– .95	.44– .46
October	.94– .98	.54 – .57	.84 – .97	.4481– .55	.82– .97	.4973– .57	.92– .95	.44– .52
November	.85– .97	.56 – .573	.79 – .97	.55 – .5523	.77– .95	.5174– .56	.92– .95	.54– .55
December	.70– .97	.58 – .60	.78 – .97	.5334– .55	.70– .95	.5326– .55	.88– .95	.53
Average	.895	.589	.826	.616	.839	.60	.884	.556

Month.	Saratoga.		Dayton.		Corsicana.		Powell.		Henrietta.	
	1907.	1908.	1907.	1908.	1907.	1908.	1907.	1908.	1907.	1908.
January	\$0.66–\$0.75	\$0.66 –\$0.8867	\$0.65–\$0.69	\$0.61	\$1.00	\$1.00	\$0.65	\$0.70	\$0.95	\$0.93
February	.69– .80	.70 – .725	.65– .73	.60	\$1.00– 1.02	.98	.65	.70	.95	.90
March	.72– .85	.70 – .725	.73	.60	1.02	\$0.85– .95	.70	\$0.65– .70	.95	\$0.75– .85
April	.75– .85	.64 – .725	.73	.57	1.02	.80– .85	.70	.60– .65	.95	.70– .75
May	.78– .90	.54 – .725	.73	.50	1.02	.77– .80	.70	.57– .60	.95	.70
June	.78– .93	.48 – .725	.75	.44	1.02	.70– .77	.70	.45– .57	.95	.45– .70
July	.81– .93	.40 – .6808	.75	.36	1.02	.70	.70	.45	.95	.45
August	.84– .93	.43 – .45	.76	.38	1.02	.70	.70	.45	.95	.45
September	.85– .92	.4488– .46	.86	.41	1.02	.70	.70	.45	.95	.45
October	.80– .94	.4514– .55	.85	.48	1.02	.70	.70	.45– .48	.95	.45– .48
November	.75– .92	.5473– .55	.84	.51	1.02	.70	.70	.48	.95	.48
December	.74– .94	.53 – .55	.72	.50	1.02	.70	.70	.48	.93	.48
Average	.818	.605	.746	.4966	1.011	.727	.682	.65	.948	.546

Prices of Corsicana and Powell oil.—The following tables show the prices of Corsicana and Powell oil from 1906 to 1908, inclusive:

Fluctuations in prices of Corsicana light and Powell heavy oil, 1906–1908, per barrel.

Corsicana.				Powell.			
1906.		1908.		1906.		1908.	
April 25	$0.91	January 1	$1.00	April 25	$0.52	January 1	$0.70
July 28	.89	February 1	.98	July 28	.50	March 16	.67
September 12	1.00	March 1	.95	September 12	.55	March 30	.65
		March 16	.90	October 29	.60	April 24	.62
1907.		March 30	.85			April 28	.60
January 1	1.00	April 24	.82	1907.		May 16	.57
February 11	1.02	April 28	.80	January 1	.65	June 4	.55
December 1	1.00	May 16	.77	January 26	.70	June 10	.50
		June 4	.75			June 13	.45
		June 10	.72			October 14	.48
		June 13	.70				

WELL RECORD IN COASTAL TEXAS.

The following tables give the well records in coastal Texas from 1906 to 1908, inclusive:

Number of wells completed in coastal Texas, 1906–1908, by districts.

District.	Completed.			Dry.			Productive.		
	1906.	1907.	1908.	1906.	1907.	1908.	1906.	1907.	1908.
Humble	345	269	281	123	[a] 99	[b] 80	222	170	201
Spindletop	68	122	108	29	21	26	39	101	82
Batson	80	206	53	4	32	10	76	174	43
Sour Lake	74	156	81	20	[c] 36	[d] 9	54	120	72
Saratoga	64	98	44	9	12	4	55	86	40
Dayton	7	18	8	3	7	6	4	11	2
Markham	......	......	10	......	......	5	......	......	5
Goose Creek	......	......	5	......	......	3	......	......	2
Matagorda	......	6	......	......	5	......	......	1	......
West Columbia } Hoskins Mound }	6	3	8	5	3	6	1	......	2
Piedras Pintas	......	4	......	......	......	......	......	4	......
Mission	......	7	5	......	4	2	......	3	3
	644	889	603	193	219	151	451	670	452

[a] 10 gas wells. [b] 7 gas wells. [c] 1 gas well. [d] 1 gas well.

Number of wells completed in coastal Texas, 1906–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	38	30	35	65	90	115	74	49	42	32	33	31	634
1907	68	63	97	85	52	74	69	73	81	86	77	44	869
1908	46	69	64	49	55	44	32	31	46	49	48	57	590

Number of dry holes drilled in coastal Texas, 1906–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	14	12	12	26	27	40	13	16	13	4	3	6	186
1907	18	13	17	5	8	24	15	20	19	38	23	7	207
1908	10	16	16	8	10	23	12	10	12	6	7	13	143

Total and average initial daily production of new wells in coastal Texas, 1906-1908, by districts, in barrels.

District.	Total initial production.			Average initial production per well.		
	1906.	1907.	1908.	1906.	1907.	1908.
Humble	5,560	30,643	46,260	79.4	180.2	230.1
Spindletop	2,275	10,452	9,385	94.8	103.5	114.4
Batson	3,935	18,004	2,806	87.4	103.5	65.2
Sour Lake	5,570	12,481	7,376	192.1	104.0	102.4
Saratoga	5,565	11,487	5,135	154.6	133.5	128.4
Dayton	200	730	90	100.0	66.3	45.0
Markham			2,700			540.0
Goose Creek			500			250.0
	[a]23,105	83,797	74,252	112.1	126.6	166.1

[a] Six months.

Total initial daily production of new wells in coastal Texas, 1906-1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906							5,915	2,950	2,530	4,020	3,180	4,510	23,105
1907	5,025	10,525	14,630	13,845	5,235	3,599	4,585	4,069	5,565	4,289	8,530	3,900	83,797
1908	6,200	6,040	6,045	5,100	4,565	5,435	5,835	5,485	6,865	6,117	9,020	7,545	74,252

Well record in Corsicana and Powell districts.—The following tables show the well records in the Corsicana and Powell districts:

Wells completed and abandoned in Corsicana and Powell oil districts in 1908, by months.

Month.	Corsicana.					Powell.				
	Oil.	Gas.	Dry.	Total.	Abandoned.	Oil.	Gas.	Dry.	Total.	Abandoned.
January								1	1	
February	2			2		2			2	
March						3		1	4	
April	1		1	2		4		2	6	
May	1			1		2			2	
June	1			1		2		3	5	
July						2		1	3	
August						3		1	4	
September						1		1	2	
October						4		3	7	
November						5			5	
December						4		1	5	
	5		1	6	8	32		14	46	13

Well record in the Corsicana and Powell oil districts, 1898-1908.

Year.	Wells.							Rigs.	
	Completed.	Producing.	Dry.	Gas.	Abandoned.	Drilling.		Total.	Monthly average.
						Total.	Monthly average.		
1898	374	342	[a] 28	4	7	154	13	136	11
1899	268	169	[a] 90	9	79	154	13	95	8
1900	373	[b] 261	[a] 98	14	112	157	13	80	7
1901	68	[c] 47	16	5	27	51	4	47	4
1902	28	[d] 12	13	3	45	23	2	46	4
1903	100	70	23	7	51	65	5	35	3
1904	74	46	25	3	31	23	2	17	1
1905	68	48	18	2	41	25	2	23	2
1906	330	217	100	13	79				
1907	129	71	52	6	24				
1908	52	37	15		21				

[a] Includes 2 artesian wells.
[b] Includes 56 wells in heavy oil district.
[c] Includes 10 wells in heavy oil district.
[d] Includes 2 wells in heavy oil district.

Well record in Henrietta district.—The following table shows the well record in the Henrietta district in 1907 and 1908:

Well record in Henrietta oil district in 1907 and 1908, by months.

Month.	1907.					1908.				
	Wells.					Wells.				
	Completed.	Producing oil.	Gas.	Dry.	Abandoned.	Completed.	Producing oil.	Gas.	Dry.	Abandoned.
January						1	1			
February						4	3		1	
March	1	1				2	2			
April	0					3	2	1		
May	3	2	0	1	0	2	1		1	
June	6	4	0	2	0	1	1			
July	4	2	0	2	0	2	1		1	
August	2	2	0	0	3	2	1		1	
September	4	2	0	2	0	3	1	1	1	
October	2	0	1	1	0	3	3			
November	0	0	0	0	0	2	2			
December	5	4	0	1	0	3	2		1	
	27	17	1	9	3	28	20	2	6	7

Fluctuation in prices of Henrietta crude oil in 1907 and 1908, per barrel.

1907.		1908.	
January 1	$0.95	January 1	$0.93
December 1	.93	February 1	.90
		March 1	.85
		March 16	.80
		March 30	.75
		April 24	.70
		June 4	.65
		June 10	.60
		June 13	.45
		October 14	.48

SHIPMENTS.

In the following table is given the shipment of crude petroleum by railroad in tank cars from the different stations of Texas during the year 1908:

Quantity of crude petroleum shipped by railroad in tank cars from the oil fields of Texas, at the stations named, by months, during the year 1908, in barrels.

Month.	Spindle-top, Beaumont, Gladys.	Sour Lake.	Humble, Trice, Houston.	Saratoga.	Danbury, Duval, Markham, Corsicana.	Total.
January	1,237	108,142	217,609	170,594	3,294	500,876
February	2,220	24,003	216,629	133,683	4,624	381,159
March	21,269	42,034	155,883	124,419	17,156	360,761
April	26,305	61,084	166,884	93,017	17,587	364,877
May	6,698	38,508	152,712	100,279	14,248	312,445
June	7,248	38,337	190,542	45,890	524	282,541
July	7,334	251,448	207,065	57,180	7,932	530,959
August	6,603	182,911	246,857	124,180	10,593	571,144
September	6,879	120,015	249,225	98,060	16,814	491,993
October	6,254	106,248	306,222	56,127	8,681	483,532
November	4,765	150,351	306,059	51,557	10,110	522,842
December	1,285	100,814	422,327	69,623	14,804	608,853
	98,097	1,223,895	2,838,014	1,124,609	126,367	5,410,982

NOTE.—These are the official figures furnished by the railroads which shipped the crude petroleum. Calculations were made in reduction of pounds to barrels on the basis of 310.8 pounds to a barrel.

EXPORTS.

The following tables, furnished by the Bureau of Statistics, Department of Commerce and Labor, give the exports of crude petroleum and its products from Texas, by months and kinds and by customs districts:

Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1908, by months, in gallons.

Month.	Crude.		Naphtha.		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	2,609,760	$78,804	1,201	$161	1,733,026	$88,833
February	1,241,631	35,441	3,080	354	1,651,526	77,050
March	2,169,731	64,574	6,537	949	6,003,607	275,993
April	161,376	16,607	6,733	996	3,834,846	190,675
May	2,490,228	79,534	5,006	692	1,715,999	87,808
June	43,146	953	3,954	490	5,390,756	254,804
July	3,114,868	91,964	1,030	113	1,971,677	104,170
August	2,518,083	70,112	1,955	218	5,942,024	270,301
September	673,234	14,469	1,469,308	103,049	7,924,458	358,944
October	2,723,261	62,257	1,470	191	8,563,813	385,066
November	2,438,196	56,814	14,865	1,698	4,324,083	195,510
December	3,905,837	119,389	3,301	491	4,235,031	191,483
	24,089,351	690,918	1,518,440	109,402	53,290,846	2,480,637

Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1908, by months, in gallons—Continued.

Month.	Residuum.		Lubricating and paraffin.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	39,163	$2,332	23,033	$4,246	4,406,183	$174,376
February	2,602,940	91,828	39,602	7,153	5,538,779	211,826
March	1,957,544	69,585	20,033	4,772	10,157,452	415,873
April	160,850	9,522	38,197	6,213	4,202,002	224,013
May	3,216,318	112,590	33,155	7,924	7,460,706	288,548
June	744,753	26,345	53,487	8,121	6,236,096	290,713
July	6,605,914	228,238	34,258	7,807	11,727,747	432,292
August	3,640,628	127,196	81,370	18,002	12,184,060	485,829
September	5,826,652	203,932	41,315	11,198	15,934,967	691,592
October	3,542,738	124,100	1,033,413	73,872	15,864,695	645,486
November	19,680	1,132	24,667	4,829	6,821,491	259,983
December	32,130	2,295	35,661	6,610	8,211,960	320,268
	28,389,310	999,095	1,458,191	160,747	108,746,138	4,440,799

Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1908, in gallons.

Kind.	Corpus Christi.		Brazos de Santiago.		Galveston.		Sabine.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Crude, including all natural oils	33,200	$942	....	....	51,035	$2,317	23,748,954	$678,903
Refined:								
Naphthas	7,579	1,397	60	$12	250	37	1,472,970	103,646
Illuminating	49,189	5,326	12,124	1,722	50,106	5,375	52,988,531	2,434,379
Lubricating and heavy paraffin	59,151	17,022	84	34	217,939	46,528	1,038,261	73,000
Residuum, etc	23,506	1,247	....	....	....	....	28,359,769	997,552
	172,625	25,934	12,268	1,768	319,330	54,257	107,608,485	4,287,480

Kind.	Paso del Norte.		Saluria.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Crude, including all natural oils	52,123	$2,236	204,039	$6,520	24,089,351	$690,918
Refined:						
Naphthas	33,919	3,694	3,662	616	1,518,440	109,402
Illuminating	81,244	8,155	109,652	25,680	53,290,846	2,480,637
Lubricating and heavy paraffin	104,898	15,984	37,858	8,179	1,458,191	160,747
Residuum, etc	6,035	296	....	....	28,389,310	999,095
	278,219	30,365	355,211	40,995	108,746,138	4,440,799

LOUISIANA.

Caddo.—The limits of the Caddo field have not been defined. Work in 1908 was greatly hampered by high water in May and June from the floods which were general in the Mid-Continent field. The developments of 1907 extended from south of Mooringsport, which is 21 miles north of Shreveport on the Kansas City Southern Railway, to Oil City, a few miles to the north. In June, 1908, the district was extended to Lewis, about 4 miles north of Oil City, by the bringing in of a large gas well whose yield was reckoned at 15,000,000 feet per day. In October a gas well was drilled in near Dixie, which indicates an important extension to the southeast. At Vivian, 10 miles northwest from Oil City, gas also has been found. With the extensions, Caddo takes first rank both in production of natural gas and in criminal waste of this fuel. Meanwhile, the year's work has developed an increasing supply of oil. Both oil and gas in this field are practically free from sulphur.

On December 17 the rank of the field as oil territory was increased greatly by the drilling in of a well near the old Hostetter well at Mooringsport. The capacity was kept secret, but the property purchases in the neighborhood are very significant and have sufficed to produce a boom in which land values have increased from $50 to as much as $1,000 an acre.

On December 15, 1908, the Secretary of the Interior withdrew from entry, by the President's order, all the public lands in the neighborhood of the Caddo field, embracing about 6,500 acres. This action was taken pending a careful geologic investigation by the United States Geological Survey, made in cooperation with the State, with a view to preventing a waste of natural gas that has been estimated at 75 million cubic feet a day, or more than one-twentieth of the amount consumed in the entire United States. An investigation of the oil field in cooperation with the geological survey of Louisiana is now in progress, and additional information concerning it will be available in the spring of 1910.

In southern Louisiana the production was maintained by steady developments at both Welsh and Jennings. A gusher known as Lake No. 9 came in on July 4 at Anse la Butte. It showed about 4,000 barrels per day, but soon declined in the usual way and gave considerable salt water.

PRODUCTION.

In the following table will be found the quantity of crude petroleum produced in Louisiana in 1908, by months:

Production of petroleum in Louisiana in 1908, by districts and months, in barrels.

Month.	Jennings.	Anse la Butte.	Caddo.	Welsh.	Total.
January	606,338	10,728	12,247	3,572	632,885
February	448,494	11,500	15,850	2,792	478,636
March	533,083	12,133	32,446	3,004	580,666
April	571,417	21,894	31,065	2,872	627,248
May	613,187	12,059	20,970	2,428	648,644
June	590,726	9,128	6,434	2,868	609,156
July	596,954	7,035	16,664	3,127	623,780
August	517,333	18,385	48,467	3,049	587,234
September	461,575	46,210	47,774	2,131	557,690
October	409,980	8,216	120,381	1,957	540,534
November	405,132	19,979	75,475	1,877	502,463
December	364,656	7,496	72,164	1,878	446,194
	6,118,875	184,763	499,937	31,555	6,835,130

Production and value of petroleum in Louisiana in 1907 and 1908, by districts, in barrels.

District.	1907.			1908.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Jennings	4,842,520	$3,938,641	$0.813	6,118,875	$3,782,601	$0.618
Anse la Butte	60,385	50,402	.835	184,763	110,858	.60
Welsh	47,316	35,127	.742	31,555	23,666	.75
Caddo	50,000	38,863	.777	499,937	214,048	.428
	5,000,221	4,063,033	.8125	6,835,130	4,131,173	.604

Production of petroleum in Louisiana, 1902–1908, by districts, in barrels.

Year.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Total.
1902	548,617				548,617
1903	892,609	25,162			917,771
1904	2,923,066	35,892			2,958,958
1905	8,891,416	10,000	9,000		8,910,416
1906	9,025,174	23,996	25,000	3,358	9,077,528
1907	4,842,520	47,316	60,385	50,000	5,000,221
1908	6,118,875	31,555	184,763	499,937	6,835,130

PRICES.

In the following table are given the prices paid for crude petroleum at wells in Louisiana in the years 1904 to 1908, inclusive:

Average monthly price of crude petroleum per barrel at wells in the Jennings and Caddo oil districts, 1904–1908.

Month.	Jennings.				
	1904.	1905.	1906.	1907.	1908.
January	$0.30	$0.15–$0.20	$0.2339–$0.25	$0.62 –$0.67	$0.6985–$0.75
February	.30	.15– .20	.2414– .25	.66 – .75	.66 – .725
March	.40	.15– .22	.25 – .2761	.69 – .80	.67 – .7919
April	$0.40– .50	.12– .22	.2565– .31	.72 – .86	.55 – .725
May	.46– .50	.12– .22	.30 – .33	.75 – .92½	.52 – .725
June	.50– .52	.12– .20	.3404– .35	.75 – .97	.45 – .725
July	.45– .57	.12– .20	.3467– .38	.78 – 1.05	.43 – .7288
August	.40– .50	.16– .20	.3525– .43	.83 – 1.08	.45 – .5641
September	.30– .44	.18– .20	.3611– .48	.85 – .94¼	.45 – .57
October	.30– .46	.18– .23	.4026– .55	.79 – .8713	.55 – .5769
November	.22– .35	.20– .25	.448 – .60	.74 – .9214	.55 – .604
December	.18– .33	.20– .27	.615 – .65	.6561– .80	.55 – .693
Average	.3589	.1788	.3906	.813	.618

Month.	Caddo.	
	1907.	1908.
January	$0.63–$0.66	$0.725
February	.66– .69	.735
March	.69– .72	.70
April	.72– .75	.675
May	.75	.635
June	.75– .78	.635
July	.78– .83	$0.35 – .465
August	.83– .85	.30 – .35
September	.85	.315– .35
October	.79– .85	.31 – .40
November	.74– .79	.37 – .40
December	.74	.37 – .40
Average	.777	.428

WELL RECORD.

In the following tables are given the well records for Louisiana for the years 1906 to 1908, inclusive:

Number of wells completed in Louisiana, 1906–1908, by districts.

District.	Completed.			Dry.			Productive.		
	1906.	1907.	1908.	1906.	1907.	1908.	1906.	1907.	1908.
Jennings	71	76	142	23	23	38	48	53	104
Caddo	2	23	58	1	[a] 15	[b] 15	1	8	43
Anse la Butte	10	4	16	5	2	9	5	2	7
Welsh	2	1	......	......	......	......	2	1	......
	85	104	216	29	40	62	56	64	154

[a] 11 gas wells. [b] 6 gas wells.

Number of wells completed in Louisiana, 1906–1908, by months.

Year.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	3	1	3	6	4	16	8	5	8	9	5	4	72
1907	10	3	9	6	3	11	6	7	11	15	10	13	104
1908	11	26	18	25	24	13	9	23	18	20	14	15	216

Number of dry holes drilled in Louisiana, 1906–1908, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec	Total.
1906	2	......	......	3	4	6	3	......	2	......	1	2	23
1907	5	3	6	4	1	4	......	1	2	7	1	6	40
1908	4	10	5	4	8	3	1	9	3	6	6	3	62

Total and average initial daily production of new wells in Louisiana, 1906–1908, by districts, in barrels.

District.	Total initial production.			Average initial production per well.		
	1906.	1907.	1908.	1906.	1907.	1908.
Jennings	12,550	43,270	84,620	261.5	816.4	813.6
Caddo	....	975	14,355	....	121.9	333.8
Anse la Butte	....	3,040	5,200	....	1,520	742.8
Welsh	50	75	....	25.0	75	....
	12,600	47,360	104,175	252.0	740	676.4

Total initial daily production of new wells in Louisiana, 1906–1908, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	....	....	....	....	....	....	50	....	2,150	7,750	1,900	750	12,600
1907	1,400	....	840	300	150	4,270	1,505	8,340	11,175	2,580	9,450	7,350	47,360
1908	2,010	10,160	19,330	15,255	21,945	2,165	3,390	3,770	10,400	8,195	1,990	5,565	104,175

The following table gives a statement of shipments of crude petroleum from stations on the line of the Louisiana Western Railroad Company and of the Kansas City Southern Railway in Louisiana during the year 1908, by months:

Rail shipments of crude petroleum from stations on the lines of the Louisiana Western Railroad and Kansas City Southern Railway in Louisiana in 1908.

Month.	Jennings.	Mermentau.	Egan.	Lake Charles.	Caddo.	Anse la Butte.	Total.
January	166,821	2,114	23,386	105,825	4,610	2,095	304,851
February	173,791	829	45,612	99,976	....	1,712	321,920
March	112,766	769	16,703	142,321	369	774	273,702
April	71,334	2,688	36,467	110,114	25,378	1,702	247,683
May	118,089	10,536	23,392	51,912	19,796	1,160	224,885
June	100,206	9,453	17,369	131,633	6,335	1,548	[a] 266,844
July	52,945	8,809	17,872	119,604	14,270	1,238	214,738
August	51,563	24,476	54,943	104,509	22,753	4,225	262,469
September	62,734	22,244	65,142	45,983	79,374	11,955	287,432
October	55,606	14,705	84,349	4,796	74,831	6,035	240,322
November	53,158	21,425	55,414	12,100	78,416	12,785	233,298
December	33,692	17,485	35,292	2,942	109,407	6,426	205,244
	1,052,705	135,533	475,941	931,715	435,539	51,655	[a] 3,083,388

[a] Includes a small shipment from Welsh.

NOTE.—These are the official figures, calculations being made on the basis of 310.8 pounds of crude petroleum to a barrel of 42 gallons.

CALIFORNIA.

The important features connected with the oil business in California in 1908 were increased production, consumption, prices, and shipments; decreased stocks; and extension of fields.

The value of California's oil production in 1908 exceeded that of any other mineral product, and the State was second in rank in quantity and first in rank in value among the oil-producing States. The total production in 1908 was 44,854,737 barrels, or 12.85 per cent more than in 1907. Every district but one shared in this increase, the Kern River field leading in point of production. This condition was brought about by the increasing demand and consequent higher prices for oil, which stimulated drilling, particularly in the Coalinga and Kern County districts. Much development work was carried on in Coalinga and the field was extended. In Kern County many new wells were brought in, and many old wells which had not been pumped for several years were cleaned out and operated.

The completion of the pipe line in 1907 and the building of the railroad to Midway, together with the construction of the new rifled pipe line of the Associated Oil Company from Kern River to tidewater in 1908, did very much to encourage drilling and to increase production. The year 1908 was one of greater activity in the Santa Maria field than ever before, but the output of this field, which in 1907 gave promise of being enormous in 1908, was considerably lowered by the presence of water. Much of this difficulty has been overcome by the application of compressed air. Some of the wells in the Santa Maria field have an extraordinary yield, and the field leads all others in the State in rate of production per well. More crude oil was shipped from the fields of southern California in 1908 than ever before. The greater part of the oil exported from California comes from the Santa Maria field, its situation giving it command of the coast trade from Alaska to Chile and of foreign trade with Japan and Hawaii. There are shipped from this field about 25,000 barrels of oil per month for fuel on the Panama Canal, and before the expiration of 1909 shipments to the Isthmus may reach a total of 50,000 barrels per month.

No new oil fields of importance were discovered in California in 1908, although petroleum was discovered in several places, one being near Mono Lake, in Mono County.

PRODUCTION.

In the following table will be found the production and value of crude petroleum in California for the years 1907 and 1908, by counties:

Production and value of crude petroleum in California in 1907 and 1908, by counties and districts.

County and district.	1907.			1908.		
	Quantity.	Value.		Quantity.	Value.	
		Total.	Per barrel.		Total.	Per barrel.
Los Angeles City	529,584	$334,498	$0.631	637,328	$432,075	$0.678
Salt Lake-Sherman	2,129,504	835,895	.393	3,141,983	1,849,871	.589
Whittier, Newhall, Puente	818,147	579,587	.708	913,184	685,758	.75
Total, Los Angeles County	3,477,235	1,749,980	.503	4,692,495	2,967,704	.632
Kern River	13,006,136	3,565,468	.274	13,648,286	6,770,018	.496
Midway	134,174	40 252	.30	410,393	177,753	.433
McKittrick	1,944,671	557,508	.287	2,517,951	1,196,686	.475
Sunset	567,175	137,874	.243	1,556,263	599,386	.385
Total, Kern County	15,652,156	4,301,102	.275	18,132,893	8,743,843	.482
Santa Maria and Lompoc	8,651,172	3,969,410	.459	7,758,579	3,739,621	.482
Summerland	56,905	34,143	.60	58,103	34,835	.599
Total, Santa Barbara County	8,708,077	4,003,553	.46	7,816,682	3,774,456	.483
Coalinga, Fresno County	8,871,723	3,091,934	.3485	10,386,168	5,392,916	.519
Fullerton, Brea Canyon, Orange County	2,604,982	1,325,057	.509	3,358,714	2,298,104	.684
Santa Paula, Ventura County	357,094	197,537	.553	379,044	210,684	.556
San Mateo County Santa Clara County San Luis Obispo County	77,108	30,793	.399	88,741	45,795	.516
Grand total	39,748,375	14,699,956	.37	44,854,737	23,433,502	.522

The following table shows the production of crude petroleum in California, by counties, from 1902 to 1908, inclusive:

Production of crude petroleum in California, 1902–1908, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	Santa Clara.	San Mateo.	Total.
1902	572,498	9,705,703	1,938,114	1,038,549	242,840	484,764	....	1,800	13,984,268
1903	2,138,058	18,077,900	2,087,627	1,413,782	306,066	348,295	5,607	5,137	24,382,472
1904	5,114,958	19,608,045	2,102,892	1,473,335	789,006	517,770	41,928	1,500	29,649,434
1905	10,967,015	14,487,967	3,469,433	1,429,688	2,684,837	337,970	50,563		33,427,473
1906	7,991,039	14,520,864	3,449,119	2,032,637	4,774,361	299,124	a 31,464		33,098,598
1907	8,871,723	15,652,156	3,477,235	2,604,982	8,708,077	357,094	a 77,108		39,748,375
1908	10,386,168	18,132,893	4,692,495	3,358,714	7,816,682	379,044	a 88,741		44,854,737

a Includes oil produced in San Luis Obispo County.

Production of petroleum in California in 1907 and 1908, by counties and districts, with increase or decrease, in barrels.

District.	1907.	1908.	Increase.	Decrease.
Los Angeles City	529,584	637,328	107,744	....
Salt Lake—Sherman	2,129,504	3,141,983	1,012,479	....
Puente Hills Newhall Whittier	818,147	913,184	95,037	....
Total, Los Angeles County	3,477,235	4,692,495	1,215,260	....
Kern River	13,006,136	13,648,286	642,150	....
Sunset	567,175	1,556,263	989,088	....
Midway	134,174	410,393	276,219	....
McKittrick	1,944,671	2,517,951	573,280	....
Total, Kern County	15,652,156	18,132,893	2,480,737	....
Santa Maria and Lompoc	8,651,172	7,758,579	....	892,593
Summerland	56,905	58,103	1,198	....
Total, Santa Barbara County	8,708,077	7,816,682	....	891,395
Coalinga, Fresno County	8,871,723	10,386,168	1,514,445	....
Fullerton, Brea Canyon, Orange County	2,604,982	3,358,714	752,732	....
Santa Paula, Ventura County	357,094	379,044	21,950	....
Santa Clara County San Luis Obispo County San Mateo County	77,108	88,741	11,633	....
Grand total	39,748,375	44,854,737	5,106,362	....

WELL RECORD.

In the following table will be found the acreage and number of wells drilled in the different counties of California during the year 1908, with the number productive in each county at the beginning and the end of the year:

Well record in California, 1908, by counties.

County.	Number of companies having wells active or idle or in process of drilling.	Acreage of oil land controlled.	Wells, Jan. 1, 1908.	Wells drilled in 1908.			Wells abandoned in 1908.	Total wells, Dec. 31, 1908.	Wells drilling, Dec. 31, 1908.
				Oil.	Dry.	Total.			
Fresno	96	34,623	320	152	....	152	1	471	121
Kern	150	47,954	1,264	321	6	327	19	1,568	19
Los Angeles	96	31,514	863	71	10	81	30	903	9
Orange	15	16,810	189	19	2	21	6	202	5
San Luis Obispo San Mateo Santa Clara	26	14,313 700 6,600	12	5	3	8	1	16	a 7 1
Santa Barbara	51	146,050	291	18	2	20	17	292	29
Ventura	29	98,244	266	8	....	8	1	273	6
	463	396,808	3,205	594	23	617	75	3,725	197

a Drilling discontinued on 10 wells.

COLORADO.

From the following table it will be noted that the production in Colorado increased from 331,851 barrels in 1907 to 379,653 barrels in 1908, a gain of 47,802 barrels. All the crude petroleum produced in this State is from wells located in the Boulder and Florence oil fields. The producers of the Boulder field have been greatly encouraged by the bringing in of a flowing well in the latter part of the year 1908, which is said to be the first flowing well struck in this field. Two refineries have been erected at Boulder to refine the crude oil produced in this field, none of which has been shipped away since February of 1908. Eight wells were completed in the Florence oil field in 1908, thereby increasing the production.

Drilling operations have been carried on in El Paso, Montrose, and Prowers counties. In Rio Blanco County a number of oil discoveries have been made, some wells pumping from 5 to 8 barrels, but there is no transportation for the product.

In the following table is given the production of crude petroleum in the Florence and Boulder fields, by months, in 1907 and 1908:

Production of crude petroleum in the Florence and Boulder fields in 1907 and 1908, by months, in barrels.

Month.	1907.			1908.		
	Florence.	Boulder.	Total.	Florence.	Boulder.	Total.
January	22,328	6,691	29,019	21,888	8,611	30,499
February	19,275	6,143	25,418	20,407	8,392	28,799
March	20,333	5,610	25,943	22,799	9,193	31,992
April	19,736	5,831	25,567	24,702	8,492	33,194
May	22,380	7,722	30,102	28,592	7,807	36,399
June	23,198	7,104	30,302	28,041	6,937	34,978
July	22,462	5,761	28,223	29,007	7,121	36,128
August	22,980	3,959	26,939	25,128	7,644	32,772
September	22,570	5,874	28,444	26,841	4,905	31,746
October	22,706	5,609	28,315	23,305	5,316	28,621
November	22,140	4,771	26,911	22,086	5,247	27,333
December	23,390	3,278	26,668	22,683	4,509	27,192
	263,498	68,353	331,851	295,479	84,174	379,653

In the following table will be found the production and value of crude petroleum in the Boulder and Florence fields in Colorado from 1902 to 1908, inclusive:

Production and value of crude petroleum in Colorado, 1902–1908, by districts, in barrels.

Year.	Boulder.		Florence.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	11,800	....	385,101	....	396,901	$484,683
1903	36,722	....	447,203	....	483,925	431,723
1904	18,167	$20,034	483,596	$558,001	501,763	578,035
1905	10,502	11,502	365,736	326,104	376,238	337,606
1906	48,952	53,847	278,630	208,828	327,582	262,675
1907	68,353	75,188	263,498	197,625	331,851	272,813
1908	84,174	124,794	295,479	221,609	379,653	346,403

Well record.—The well record of Colorado in 1908 is shown in the following table:

District.	Total wells, Jan. 1, 1908.	Completed in 1908. Oil.	Dry.	Total.	Abandoned.	Total wells, Dec. 31, 1908.
Boulder	14	5	1	6	1	18
Florence	55	8	11	19	7	56
	69	13	12	25	8	74

MICHIGAN AND MISSOURI.

The crude petroleum production of Michigan was in 1908, as in previous years, from wells located near Port Huron, St. Clair County, there being no change in the quantity of the output. The production for 1908 is included with that of Missouri.

During the year 1908 considerable development work was done in Missouri with the hope of obtaining petroleum, but as yet no large producers have been struck, although indications of oil have been found in some of the wells. In 1908 some crude oil was produced and sold from wells in Jackson County. Some oil is also found in wells drilled in Clay and Cass counties. Drilling operations have been under way in Phelps, Jasper, Harrison, Maries, Greene, and Christian counties in 1908.

The production of crude petroleum in Missouri and Michigan is shown in the following table:

Production of petroleum in Missouri, 1901–1908.

Year	Barrels.	Year	Barrels.
1901	[a] 2,335	1905	[b] 3,100
1902	[b] 757	1906	[b] 3,500
1903	[b] 3,000	1907	[b] 4,000
1904	[b] 2,572	1908	[b] 15,246

OREGON.

A well is in process of drilling near Ontario, eastern Oregon, by a syndicate that has a large area under lease. It is proposed to continue this well to a depth of at least 3,000 feet to test thoroughly the resources of the region. The encouraging feature so far has been a good showing of natural gas. It has not been possible to substantiate the claim made in regard to a previous well that oil was actually obtained. Testing operations are also in progress at Vale, Oreg.

UTAH.

Although considerable development work was done in Utah, the crude petroleum industry made little progress in 1908. The principal productive field is at Virgin, Washington County, where the land is held by locating it under the placer-claim law. Two wells were being pumped in 1908. There is no transportation for the product, and the only crude produced is what is sold to or consumed by the operators in the field for fuel purposes. Crude petroleum has also been found at Bluff, San Juan County, and near Vernal, Uinta County. The production for this State is included with that of Wyoming.

[a] Includes the production of Michigan and Oklahoma Territory.
[b] Includes the production of Michigan.

WYOMING.

The only oil fields in Wyoming from which petroleum was produced and used in 1908 were the Brenning Basin field of Converse County and the Spring Valley field of Uinta County. The crude oil produced in Converse County was used for fuel purposes in the development of the field. The crude oil produced in this field is also good for lubricating purposes. Very little development work was done in the Spring Valley field in 1908, but as several individuals and companies have taken leases the indications are that work will be carried on in 1909. The product of this field is either utilized at the refinery of the Pittsburg-Salt Lake Oil Company or consumed for fuel purposes in the development and operation of wells. The average gravity of the Spring Valley crude oil is 42° B., the kerosene contents being 42.07 per cent and the gasoline 14.02 per cent.

Some wells, which will produce a very fine grade of oil of 46° B. gravity, have been developed in Bighorn County, but as there is no transportation or market for the product no oil has been sold. Considerable gas has also been developed in this field, the product of which is used for drilling operations.

Some oil of excellent lubricating qualities has been developed in wells in the Moorecroft field, Crook County, but none has been shipped.

No petroleum was shipped from the Murphy wells, Fremont County, nor from the wells on Salt Creek, Natrona County, during 1908. It is reported, however, that several wells were developed in the Salt Creek district during 1908, which have proven this district to be greater than was heretofore thought. Of the total number of wells completed in this district the greatest producer was brought in in 1908. It is claimed that this well flows from 60 to 80 barrels per day, having an initial production of 100 barrels, which is wonderful when the gravity of the oil is taken into consideration. Several companies are interested in this district and considerable development work is promised for the summer of 1909. The oil wells are 40 miles from railway, and as yet there is no pipe line. The Salt Creek crude shows the following analysis:

Analysis of crude petroleum from Salt Creek, Wyo.

	Per cent.
Gasoline	15
Light oil	35
Kerosene	40
Lubricating	10

In the following table is found the production of petroleum in Wyoming from 1895 to 1908, inclusive:

Production of petroleum in Wyoming, 1895–1908.

	Barrels.		Barrels.
1895	3,455	1902	6,253
1896	2,878	1903	8,960
1897	3,650	1904	11,542
1898	5,475	1905	8,454
1899	5,560	1906	[a] 7,000
1900	5,450	1907	[b] 9,339
1901	5,400	1908	[b] 17,775

[a] Estimated.

[b] Includes the production of Utah.

EXPORTS.

TERRITORIAL SHIPMENTS.

Alaska.—In the following table are given the shipments of petroleum products to Alaska from 1905 to 1908, inclusive:

Shipments of petroleum products to Alaska from other parts of the United States, 1905–1908, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	2,715,386	$91,068	713,496	$109,921	627,391	$113,921	83,319	$31,660
1906	2,688,100	38,409	580,978	100,694	568,033	109,964	83,992	32,854
1907	9,104,300	143,506	636,881	119,345	510,145	99,342	100,145	37,929
1908	11,891,375	176,483	939,424	147,104	566,598	102,567	94,542	36,423

Hawaiian Islands, Philippine Islands, and Porto Rico.—In the following table are given the shipments of petroleum products to the Hawaiian Islands, Philippine Islands, and Porto Rico from 1905 to 1908, inclusive:

Shipments of petroleum products to Hawaii, the Philippines, and Porto Rico, 1905–1908, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
HAWAII.								
1905	31,904,340	$1,112,939	320,703	$39,069	892,094	$142,313	195,850	$61,605
1906	38,883,100	871,830	550,975	71,954	1,225,864	199,443	241,567	76,134
1907	38,916,400	581,905	484,435	73,405	1,441,637	230,968	355,451	104,930
1908	47,719,900	802,325	648,310	91,851	1,143,591	179,507	358,262	140,157
PHILIPPINES.								
1905	....	....	60,000	9,096	3,847,810	380,322	236,123	44,573
1906	7,360	442	40,450	6,482	4,412,398	398,706	195,006	39,887
1907	....	....	79,560	12,930	8,218,400	842,111	181,504	32,598
1908	4,594	322	140,550	21,775	9,234,263	957,284	257,800	61,571
PORTO RICO.								
1905	....	....	49,493	7,697	1,365,446	140,569	93,513	20,253
1906	16,585	1,224	79,841	17,766	1,315,589	151,013	196,732	41,777
1907	....	....	219,691	38,003	1,700,838	176,808	223,389	53,599
1908	24,937	2,100	285,188	45,479	1,623,477	189,021	264,012	65,776

FOREIGN EXPORTS.

The following tables are the official statement by the Bureau of Statistics of the Department of Commerce and Labor of the quantity and value of petroleum and its products (mineral oils) exported from ports and districts in the United States for the years ending December 31, 1907 and 1908:

Exports of mineral oils from the United States in 1907 and 1908, by kind and port, in gallons.

Kind and port.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
CRUDE.				
New York	420,504	$25,600	36,547,123	$2,301,040
Philadelphia	75,518,259	4,798,585	25,231,014	1,743,547
Galveston	4,821,699	241,238	51,035	2,317
Other districts	45,546,087	1,268,292	87,360,845	2,472,945
	126,306,549	6,333,715	149,190,017	6,519,849
NAPHTHA.				
Baltimore	1,505	303	32,425	8,481
Boston and Charlestown	18,816	3,305	47,516	6,685
New York	16,300,755	1,870,151	17,750,261	2,254,983
Philadelphia	11,749,363	1,094,768	16,897,562	1,422,867
Galveston	50	12	250	37
Other districts	6,555,036	707,667	9,159,030	849,498
	34,625,525	3,676,206	43,887,044	4,542,551
ILLUMINATING.				
Baltimore	4,026,217	264,843	11,271,567	658,941
Boston and Charlestown	302,286	37,779	196,722	24,386
New York	535,945,536	38,903,722	646,872,094	48,449,555
Philadelphia	288,163,576	16,410,530	339,507,776	20,465,249
Galveston	2,872,830	163,975	50,106	5,375
Other districts	74,603,851	3,854,359	131,106,568	6,384,750
	905,924,296	59,635,208	1,129,004,833	75,988,256
LUBRICATING AND PARAFFIN.				
Baltimore	4,649,512	657,746	4,440,400	682,023
Boston and Charlestown	409,262	76,484	225,499	41,583
New York	95,483,024	12,771,107	94,612,963	12,829,262
Philadelphia	44,325,811	4,607,271	43,698,080	4,634,629
Galveston	30,225	5,835	217,939	46,528
Other districts	7,131,021	1,091,910	4,574,143	737,411
	152,028,855	19,210,353	147,769,024	18,971,436
RESIDUUM.				
Boston and Charlestown	464,500	14,510	644,832	22,202
New York	2,564,869	95,997	1,682,976	82,128
Philadelphia	44,803,506	1,477,635	34,663,273	1,224,596
Galveston	1,473,585	44,208	....	....
Other districts	26,468,294	895,232	40,560,602	1,464,437
	75,774,754	2,527,582	77,551,683	2,793,363
Grand total	1,294,659,979	91,383,064	1,547,402,601	108,815,455

RECAPITULATION BY KINDS, IN GALLONS.

Crude	126,306,549	$6,333,715	149,190,017	$6,519,849
Naphtha	34,625,525	3,676,206	43,887,044	4,542,551
Illuminating	905,924,296	59,635,208	1,129,004,833	75,988,256
Lubricating and paraffin	152,028,855	19,210,353	147,769,024	18,971,436
Residuum	75,774,754	2,527,582	77,551,683	2,793,363
	1,294,659,979	91,383,064	1,547,402,601	108,815,455

RECAPITULATION BY PORTS, IN GALLONS.

Baltimore	8,677,234	$922,892	15,744,392	$1,349,445
Boston and Charlestown	1,194,864	132,078	1,114,569	94,856
New York	650,714,688	53,666,577	797,465,417	65,916,968
Philadelphia	464,560,515	28,388,789	459,997,705	29,490,888
Galveston	9,198,389	455,268	319,330	54,257
Other districts	160,314,289	7,817,460	272,761,188	11,909,041
Grand total	1,294,659,979	91,383,064	1,547,402,601	108,815,455

Exports of mineral oils from the United States in 1908, by months, in gallons.

	Quantity.	Value.
January	107,322,016	$7,830,355
February	116,140,370	8,008,708
March	122,363,300	9,416,813
April	118,900,738	9,207,013
May	140,940,632	9,906,110
June	135,950,594	9,805,473
July	150,681,620	10,347,268
August	137,039,268	9,272,545
September	144,481,414	9,860,970
October	143,221,807	9,379,026
November	104,530,658	7,375,916
December	125,830,184	8,405,258
	1,547,402,601	108,815,455

The following table exhibits the total production of crude petroleum from 1902 to 1908, in barrels and in gallons, also the separate derivatives exported and their value, together with their sum and value.

Quantity of crude petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1902 to 1908, inclusive, in gallons.

Year.	Production.		Exports.			
					Mineral, refined or manufactured.	
	Barrels of 42 gallons.	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Naphtha, benzine, gasoline, etc.	
1902	88,766,916	3,728,210,472	145,233,723	$6,331,011	19,682,637	$1,392,771
1903	100,461,337	4,219,376,154	126,511,687	6,782,136	12,973,153	1,518,541
1904	117,080,960	4,917,400,320	111,176,476	6,350,682	24,989,422	2,321,714
1905	134,717,580	5,658,138,360	126,185,187	6,085,592	28,419,930	2,214,609
1906	126,493,936	5,312,745,312	148,045,315	7,731,226	27,544,939	2,488,401
1907	166,095,335	6,976,004,070	126,306,549	6,333,715	34,625,525	3,676,206
1908	179,572,479	7,542,044,118	149,190,017	6,519,849	43,887,044	4,542,551

Year.	Exports.							
	Mineral, refined or manufactured.				Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total exports.	
	Illuminating.		Lubricating (heavy paraffin, etc.).					
1902	778,800,978	$49,079,055	82,200,503	$10,872,154	38,315,760	$922,152	1,064,233,601	$68,597,143
1903	691,837,234	51,355,668	95,621,941	12,690,065	9,753,240	282,129	936,697,255	72,628,539
1904	761,358,155	58,384,273	89,688,123	12,393,382	34,904,100	1,174,156	1,022,116,276	80,624,207
1905	881,450,388	54,900,649	113,730,205	14,312,383	70,727,877	2,127,696	1,220,513,587	79,640,929
1906	878,274,104	54,858,312	151,268,522	18,689,622	64,644,765	1,971,305	1,269,777,645	85,738,866
1907	905,924,296	59,635,208	152,028,855	19,210,353	75,774,754	2,527,582	1,294,659,979	91,383,064
1908	1,129,004,833	75,988,256	147,769,024	18,971,436	77,551,683	2,793,363	1,547,402,601	108,815,455

Exports of domestic crude petroleum from Pacific ports during the calendar years 1907 and 1908 were as follows:

Exports of crude petroleum from Pacific ports in 1907 and 1908, in gallons.

Customs district.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
From—				
Los Angeles	14,880,000	$241,000	20,720,433	$446,386
Puget Sound	3,615,531	65,949	3,814,301	73,017
San Diego	1,700	135		
San Francisco	43,749,446	702,128	64,099,635	1,018,802
	62,246,677	1,009,212	88,634,369	1,538,205
To—				
Alaska	9,104,300	143,506	11,891,375	176,483
Canada	3,264,031	58,083	3,492,151	59,765
Chile	1,546,200	29,537	4,578,000	65,400
Guatamala	1,890,000	45,000	2,793,000	66,500
Hawaii	38,916,400	581,905	47,719,900	802,325
Japan	2,100,000	50,000	10,934,433	262,486
Mexico	1,513,700	45,135		
Panama	3,906,000	55,800	7,224,000	105,200
Salvador	5,500	230	1,100	33
Other	546	16	410	13
	62,246,677	1,009,212	88,634,369	1,538,205

FOREIGN MARKETS.

In the following table is given a statement showing the foreign markets for our oil in the four fiscal years ending June 30, 1908:

Exports of petroleum in its various forms from the United States for the fiscal years 1905–1908, by countries and kinds, in gallons.

Country and kind.	Year ending June 30—			
	1905.	1906.	1907.	1908.
CRUDE.				
Europe:				
France	47,015,325	55,103,511	47,777,692	40,555,219
Germany	5,669,934	6,543,989	4,936,082	6,485,413
Netherlands	774,085			
Spain	11,822,756	13,490,077	8,603,703	9,526,563
United Kingdom	14,075,577	19,131,352	12,660,797	8,934,223
Other Europe	529	1,250	897,520	2,522
	79,358,206	94,270,179	74,875,794	65,503,940
North America:				
Mexico	14,036,517	14,366,495	19,992,434	17,523,440
Cuba	7,440,234	6,266,626	5,385,898	5,040,720
Dominion of Canada	22,220,665	23,882,943	22,571,811	28,577,508
Panama		27,963	3,398,100	5,562,745
Other North America	3,073	45,192	5,305,767	906,405
	43,700,489	44,561,256	53,255,910	57,610,818
South America	315	850,180	23,200	3,365,728
Japan			1,075	8,742,789
All other countries		7,000	20,833	300
Total crude	123,059,010	139,688,615	128,175,737	135,223,575
REFINED.				
Naphtha.				
Europe:				
France	8,980,020	8,417,101	5,623,747	10,485,796
Germany	3,258,042	3,782,176	492,865	2,074
Sweden	268,354	259,648	336,045	1,267,611
United Kingdom	11,806,289	12,888,828	7,222,433	6,843,892
Other Europe	2,393,251	1,884,941	3,016,619	2,701,661
	26,705,956	27,232,694	16,691,709	21,301,034

Exports of petroleum in its various forms from the United States for the fiscal years 1905–1908, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30— 1905.	1906.	1907.	1908.
REFINED—continued.				
Naphtha—Continued.				
North America	1,645,855	1,980,814	4,770,891	7,994,179
West Indies	32,042	80,338	131,825	132,171
South America	502,955	1,095,499	1,934,204	2,499,971
Asia and Oceania	1,572,965	1,664,071	2,214,135	3,588,315
Africa	356,882	703,278	614,290	726,700
	4,110,699	5,524,000	9,665,345	14,941,336
Total naphtha	30,816,655	32,756,694	26,357,054	36,242,370
Illuminating.				
Europe:				
Belgium	39,526,415	43,478,987	47,942,197	48,597,412
Denmark	15,550,986	18,120,251	16,123,410	17,873,509
France	9,875,589	22,739,414	32,632,548	52,752,810
Germany	126,577,304	110,336,514	120,183,398	151,802,286
Italy	23,048,026	28,979,309	22,627,583	22,926,445
Netherlands	110,037,453	123,208,276	113,779,776	126,335,611
Sweden and Norway	25,447,181	25,626,562	29,799,154	37,738,705
United Kingdom	174,057,928	190,383,239	182,328,955	206,875,262
Portugal	4,482,064	6,021,243	5,265,000	7,759,171
Other Europe	1,336,875	3,569,867	1,395,847	4,002,069
	529,939,821	572,463,662	572,077,868	676,663,280
North America:				
British North America	13,767,128	11,263,304	10,088,253	6,196,631
Central America	1,462,787	2,014,071	2,014,242	2,424,129
Mexico	461,266	2,095,939	2,495,070	764,067
West Indies—				
British	2,538,784	2,679,322	2,878,322	2,777,266
Other	3,728,017	2,901,690	3,264,340	2,885,350
Other North America	709,500	573,702	512,331	653,375
	22,667,482	21,528,028	21,252,558	15,700,818
South America:				
Argentina	15,818,832	14,430,159	14,900,929	18,532,187
Brazil	21,389,827	24,198,146	24,528,640	24,359,423
Chile	5,945,330	7,263,136	5,842,470	6,250,448
Uruguay	2,918,600	4,286,600	4,875,966	5,158,182
Venezuela	1,259,776	1,236,512	1,422,441	1,207,665
Other South America	3,391,885	3,520,193	3,510,906	3,557,761
	50,724,250	54,934,746	55,081,352	59,065,666
Asia:				
Chinese Empire	89,368,014	54,376,377	77,913,487	103,737,770
Hongkong	18,660,090	5,561,590	12,048,815	11,107,670
East Indies—				
British	24,853,070	38,204,743	37,837,841	39,173,434
Dutch	9,798,770	12,039,360	13,475,350	11,786,410
Other East Indies	1,242,000	....	2,441,190	5,331,150
Japan	26,824,694	42,787,890	43,810,870	60,540,424
Other Asia	4,194,710	11,923,490	8,775,675	7,973,490
	174,941,348	164,893,450	196,303,228	239,650,348
Oceania:				
British Australasia	21,633,821	20,618,140	21,621,640	22,129,092
Philippine Islands	7,358,810	1,641,178	6,141,490	10,097,393
Other Oceania	4,770	1,370	4,410	1,285
	28,997,401	22,260,688	27,767,540	32,227,770
British Africa	11,621,470	13,477,323	9,976,024	10,966,114
Other Africa	3,990,181	14,803,313	12,070,862	7,451,905
	....	....	22,046,886	18,418,019
Total illuminating	822,881,953	864,361,210	894,529,432	1,041,725,901

Exports of petroleum in its various forms from the United States for the fiscal years 1905–1908, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30			
	1905.	1906.	1907.	1908.
REFINED—continued.				
Lubricating.				
Europe:				
Belgium	6,212,754	12,719,017	10,582,303	9,706,311
France	8,755,856	19,007,626	15,241,696	19,943,853
Germany	12,385,112	19,229,818	19,591,795	22,158,084
Italy	3,528,671	4,974,497	6,139,766	5,845,997
Netherlands	6,569,410	9,485,260	8,808,058	9,650,719
United Kingdom	35,571,115	46,245,278	42,141,248	50,427,085
Other Europe	3,514,778	5,736,974	5,648,556	6,936,297
	76,537,696	117,398,470	108,153,422	124,668,346
North America	2,603,403	3,244,991	4,344,831	4,287,590
West Indies	786,106	941,191	1,753,262	1,240,239
South America	3,621,853	4,840,251	5,402,478	6,057,608
Asia and Oceania	11,798,775	16,622,725	14,340,665	20,203,987
Africa	2,009,363	3,063,074	2,145,568	3,306,130
	20,819,500	28,712,232	27,986,804	35,095,554
Total lubricating	97,357,196	146,110,702	136,140,226	159,763,900
Residuum (barrels).				
Europe	1,101,804	1,688,741	63,650,768	65,979,758
North America	59,768	95,451	1,323,710	4,467,937
All other countries	3,889	2,280	253,531	134,127
Total residuum	1,165,461	1,786,472	65,228,009	70,581,822

PRICES.

In the following tables the prices per gallon of refined oils of 70° Abel test are given:

Weekly prices of refined petroleum in the United States in 1908, at New York, in cents per gallon.

Week ending—	Refined oil. New York.			Week ending—	Refined oil. New York.		
	Bulk.	Cases.	Barrels.		Bulk.	Cases.	Barrels.
January 4	5.00	10.90	8.75	July 4	5.00	10.90	8.75
January 11	5.00	10.90	8.75	July 11	5.00	10.90	8.75
January 18	5.00	10.90	8.75	July 18	5.00	10.90	8.75
January 25	5.00	10.90	8.75	July 25	5.00	10.90	8.75
February 1	5.00	10.90	8.75	August 1	5.00	10.90	5.75
February 8	5.00	10.90	8.75	August 8	5.00	10.90	8.75
February 15	5.00	10.90	8.75	August 15	5.00	10.90	8.75
February 22	5.00	10.90	8.75	August 22	5.00	10.90	8.75
February 29	5.00	10.90	8.75	August 29	5.00	10.90	8.75
March 7	5.00	10.90	8.75	September 5	5.00	10.90	8.75
March 14	5.00	10.90	8.75	September 12	5.00	10.90	8.75
March 21	5.00	10.90	8.75	September 19	5.00	10.90	8.50
March 28	5.00	10.90	8.75	September 26	5.00	10.90	8.50
April 4	5.00	10.90	8.75	October 3	5.00	10.90	8.50
April 11	5.00	10.90	8.75	October 10	5.00	10.90	8.50
April 18	5.00	10.90	8.75	October 17	5.00	10.90	8.50
April 25	5.00	10.90	8.75	October 24	5.00	10.90	8.50
May 2	5.00	10.90	8.75	October 31	5.00	10.90	8.50
May 9	5.00	10.90	8.75	November 7	5.00	10.90	8.50
May 16	5.00	10.90	8.75	November 14	5.00	10.90	8.50
May 23	5.00	10.90	8.75	November 21	5.00	10.90	8.50
May 30	5.00	10.90	8.75	November 28	5.00	10.90	8.50
June 6	5.00	10.90	8.75	December 5	5.00	10.90	8.50
June 13	5.00	10.90	8.75	December 12	5.00	10.90	8.50
June 20	5.00	10.90	8.75	December 19	5.00	10.90	8.50
June 27	5.00	10.90	8.75	December 26	5.00	10.90	8.50

Wholesale prices of refined petroleum at New York at the first of each month, 1904–1908.

Month.	1904.			1905.			1906.			1907.			1908.		
	Date.	Cents per gallon. In barrels.	Cents per gallon. In cases.	Date.	Cents per gallon. In barrels.	Cents per gallon. In cases.	Date.	Cents per gallon. In barrels.	Cents per gallon. In cases.	Date.	Cents per gallon. In barrels.	Cents per gallon. In cases.	Date.	Cents per gallon. In barrels.	Cents per gallon. In cases.
January	6	9.10	11.80	4	7.65	10.35	3	7.60	10.30	5	7.50	10.00	4	8.75	10.90
February	3	9.10	11.80	1	7.25	9.95	7	7.60	10.30	2	7.75	10.25	1	8.75	10.90
March	2	8.75	11.40	1	7.25	9.95	7	7.60	10.30	2	7.75	10.25	7	8.75	10.90
April	6	8.50	11.20	5	7.15	9.85	4	7.60	10.30	6	8.20	10.65	4	8.75	10.90
May	4	8.15	10.85	3	6.95	9.65	2	7.60	10.30	4	8.20	10.65	2	8.75	10.90
June	1	8.15	10.85	7	6.90	9.60	6	7.80	10.30	1	8.20	10.65	6	8.75	10.90
July	6	7.95	10.65	5	6.90	9.60	6	7.80	10.30	6	8.45	10.90	4	8.75	10.90
August	3	7.70	10.40	2	6.90	9.60	2	7.80	10.30	3	8.45	10.90	1	8.75	10.90
September	7	7.85	10.55	6	6.90	9.60	7	7.50	10.00	7	8.45	10.90	5	8.75	10.90
October	5	7.95	10.65	4	7.60	10.30	6	7.50	10.00	5	8.45	10.90	3	8.50	10.90
November	2	7.95	10.65	1	7.70	10.40	3	7.50	10.00	2	8.75	10.90	7	8.50	10.90
December	7	7.95	10.65	6	7.60	10.30	1	7.50	10.00	7	8.75	10.90	5	8.50	10.90

Monthly average prices, in cents per gallon, of petroleum exported from the United States in bulk, 1905–1908.

Month.	1905.		1906.		1907.		1908.	
	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.
January	5.3	6.6	5.4	6.2	5.3	6.3	4.9	6.5
February	5.4	6.2	5.3	6.4	4.9	6.1	4.7	6.4
March	5.3	6.8	5.3	6.5	4.8	6.8	5.4	7.1
April	4.5	7.0	5.2	6.2	5.3	6.8	4.5	7.2
May	4.6	5.9	5.1	6.3	4.1	6.1	3.3	7.3
June	4.9	5.9	5.2	6.8	5.8	6.8	5.6	6.8
July	4.8	5.9	5.1	6.3	5.6	6.8	4.6	7.0
August	4.1	6.1	5.3	6.2	5.5	6.8	3.8	6.8
September	4.7	5.8	4.9	6.0	4.8	6.6	4.3	6.7
October	4.8	6.2	5.2	6.3	4.9	6.6	4.9	6.1
November	4.5	6.5	5.2	5.9	4.9	6.6	3.8	6.6
December	5.1	6.4	5.3	6.1	3.7	6.6	3.6	6.4

ANALYSES OF CRUDE PETROLEUM.

The systematic examination of all the varieties of crude petroleum found in the United States has been continued. The series representative of the Mid-Continent field collected by J. P. Dunlop has been examined and the results are published in Bulletin 381. A summary of these results is given below. A representative series of West Virginia oils has been collected in cooperation with the State Geological Survey of West Virginia, and is in course of examination. A few results are here published. Samples representative of the Louisiana pools, and individual specimens from other States have also been examined, and the results are published below.

Many analyses of California oils were made during the year by Irving Allen and are to be published as a bulletin.

Analyses of crude petroleum.[a]

Serial No.	Collected from—	Location of well.	Number of well.	Depth of well.	Physical properties. Gravity at 60° F. Specific.	Baumé.	Color.	Distillation by Engler's method. Begins to boil at ° C.	By volume. To 150° C. Cubic centimeters.	Specific gravity.	150°-300° C. Cubic centimeters.	Specific gravity.	Residuum. Cubic centimeters.	Specific gravity.	Total. Cubic centimeters.	Paraffin.	Asphalt.
		LOUISIANA.															
		Caddo Parish.		*Feet.*													
La. 1	Well	Hostetter farm, Mooringsport			0.8187	41.0	Black	138	3.0		55.0	0.7778	40.4	0.8866	98.4		0.09
La. 2	do	Caddo Oil and Mineral Co., Gilbert well	1		.8264	39.4	do	136	1.5		49.0	.7778	49.1	.8805	99.6		.25
La. 3	Tank	Frank Filer Lease, NW. ¼ SE. ¼ sec. 7, T. 15, R. 20.	1	2,250	.9211	22.0	do	200			12.0	.8510	82.9	.9061	100.9		.91
La. 4	Well	Old Caddo Oil and Gas Co., E. K. Smith's land.	1	1,620	.8723	30.5	do	210			28.0	.8299	69.5	.8895	97.5		.14
La. 5	do	Richardson well, NW. ¼ NW. ¼ sec. 7, T. 15, R. 20.	2	2,245	.8929	26.8	do	173			20.0	.8408	79.0	.9061	99.0		.50
La. 6	do	Black Bayou Oil Co., SW. ¼ sec. 10, T. 15, R. 20.	1	2,220	.9150	23.0	do	210			18.0	.8450	81.2	.9138	99.2		.24
La. 7	do	Dawes well, 1 mile southeast of Vivian, NW. ¼ NE. ¼ sec. 36, T. 22 N., R. 16 W.	1	1,050	.9253	21.3	do	265			17.0	.8406	85.9	.9302	102.9		.22
La. 8	do	Caddo Oil and Gas Co., E. K. Smith's farm.	4	2,260	.9211	22.0	Brown	200			14.0	.8142	59.0	.8974	73.0		.34
La. 9	do	Caddo Oil and Gas Co., E. K. Smith's farm, SE. ¼ SW. ¼ sec. 1, T. 16, R. 20.	5		.8889	27.5	Black	220			18.0	.8406	79.4	.9003	97.4		.64
La. 10	do	Richardson Oil Co., NE. ¼ NW. ¼ sec. 32, T. 15 W., R. 21 N.	4	2,132	.9121	23.5	do	220			16.5	.8713	66.6	.9241	83.1		.54
		WYOMING.															
		Fremont County.															
Wyo. 1	Shale Spring	Oil Spring reserve, No. 12 Shale Spring, T. 1 S., R. 1 EWM.			.8573	33.3	Light green	143	Trace.		51.0	.8271	48.7	.8929	99.7		
Wyo. 2	Tar Spring	Shoshone Reservation			.9950	10.7	Black										
Wyo. A	Well	Big Horn Basin			.8315		Transparent red.	77	14.0	0.7220	45.5	.7800					

[a] These are additional to the analyses published in the report for 1907.

Analyses of crude petroleum—Continued.

Serial No.	Collected from	Location of well	Number of well	Depth of well	Physical properties: Gravity at 60° F.: Specific.	Physical properties: Gravity at 60° F.: Baumé.	Color.	Distillation by Engler's method: Begins to boil at °C.	By volume: To 150° C.: Cubic centimeters.	By volume: To 150° C.: Specific gravity.	By volume: 150°–300° C.: Cubic centimeters.	By volume: 150°–300° C.: Specific gravity.	By volume: Residuum: Cubic centimeters.	By volume: Residuum: Specific gravity.	By volume: Total: Cubic centimeters.	Paraffin.	Asphalt.
		COLORADO.															
Colo. 385	Well	United Oil Co., Florence, NE. ¼ NE. ¼ sec. 21, T. 19 S., R. 69 W.	385	2,455	0.8750	30.0		122	1.5		27.0	0.7988	70.2	0.9079	98.7	9.23	
		OKLAHOMA.															
		Creek County.															
Okla. 41	Well	Glenn pool, Pittman farm, sec. 7, T. 17 N., R. 12, Argue & Compton, Tulsa	11	1,500	.8450	35.5	Black	105	8.5	.7566	42.0	.8001	49.9	.9042	100.4	6.98	0.45
		Muskogee County.															
Okla. 60	Well	New field, Evans lease, Julia Oil Co., Muskogee	1	1,553	.8328	38.1	Green	97	11.0	.7332	36.0	.7960	52.8	.8866	99.8	7.64	0
Okla. 66	do	Old field, Pioneer Oil and Gas Co., Muskogee	1-2-3	1,000	.8216	40.4	Light olive green	110	5.5	.7415	46.0	.7812	43.7	.8745	95.2	3.88	0
		Pawnee County.															
Okla. 77	Well	Cleveland pool, Ohio and Indiana Oil Co., Cleveland	8-9		.8516	34.4	Dark green	117	4.5	.7670	39.0	.8060	55.9	.8990	99.4	6.62	.30
		Osage County.															
Okla. 88	Well	Bartlesville pool, lot 32, Illuminating Oil Co., Bartlesville	20	1,500	.8547	33.8	do	113	3.5	.7514	44.0	.7868	52.4	.9009	99.9	7.90	1.12
		Rogers County.															
Okla. 90	Wells	Chelsea pool, sec. 11, T. 24, R. 16, Bennett lease, H. M. Adams, Chelsea	1	498	.8516	34.4	Dark brown	97	6.0	.7206	35.0	.7924	54.6	.9272	95.6	4.16	2.19

		Nowata and Rogers counties.															
Okla 101	Pipe line	Shallow Sand pool, Prairie Oil and Gas Co., Station 45, Nowata			[illegible]	[illegible]	Black	100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Marshall County.															
Okla 111	Well	McMillan Oil Co., Madill, sec. 5, T. 5 S., R. 5 E.	[illegible]	[illegible]	[illegible]	[illegible]	Light green	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		KANSAS.															
		Chautauqua County.															
Kans 109	Pipe line	Prairie Oil and Gas Co., Peru Station, Independence			[illegible]	[illegible]	Black	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Montgomery County.															
Kans 110	Pipe line tank	Bolton pool, Prairie Oil and Gas Co., station 5, Independence			[illegible]	[illegible]	do	100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Allen County.															
Kans 127	Well	Chanute pool, Beach lease, Fox Oil and Gas Co., Chanute	[illegible]	[illegible]	[illegible]	[illegible]	Dark green	100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Neosho County.															
Kans 131	Tank	Webb lease, Heathland Oil and Gas Co., Erie			[illegible]	[illegible]	Black	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		ILLINOIS.															
		Crawford County.															
Ill 50	Well	W. C. Jones, Robinson, NW. ¼ SW. ¼ sec. 35, T. [illegible], R. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Dark green	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Marion County.															
Ill 51	Well	Near Junction City, NW. ¼ sec. [illegible], T. [illegible], R. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ill 53	do	do	[illegible]	[illegible]	[illegible]	[illegible]	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		KENTUCKY.															
Ky 1	Well	H. M. Caldwell, Monticello			[illegible]	[illegible]	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Analyses of crude petroleum—Continued.

Serial No.	Collected from—	Location of well.	Number of well.	Depth of well.	Physical properties. Gravity at 60° F. Specific.	Physical properties. Gravity at 60° F. Baumé.	Color.	Distillation by Engler's method. Begins to boil at ° C.	By volume. To 150° C. Cubic centimeters.	By volume. To 150° C. Specific gravity.	By volume. 150°–300° C. Cubic centimeters.	By volume. 150°–300° C. Specific gravity.	By volume. Residuum. Cubic centimeters.	By volume. Residuum. Specific gravity.	By volume. Total. Cubic centimeters.	Paraffin.	Asphalt.
		WEST VIRGINIA.															
		Pleasants County.															
		Washington Township:															
W. Va. 1.	Well	Elmer Edmunds & Co., Big Injun Sand, St. Marys.	....	1,260	.7756	50.3	Green	53	20.0	0.6950	41.0	0.7673	35.5	0.8584	96.5	......	0.00
W. Va. 2.	do	Smith Bros. & Sweeney, St. Marys	....	1,234	.7883	47.6	do	73	15.0	.7076	43.5	.7688	39.4	.8578	97.9	9.00	.00
W. Va. 3.	do	Sweeney Bros. & Co., Keener Sand, St. Marys.	....	1,327	.8005	44.9	do	97	14.0	.7173	42.0	.7700	43.4	.8573	99.4	6.68	.00
W. Va. 4.	do	Ohio and West Virginia Oil Co., Keener Sand, St. Marys.	....	1,330	.7865	48.0	do	68	18.0	.7050	39.0	.7716	39.3	.8587	96.3	7.86	.00
W. Va. 5.	do	Do	....	1,365	.7865	48.0	do	59	20.0	.7080	36.0	.7744	39.1	.8600	95.1	8.43	.00
W. Va. 6.	do	J. D. Dinsmore & Co, Big Injun Sand, St. Marys.	....	1,673	.7870	47.9	do	70	16.5	.7111	41.0	.7694	34.5	.8573	92.0	5.00	.00
W. Va. 7.	do	Ohio and West Virginia Oil Co., First Cow Run Sand, St. Marys.	....	590	.8041	44.1	do	89	18.0	.7256	39.5	.7818	42.8	.8653	100.3	8.92	.00
W. Va. 9.	do	Ohio and West Virginia Oil Co., Salt Sand, St. Marys.	....	1,130	.8074	43.4	do	85	16.0	.7202	37.0	.7784	46.2	.8663	99.2	5.46	.00
W. Va. 10	do	J. D. Dinsmore & Co., First Cow Run Sand, St. Marys.	....	546	.8041	44.1	do	87	10.9	.7220	45.0	.7686	44.4	.8621	99.4	5.56	.00
W. Va. 8.	do	Grant Township: N. Y. Producers' Oil Co., Berea Sand, Belmont Pool.	....	1,400	.7870	47.9	do	53	27.5	.7093	33.0	.7826	36.7	.8666	97.2	2.45	.00
W. Va. 11	do	Jefferson Township: Dinsmore Oil Co., First Cow Run Sand, St. Marys.	....	......	.7982	45.4	do	74	8.0	.7165	43.5	.7686	42.4	.8613	94.0	6.93	.00

FOREIGN OIL FIELDS.

MEXICO.

The following report on the oil fields of Mexico, by Dr. C. W. Hayes, chief geologist, was transmitted to the Senate in response to a Senate resolution:

"The conclusions of general public interest derived from my personal inspection of the Mexican oil fields are briefly as follows:

While these fields promise to yield a large quantity of crude oil, its quality is such that it can not compete under present conditions in the markets of the United States or Europe with the higher-grade petroleum of the Appalachian, Illinois, or Mid-Continent fields. Further, the conditions are such that the demand for fuel oil and refined products in Mexico exceeds the supply available at present or in sight in the near future. There is practically no coal in Mexico, and the railroads now dependent chiefly on Texas, Oklahoma, and English coal could consume several times the present production of oil if it were generally adopted as fuel. The increased production in the Mexican fields therefore will affect the United States by reducing the demand for coal, by reducing the demand for high-grade crude oil for refining to supply the local market, and to some extent by competing in the European market with American refined products.

Finally, the conditions in the Mexican fields are not favorable for the small operator, and it is highly probable that production as well as refining will remain in the control of a very few strong companies. The geological conditions under which the oil occurs are such as to increase the hazards and uncertainties encountered in the development of an oil field, and it is probable that both the difficulty of securing a steady supply of oil and the average cost of production will be correspondingly increased."

The best available estimate of the production of crude petroleum in 1907 and 1908 in Mexico is given below:

Production of crude petroleum in Mexico in 1907 and 1908.

1907	barrels	1,000,000
1908	do	3,481,410

The following table shows the quantity of crude petroleum, naphtha, and illuminating oil imported from the United States into Mexico in 1906, 1907, and 1908:

Imports of petroleum and its products from the United States into Mexico, years ending June 30, 1906, 1907, and 1908.

[Gallons.]

Kind of oil.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Crude	14,366,495	$766,353	19,992,434	$1,037,226	17,523,440	$901,115
Naphtha	100,674	20,183	133,147	22,069	79,686	17,756
Illuminating	2,095,939	203,241	2,495,070	252,020	764,067	114,655
Lubricating	1,097,746	212,970	1,255,991	236,074	839,966	178,865
	17,660,854	1,202,747	23,876,642	1,547,389	19,207,159	1,212,391

Quantity and value of mineral oils imported from the United States into Mexico, 1903 to 1908, inclusive.

[Gallons.]

Year ending June 30—	Mineral.			
	Crude.		Refined, including residuum.	
1903	9,859,154	$559,332	1,153,015	$218,272
1904	10,938,448	663,575	1,179,894	222,005
1905	14,036,517	786,613	1,216,421	224,061
1906	14,366,495	766,353	3,295,325	616,479
1907	19,992,434	1,037,226	3,906,472	511,990
1908	17,523,440	901,115	1,683,719	311,276

CANADA.

Production.—In the following table is given the total production of crude petroleum in Canada from 1902 to 1908, inclusive, as reported by the Geological Survey of Canada:

Production of crude petroleum in Canada, 1902–1908.

Year.	Quantity (barrels).	Value.	Average price per barrel.
1902	530,624	$951,190	$1.79¼
1903	486,637	1,048,974	2.15½
1904	552,575	984,310	1.78
1905	634,095	856,028	1.35
1906	569,753	761,760	1.337
1907	788,872	1,057,088	1.34
1908	527,987	747,102	1.41½

Prices.—The average monthly prices per barrel from 1904 to 1908, inclusive, are given in the following table:

Average monthly prices per barrel for crude oil at Petrolia, 1904–1908.

Month.	1904.	1905.	1906.	1907.	1908.	Month.	1904.	1905.	1906.	1907.	1908.
January	$2.36	$1.42	$1.38	$1.34	$1.34	August	$1.54	$1.30	$1.38	$1.38	$1.44
February	2.34	1.37	1.38	1.35	1.34	September	1.52	1.33	1.34	1.38	1.44
March	2.24	1.37	1.38	1.37	1.34	October	1.56	1.39	1.34	1.38	1.44
April	2.17	1.33	1.40	1.38	1.44	November	1.55	1.39	1.34	1.38	1.44
May	2.13	1.31	1.40	1.38	1.44	December	1.53	1.38	1.34	1.38	1.44
June	1.84	1.30	1.40	1.38	1.44						
July	1.59	1.30	1.38	1.37	1.44	The year	1.78	1.35	1.3734	1.37	1.41½

In the following table, furnished by the Imperial Oil Company Limited), is given the production of petroleum in Canada during the ears 1906 to 1908, by districts:

Production of crude petroleum in Canada from 1906 to 1908, by districts, in barrels of 35 imperial gallons.

District.	1906.	1907.	1908.
utton	18,597	14,698	12,268
eamington (Staples and Comber and Blytheswood)	35,958	16,210	18,117
othwell	43,836	40,556	39,820
ichardson (Chatham)	1,376	940	2,883
hamesville	1,585	1,139	853
oore Township	53,030	32,720	25,667
il Springs	68,100	55,813	61,252
erlin (E. Tilbury and Raleigh)	115,400	344,358	170,589
oatsworth (Romney)	....	49,784	11,165
etrolia (includes all districts not enumerated above)	247,446	206,285	171,019
	585,328	762,503	513,633

PERU.

A bulletin of the Peruvian Mining Engineers Society by V. F. asters gives a very complete account of the geography and geology f the Peruvian oil fields and the characteristics of the oils. Boverton edwood is quoted as the authority for an examination of Negritos etroleum as follows: Color, reddish-brown, fluorescent; specific ravity, at 60° F., 0.841, sulphur 0.0001.

Fractional distillation of Negritos petroleum, Peru.[a]

Tenths.	Temperature of distillation.	Specific gravity of distillate.
	°F.	
1	230–270	0.714
2	270–305	.746
3	305–350	.770
4	350–405	.794
5	405–490	.825
6	490–590	.861
7	590–705	.885
8	705–750	.890
9	750–800	.898

[a] Boverton Redwood, analyst.

The percentages of commercial products were: Benzine, 22.3; erosene (flash point, 73; specific gravity, 0.813), 23.8; lubricating nd intermediate oils, 47.1; coke, 2.8; loss, 4 per cent.

Samples of Zorritos petroleum have been analyzed by G. E. Colvy 1894 and by the American Analysis and Chemical Company in 885, showing approximately 25 per cent of benzine, 28.5 to 35 per ent of kerosene, 17 per cent of lubricating oils, and 31 per cent of esiduum, which the report calls asphalt. The specific gravity of e oil is 0.848 at 60° F., equivalent to 36° B. The lubricating oil istillates contained extremely little paraffin. The color of the crude dark brown with greenish fluorescence. The odor is pleasant. An ltimate analysis by Dr. R. Fresenius in 1887 gave: Carbon, 86.08 er cent; hydrogen, 13.06; oxygen, 0.748; nitrogen, 0.071; and sulhur, 0.041.

At La Brea the petroleum is heavy and black in color, sometimes with a greenish cast; it is evaporated for asphaltic paint.

The chief producing oil district of Peru is at Negritos, the port of shipment being Talara, a few miles distant. Operations in this field cover an area of 4 or 5 square miles, with over 200 producing wells. The production of this field in 1908 was about 72,500 tons, or 19,600 tons more than in 1907. The second district in importance is the Lobitos oil field, situated at Lobitos, a little north of Talara. The production in 1908 was approximately 5,000 tons a month. The third producing district is at Zorritos. Another district, situated near Lake Titicaca, is being developed, and although some good wells have been struck no large sales or export of oil has been undertaken.

The following table gives the production of crude petroleum in Peru from 1904 to 1908, in tons and barrels:

Production of crude petroleum in Peru from 1904 to 1908, in tons and barrels.

Year.	Production.	
	Tons.	Barrels.
1904	46,111	345,834
1905	59,718	447,880
1906	71,324	534,929
1907	98,830	741,226
1908	134,824	1,011,180

NOTE.—Credit is given for information concerning the Peruvian oil fields to Mr. A. Beeby Thompson, London, England, and to Señor F. G. Piaggio, of Callao, Peru.

In the following table is given the production of petroleum and its products in the Zorritos oil field of Peru from 1901 to 1908, inclusive, in gallons:

Production of petroleum in Zorritos oil field of Peru, 1901–1908, in gallons.

Year.	Crude petroleum.	Refined. [a]	Gasoline.	Benzine.
1901	3,135,000	282,430	19,060	
1902	2,489,500	373,250	25,920	
1903	2,060,000	276,100	61,745	
1904	2,080,000	365,000	46,200	
1905	1,584,242	300,000	29,570	
1906	1,781,600	350,000	54,000	10,000
1907	2,750,000	420,000	101,000	20,000
1908	3,000,000	500,000	150,000	30,000

[a] Kerosene.

CHILE.

According to the Daily Consular and Trade Reports, Consul Alfred A. Winslow sends from Valparaiso the report that petroleum and natural gas have been discovered in the township of Carelmapu, in the Province of Llanquihue, Chile, about 500 miles south of Valparaiso, to which he adds:

"Enough gas pressure has been secured to run a cook stove, a heating stove, and two gas jets at one time. Soundings have been made to the depth of 500 feet with good results. Mr. Aurelio Fernández Jara is interested in the present investigation. He proposes to put down a well to the depth of 3,000 feet in order to determine what may be expected. This discovery is made in the vicinity of a fairly rich gold-mining district, and not very far from the site of the extensive steel works being built near Corral."

ARGENTINA

According to the Buenos Aires Review of the River Plata, the Argentine Government has for some time been carrying out a number of borings in various parts of the Republic with a view of obtaining water. In a bore in the Chubut territory near Comodoro Rivadavia a spring of petroleum was found at a depth of 1,738 feet. The discovery is reported to be regarded as very important, and experts have been sent to report fully to the Government.

COLOMBIA.

Consul Isaac A. Manning, of Cartagena, Colombia, advises that recent reports from the Colombian regions about the Gulf of Uraba, between the rivers Atrato and Leon, bring the news that valuable coal deposits have been discovered there; also that a spring has been encountered which flows about a pint of crude petroleum per hour. This is probably an extension of the coal and oil belt, heretofore known to exist, reaching from the vicinity of Cartagena to the valley of Sinu River.

BARBADOS.

E. O. Hovey has published in the Mining World a comprehensive account of the oil indications and developments of Barbados, which shows the oil to contain 3.5 per cent of benzine, 12.5 per cent of lamp oil, 56 per cent of heavier distillates, and 28 per cent of asphalt. The oil resembles the Mexican crudes. The British Admiralty is encouraging exploration in the hope of a naval supply of fuel oil. Thus far the exploitation has been small, but the considerable occurence of solid asphalt (manjak) associated with the oil gives hope for oil developments.

TRINIDAD.

Boring was commenced in August, 1908, near the pitch lake by the New Trinidad Lake Asphalt Company (Limited). At 240 feet indications of oil were found, at 580 feet oil commenced to flow, and at 700 feet it spouted to a height of 70 feet. This was six weeks after drilling commenced. Further operations are in prospect as soon as proper facilities are obtained. This development resulted from the report of E. H. Cunningham-Craig, government geologist.

RUSSIA.

The Russian production increased very slightly in 1908, just as in 1907 and 1906. The developments of light oil in Surakhany were of interest principally from the light character of the oil. Investigations have shown that this oil, while resembling Pennsylvania oil in appearance, is chemically similar to other Russian oils—that is, it is characterized by hydrogenated aromatic hydrocarbons.

Production of crude petroleum in Russia, 1903–1908, by fields.

Year.	Baku.		Groznyi.		Total.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1903	596,581,155	71,618,386	33,094,000	3,972,870	629,675,155	75,591,256
1904	614,115,445	73,723,290	40,095,331	4,813,365	654,210,776	78,536,655
1905	414,762,000	49,791,356	43,057,052	5,168,914	457,819,052	54,960,270
1906	447,520,000	53,723,889	38,373,603	4,606,675	[b] 490,614,603	58,897,311
1907	476,002,000	57,143,097	39,214,612	4,707,637	515,216,612	61,850,734
1908	465,343,000	55,863,504	52,058,895	6,249,567	[c] 518,013,116	62,186,447

[a] 8.33 poods crude=1 United States barrel of 42 gallons.
8 poods illuminating oil=1 United States barrel of 42 gallons.
8.18 poods lubricating oil=1 United States barrel of 42 gallons.
9 poods residuum=1 United States barrel of 42 gallons.
7.50 poods naphtha=1 United States barrel of 42 gallons.
8.3775 poods other products=1 United States barrel of 42 gallons, estimated.
1 pood=36.112 pounds.
1 kopek=1.958 cents.
[b] Includes 4,721,000 poods, or 566,747 barrels, produced in Bereki and Tchimion oil fields in 1906.
[c] Includes 611,221 poods produced at Surakhany.

The total production of crude petroleum on the Apsheron Peninsula and the shipments of the chief petroleum products from Baku to all points from 1902 to 1908 have been as follows:

Total production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku, 1902–1908, in barrels.

Year.	Production.	Shipments from Baku.					
		Illuminating.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
1902	76,414,045	15,026,000	1,750,367	298,657	38,049,555	4,090,036	59,214,615
1903	71,618,386	18,313,125	2,032,347	117,815	33,763,778	3,172,509	57,399,574
1904	73,723,290	19,205,250	1,896,455	159,355	33,622,111	2,249,340	57,132,511
1905	49,791,356	9,209,125	1,303,912	150,045	29,555,777	2,897,359	43,116,218
1906	53,723,889	8,941,125	1,847,799	179,289	22,697,667	4,001,441	37,667,321
1907	57,143,097	11,450,019	1,724,664	565,689	27,833,892	4,290,500	45,864,764
1908	55,863,504	10,682,750	1,754,034	105,163	23,989,778	5,398,200	41,929,925

The division of the production among the districts of the Apsheron Peninsula or Baku field is as follows:

Production of the several districts of the Apsheron Peninsula, 1902–1908, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
1902	12,185,354	32,071,908	16,800,000	15,298,200	58,583	76,414,045
1903	10,642,274	27,663,859	14,398,951	18,882,294	31,008	71,618,386
1904	9,848,380	26,029,292	16,063,505	21,745,618	36,495	73,723,290
1905	6,866,747	16,494,310	11,230,732	15,175,558	24,009	49,791,356
1906	8,142,017	18,739,015	11,489,796	15,317,647	35,414	53,723,889
1907	8,594,118	22,036,734	10,750,901	15,761,344	....	57,143,097
1908	8,363,860	23,727,367	9,392,557	14,379,720	....	55,863,504

Production of crude petroleum from pumping and flowing wells in the Baku field 1906–1908, by districts, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Total.
PUMPING.					
1906	8,142,017	18,513,445	10,436,615	15,282,113	a 52,409,604
1907	8,594,118	21,676,950	10,353,782	15,137,215	55,762,065
1908	8,363,860	23,585,230	9,250,060	13,529,900	54,729,050
FLOWING.					
1906		225,570	1,053,181	35,534	1,314,285
1907		359,784	397,119	624,129	1,381,032
1908		142,137	142,497	849,820	1,134,454

a Includes 35,414 barrels in Binagadi.

Groznyi field.—The following table shows the production in the Groznyi field from 1906 to 1908:

Production of petroleum in the Groznyi oil field, 1906–1908, in barrels.

Wells.	1906.		1907.		1908.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
Pumping	30,041,912	3,606,472	33,840,762	4,062,517	37,741,980	4,530,850
Flowing	8,331,691	1,000,203	5,373,850	645,120	14,316,915	1,718,717
	38,373,603	4,606,675	39,214,612	4,707,637	52,058,895	6,249,567

Well record in the Groznyi field in 1907 and 1908.

Year.	Total wells.	Producing, December 31.	Drilling, December 31.
1907	271	205	37
1908	286	172	42

The following table shows the deliveries of petroleum and petroleum products from the Groznyi district from 1906 to 1908:

Deliveries of petroleum and petroleum products from the Groznyi district, 1906–1908, in barrels.

Year.	Crude oil.	Kerosene.	Benzine.	Residuals.	Total.
1906	150,825	363,649	178,568	2,462,484	3,155,526
1907	209,584	243,170	342,306	2,199,756	2,994,816
1908	164,294	400,139	288,783	3,061,256	3,914,472

The following table shows the shipments of petroleum from Novorossisk from 1906 to 1908:

Shipments of petroleum from Novorossisk, 1906–1908, in barrels.

Year.	Crude oil.	Illuminating.	Benzine.	Residuals.	Total.
1906	486	435,670	86,230	347,858	870,244
1907	770	246,246	299,658	209,812	756,486
1908 a	13,763	141,727	279,938	144,932	580,360

a Eleven months in all.

The receipts of oils at Batum and the deliveries therefrom for the last four years are given in the following table:

Receipts and deliveries of petroleum at Batum, 1905–1908.

Year.	Receipts.		Deliveries.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*
1905	25,743,344	2,647,900	36,763,124	3,781,349
1906	31,607,655	3,247,644	30,999,197	3,188,500
1907	39,467,78	4,059,534	37,073,586	3,813,283
1908	44,625,829	4,434,633	43,250,065	4,325,182

Stocks at Batum.—The following were the stocks of petroleum products held at Batum at the close of the year from 1906 to 1908, in poods and barrels:

Stocks of petroleum at Batum, December 31, 1906–1908.

	1906.		1907.		1908.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
Illuminating	4,408,999	551,125	4,232,000	529,000	3,484,000	435,500
Lubricating	1,160,168	141,830	1,273,000	155,623	1,124,000	137,410
Solar oil					97,000	11,758
Vaseline			69,000	7,909	23,000	2,644
Residuals	257,217	28,580	257,000	28,556	714,000	79,333
	5,826,384	721,535	5,831,000	721,088	5,442,000	666,645

Well record.—In the table following is given a statement of the number and condition of the wells on the Apsheron Peninsula on December 31, 1907 and 1908:

Number and condition of wells in the Baku fields in years ending December 31, 1907 and 1908.

Condition of wells.	Balakhani-Sabunchi.		Romani.		Bibi-Eibat.		Total.	
	1907.	1908.	1907.	1908.	1907.	1908.	1907.	1908.
Completed	145	146	32	34	37	48	214	228
Producing, December 31	2,220	2,211	334	317	375	429	[a] 2,941	2,957
Trial pumping, December 31	878	819	185	151	235	253	1,298	1,223
Drilling, December 31	162	179	34	28	41	24	237	231
Drilling deeper, December 31	191	203	78	80	99	130	368	413
Cleaning out and repairing	413	258	166	151	195	162	774	571
Standing idle	1,020	600	163	100	147	195	1,330	895
Rigs up, ready for drilling	167	170	32	24	33	21	232	215
New wells sunk	196	417	39	51	40	28	275	496
Length of wells drilled, in feet	233,574	34,249	70,310	9,134	118,302	12,901	422,186	56,284

[a] Includes 12 wells in Binagadi.

Stocks in Baku field.—The stocks of petroleum and petroleum products in the Baku field at the close of 1906, 1907, and 1908 were as follows:

Stocks of petroleum in Baku, December 31, 1906–1908, in barrels.

	1906.	1907.	1908.
At oil wells: Crude	930,965	720,288	1,032,413
At refineries:			
Crude	2,187,339	2,028,812	1,239,736
Illuminating	953,751	1,225,000	675,375
Lubricating	387,217	268,949	195,600
Residuals	4,669,882	3,822,222	4,804,333
Other products	92,762	179,051	119,370
	9,221,916	8,244,322	8,066,827

AUSTRIA-HUNGARY.

GALICIA.

As in 1907, production again showed a very heavy increase in 1908, resulting in increased exports to Roumania.

In the following table is given a statement of the production of crude petroleum in Galicia from 1903 to 1908, inclusive, as ascertained by the statistical bureau of the Galizischer Landes-Petroleum-Verein, Lemberg:

Production of crude petroleum in Galicia, 1903–1908.

Year.	Metric centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels of 42 gallons.
1903	7,279,710	5,234,475	1906	7,604,432	5,467,967
1904	8,271,167	5,947,383	1907	11,759,740	8,455,841
1905	8,017,964	5,765,317	1908	17,540,220	12,612,295

[a] 1 metric centner } =100 kilograms (220.462 pounds).
1 quintal.......}

In the following table is given the production of crude petroleum in Galicia in 1907 and 1908, by fields, in tons:

Production of crude oil in Galicia in 1907 and 1908, by fields, in metric tons.[a]

Field.	1907.			1908.
	First half year.	Second half year.	Total.	
East Galicia:				
Tustanowice	....	....	....	1,318,710
Boryslaw	391,300	620,290	1,011,590	266,910
Schodnica	20,450	19,200	39,650	36,480
Urycz	6,950	6,560	13,510	
Mraznica	700	790	1,490	30,022
Other East Galician fields	6,300	5,930	12,230	
West Galicia:				
Potok	7,330	6,520	13,850	
Rogi	4,313	4,720	9,033	
Rowne	841	1,140	1,981	50,640
Krosno	14,660	15,300	29,960	
Tarnawa-Wielopole-Zagorz	7,550	9,840	17,390	18,200
Other West Galician fields	12,640	12,650	25,290	33,060
	473,034	702,940	1,175,974	1,754,022

[a] 1 metric ton=7.1905 barrels of crude petroleum of 42 gallons=2,204.62 pounds.

Of the total production of 1,754,022 tons of crude petroleum in Galicia in 1908, there was delivered to refineries a total of 1,266,560 tons, as compared with 977,168 tons delivered in 1907, an increase of 289,392 tons. The deliveries were as follows:

Deliveries of Galician crude petroleum to refineries in 1907 and 1908, in metric tons.

	1907.	1908.
Delivered to refineries in—		
Galicia and Bucovina	281,344	387,020
Austria	422,829	540,820
Hungary	272,995	338,720
	977,168	1,266,560

Of the total consumption of crude petroleum in 1908, 70,000 tons were consumed as fuel by industries and 6,250 tons were exported—a total consumption of 1,342,810 tons in 1908. The crude stocks in Galicia at the close of 1908 were 1,048,110 tons, as compared with 636,898 tons at the close of 1907, a gain of 411,212 tons.

In the following table are given the imports into and exports of petroleum products from Austria-Hungary in 1907 and 1908:

Imports into and exports of petroleum from Austria-Hungary in 1907 and 1908, in metric tons.

Kind.	1907.		1908.	
	Imports.	Exports.	Imports.	Exports.
Illuminating oils	2,717	141,572	1,868	234,160
Lubricating and other oils	16,079	63,250	16,268	111,060
Benzine	8	12,637	8	25,597
Paraffin	313	14,737	357	28,666
Crude petroleum	18,342	8,250	3,114	6,250
	37,459	240,446	21,615	405,733

ROUMANIA.

In 1908 there was a check to the significant advance in production characteristic of previous years. The total product increased by about 1.5 per cent. This was not at all comparable to the increase of 1907 over 1906. The largest producing district—Bustenari—showed a decreased output, which was slightly more than compensated by an increase in Moreni and in Campina. The production did not suffice for the large increase in refining capacity, so that the importation of crude oil was begun from the excessive supply in Galicia.

Under a new law the experiment is being made of regulating the proportion of refined oil which each refining company shall furnish to the domestic trade, the price being regulated by the price of crude oil.

The statistics given below have been furnished by the Moniteur du Pétrole Roumain.

Production.—In the following table is given the production of Roumania, by districts and months, during the year 1908, in metric tons:

Production of crude petroleum in Roumania in 1908, by districts and months, in metric tons.[a]

Month.	District Prahova.					Dimbovitza.	Buzeu.	Bacau.	Total.
	Bustenari.	Campina-Poiana.	Moreni.	Other.	Total.				
January	37,596	26,234	27,126	5,211	96,167	2,675	722	884	100,448
February	37,730	18,986	26,002	3,763	86,481	2,245	672	910	90,308
March	41,466	19,214	28,941	4,522	94,143	2,206	663	957	97,969
April	40,197	21,738	24,135	3,976	90,046	2,039	559	944	93,588
May	43,502	21,539	26,697	3,953	95,691	2,005	712	1,384	99,792
June	41,432	16,640	22,941	3,702	84,715	1,911	685	1,313	88,624
July	40,163	20,075	29,871	4,196	94,305	1,945	1,062	1,462	98,774
August	38,810	17,406	32,321	4,901	93,438	1,818	1,131	1,378	97,765
September	37,999	20,100	32,425	4,495	95,019	2,105	1,058	1,312	99,494
October	39,131	18,512	30,065	4,405	92,113	2,333	914	1,515	96,875
November	37,601	16,887	27,315	3,610	85,413	2,419	1,221	1,476	90,529
December	37,479	16,494	29,924	4,393	88,290	2,571	1,369	1,331	93,561
	473,106	233,825	337,763	51,127	1,095,821	26,272	10,768	14,866	1,147,727

[a] 1 metric ton=7.19 barrels of 42 gallons.

The production of crude petroleum in Roumania in the last six years has been as follows:

Production of crude petroleum in Roumania, 1903–1908.

	Barrels.		Barrels.
1903	2,763,117	1906	6,378,184
1904	3,599,026	1907	8,118,207
1905	4,420,987	1908	8,252,157

The following table shows the progress made in every branch of the Roumanian petroleum industry during the last four years:

Roumanian petroleum industry, 1905–1908.

[Metric tons.]

	1905.	1906.	1907.	1908.
Crude-oil production	614,870	887,091	1,129,097	1,147,727
Crude oil treated at refineries	510,143	748,798	950,614	1,012,616
Output of refineries:				
Benzine	78,182	114,428	146,263	180,390
Illuminating oil	153,499	221,683	261,684	248,274
Lubricating oils	17,255	53,588	57,337	89,753
Residuals	237,677	333,714	452,685	473,770
Home consumption:				
Benzine	2,696	4,059	5,689	9,055
Illuminating oil	31,558	35,243	38,467	38,422
Lubricating oil	6,307	9,848	9,047	11,955
Residuals	162,243	237,477	332,999	347,323
Exports:				
Benzine	46,696	79,493	89,522	122,332
Illuminating oil and distillate	118,134	190,914	262,489	262,176
Crude, residuals, etc	49,515	54,799	76,062	76,196
Stocks on December 31:				
Benzine	20,084	18,275	47,506	44,783
Illuminating oil	30,144	48,967	36,128	41,541
Lubricating oil and residuals	64,452	67,334	67,816	73,761

Well record.—The well record in Roumania in 1907 and 1908 is shown in the following table:

Well record in Roumania at close of 1907 and 1908, by districts.

District.	December 31, 1907.						December 31, 1908.					
	Boreholes.			Handwells.			Boreholes.			Handwells.		
	Producing.	Drilling.	Abandoned.	Producing.	Sinking.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Sinking.	Abandoned.
Prahova	529	259	233	163	68	506	600	265	271	137	94	452
Dambovitza	12	8	18	101	16	98	15	11	20	83	19	89
Buzeu	......	4	19	63	2	57	7	7	18	59	9	58
Bacau	54	25	55	316	26	416	59	18	50	304	27	486
	595	296	325	643	112	1,077	681	301	359	583	149	1,085

GERMANY.

Although the total product in Germany is unimportant compared with the quantity consumed, still the increase of 30 per cent in 1907 and of over 33 per cent in 1908 is worthy of attention.

In the following table are shown the quantity and value of petroleum produced in the German Empire, by States, from 1901 to 1908, inclusive:

Production and value of petroleum in the German Empire, 1901–1908, by States.

Year.	Alsace-Lorraine.	Prussia and Bavaria.	Total.		Total value.	
	Quantity.	Quantity.	Quantity.			
	Metric tons.	*Metric tons.*	*Metric tons.*	*Barrels (42 gallons).*	*Marks.*	*Dollars.*
1901	19,997	24,098	44,095	313,630	2,950,478	702,213
1902	20,205	29,520	49,725	353,674	3,351,000	797,538
1903	20,947	41,733	62,680	445,818	4,334,000	1,031,492
1904	22,016	67,604	89,620	637,431	5,805,000	1,381,590
1905	21,128	57,741	78,869	560,963	5,207,000	1,239,266
1906	[a] 22,154	59,196	81,350	578,610	5,036,000	1,198,568
1907	[a] 26,124	80,255	106,379	756,631	7,056,000	1,679,328
1908	[a] 28,898	113,002	141,900	1,009,278	9,942,000	2,366,196

[a] Includes Bavaria.

1 metric ton, crude, =7.1126 barrels.

GREAT BRITAIN.

Oil shale.—In the following table is shown the production of oil shale in Great Britain in 1907 and 1908, taken from the Mineral Statistics of the United Kingdom:

Quantity and value of oil shale in Great Britain, 1907–1908, in long tons.

Country.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
England				
Scotland	2,690,028	£806,323		
Wales				
	2,690,028	806,323		

ITALY.

Although production remained stationary in Italy, much interest is shown in the explorations for petroleum.

In the following table will be found the production and value of crude petroleum in Italy from 1901 to 1908. This table is taken from the volumes of the Rivista del Servizio Minerario:

Production of crude petroleum in Italy, 1901–1908.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.	United States barrels.	Lire.	Dollars.
1901	9	2,246	16,150	671,065	129,515
1902	9	2,633	18,933	778,163	150,185
1903	10	2,486	17,876	737,293	142,298
1904	10	3,543	25,476	1,053,294	203,286
1905	9	6,123	44,027	1,826,802	352,573
1906	12	7,451	53,577	2,226,559	429,726
1907	13	8,327	59,875	1,663,300	321,017
1908	13	[a] 8,344	60,000		

[a] Estimated.

1 metric ton, crude, =7.1905 barrels.

INDIA.

The Indian oil fields are comprehensively described in a report by Consul-General William H. Michael in 1908 to the United States Consular Bureau, Washington, D. C. The following table gives the production of petroleum in India from 1902 to 1908 in imperial gallons reduced to barrels of 42 gallons and in rupees reduced to dollars:

Production and value of petroleum in India, 1902–1908.

Year.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupee.[a]	Dollars.
1902	56,607,688	1,617,363	3,267,245	1,058,587
1903	87,859,069	2,510,259	5,315,470	1,722,212
1904	118,491,382	3,385,468	7,109,566	2,303,499
1905	144,798,444	4,137,098	9,063,051	2,936,429
1906	140,553,122	4,015,803	8,613,576	2,790,799
1907	152,045,677	4,344,162	9,150,225	2,968,637
1908	176,646,320	5,047,038	10,530,135	3,416,327

[a] The value of the rupee is taken as 32.44⅓ cents; 15 rupees=£1.

Production of crude petroleum in India, 1904–1908, by provinces, in imperial gallons.

Province.	1904.	1905.	1906.	1907.	1908.
Burma	115,903,804	142,063,846	137,654,261	148,888,002	173,402,790
Eastern Bengal and Assam	2,585,920	2,733,110	2,897,990	3,156,665	3,243,110
Punjab	1,658	1,488	871	1,010	420
	118,491,382	144,798,444	140,553,122	152,045,677	176,646,320

DUTCH EAST INDIES.

In the following table is given the production of crude petroleum in the Dutch East Indies during the years 1903 to 1908, inclusive:

Production of crude petroleum in Dutch East Indies, 1903–1908.

Year.	Metric tons.	Liters.[a]	Barrels.
1903	780,985	920,422,000	5,789,364
1904	1,036,304	1,221,325,000	7,682,014
1905	1,158,360	1,365,173,000	8,586,804
1906	1,168,581	1,377,219,000	8,662,572
1907	1,094,716	1,481,143,158	8,377,099
1908	1,143,243	1,534,644,018	8,752,822

[a] Estimated 1 United States barrel=158.985 liters; 1 liter=1.0567 quarts.

Production of crude petroleum in the Dutch East Indies in 1907 and 1908, by fields.

Field.	1907.		1908.	
	Tons of 1,000 liters.	*Barrels.*	*Tons of 1,000 liters.*	*Barrels.*
Java	165,900	104,349	158,974	99,993
	Tons of 2,240 pounds.		*Tons of 2,240 pounds.*	
Sumatra	940,093	7,400,050	987,816	7,775,706
Borneo	123,250	872,700	123,875	877,123
	....	8,377,099	....	8,752,822

JAPAN.

In the following table is given the production of petroleum in Japan from 1903 to 1908, inclusive:

Production of petroleum in Japan, 1903–1908. [a]

[Barrels of 42 gallons.]

Year.	Crude.		Refined.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*
1903	1,065,116	1,209,971	333,346	378,681
1904	1,249,536	1,419,473	....	....
1905	1,296,482	1,472,804	....	....
1906	1,501,563	1,705,776	582,138	661,309
1907	1,755,464	1,994,207	655,420	744,557
1908	1,815,001	2,061,841	698,833	793,874

[a] Excluding the island of Formosa.

1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

In the following table is given a statement of the production of crude petroleum in Japan, 1905–1908, by fields, as reported by the mining bureau of the department of agriculture and commerce, Tokyo:

Production of crude petroleum in Japan, 1905–1908, by fields.

Field.	1905.	1906.	1907.	1908.
NIIGATA PREFECTURE.				
Echigo:	*Koku.*	*Koku.*	*Koku.*	*Koku.*
Higashiyama	273,844	304,847	342,042	263,667
Nishiyama	271,495	294,277	360,115	492,393
Niitsu	634,704	808,655	970,556	807,002
Kubiki	97,075	76,578	63,572	62,938
Amaze	5,220	7,262	12,447	....
Ojiya	14,180	9,964	6,732	7,097
Others (except Formosa)	....	....	....	6,450
Total quantity	1,296,482	1,501,563	1,755,464	1,639,547
Total value	....	....	....	$3,225,153

The following table, taken from the report of the Nagaoka Chamber of Commerce, gives the production of refined petroleum in Niigata Prefecture in the year 1908:

Production of refined petroleum in Niigata Prefecture in 1908.

Kind.	Quantity.		Value.	
	Koku.	*Barrels.*	*Yen.*	*Dollars.*
Kerosene	548,650	623,266	10,012,863	4,986,406
Solar oil	150,183	170,608	2,380,401	1,185,440
	698,833	793,874	12,393,264	6,171,846

1 yen=$0.498.

Production of crude petroleum in Japan and Formosa in 1906–1908.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1906	1,501,563	1,705,776	4,394	4,992	1,505,957	1,710,768
1907	1,755,464	1,994,207	[a] 14,465	16,432	1,769,929	2,010,639
1908	1,815,001	2,061,841	[a] 8,000	9,088	1,823,001	2,070,929

[a] Estimated.

Production of refined petroleum in Japan and Formosa in 1906–1908.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1906	582,138	661,309	[a] 3,515	3,993	585,653	665,302
1907	655,420	744,557	[a] 11,572	13,146	666,992	757,703
1908	698,833	793,874	[a] 16,986	19,296	715,819	813,170

[a] Estimated.

That the oil fields of Japan are far from supplying the wants of Japan is evident from the following statement taken from the British consular report showing the imports of petroleum during the years 1906 and 1907:

Whence imported.	1906.		1907.	
	Gallons.	Value.	Gallons.	Value.
United States	44,510,557	$4,758,816	44,489,816	$4,734,626
Dutch India	12,084,279	1,137,529	24,094,321	2,250,877
Asiatic Russia	1,184,202	94,371	1,581,477	148,245
All other countries	1,649,969	147,904	12	2
	59,429,008	6,138,793	70,165,626	7,133,750

Consumption of kerosene in Japan, 1904–1907.

Year.	Domestic.	Imported.	Total.	
	Koku.	*Koku.*	*Koku.*	*Barrels.*
1904	562,143	2,041,295	2,603,438	2,957,506
1905	596,580	1,467,582	2,064,162	2,344,888
1906	686,483	1,485,725	2,172,208	2,467,628
1907 [a]	389,126	671,102	1,060,228	1,204,419

[a] First six months.

PROSPECTING IN FOREIGN COUNTRIES.

In Persia the existence of petroleum has been recognized for many years, but the general interest aroused in fuel oils for naval purposes, especially by the British Admiralty, has led to much prospecting, and three wells were drilled near Shuster, south Persia, which showed moderate outputs of petroleum similar to Russian oil and much natural gas. The Egyptian oil trust has opened the long-known oil indications along the Gulf of Suez, with reported successful results.

Nigeria, in West Africa, also began definite exploration of the petroleum indications, and some interest was aroused in the Orange Colony in South Africa. Chance finds of oil in excavations for other purposes are noted in Pas-de-Calais, in the north of France, and near Villamartin, in Spain. At Roma, 300 miles west of Brisbane, in New Zealand, natural gas and oil have been struck at 3,700 feet. The gas has been put to local use.

WORLD'S PRODUCTION.

World's production of crude petroleum, 1904–1908, by countries.

[Barrels of 42 gallons.]

Country.	1904.	1905.	1906.	1907.	1908.		Percentage of total production.
					Barrels.	*Metric tons.*	
United States	117,080,960	134,717,580	126,493,936	166,095,335	179,572,479	23,942,997	63.09
Russia	78,536,655	54,960,270	58,897,311	61,850,734	62,186,447	8,291,526	21.85
Sumatra, Java, and Borneo	7,682,014	8,586,804	8,662,572	8,377,099	8,752,822	1,143,243	3.08
Galicia	5,947,383	5,765,317	5,467,967	8,455,841	12,612,295	1,754,022	4.43
Roumania	3,599,026	4,420,987	6,378,184	8,118,207	8,252,157	1,147,727	2.90
India	3,385,468	4,137,098	4,015,803	4,344,162	5,047,038	672,938	1.77
Japan	1,418,767	1,341,157	1,710,768	2,010,639	2,070,929	276,124	.73
Mexico	....	....	....	1,000,000	3,481,410	464,188	1.22
Canada	552,575	634,095	569,753	788,872	527,987	70,400	.19
Germany	637,431	560,963	578,610	756,631	1,009,278	141,900	.35
Peru	345,834	447,880	534,929	741,226	1,011,180	134,824	.36
Italy	25,476	44,027	53,577	59,875	[a] 60,000	8,344	.03
Other	[a] 40,000	[a] 30,000	[a] 30,000	[a] 30,000	[a] 30,000	4,000	
	219,251,589	215,646,178	213,393,410	262,628,621	284,614,022	38,052,233	100.00

[a] Estimated.

MAP OF THE OIL AND NATURAL-GAS FIELDS.

The map accompanying this report is a revision of the map prepared by F. H. Oliphant and published by the United States Geological Survey in 1904. The object of the map is to show the general areas where oil and gas have actually been found, without any prediction as to the probability of future developments. Inasmuch as these outlines are continually changing, further revisions of this map will be published, and criticisms of this publication will therefore be welcomed.

THE CEMENT INDUSTRY IN THE UNITED STATES IN 1908.

By Edwin C. Eckel.

ACKNOWLEDGMENTS.

The data on cement production in the United States on which the following report is based are collected directly by the United States Geological Survey, requests for statistics of production being sent to every cement plant in the country operating during the year. It is a pleasure to acknowledge the promptness and completeness with which these statistical inquiries are answered. For a number of years past returns have been received from every producing plant, so that the Survey's cement statistics have covered the industry completely. At the present time it is particularly desirable to note that the figures reported by the various producers are accepted and used absolutely without change in the various tables of this report. This is necessary, since there is no legal or other convenient method of checking the individual returns.

PRODUCTION.

Before taking up the statistics relating to the three kinds of cement separately, it is of interest to summarize the facts relative to the total cement production of the United States in 1908.

The total quantity of Portland, natural, and puzzolan cements produced in the United States during 1908 was 52,910,925 barrels, valued at $44,477,653. As compared with 1907, whose production was 52,230,342 barrels, valued at $55,903,851, the year 1908 showed an increase of 1.3 per cent in quantity, and a decrease of 20 per cent in value. The increase in quantity is the smallest ever recorded, and the heavy decrease in value indicates the serious trade conditions which the cement industry encountered during 1908.

The distribution of the total production among the three main classes of cement is shown in the following table. For comparison the figures for 1906 and 1907 are also presented.

Total production of cement in the United States in 1906, 1907, and 1908, by classes.

Class.	1906.		1907.		1908.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Portland	46,463,424	$52,466,186	48,785,390	$53,992,551	51,072,612	$43,547,679
Natural	4,055,797	2,423,170	2,887,700	1,467,302	1,686,682	834,509
Puzzolan	481,224	412,921	557,252	443,998	151,451	95,468
	51,000,445	55,302,277	52,230,342	55,903,851	52,910,925	44,477,653

TOTAL CEMENT PRODUCTION, 1818-1908.

It is of advantage to summarize, at intervals, the complete statistics relative to any industry. For this reason the present report contains tables giving the production, in each year, of Portland, natural, and puzzolan cements since the commencement of their manufacture in the United States. In the following summary table these figures are combined so as to give the total production of all kinds of cement in the United States to date:

Total production of cement in the United States, 1818–1908, by kinds.

Kind.	Period.	Total (barrels).
Portland	1870–1908	395,567,395
Natural	1818–1908	227,102,085
Puzzolan	1896–1908	4,145,657
		626,815,137

PORTLAND CEMENT.

PRODUCTION.

The total Portland cement production of the United States in 1908 was 51,072,612 barrels, valued at $43,547,679. As compared with the output of 1907, which was 48,785,390 barrels, valued at $53,992,551, the figures reported for 1908 indicate an increase in quantity of 4.6 per cent and a decrease in value of 19.3 per cent.

In view of the trade conditions during the year, the matter for surprise is not that the increase in output was so small, but that there should have been any increase at all. When the total production is grouped by States, as in the table below, certain peculiarities of distribution of this increase become obvious; and when the reports of individual plants are examined, the matter becomes still more interesting. In the present place it can only be said that all of the older producing States, especially in the East, showed heavy decreases in output; that a relatively small number of plants, mostly in the Middle West, reported very large increases as against 1907; and that the only really large producer to report an increase was the United States Steel Corporation. This latter fact is the more interesting because, as shown in the table immediately following, the gain reported by the Steel Corporation accounts for all (and more than all) of the increase in production for the country.

Production of Portland cement by the whole country and by the United States Steel Corporation in 1907 and 1908.

	1907.	1908.
	Barrels.	*Barrels.*
Total production	48,785,390	51,072,612
Production United States Steel Corporation	2,129,700	4,535,300
Total production less production of United States Steel Corporation	46,655,690	46,537,312

It need hardly be explained that the figures here quoted, as giving the output of the Steel Corporation's cement plants, are taken from the annual reports of the Corporation as issued, so that there is no violation of confidence in presenting them thus separately.

PRODUCTION BY STATES.

In the following table the Portland cement production has been grouped by States. For convenience in comparison, the production for 1907 is also presented in as nearly similar grouping as is possible.

Production of Portland cement in the United States in 1907 and 1908, by States.

1907.

State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	22	20,393,965	$19,698,006
New Jersey	3	4,449,896	4,738,516
Indiana	7	3,782,841	4,757,860
Michigan	14	3,572,668	4,384,731
Kansas	5	3,353,925	4,240,358
Kentucky Missouri	1 2	3,186,925	3,320,248
New York	9	2,290,955	2,433,918
Illinois	5	2,036,093	2,632,576
California Washington	4 1	1,893,004	2,715,398
Alabama Georgia Virginia West Virginia	2 1 1 1	1,274,470	1,383,305
Ohio	9	1,151,176	1,377,155
Colorado Utah	1 2	864,938	1,395,179
Arizona South Dakota Texas	1 1 2	534,534	915,301
	94	48,785,390	53,992,551

1908.

State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	17	18,254,806	$13,899,807
Indiana	7	6,478,165	5,386,563
Kansas	7	3,854,603	2,874,457
Illinois	5	3,211,168	2,707,044
New Jersey	3	3,208,446	2,416,009
Michigan	15	2,892,576	2,556,215
Missouri	4	2,929,504	2,571,236
California Washington	4 2	2,480,100	3,268,196
New York	7	1,988,874	1,813,623
Ohio	8	1,521,764	1,305,210
Iowa Kentucky Tennessee	1 1 1	1,205,251	1,176,499
Texas Oklahoma	2 2	917,977	924,039
South Dakota Colorado	1 2	809,306	1,057,433
Arizona Utah	1 2	507,603	805,235
Maryland Virginia Massachusetts	1 1 1	502,225	511,118
Alabama Georgia	2 1	310,244	274,995
	98	51,072,612	43,547,679

RANK OF PRODUCING STATES.

In 1906 and 1907 the leading cement-producing States ranked in the same order, as follows: Pennsylvania, New Jersey, Indiana, Michigan, Kansas, New York, Illinois, Missouri. In 1908, however, some very curious changes in rank occurred, owing to the decreases shown by the Eastern States and Michigan, and the heavy increases reported from some of the Middle Western States. The order of production in 1908 was therefore as follows: Pennsylvania, Indiana, Kansas, Illinois, New Jersey, Michigan, Missouri, New York.

PRODUCTION BY DISTRICTS.

The present geographic distribution of the Portland cement industry is indicated in the following tables, where the total production of the years 1905, 1906, 1907, and 1908 is grouped according to locality.

The term "East," as used in these tables, includes plants in Pennsylvania, New Jersey, New York, and Massachusetts. The "Central" plants are those in Ohio, Indiana, Michigan, Illinois, Iowa, and Missouri. Under "West" are included plants in Kansas, Colorado, South Dakota, Utah, and Arizona. On the Pacific coast plants are operating in California and Washington. In the South plants are located in Maryland, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Oklahoma, and Texas.

Geographic distribution of the Portland cement industry, 1905–1908.

District.	Output, in barrels.			
	1905.	1906.	1907.	1908.
East	19,589,675	25,483,025	27,134,816	23,472,126
Central	10,723,802	14,030,665	13,479,703	17,744,034
West	2,470,349	3,834,656	4,463,397	5,171,512
Pacific coast	1,225,429	1,310,435	1,893,004	2,480,100
South	1,237,557	1,804,643	1,814,470	2,204,840
	35,246,812	46,463,424	48,785,390	51,072,612

District.	Plants in operation.				Percentage of total output.			
	1905.	1906.	1907.	1908.	1905.	1906.	1907.	1908.
East	30	31	34	28	55.6	54.9	55.6	46.0
Central	32	34	37	40	30.4	30.2	27.6	34.7
West	7	8	10	13	7.0	8.2	9.2	10.1
Pacific coast	3	4	5	6	3.5	2.8	3.9	4.9
South	7	7	8	11	3.5	3.9	3.7	4.3
	79	84	94	98	100.0	100.0	100.0	100.0

PRODUCTION OF THE LEHIGH DISTRICT, 1890–1908.

In an earlier report of this series the statement was made that "The Portland cement industry exhibits the same tendency toward geographic centralization, though to a less degree, that has given Pittsburg its preeminence as an iron producer. In the case of the Portland cement industry the concentration of plants is in the so-called Lehigh district of Pennsylvania, with its New Jersey continuation. The Lehigh district was the point where Portland cement manufacture was first undertaken, and it owes its continued preeminence to the possession of good raw materials, good labor, good and fairly cheap fuel, and excellent transportation facilities to large eastern markets."

At the present time it might well be added that, just as the future of the Pittsburg steel district is definitely limited by the growth of production at Gary, Buffalo, Birmingham, and the Atlantic plants, so the Lehigh district is now facing similar limitations. Each year witnesses a marked narrowing of the profitable market area for cement made in the Lehigh district. The existing plants in western Pennsylvania now control the situation, during ordinary years, in that direction, while existing and prospective plants in West Virginia, Virginia, and New York will more and more restrict shipments to the South and East.

The Lehigh district possesses great manufacturing advantages, and its annual output has by no means necessarily reached its maximum, but the decrease in the margin of profit and the narrowing of the market area are so obvious that strong companies can no longer look to their Lehigh district plants as being sufficient for the future.

The following table shows, by three-year periods since 1890, the production of the Lehigh district, the total production, and the percentage of the Lehigh district output to the total production:

Portland cement production in the Lehigh district and in the United States, 1890–1908, in barrels.

Year.	Lehigh district output.	Total output.	Percentage of total manufactured in Lehigh district.	Year.	Lehigh district output.	Total output.	Percentage of total manufactured in Lehigh district.
1890	201,000	335,500	60.0	1899	4,110,132	5,652,266	72.7
1891	248,500	454,813	54.7	1900	6,153,629	8,482,020	72.6
1892	280,840	547,440	51.3	1901	8,595,340	12,711,225	67.7
1893	265,317	590,652	44.9	1902	10,829,922	17,230,644	62.8
1894	485,329	798,757	60.8	1903	12,324,922	22,342,973	55.2
1895	634,276	990,324	64.0	1904	14,211,039	26,505,881	53.7
1896	1,048,154	1,543,023	68.1	1905	17,368,687	35,246,812	49.3
1897	2,002,059	2,677,775	74.8	1906	22,784,613	46,463,424	49.0
1898	2,674,304	3,692,284	72.4	1907	24,417,686	48,785,390	50.0
				1908	20,200,387	51,072,612	39.6

THE STATUS OF NEW YORK AS A CEMENT PRODUCER.

In view of the relation of New York to the early history of the Portland cement industry in this country, it is a matter of surprise that the State has not assumed a more prominent position in the present stage of the industry. The matter can not be cleared up by referring its low rank to deficiencies in raw materials, transportation routes, or markets, for a very casual examination will show that its supplies of available raw materials are large, and that it contains or gives ready access to a number of important markets. The fact that during 1908 it ranked eighth among the States as a cement producer is therefore to be explained otherwise.

New York State at present contains a number of Portland cement plants, but even the successful ones have been able to exert little influence on the industry at large. This is chiefly due to the manner in which they were located, when regard was paid chiefly to the limestone supply and only secondarily to questions of market. To build a cement plant so located as to yield only cement may be an interesting technical operation, but it is not good business. In order to be satisfactory industrially, a plant should produce dividends as well as cement. In the past history of the New York industry this fact seems to have been overlooked.

When the situation is examined critically, with markets, routes, and raw materials all in mind, it will be seen that there are only a few locations in New York where to-day the erection of a large plant would be justifiable. In the writer's opinion the number of such areas or localities does not exceed four. To put the matter in another way, the erection of large plants at each of these localities would dominate the cement trade not only of New York but of New England as well. To add to the interest of the situation, it may be noted that in three out of the four critical areas the raw-material supplies were geographically so compact that it was by no means impossible for one company to secure complete control of all the really available rock.

In order to compare the ideal with the actual New York locations, it can be said that a year ago three of the controlling areas were not held by any cement company; the fourth was occupied by a company which for many reasons could not avail itself of its natural advantages of location. The last twelve months, however, have brought about many changes in the cement trade, and the readjustments in New York are not among the least of them. Of the four locations noted, that at Hudson is now controlled by leading interests in the Atlas Portland Cement Company; two of the other areas are held by another established cement company, and the fourth may be developed in the near future. The result of these acquisitions is that New York State will have a new series of modern and well-located plants, and that its output may then approximate that of Indiana.

GROWTH OF THE PORTLAND CEMENT INDUSTRY, 1870–1908.

In the table following statistics are given covering the annual production of Portland cement in this country from the inception of the industry, in the early seventies, to the present day:

Production of Portland cement in the United States, 1870–1908, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1870–1879	82,000	$246,000	1894	798,757	$1,383,473
1880	42,000	126,000	1895	990,324	1,586,830
1881	60,000	150,000	1896	1,543,023	2,424,011
1882	85,000	191,250	1897	2,677,775	4,315,891
1883	90,000	193,500	1898	3,692,284	5,970,773
1884	100,000	210,000	1899	5,652,266	8,074,371
1885	150,000	292,500	1900	8,482,020	9,280,525
1886	150,000	292,500	1901	12,711,225	12,532,360
1887	250,000	487,500	1902	17,230,644	20,864,078
1888	250,000	487,500	1903	22,342,973	27,713,319
1889	300,000	500,000	1904	26,505,881	23,355,119
1890 [a]	335,500	704,050	1905	35,246,812	33,245,867
1891	454,813	967,429	1906	46,463,424	52,466,186
1892	547,440	1,153,600	1907	48,785,390	53,992,551
1893	590,652	1,158,138	1908	51,072,912	43,547,679
				395,567,395	....

[a] The figures for 1890 and prior years were estimates made at the close of each year, but are believed to be substantially correct. Since 1890 the official figures are based on complete returns from all producers.

On examination of this table it will be seen that the industry showed a fair but not in any way remarkable rate of growth from its commencement in the seventies until 1895. At the latter date, however, a very striking development commenced, coincident, it may be noted, with the development of coal burning in the rotary kiln. This rapid rate of growth continued until 1907, when it was checked temporarily by the financial crisis of that year

The phenomenal growth of the industry in this period is illustrated very strikingly in figure 1, where it is shown graphically for the years 1890 to 1908, inclusive. For comparison, the decline in the natural cement industry is plotted on the same diagram.

On examining the cement statistics for a series of years, it will be seen that the output of Portland cement has so far shown an increase each year, rising from 42,000 barrels in 1880 to 335,500 barrels in 1890, to 8,482,020 barrels in 1900, and to 51,072,912 barrels in 1908. The natural cement production, on the other hand, reached its maximum in 1899, with an output of 9,868,179 barrels. Since that year it has shown an almost continuous and rapid decrease annually, until now it has become a relatively unimportant factor in the cement situation.

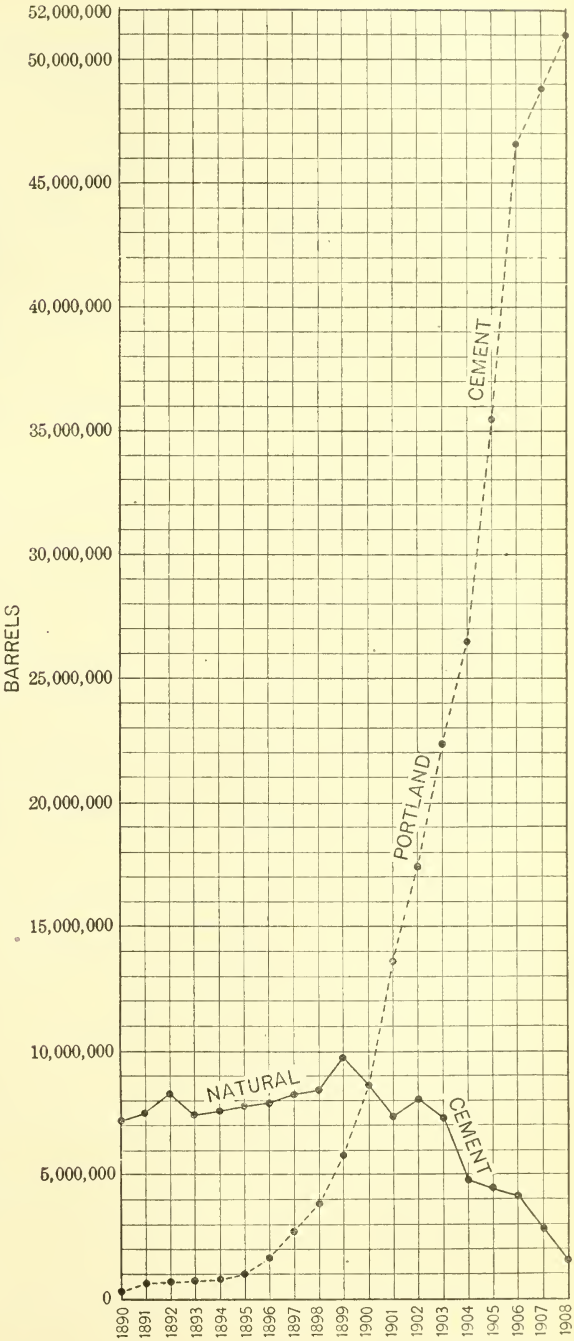

FIGURE 5.—Comparison of production of Portland and natural cement, 1890–1908.

DECLINE IN CEMENT PRICES, 1880–1908.

Perhaps the most striking feature connected with the Portland cement industry in this country has been the decline in cement prices during the last thirty years. This decline has, as a matter of fact, been as steady and as marked as the growth in annual output.

The following table gives the average price per barrel of Portland cement in bulk at the point of manufacture, derived from the official figures published annually by the Geological Survey. The price excludes the cost of the package but includes packing-house labor.

Average prices per barrel of Portland cement, 1870–1908.

1870–1880	$3.00	1892	$2.11	1901	$0.99
1881	2.50	1893	1.91	1902	1.21
1882	2.01	1894	1.73	1903	1.24
1883	2.15	1895	1.60	1904	.88
1884	2.10	1896	1.57	1905	.96
1885–1888	1.95	1897	1.61	1906	1.13
1889	1.67	1898	1.62	1907	1.11
1890	2.09	1899	1.43	1908	.85
1891	2.13	1900	1.09		

In the following diagram (fig. 6), the fall in cement prices during the period 1880–1907 is shown graphically:

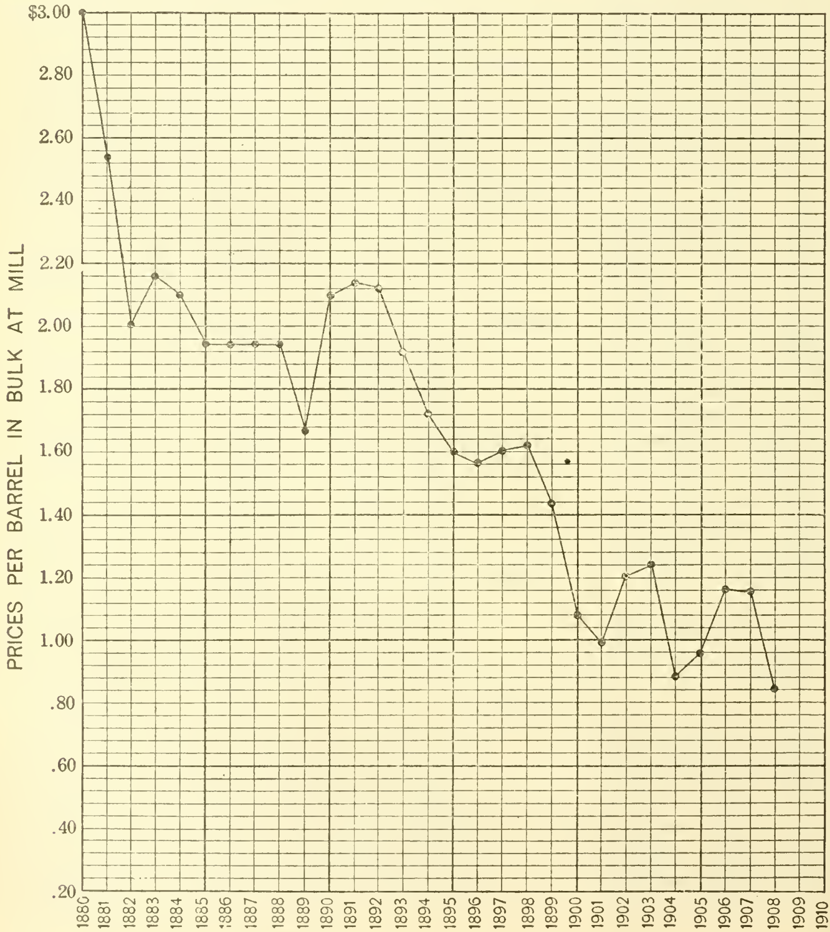

FIGURE 6.—The decline in cement prices, 1880–1908.

PRODUCTION ACCORDING TO RAW MATERIALS USED.

In the following table the production of Portland cement in the United States is classified according to the kinds of raw materials from which the cement is manufactured. The production is grouped as follows:

Type 1 includes cement produced from a mixture of argillaceous limestone ("cement rock") and pure limestone. This is the combination of materials used in all the cement plants of the Lehigh district of Pennsylvania and New Jersey, and also at several western plants.

Type 2 includes cement made from a mixture of comparatively pure limestone with clay or shale. This mixture is employed at many plants all over the United States.

Type 3 includes cement manufactured from a mixture of marl and clay. This type of mixture is used only in the States of Michigan, Ohio, Indiana, and New York.

Type 4 includes Portland cement manufactured from a mixture of limestone and blast-furnace slag.

Production, in barrels, and percentage of total output of Portland cement in the United States according to type of material used, 1898–1908.

Year.	Type 1. Cement rock and pure limestone.		Type 2. Limestone and clay or shale.		Type 3. Marl and clay.		Type 4. Slag and limestone.	
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.
1898	2,764,694	74.9	365,408	9.9	562,092	15.2		
1899	4,010,132	70.9	546,200	9.7	1,095,934	19.4		
1900	5,960,739	70.3	1,034,041	12.2	1,454,797	17.1	32,443	0.4
1901	8,503,500	66.9	2,042,209	16.1	2,001,200	15.7	164,316	1.3
1902	10,953,178	63.6	3,738,303	21.7	2,220,453	12.9	318,710	1.8
1903	12,493,694	55.9	6,333,403	28.3	3,052,946	13.7	462,930	2.1
1904	15,173,391	57.2	7,526,323	28.4	3,332,873	12.6	473,294	1.8
1905	18,454,902	52.4	11,172,389	31.7	3,884,178	11.0	1,735,343	4.9
1906	23,896,951	51.4	16,532,212	35.6	3,958,201	8.5	2,076,000	4.5
1907	25,859,095	53.0	17,190,697	35.2	3,606,598	7.4	2,129,000	4.4
1908	20,678,693	40.6	23,047,707	45.0	2,811,212	5.5	4,535,300	8.9

This table, brought up to date, shows a continuation of movements whose trend has been noted in earlier years—the decrease in the relative production from cement rock (type 1) and from marl (type 3), and the corresponding increase in the production from limestone (type 2) and from slag (type 4). The falling off in the relative output from marl is natural enough, and this relative decrease may be expected to continue. The decrease in the percentage produced from cement rock is due simply to the lessening comparative importance of the Lehigh district, a condition concerning which there is some discussion on a preceding page and concerning which it may be added here that this trend may be reversed in the near future. Two districts, containing cement rock of the Lehigh type but widely separated geographically from the Lehigh district itself, may reasonably be expected to become heavy producers within the next two or three years.

All of the Portland cement now made in this country from slag and limestone is the output of the Universal Portland Cement Company, a subsidiary of the United States Steel Corporation. The product is a true Portland cement in every sense of the term, and the growth of output reflects credit on the way in which prejudice and ignorance have been gradually overcome.

NATURAL CEMENT

PRODUCTION.

The natural cement produced in the United States during 1908 amounted to 1,686,862 barrels, valued at $834,509, as compared with an output of 2,887,700 barrels, valued at $1,467,302, in 1907, a decrease in 1908 of 1,200,838 barrels, or over 41 per cent, in quantity, and of $632,793, or over 43 per cent, in value.

PRODUCTION BY STATES.

In the following table the natural-cement production of 1908 is classified by States, the figures for 1907 being added for comparison:

Production of natural cement, in 1907 and 1908, by States.

State.	1907.			State.	1908.		
	Number of works.	Quantity (barrels).	Value.		Producing plants.	Quantity (barrels).	Value.
Illinois	3	284,599	$92,750	New York	6	623,618	$441,136
Indiana	12	400,000	140,000	Pennsylvania	3	252,479	87,192
New York	15	947,929	633,170	Indiana	3	212,901	42,580
Pennsylvania	4	645,871	263,969	Illinois	2	188,859	68,772
Kansas	2	129,077	71,052	Kansas	2		
Texas	1			Texas	1	87,159	47,725
Georgia	2			Colorado	1		
Kentucky	2			Kentucky	2		
Maryland	4	338,195	176,379	Georgia	1	119,656	53,904
Ohio	1			Ohio	1		
Virginia	1			Minnesota	2	202,190	93,200
Minnesota	2			Wisconsin	1		
North Dakota	1	162,029	89,982				
Wisconsin	2						
	52	2,887,700	1,467,302		25	1,686,862	834,509

GROWTH AND DECLINE OF THE NATURAL-CEMENT INDUSTRY, 1818–1908.

The following table contains statistics relative to the natural-cement industry since its commencement in this country in 1818. It will be seen that the natural-cement trade reached its greatest prosperity in the period 1887-1903, inclusive, its year of maximum output being 1899, when 9,868,179 barrels of natural cement were manufactured in the United States. Beginning with 1904, the industry has shown marked and continuous declines in production each year, and its production for 1908 is by far the lowest on record since 1870.

Production of natural cement in the United States, 1818–1908, in barrels.

1818–1829	300,000	1883	4,190,000
1830–1839	1,000,000	1884	4,000,000
1840–1849	4,250,000	1885	4,100,000
1850–1859	11,000,000	1886	4,186,152
1860–1869	16,420,000	1887	6,692,744
1870–1879	22,000,000	1888	6,253,295
1880	2,030,000	1889	6,531,876
1881	2,440,000	1890	7,082,204
1882	3,165,000	1891	7,451,535

1892	8,211,181	1902	8,044,305
1893	7,411,815	1903	7,030,271
1894	7,563,488	1904	4,866,331
1895	7,741,077	1905	4,473,049
1896	7,970,450	1906	4,055,797
1897	8,311,688	1907	2,887,700
1898	8,418,924	1908	1,686,682
1899	9,868,179		
1900	8,383,519		227,102,085
1901	7,084,823		

PUZZOLAN CEMENT.

PRODUCTION.

Puzzolan cement, made by mixing blast-furnace slag with slaked lime, was manufactured during 1908 at a number of plants in the United States. The output reported for 1908 was 151,451 barrels, valued at $95,468. This shows a heavy decrease when compared with the production reported for 1907, which was 557,252 barrels, valued at $443,998.

There are at present at least ten plants equipped for the manufacture of puzzolan cement in the United States, though it is difficult to ascertain how many of these have been completely or partly dismantled. Of the ten plants constructed, the States of Ohio and Alabama contained two each, while Illinois, Kentucky, Maryland, New York, Pennsylvania, and New Jersey had single plants. During 1908 four plants reported production to the Survey.

The following table contains the leading facts relative to this industry for the five years from 1904 to 1908, inclusive:

Statistics of the puzzolan cement industry, 1904–1908, by States.

	1904.	1905.	1906.	1907.	1908.
Number of plants reporting production:					
Alabama	2	2	2	1	1
Illinois	1	1	1	1	
Kentucky		1	1	1	
Maryland	1	1	1		
New Jersey	1	1	1		
New York			1	1	
Ohio	2	2	2	2	2
Pennsylvania	1	1	1	1	1
Total	8	9	10	7	4
Production, in barrels	303,045	382,447	481,224	557,252	151,451
Value of production	$226,651	$272,614	$412,921	$443,998	$95,468

The following table includes statistics relative to the production of puzzolan cement in the United States since 1896, when the first output of this product was reported:

Production of puzzolan cement in the United States, 1896–1908, in barrels.

1896	12,265	1904	303,045
1897	48,329	1905	382,447
1898	150,895	1906	481,224
1899	335,000	1907	557,252
1900	446,609	1908	151,451
1901	272,689		
1902	478,555		4,145,657
1903	525,896		

IMPORTS OF FOREIGN CEMENT.

The following table shows the foreign cement imported into the United States during the years 1878 to 1908, inclusive. It is to be noted that, owing to the manner in which import statistics are grouped under existing tariff schedules, the quantities given include not only Portland cement, but all other hydraulic cements. The Portland cement, however, probably makes up at least 95 per cent of the total in each year.

Imports of foreign cement, 1878–1908, in barrels.

1878	92,000	1889	1,740,356	1900	[a] 2,386,683
1879	106,000	1890	1,940,186	1901	[a] 939,330
1880	187,000	1891	2,988,313	1902	[a] 1,963,023
1881	221,000	1892	2,440,654	1903	[a] 2,251,969
1882	370,406	1893	2,674,149	1904	[a] 968,409
1883	456,418	1894	2,638,107	1905	[a] 896,845
1884	585,768	1895	2,997,395	1906	[a] 2,273,493
1885	554,396	1896	2,989,597	1907	[a] 2,033,438
1886	915,255	1897	2,090,924	1908	[a] 842,121
1887	1,514,095	1898	1,152,861		
1888	1,835,504	1899	[a] 2,108,388		

EXPORTS.

The United States now possesses only a small export trade in cement, the quantity annually exported ranging usually between 1 per cent and 3 per cent of the domestic production. There seem to be excellent reasons for increasing this export trade as rapidly as possible, and it may soon become a more important feature of the industry.

The following table gives the quantity and value of all classes of hydraulic cement exported during the years 1900–1908, inclusive. These totals represent almost entirely exports of Portland cement.

Exports of hydraulic cement, 1900–1908, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	100,400	$225,306	1905	897,686	$1,387,906
1901	373,934	679,296	1906	583,299	944,886
1902	340,821	526,471	1907	900,550	1,450,841
1903	285,463	433,984	1908	846,528	1,249,229
1904	774,940	1,104,086			

Shipments to the Canal Zone, for use in the Panama Canal, may hereafter be expected to increase heavily the exports of cement from the United States.

APPARENT ANNUAL CONSUMPTION OF PORTLAND CEMENT.

The following table contains data on the apparent annual consumption of Portland cement in the United States for recent years. The computed results are of course merely approximations to the truth,

[a] "Imports for consumption." All other years' figures given are for "total imports."

for unavoidable errors arise from the facts that (*a*) both imports and exports, as reported officially, include not only Portland but small quantities of other classes of cement; and (*b*) no data are available as to stocks on hand at mills or at distributing points at the close of each year.

Apparent annual consumption of Portland cement, 1902–1908, in barrels.

Year.	Domestic production.	Imports.	Total available supply.	Exports.	Apparent consumption.
1902	17,230,644	1,963,023	19,193,667	340,821	18,852,846
1903	22,342,973	2,251,969	24,594,942	285,463	24,309,479
1904	26,505,881	968,410	27,474,291	774,940	26,699,351
1905	35,246,812	896,845	36,143,657	897,686	35,245,971
1906	46,463,424	2,273,493	48,736,917	583,299	48,153,618
1907	48,785,390	2,033,438	50,818,828	900,550	49,918,278
1908	51,072,912	842,121	51,915,033	846,528	51,068,505

CLAY-WORKING INDUSTRIES.

By Jefferson Middleton.

INTRODUCTION.

With the exception of the section on clay production, this report deals with the products of the clay-working industries, and hence the tables are made up to show the products of clay manufactured and not the production of clay.

The year 1908 was one of unusual dullness in the building trades, owing to the prevailing business depression. As a result, the record of the year shows the only important decrease in the value of clay products since the collection of statistics on the subject was begun by this office. The decrease in the value of these products in 1908 was $25,744,607, or 16.20 per cent—the largest recorded. Since 1894, the first year for which statistics were collected, there have been only four years, besides 1908, in which the value of the clay products showed decreases, viz: 1896, $2,299,398, or 3.52 per cent; 1897, $750,417, or 1.19 per cent; 1904, $39,173, or 0.03 per cent; and 1907, $2,090,353, or 1.30 per cent. It is thus seen that the decrease in 1908 was more than twelve times as great as the greatest decrease heretofore recorded.

Of the two great branches, brick and tile, and pottery, the latter seems to have suffered proportionately slightly more than the former, the decreases being 16.61 per cent for the pottery and 16.10 per cent for the brick and tile, though of course the actual loss was much greater—more than four times as much—in the brick and tile than in the pottery. In 1907 the brick and tile decreased $792,943, or 0.61 per cent, and pottery $1,297,410, or 4.13 per cent. Not only did the totals for these branches decrease, but in the brick and tile industries only two products increased in value, and in the pottery industry every variety of ware decreased. Imports and exports also decreased in every item, and only eight States showed increases, none of which were large. The most noteworthy incidents in the history of the trade during 1908 were the increases in the output and value of paving brick and the increase in the value of the drain-tile product, and the large losses in the common and fire brick products and values. The increase in the paving-brick industry is probably due to the inherent qualities of brick as a paving material, and the educational campaign conducted by the National Association of Paving Brick Manufacturers for several years. The increase in the drain-tile production has been consistent for several years, the gain in 1908 being 20.75 per cent. Its market is largely in the Middle West—the great agricultural States of Iowa, Illinois, Indiana, and Ohio being the principal producers. All of these States showed large gains in the value of this material, while they suffered losses in the building-clay products.

The average value per thousand decreased for common front and paving brick and increased for fire brick.

The eight States which reported gains were Arizona, 3.48 per cent; Idaho and Nevada, 3.75 per cent; Iowa, 9.14 per cent; Montana, 42.02 per cent; Oregon, 1.82 per cent; South Dakota, 59.19 per cent; Utah, 3.97 per cent; and Washington, 9.49 per cent. Although the gains in these States are small, their location would seem to indicate that in the clay-working industries, at least, a portion of the country did not suffer from the financial depression so much as the rest of the country. The prospects for 1909 are that the industry will be in a much healthier condition than in 1908, and that the year will show a material gain in the value of the products.

ACKNOWLEDGMENTS.

Again the writer, on behalf of the Survey, desires to thank the clay workers of the country for their cooperation, without which this report would be impossible.

The state geological surveys of Alabama, Georgia, Illinois, Iowa, Kentucky, Maryland, Missouri, New Jersey, New York, North Carolina, and Virginia have cooperated in the collection of statistics, the completeness of the returns from these States being due largely to their efforts.

Thanks are also extended to the officials who have supplied information concerning the building operations of the various cities of the country, and to the clay-working press for its support and appreciation.

PRODUCTION.

In the following table will be found a statement of the value of the clay products of the United States in 1907 and 1908:

Value of the products of clay in the United States in 1907 and 1908, by States and Territories.

State or Territory.	1907.			1908.		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
Alabama	$1,726,664	$27,745	$1,754,409	$1,535,517	$24,089	$1,559,606
Arizona	101,462	....	101,462	104,992	....	104,992
Arkansas	519,336	16,950	536,286	481,288	27,500	508,788
California	5,642,699	97,838	5,740,537	4,436,619	87,126	4,523,745
Colorado	1,997,331	44,144	2,041,475	1,920,674	49,407	1,970,081
Connecticut and Rhode Island	1,361,476	[a] 123,116	1,484,592	825,561	[a] 76,000	901,561
Delaware	190,440	....	190,440	146,527	....	146,527
District of Columbia	322,084	([b])	322,084	268,600	([b])	268,600
Florida	354,575	([b])	354,575	233,162	....	233,162
Georgia	2,456,352	33,885	2,490,237	1,917,960	10 651	1,928,611

[a] Produced by Connecticut alone. [b] Included in "Other States."

Value of the products of clay in the United States in 1907 and 1908, by States and Territories—Continued.

State or Territory.	1907.			1908.		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
Idaho and Nevada	$327,078	....	$327,078	$339,356	....	$339,356
Illinois	12,216,323	$1,004,166	13,220,489	10,752,160	$806,954	11,559,114
Indiana	5,988,970	869,154	6,858,124	5,979,677	760,490	6,740,167
Iowa	3,709,903	18,882	3,728,785	4,050,787	18,710	4,069,497
Kansas	2,370,058	(a)	2,370,058	2,248,805	(a)	2,248,805
Kentucky	2,444,743	166,621	2,611,364	2,085,460	153,648	2,239,108
Louisiana	922,877	5,693	928,570	623,753	6,171	629,924
Maine	658,913	(a)	658,913	542,730	(a)	542,730
Maryland	1,519,465	366,897	1,886,362	1,165,412	275,687	1,441,099
Massachusetts	1,826,076	302,744	2,128,820	1,397,636	249,726	1,647,362
Michigan	1,786,190	61,574	1,847,764	1,666,381	62,409	1,728,790
Minnesota	1,689,933	(a)	1,689,933	1,508,710	(a)	1,508,710
Mississippi	825,408	21,121	846,529	806,889	21,850	828,739
Missouri	6,820,684	78,187	6,898,871	5,562,548	68,908	5,631,456
Montana	272,872	(a)	272,872	387,525	(a)	387,525
Nebraska	953,432	....	953,432	946,516	....	946,516
New Hampshire	510,599	(a)	510,599	371,640	(a)	371,640
New Jersey	9,019,834	6,985,626	16,005,460	6,363,705	5,949,991	12,313,696
New Mexico	180,284	....	180,284	140,671	(a)	140,671
New York	9,838,376	1,934,498	11,772,874	7,270,981	1,658,243	8,929,224
North Carolina	1,305,600	10,222	1,315,822	930,606	13,362	943,968
North Dakota	287,919	....	287,919	206,222	....	206,222
Ohio	16,807,631	13,533,199	30,340,830	15,915,703	10,706,787	26,622,490
Oklahoma	664,512	....	664,512	562,929	....	562,929
Oregon	545,839	(a)	545,839	555,768	(a)	555,768
Pennsylvania	18,981,743	1,309,878	20,291,621	13,566,479	1,276,503	14,842,982
South Carolina	829,029	14,350	843,379	606,779	8,469	615,248
South Dakota	40,107	....	40,107	63,847	....	63,847
Tennessee	1,446,647	167,215	1,613,862	1,123,802	112,632	1,236,434
Texas	2,401,388	156,173	2,557,561	1,941,589	125,146	2,066,735
Utah	633,387	(a)	633,387	655,067	3,450	658,517
Vermont	109,500	....	109,500	89,064	....	89,064
Virginia	1,611,335	(a)	1,611,335	1,499,130	(a)	1,499,130
Washington	1,891,239	30,695	1,921,934	2,083,688	20,601	2,104,289
West Virginia	1,481,255	2,159,132	3,640,387	1,177,915	2,083,821	3,261,736
Wisconsin	1,118,987	8,832	1,127,819	949,095	9,300	958,395
Wyoming	88,340	....	88,340	52,282	....	52,282
Other States	....	594,937	594,937	....	467,924	467,924
	128,798,895	30,143,474	158,942,369	108,062,207	25,135,555	133,197,762
Per cent of total	81.03	18.97	100.00	81.13	18.87	100.00

[a] Included in "Other States."

This table shows that the marketed clay products of the United States in 1908 were valued at $133,197,762, compared with $158,942,369 in 1907, a decrease of $25,744,607, or 16.20 per cent.

Of the output for 1908, the brick and tile of this classification, the materials which enter most largely into structural and engineering arts, was valued at $108,062,207, or 81.13 per cent of the total, and the pottery was valued at $25,135,555, or 18.87 per cent of the total. Approximately these relative percentages have been maintained for a number of years. In 1906 the value of the brick and tile was $129,591,838, or 80.48 per cent of the total, and the pottery products $31,440,884, or 19.52 per cent.

Every State and Territory except Alaska is a producer of clay products, though in Rhode Island and Nevada there were not a sufficient number of producers to permit the publication of state totals without disclosing individual statements, so that these States are combined with contiguous ones.

Value of the clay products of the United States, by States and Territories, in 1907 and 1908, showing increase or decrease, with percentage of increase or decrease.

State or Territory.	1907.	1908.	Increase (+) and decrease (−) in 1908.	Percentage of increase (+) and decrease (−) in 1908.
Alabama	$1,754,409	$1,559,606	− $194,803	−11.10
Arizona	101,462	104,992	+ 3,530	+ 3.48
Arkansas	536,286	508,788	− 27,498	− 5.13
California	5,740,537	4,523,745	− 1,216,792	−21.20
Colorado	2,041,475	1,970,081	− 71,394	− 3.50
Connecticut and Rhode Island	1,484,592	901,561	− 583,031	−39.27
Delaware	190,440	146,527	− 43,913	−23.06
District of Columbia	322,084	268,600	− 53,484	−16.61
Florida	354,575	233,162	− 121,413	−34.24
Georgia	2,490,237	1,928,611	− 561,626	−22.55
Idaho and Nevada	327,078	339,356	+ 12,278	+ 3.75
Illinois	13,220,489	11,559,114	− 1,661,375	−12.57
Indiana	6,858,124	6,740,167	− 117,957	− 1.72
Iowa	3,728,785	4,069,497	+ 340,712	+ 9.14
Kansas	2,370,058	2,248,805	− 121,253	− 5.12
Kentucky	2,611,364	2,239,108	− 372,256	−14.26
Louisiana	928,570	629,924	− 298,646	−32.16
Maine	658,913	542,730	− 116,183	−17.63
Maryland	1,886,362	1,441,099	− 445,263	−23.60
Massachusetts	2,128,820	1,647,362	− 481,458	−22.62
Michigan	1,847,764	1,728,790	− 118,974	− 6.44
Minnesota	1,689,933	1,508,710	− 181,223	−10.72
Mississippi	846,529	828,739	− 17,790	− 2.10
Missouri	6,898,871	5,631,456	− 1,267,415	−18.37
Montana	272,872	387,525	+ 114,653	+42.02
Nebraska	953,432	946,516	− 6,916	− .73
New Hampshire	510,599	371,640	− 138,959	−27.21
New Jersey	16,005,460	12,313,696	− 3,691,764	−23.07
New Mexico	180,284	140,671	− 39,613	−21.97
New York	11,772,874	8,929,224	− 2,843,650	−24.15
North Carolina	1,315,822	943,968	− 371,854	−28.26
North Dakota	287,919	206,222	− 81,697	−28.37
Ohio	30,340,830	26,622,490	− 3,718,340	−12.26
Oklahoma	664,512	562,929	− 101,583	−15.29
Oregon	545,839	555,768	+ 9,929	+ 1.82
Pennsylvania	20,291,621	14,842,982	− 5,448,639	−26.85
South Carolina	843,379	615,248	− 228,131	−27.05
South Dakota	40,107	63,847	+ 23,740	+59.19
Tennessee	1,613,862	1,236,434	− 377,428	−23.39
Texas	2,557,561	2,066,735	− 490,826	−19.19
Utah	633,387	658,517	+ 25,130	+ 3.97
Vermont	109,500	89,064	− 20,436	−18.66
Virginia	1,611,335	1,499,130	− 112,205	− 6.96
Washington	1,921,934	2,104,289	+ 182,355	+ 9.49
West Virginia	3,640,387	3,261,736	− 378,651	−10.40
Wisconsin	1,127,819	958,395	− 169,424	−15.02
Wyoming	88,340	52,282	− 36,058	−40.82
Other States	[a] 594,937	[a] 467,924	− 127,013	−21.35
	158,942,369	133,197,762	−25,744,607	−16.20

[a] Includes pottery products which could not be separately classified without disclosing individual figures.

Of the States and Territories represented by the 47 totals, 8 showed gains and 39 showed losses in 1908. The combined gain in these 8 States was $712,327, and the combined losses, $26,456,934. In 1907, 25 showed gains and 22 losses, and in 1906, 37 showed gains and 11 losses. In 1908 the gains ranged from $3,530, or 3.48 per cent, in Arizona to $340,712, or 9.14 per cent, in Iowa, and the decreases ranged from $6,916, or 0.73 per cent, in Nebraska, to $5,448,639, or 26.85 per cent, in Pennsylvania. All of the increases are in the West and most of them in the Far West. Five of the 8 States that showed increases in 1908—Arizona, Idaho and Nevada, Iowa, Oregon, and Washington—also showed increases in 1907. Of the 25 States that showed gains in 1907, 20 showed decreases in 1908—Alabama, Arkansas, California, Colorado, Florida, Georgia, Illinois, Kentucky, Louisiana, Michigan, Minnesota, Missouri, New Mexico, North Carolina, North Dakota, Oklahoma, South Carolina, Texas, West Virginia, and Wyoming. Seven States showed losses of over a million dollars each, all among the first 8 States in value of products. Only 1, Iowa, among the first 10 States showed an increase and that a small gain—$340,712, or 9.14 per cent. The first 10 States showed a net loss of $20,003,871, or 77.70 per cent of the loss of the entire country. Of the first 10 States that reported losses, Indiana showed the smallest—$117,957, or 1.72 per cent. The largest proportionate decrease, 40.82 per cent, was in Wyoming, and the smallest, 0.73 of 1 per cent, in Nebraska. The largest proportionate gain, 59.19 per cent, was in South Dakota, and the smallest, 1.82 per cent, in Oregon.

In the following table will be found a comparison of the several varieties of clay products marketed in 1907 and 1908, showing the actual gain or loss in each variety, and the percentage of gain or loss in each variety:

Value of the products of clay in the United States in 1907 and 1908, with increase or decrease.

Product.	1907.	1908.	Increase (+) and decrease (−) in 1908.	Percentage of increase (+) and decrease (−) in 1908.
Common brick	$58,785,461	$44,765,614	−14,019,847	− 23.85
Vitrified paving brick or block	9,654,282	10,657,475	+ 1,003,193	+ 10.39
Front brick	7,329,360	6,935,600	− 393,760	− 5.37
Fancy or ornamental brick	361,243	259,556	− 101,687	− 28.15
Enameled brick	918,173	660,862	− 257,311	− 28.02
Drain tile	6,864,162	8,661,476	+ 1,797,314	+ 26.18
Sewer pipe	11,482,845	11,003,731	− 479,114	− 4.17
Architectural terra cotta	6,026,977	4,577,367	− 1,449,610	− 24.05
Fireproofing	4,250,618	3,168,037	− 1,082,581	− 25.47
Tile (not drain)	4,551,881	3,877,780	− 674,101	− 14.81
Stove lining	627,647	529,976	− 97,671	− 15.56
Fire brick	14,946,045	10,696,216	− 4,249,829	− 28.43
Miscellaneous	3,000,201	2,268,517	− 731,684	− 24.39
Total brick and tile	128,798,895	108,062,207	−20,736,688	− 16.10
Total pottery	30,143,474	25,135,555	− 5,007,919	− 16.61
Grand total	158,942,369	133,197,762	−25,744,607	− 16.20

This table shows in concise form the industries in the two years under review, and gives at a glance the total value of the several products, as well as the gain or loss in 1908 compared with 1907. Of the 13 items given for brick and tile products in the table, 11 show a decrease and 2 show an increase, the grand total showing a decrease of more than twelve times the decrease of 1907 from 1906—$2,090,353.

The greatest of all clay products in value, the common brick, showed the greatest decrease in 1907—$14,019,847, or 23.85 per cent. This fact is the greatest evidence of the continued dullness in the building trades in 1908.

Vitrified paving brick showed an increase of $1,003,193, or 10.39 per cent; in 1907 this product made a gain of $1,796,514, or 22.86 per cent over 1906.

Drain tile also showed a large gain of $1,797,314, or 26.18 per cent. Its principal field of usefulness is in the Middle West, though it is spreading to other portions of the country.

Next to common brick, the product of greatest value in 1908 was sewer pipe, though in 1907 it was third in value. In 1908 it showed a decrease of $479,114, or 4.17 per cent. In 1907 this product showed an increase of $367,878, or 3.31 per cent.

Fire brick, which was the product of second greatest value in 1907, was third in 1908, showing the largest proportional loss—$4,249,829, or 28.43 per cent.

The total decrease in the brick and tile products was $20,736,688, or 16.10 per cent, and in the pottery products, $5,007,919, or 16.61 per cent, showing that the structural and engineering materials were slightly less affected in 1908 than the higher grade ceramic wares.

The following table shows the products of clay in the United States from 1899 to 1908, inclusive, by varieties of products, together with the total for each year and the number of operating firms reporting:

Products of clay in the United States, 1899–1908, by varieties.

Year.	Number of operating firms reporting.	Common brick.			Vitrified paving brick.		
		Quantity (thousands).	Value.	Average value per thousand.	Quantity (thousands).	Value.	Average value per thousand.
1899	6,962	7,695,305	$39,887,522	$5.18	580,751	$4,750,424	$8.18
1900	6,475	7,140,622	38,621,514	5.41	546,679	4,764,124	8.71
1901	6,421	8,038,579	45,503,076	5.66	605,077	5,484,134	9.06
1902	6,046	8,475,067	48,885,869	5.77	617,192	5,744,530	9.31
1903	6,034	8,463,683	50,532,075	5.97	654,499	6,453,849	9.86
1904	6,108	8,665,171	51,786,558	5.97	735,489	7,557,425	10.28
1905	5,925	9,817,355	61,394,383	6.25	665,879	6,703,710	10.07
1906	5,857	10,027,039	61,300,696	6.11	751,974	7,857,768	10.45
1907	5,536	9,795,698	58,785,461	6.00	876,245	9,654,282	11.02
1908	5,328	7,811,046	44,765,614	5.73	978,122	10,657,475	10.90

Year.	Front brick.			Fancy or ornamental brick (value).	Enameled brick (value).	Fire brick (value).	Stove lining (value).	Drain tile (value).
	Quantity (thousands).	Value.	Average value per thousand.					
1899	438,817	$4,767,343	$10.86	$476,191	$329,969	$8,641,882	$416,235	$3,682,394
1900	344,516	3,864,670	11.09	289,698	323,630	9,830,517	462,541	2,976,281
1901	415,343	4,709,737	11.34	372,131	463,709	9,870,421	423,371	3,143,001
1902	458,391	5,318,008	11.60	335,290	471,163	11,970,511	630,924	3,506,787
1903	433,016	5,402,861	12.48	328,387	569,689	[a] 14,062,369	(a)	4,639,214
1904	434,351	5,560,131	12.80	300,233	545,397	11,167,972	(a)	5,348,555
1905	541,590	7,108,092	13.12	293,907	636,279	12,735,404	645,432	5,850,210
1906	617,469	7,895,323	12.79	207,119	773,104	14,206,868	743,414	6,543,289
1907	585,943	7,329,360	12.51	361,243	918,173	14,946,045	627,647	6,864,162
1908	584,482	6,935,600	11.87	259,556	660,862	10,696,216	529,976	8,661,476

Year.	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).	Tile, not drain (value).	Miscellaneous (value).	Total brick and tile (value).	Pottery (value).	Total value.
1899	$4,560,334	$2,027,532	$1,665,066	$1,276,300	$6,065,928	$78,547,120	$17,250,250	$95,797,370
1900	5,842,562	2,372,568	1,820,214	2,349,420	2,896,036	76,413,775	19,798,570	96,212,345
1901	6,736,969	3,367,982	1,860,269	2,867,659	2,945,268	87,747,727	22,463,860	110,211,587
1902	7,174,892	3,526,906	3,175,593	3,622,863	3,678,742	98,042,078	24,127,453	122,169,531
1903	8,525,369	4,672,028	3,861,343	3,505,329	3,073,856	105,626,369	25,436,052	131,062,421
1904	9,187,423	4,107,473	3,629,101	3,023,428	3,669,282	105,864,978	25,158,270	131,023,248
1905	10,097,089	5,003,158	4,098,793	3,647,726	3,564,111	121,778,294	27,918,894	149,697,188
1906	11,114,967	5,739,460	4,586,538	4,634,898	3,988,394	129,591,838	31,440,884	161,032,722
1907	11,482,845	6,026,977	4,250,618	4,551,881	3,000,201	128,798,895	30,143,474	158,942,369
1908	11,003,731	4,577,367	3,168,037	3,877,780	2,268,517	108,062,207	25,135,555	133,197,762

[a] Stove lining, not separately classified prior to 1899, is included in fire brick in 1903; in miscellaneous in 1904.

This table shows the growth of the clay-working industries during ten years. In this decade the industries have gained in economical methods of production, and although the value of the products has declined in the last two years, with the revival of business they will undoubtedly regain the lost ground. The total value of the clay products ranged from $95,797,370 in 1899 to $161,032,722 in 1906; 1907 and 1908 both showed decreases. This is a difference between the maximum and the minimum as shown in the table of $65,235,352, or 68.10 per cent. Comparing 1899 and 1908, the difference in favor of the latter year is $37,400,392, or 39.04 per cent. The value of the clay products reported for 1908 is the smallest since 1904, when it was $131,023,248. The increase in 1908 over 1904 was, therefore, $2,174,514, or 1.66 per cent. In 1908 the maximum total was reached in only two products, viz, vitrified brick and drain tile.

The maximum quantity of common brick was reached in 1906, 10,027,039,000, and the maximum value in 1905, $61,394,383. The production and value of common brick reported for 1908 are the smallest since 1900. The average value per thousand ranged from $5.18 in 1899 to $6.25 in 1905, that for 1908 ($5.73) being the lowest since 1901.

After a steady rise in value of product from 1899 to 1905, and then a drop of nearly a million dollars, vitrified paving brick has come back with an increase each year, reaching its maximum in both quantity and value in 1908. Since 1905, this gain has been $3,953,765, or 58.98 per cent. The proportional increase in number (46.89 per cent) during the same period has not been so great as in the value, owing to the increase in the average value per thousand. The average value per thousand has ranged from $8.18 in 1899 to $11.02 in 1907, there being a slight decline from this in 1908 to $10.90.

Front brick was practically the same in quantity in 1908 as in 1907, there being only 1,461,000 less reported in the former than in the latter year, and this production in 1908 was greater than that of any year previous to 1906, the year of its maximum quantity and value. In value front brick reached its maximum in 1906, and the 1908 figures are the smallest since 1904. The average value per thousand was highest in 1905, and has declined steadily since. Fancy or ornamental brick has declined steadily, with the exception of two years, since its maximum in 1899.

Enameled brick reached its maximum in 1907, and then declined, after an almost steady rise since 1899. The value of the fire brick reached its maximum in 1907, ranging from $8,641,882 in 1899 to $14,946,045 in 1907.

The drain-tile industry has been prosperous even during the last two years and is the only one of the clay-working industries that has shown an advance in the value of its product each year since 1900, reaching its maximum of $8,661,476 in 1908, a gain in eight years of $5,685,195, or 191.02 per cent. Sewer pipe reached its maximum in 1907, having gained each year since 1899. Architectural terra cotta showed an almost steady growth in value during the period covered by the table, declining only in 1904 and 1908 and reaching its maximum in 1907.

RANK OF STATES.

In the following table will be found a statement of the rank of the States in the value of clay products, the number of operating firms reporting, the value of the products by States, and the percentage of total value produced by each State:

Rank of States, value of output, and percentage of total value of clay products in 1907 and 1908.

State.	1907. Rank.	1907. Number of operating firms reporting.	1907. Value.	1907. Percentage of total product.	1908. Rank.	1908. Number of operating firms reporting.	1908. Value.	1908. Percentage of total product.
Ohio	1	736	$30,340,830	19.09	1	706	$26,622,490	19.99
Pennsylvania	2	487	20,291,621	12.77	2	466	14,842,982	11.14
New Jersey	3	165	16,005,460	10.07	3	165	12,313,696	9.24
Illinois	4	417	13,220,489	8.32	4	400	11,559,114	8.68
New York	5	247	11,772,874	7.41	5	241	8,929,224	6.70
Indiana	7	392	6,858,124	4.32	6	369	6,740,167	5.06
Missouri	6	172	6,898,871	4.34	7	161	5,631,456	4.23
California	8	118	5,740,537	3.61	8	119	4,523,745	3.40
Iowa	9	276	3,728,785	2.35	9	263	4,069,497	3.06
West Virginia	10	63	3,640,387	2.29	10	60	3,261,736	2.45
Kansas	14	67	2,370,058	1.49	11	65	2,248,805	1.69
Kentucky	11	115	2,611,364	1.64	12	116	2,239,108	1.68
Washington	17	63	1,921,934	1.21	13	67	2,104,289	1.58
Texas	12	131	2,557,561	1.61	14	122	2,066,735	1.55
Colorado	16	88	2,041,475	1.28	15	80	1,970,081	1.48
Georgia	13	106	2,490,237	1.57	16	108	1,928,611	1.45
Michigan	19	136	1,847,764	1.16	17	132	1,728,790	1.30
Massachusetts	15	80	2,128,820	1.34	18	76	1,647,362	1.24
Alabama	20	100	1,754,409	1.10	19	103	1,559,606	1.17
Minnesota	21	106	1,689,933	1.06	20	92	1,508,710	1.13
Virginia	23	87	1,611,335	1.01	21	80	1,499,130	1.13
Maryland	18	63	1,886,362	1.19	22	65	1,441,099	1.08
Tennessee	22	116	1,613,862	1.02	23	104	1,236,434	.93
Wisconsin	26	138	1,127,819	.71	24	121	958,395	.72
Nebraska	27	89	953,432	.60	25	90	946,516	.71
North Carolina	25	215	1,315,822	.83	26	216	943,968	.71
Connecticut and Rhode Island	24	43	1,484,592	.93	27	41	901,561	.68
Mississippi	29	90	846,529	.53	28	88	828,739	.62
Utah	33	41	633,387	.40	29	47	658,517	.49
Louisiana	28	62	928,570	.58	30	62	629,924	.47
South Carolina	30	63	843,379	.53	31	60	615,248	.46
Oklahoma	31	41	664,512	.42	32	33	562,929	.42
Oregon	34	63	545,839	.34	33	62	555,768	.42
Maine	32	59	658,913	.42	34	53	542,730	.41
Arkansas	35	52	536,286	.34	35	52	508,788	.38
Montana	41	24	272,872	.17	36	28	387,525	.29
New Hampshire	36	32	510,599	.32	37	30	371,640	.28
Idaho and Nevada	38	55	327,078	.21	38	51	339,356	.25
District of Columbia	39	11	322,084	.20	39	12	268,600	.20
Florida	37	23	354,575	.22	40	22	233,162	.17
North Dakota	40	19	287,919	.18	41	18	206,222	.15
Delaware	42	20	190,440	.12	42	19	146,527	.11
New Mexico	43	16	180,284	.11	43	16	140,671	.11
Arizona	45	17	101,462	.06	44	16	104,992	.08
Vermont	44	11	109,500	.07	45	11	89,064	.07
South Dakota	47	8	40,107	.03	46	10	63,847	.05
Wyoming	46	13	88,340	.06	47	10	52,282	.04
Other States	......	......	[a] 594,937	.37	......	......	[a] 467,924	.35
	......	5,536	158,942,369	100.00	......	5,328	133,197,762	100.00

[a] Undistributed pottery products.

This table shows that every State and Territory, except Alaska, was a producer of clay products in 1908, which ranged in value from $52,282 in Wyoming, or 0.04 per cent, to $26,622,490, or 19.99 per cent, in Ohio. Ohio continues to be the leading clay-working State.

The difference between the value of Ohio and of Pennsylvania products is growing, and was $11,779,508 in 1908, as compared with $10,049,209 in 1907. The value of Ohio's product in 1908 was thus 79.36 per cent greater than that of the second State, a difference that seems to indicate Ohio's supremacy for many years. New Jersey was third in both years, reporting 10.07 per cent of the total in 1907, and 9.24 per cent in 1908. Illinois was fourth in both years, reporting 8.32 per cent of the total in 1907 and 8.68 per cent in 1908. New York was fifth in both years. Indiana, which was seventh in 1907, became sixth in 1908, exchanging places with Missouri. Kansas, which was fourteenth in 1907, rose to eleventh in 1908. Washington rose from seventeenth in 1907 to thirteenth in 1908; Utah rose from thirty-third in 1907 to twenty-ninth in 1908, and Montana from forty-first in 1907 to thirty-sixth in 1908. Georgia fell from thirteenth in 1907 to sixteenth in 1908; Massachusetts from fifteenth to eighteenth; Maryland from eighteenth to twenty-second; Connecticut and Rhode Island from twenty-fourth to twenty-seventh; and Florida from thirty-seventh to fortieth.

The first ten States marketed wares in 1908 valued at $98,494,107, or 73.95 per cent of the total; in 1907 these same States reported wares valued at $118,497,978, or 74.55 per cent of the total. The first five reported wares in 1908 valued at $74,267,506, or 55.75 per cent of the total, compared with $91,631,274, or 57.66 per cent of the total.

The number of firms reporting decreased from 5,536 in 1907 to 5,328 in 1908, a decrease of 3.76 per cent. No attempt is made to show the number of yards or plants, but merely the number of firms reporting. The number of plants is considerably larger than the number of firms, as many firms have more than one yard, and some as high as 30. Nor has any attempt been made to show the number of plants from which no sales were made, which number was considerable in 1908.

Ohio has the largest number of reporting firms—736 in 1907 and 706 in 1908. California was the only State among the first ten to show an increase in the number of firms, and the gain was only 1. The following States showed gains as indicated: Kentucky, 1; Washington, 4; Georgia, 2; Alabama, 3; Maryland, 2; Nebraska, 1; North Carolina, 1; Utah, 6; Montana, 4; District of Columbia, 1; and South Dakota, 2. The other States showed losses.

BRICK AND TILE.

PRODUCTION.

The tables following show the production and value of the building brick and other structural products of clay, together with fire brick, paving brick, and other clay products used in engineering work, the rank of States, and the percentage of total value of each State in 1907 and 1908.

Brick and tile products of the United States in 1907.

Rank.	State.	Common brick.			Vitrified paving brick or block.		
		Quantity.	Value.	Average price per thousand.	Quantity.	Value.	Average price per thousand.
		Thousands.			*Thousands.*		
18	Alabama	159,315	$1,004,644	$6.31	13,362	$183,895	$13.76
45	Arizona	10,988	100,062	9.11			
35	Arkansas	68,463	468,706	6.85	(a)	(a)	10.00
8	California	339,439	2,483,062	7.32	(a)	(a)	15.79
14	Colorado	118,551	803,701	6.78	3,145	37,782	12.01
24	Connecticut and Rhode Island	198,414	1,240,575	6.25	(a)	(a)	24.23
42	Delaware	22,047	175,410	7.96			
39	District of Columbia	28,735	219,110	7.63			
37	Florida	51,779	343,704	6.64			
10	Georgia	318,844	1,807,148	5.67	(a)	(a)	12.50
38	Idaho and Nevada	34,034	299,403	8.80	(a)	(a)	25.14
3	Illinois	1,494,807	6,499,777	4.35	126,927	1,405,821	11.08
7	Indiana	251,766	1,509,415	6.00	46,224	548,448	11.87
9	Iowa	157,618	1,085,383	6.89	21,686	223,193	10.29
13	Kansas	263,887	1,189,263	4.51	85,110	727,979	8.55
11	Kentucky	143,731	932,469	6.49	(a)	(a)	14.27
28	Louisiana	110,386	839,236	7.60			
32	Maine	54,815	394,003	7.19	(a)	(a)	15.00
21	Maryland	166,768	1,026,922	6.16	(a)	(a)	15.00
16	Massachusetts	184,005	1,294,918	7.04			
17	Michigan	200,817	1,181,015	5.88	7,911	94,601	11.96
19	Minnesota	168,931	1,045,874	6.19	(a)	(a)	12.00
30	Mississippi	114,054	783,789	6.87			
6	Missouri	264,462	1,844,255	6.97	47,807	462,341	9.67
41	Montana	21,957	188,819	8.60	(a)	(a)	15.01
27	Nebraska	117,276	789,170	6.73	2,900	24,600	8.48
36	New Hampshire	66,737	500,599	7.50			
5	New Jersey	388,735	2,289,883	5.89	(a)	(a)	13.31
43	New Mexico	15,275	116,519	7.63	(a)	(a)	10.00
4	New York	1,319,416	7,056,453	5.35	18,516	253,664	13.70
25	North Carolina	174,800	1,150,685	6.58	(a)	(a)	10.00
40	North Dakota	27,058	210,212	7.77			
2	Ohio	495,025	3,012,485	6.09	264,571	2,672,600	10.10
31	Oklahoma	88,124	590,488	6.70	4,528	39,676	8.76
34	Oregon	42,857	355,912	8.30	(a)	(a)	20.00
1	Pennsylvania	980,102	6,353,799	6.48	115,729	1,232,718	10.65
29	South Carolina	125,642	760,461	6.05			
47	South Dakota	4,072	40,107	9.85			
23	Tennessee	170,972	1,036,112	6.06	(a)	(a)	11.98
12	Texas	243,853	1,707,812	7.00	(a)	(a)	10.36
33	Utah	50,982	357,010	7.00			
44	Vermont	12,724	83,200	6.54			
20	Virginia	197,052	1,285,374	6.52			
15	Washington	101,905	846,971	8.31	(a)	(a)	18.22
22	West Virginia	58,102	384,007	6.61	60,681	952,060	15.69
26	Wisconsin	158,602	1,019,522	6.43	(a)	(a)	8.04
46	Wyoming	7,774	78,017	10.04			
	Other States[b]				57,148	794,904	13.91
		9,795,698	58,785,461	6.00	876,245	9,654,282	11.02
	Per cent of brick and tile products		45.64			7.50	
	Per cent of total of clay products		36.99			6.07	

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State

Brick and tile products of the United States in 1907—Continued.

Rank.	State.	Front brick. Quantity.	Front brick. Value.	Front brick. Average price per thousand.	Fancy or ornamental brick (value).	Drain tile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).
		Thousands.							
18	Alabama	(a)	(a)	$13.90	(a)	(a)	(a)	....	(a)
45	Arizona	(a)	(a)	13.73	....	....	....	....	....
35	Arkansas	1,010	$11,940	11.82	....	$5,160	....	....	....
8	California	12,922	283,375	21.93	$150,165	53,997	$1,086,916	$528,623	$149,959
14	Colorado	24,572	254,522	10.36	46,128	19,608	(a)	(a)	(a)
24	Connecticut and Rhode Island	(a)	(a)	15.44	....	....	....	....	....
42	Delaware	(a)	(a)	19.40	....	(a)	....	....	....
39	District of Columbia	....	....	....	....	(a)	(a)	....	(a)
37	Florida	(a)	(a)	15.00	....	(a)	....	....	....
10	Georgia	1,625	16,450	10.12	(a)	8,050	244,000	(a)	(a)
38	Idaho and Nevada	361	7,675	21.26	....	....	....	....	....
3	Illinois	20,828	266,270	12.78	(a)	1,031,192	662,487	(a)	404,265
7	Indiana	36,890	437,796	11.87	(a)	1,437,735	487,537	(a)	304,151
9	Iowa	8,028	96,316	12.00	....	2,011,793	(a)	....	....
13	Kansas	24,381	236,876	9.72	(a)	15,320	(a)	(a)	....
11	Kentucky	7,926	86,568	10.92	....	32,723	(a)	....	....
28	Louisiana	(a)	(a)	11.50	....	(a)	....	....	....
32	Maine	(a)	(a)	10.00	....	(a)	(a)	....	....
21	Maryland	1,597	19,854	12.43	(a)	3,190	....	(a)	....
16	Massachusetts	(a)	(a)	37.13	(a)	....	....	(a)	(a)
17	Michigan	3,956	32,116	8.12	....	289,868	(a)	....	....
19	Minnesota	(a)	(a)	12.93	(a)	49,622	(a)	....	(a)
30	Mississippi	1,608	20,769	12.92	....	18,200	....	....	....
6	Missouri	30,178	387,455	12.84	33,638	72,316	1,332,080	(a)	(a)
41	Montana	(a)	(a)	20.00	(a)	....	(a)	....	....
27	Nebraska	7,280	100,654	13.83	(a)	(a)	....	....	....
36	New Hampshire	....	....	....	....	....	....	....	....
5	New Jersey	61,521	825,767	13.42	4,605	21,869	(a)	1,722,067	1,039,808
43	New Mexico	4,047	51,362	12.69	....	....	....	....	....
4	New York	12,265	198,265	16.17	(a)	180,818	(a)	1,089,278	73,064
25	North Carolina	770	7,925	10.29	....	(a)	(a)	....	....
40	North Dakota	4,067	67,482	16.59	(a)	....	....	....	....
2	Ohio	88,992	1,033,434	11.61	24,468	1,433,341	3,792,352	(a)	691,531
31	Oklahoma	1,752	20,990	11.98	....	....	....	....	....
34	Oregon	1,713	49,900	29.13	....	25,631	(a)	....	(a)
1	Pennsylvania	134,869	1,526,565	11.32	17,727	10,386	795,991	507,116	185,127
29	South Carolina	1,850	26,750	14.46	....	(a)	....	....	....
47	South Dakota	....	....	....	....	....	....	....	....
23	Tennessee	15,514	169,616	10.93	3,087	28,000	(a)	....	....
12	Texas	11,494	153,187	13.33	....	(a)	(a)	....	....
33	Utah	14,166	167,581	11.83	....	(a)	(a)	....	....
44	Vermont	(a)	(a)	10.00	....	(a)	....	....	....
20	Virginia	19,989	290,411	14.53	8,903	6,250	....	....	....
15	Washington	4,539	127,245	28.03	....	17,025	482,870	94,795	(a)
22	West Virginia	(a)	(a)	15.16	....	1,211	....	....	....
26	Wisconsin	4,106	43,387	10.57	(a)	49,832	....	....	....
46	Wyoming	728	10,323	14.18	....	....	....	....	....
	Other States [b]	20,399	300,534	14.73	72,522	41,025	2,598,612	2,085,098	314,548
		585,943	7,329,360	12.51	[c]1,279,416	6,864,162	11,482,845	6,026,977	3,162,453
	Per cent of brick and tile products	....	5.69	....	.99	5.33	8.92	4.68	2.46
	Per cent of total of clay products	....	4.61	....	.81	4.32	7.22	3.79	1.99

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.
[c] Includes enameled brick, valued at $918,173, made in the following States: California, Colorado, Illinois, Maryland, New Jersey, and Pennsylvania.

Brick and tile products of the United States in 1907—Continued.

Rank.	State.	Hollow building tile or blocks (value).	Tile not drain (value).	Stove lining (value).	Fire brick. Quantity.	Fire brick. Value.	Fire brick. Average price per thousand.	Miscellaneous (value).[a]	Total value.	Per centage of total value.
					Thousands.					
18	Alabama	(b)			11,026	$170,711	$15.48	$6,900	$1,726,664	1.34
45	Arizona								101,462	.08
35	Arkansas	(b)			(b)	(b)	12.36		519,336	.40
8	California	$58,246	$107,492	(b)	13,048	374,378	28.69	137,542	5,642,699	4.38
14	Colorado		(b)		19,863	430,897	21.69	75,225	1,997,331	1.55
24	Connecticut and Rhode Island			(b)	(b)	(b)	22.00	7,000	1,361,476	1.06
42	Delaware								190,440	.15
39	District of Columbia	(b)							322,084	.25
37	Florida				(b)	(b)	18.00		354,575	.28
10	Georgia	(b)	(b)	(b)	5,831	82,391	14.13	13,500	2,456,352	1.91
38	Idaho and Nevada				(b)	(b)	30.00	400	327,078	.25
3	Illinois	25,270	(b)	(b)	15,102	241,008	15.96	38,481	12,216,323	9.48
7	Indiana	110,192	(b)		15,825	160,373	10.13	344,885	5,988,970	4.65
9	Iowa	176,854			48	795	16.56	12,200	3,709,903	2.88
13	Kansas	(b)	(b)		(b)	(b)	25.08	4,535	2,370,058	1.84
11	Kentucky	(b)	255,054		53,398	940,415	17.61		2,444,743	1.90
28	Louisiana							37,341	922,877	.72
32	Maine				(b)	(b)	15.00		658,913	.51
21	Maryland		(b)	$31,048	12,964	242,312	18.69	10,864	1,519,465	1.18
16	Massachusetts		123,220	206,042	2,019	74,115	36.71	753	1,826,076	1.42
17	Michigan	6,386	(b)		(b)	(b)	12.00	1,500	1,786,190	1.39
19	Minnesota	(b)			(b)	(b)	20.00		1,689,933	1.31
30	Mississippi				(b)	(b)	15.00	2,500	825,408	.64
6	Missouri	42,673	(b)	(b)	76,351	1,634,209	21.40	175,846	6,820,684	5.30
41	Montana	(b)			948	35,553	37.50		272,872	.21
27	Nebraska	29,000							953,432	.74
36	New Hampshire				(b)	(b)	31.25		510,599	.40
5	New Jersey	119,659	1,050,085	(b)	36,918	947,472	25.66	620,482	9,019,834	7.00
43	New Mexico				(b)	(b)	25.00		180,284	.14
4	New York	47,254	43,726	129,467	13,769	538,721	39.13	98,828	9,838,376	7.64
25	North Carolina				(b)	(b)	17.99	5,000	1,305,600	1.01
40	North Dakota	(b)			(b)	(b)	25.87		287,919	.22
2	Ohio	314,545	1,586,174	22,416	108,197	1,668,728	15.42	550,395	16,807,631	13.05
31	Oklahoma				(b)	(b)	15.53	11,883	664,512	.52
34	Oregon	(b)			540	22,000	40.74		545,839	.42
1	Pennsylvania	59,646	406,269	179,218	369,956	6,907,904	18.67	784,830	18,981,743	14.74
29	South Carolina				3,025	41,318	13.66		829,029	.64
47	South Dakota								40,107	.03
23	Tennessee	(b)			3,386	40,959	12.09	6,000	1,446,647	1.12
12	Texas				4,154	75,946	18.28	16,763	2,401,388	1.86
33	Utah		(b)		1,359	34,804	25.61	11,555	633,387	.49
44	Vermont			(b)					109,500	.09
20	Virginia				(b)	(b)	15.59		1,611,335	1.25
15	Washington	(b)			1,506	43,940	29.18	13,660	1,891,239	1.47
22	West Virginia	(b)	52,429		2,384	34,438	14.45	9,680	1,481,255	1.15
26	Wisconsin	1,595						1,653	1,118,987	.87
46	Wyoming								88,340	.07
	Other States [c]	96,845	927,432	59,456	11,400	202,658	17.78		(d)	
		1,088,165	4,551,881	627,647	783,017	14,946,045	19.09	3,000,201	128,798,895	100.00
	Per cent of brick and tile products	.84	3.53	.49		11.60		2.33	100.00	
	Per cent of total clay products	.68	2.86	.40		9.40		1.89	81.03	

[a] Including adobes, brick for chemical purposes, burnt clay ballast, charcoal furnaces, chimney pipe flues and tops, conduits, crucibles, curbing, gas logs, glass-house supplies, grave and lot markers, insulators, muffles, oven tile, radial chimney brick, block and tile, retorts, scorifiers, sewer brick and blocks, sleeves and nozzles, stone pumps, vases and ornaments, and wall coping.
[b] Included in "Other States."
[c] Includes all products made by less than three producers in one State.
[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Brick and tile products in the United States in 1908.

Rank.	State.	Common brick.			Vitrified brick or block.		
		Quantity.	Value.	Average price per thousand.	Quantity.	Value.	Average price per thousand.
		Thousands.			*Thousands.*		
17	Alabama	120,237	$690,963	$5.75	18,248	$244,084	$13.38
44	Arizona	11,282	104,042	9.22			
35	Arkansas	57,885	389,617	6.73	(a)	(a)	7.09
8	California	236,383	1,593,814	6.74	3,499	66,214	18.92
14	Colorado	112,859	795,733	7.05	2,372	30,262	12.76
27	Connecticut and Rhode Island	131,760	749,093	5.69	(a)	(a)	16.25
42	Delaware	15,388	125,127	8.13			
39	District of Columbia	23,931	177,503	7.42			
40	Florida	38,559	225,441	5.85			
15	Georgia	248,585	1,335,349	5.37	(a)	(a)	15.50
38	Idaho and Nevada	36,314	319,636	8.80	(a)	(a)	25.00
3	Illinois	1,119,224	4,834,652	4.32	138,362	1,622,496	11.73
6	Indiana	224,454	1,221,910	5.44	57,748	776,533	13.45
9	Iowa	135,678	904,308	6.67	16,672	185,112	11.10
10	Kansas	225,820	896,542	3.97	102,922	862,019	8.38
11	Kentucky	110,545	687,365	6.22	(a)	(a)	13.26
30	Louisiana	77,856	547,160	7.03			
34	Maine	45,112	303,259	6.72	(a)	(a)	13.77
22	Maryland	141,071	828,981	5.88	(a)	(a)	13.06
20	Massachusetts	141,591	950,921	6.72			
16	Michigan	181,049	994,525	5.49	6,165	76,630	12.43
18	Minnesota	145,712	869,532	5.97	(a)	(a)	9.00
28	Mississippi	112,999	748,052	6.62			
7	Missouri	219,526	1,465,311	6.67	56,805	647,097	11.39
36	Montana	34,065	310,962	9.13	(a)	(a)	20.00
25	Nebraska	114,399	766,146	6.70	(a)	(a)	7.59
37	New Hampshire	50,372	365,400	7.25			
5	New Jersey	300,544	1,579,835	5.26	(a)	(a)	11.43
43	New Mexico	11,292	90,498	8.01	(a)	(a)	10.07
4	New York	1,055,006	5,066,084	4.80	14,570	211,290	14.50
26	North Carolina	144,192	900,611	6.25	(a)	(a)	8.00
41	North Dakota	17,476	136,260	7.80			
1	Ohio	369,410	2,105,910	5.70	327,718	3,232,335	9.86
32	Oklahoma	74,836	457,588	6.11	7,681	71,545	9.31
33	Oregon	43,732	373,008	8.53			
2	Pennsylvania	717,016	4,539,978	6.33	90,044	1,038,254	11.53
31	South Carolina	96,827	573,572	5.92			
46	South Dakota	5,893	57,247	9.71			
23	Tennessee	134,171	767,773	5.72	(a)	(a)	11.46
13	Texas	194,551	1,285,857	6.61	(a)	(a)	10.81
29	Utah	48,645	351,827	7.23			
45	Vermont	10,419	62,172	5.97			
19	Virginia	185,738	1,219,946	6.57			
12	Washington	107,638	817,962	7.60	(a)	(a)	19.82
21	West Virginia	47,402	300,776	6.35	70,924	718,017	10.12
24	Wisconsin	129,041	830,249	6.43			
47	Wyoming	4,561	47,117	10.33			
	Other States[b]				64,392	875,587	13.60
		7,811,046	44,765,614	5.73	978,122	10,657,475	10.90
	Per cent of brick and tile products		41.43			9.86	
	Per cent of total of clay products		33.61			8.00	

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.

Brick and tile products in the United States in 1908—Continued.

Rank.	State.	Front brick.			Fancy or ornamental brick (value).	Drain tile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).
		Quantity.	Value.	Average price per thousand.					
		Thousands.							
17	Alabama	(a)	(a)	$17.89	(a)	$2,046	(a)	....	(a)
44	Arizona	(a)	(a)	17.27	....	....	....	....	....
35	Arkansas	460	$5,550	12.07	....	5,330	....	....	....
8	California	12,393	283,701	22.89	$34,947	34,457	$1,036,320	$500,130	$188,221
14	Colorado	31,667	364,367	11.51	34,777	16,472	(a)	(a)	(b)
27	Connecticut and Rhode Island	(a)	(a)	15.75	....	....	....	....	....
42	Delaware	(a)	(a)	13.00	....	(a)	....	....	....
39	District of Columbia	(a)	(a)	12.00	....	(a)	(a)	....	(a)
40	Florida	(a)	(a)	9.00	....	(a)	....	....	....
15	Georgia	2,929	34,385	11.74	....	(a)	253,664	(a)	(a)
38	Idaho and Nevada	827	17,600	21.28	....	....	....	....	....
3	Illinois	22,851	301,515	13.19	(a)	1,421,878	514,386	(a)	264,986
6	Indiana	34,336	403,545	11.75	(a)	1,797,329	486,946	(a)	359,817
9	Iowa	7,900	86,232	10.92	(a)	2,509,505	211,044	....	129,003
10	Kansas	29,477	233,578	7.92	(a)	22,359	(a)	(a)	(a)
11	Kentucky	11,067	119,785	10.82	....	53,308	(a)	....	7,263
30	Louisiana	2,991	36,792	12.30	....	(a)	....	....	....
34	Maine	1,640	13,950	8.51	(a)	3,758	(a)	....	....
22	Maryland	936	13,498	14.42	1,463	3,895	....	(a)	....
20	Massachusetts	1,899	34,055	17.93	(a)	....	....	....	(a)
16	Michigan	1,896	19,496	10.28	....	327,630	(a)	....	4,100
18	Minnesota	9,900	118,860	12.01	(a)	70,161	(a)	....	45,940
28	Mississippi	788	11,837	15.02	(a)	38,000	....	....	....
7	Missouri	32,136	356,758	11.10	25,035	76,865	962,116	(a)	105,136
36	Montana	(a)	(a)	20.00	(a)	(a)	(a)	....	(a)
25	Nebraska	(a)	(a)	13.99	(a)	12,346	....	....	63,191
37	New Hampshire	....	....	....	(a)	....	....	....	....
5	New Jersey	64,302	667,682	10.38	3,619	30,325	(a)	1,039,856	826,224
43	New Mexico	(a)	(a)	13.47	....	....	....	....	....
4	New York	9,721	135,342	13.92	(a)	275,681	133,716	709,360	122,395
26	North Carolina	300	2,700	9.00	....	1,635	(a)	....	(a)
41	North Dakota	4,159	63,975	15.38	(a)	(a)	....	....	(a)
1	Ohio	94,435	1,067,888	11.31	39,309	1,725,462	3,918,971	....	552,887
32	Oklahoma	1,231	16,010	13.01	(a)	(a)	....	....	....
33	Oregon	986	29,227	29.64	(a)	34,453	(a)	....	(a)
2	Pennsylvania	124,642	1,403,594	11.26	49,199	14,904	578,800	389,596	241,175
31	South Carolina	(a)	(a)	11.00	....	(a)	....	....	....
46	South Dakota	(a)	(a)	16.50	....	....	....	....	....
23	Tennessee	9,494	103,228	10.87	1,505	36,114	(a)	....	(a)
13	Texas	10,411	154,298	14.82	....	5,275	(a)	....	(a)
29	Utah	15,239	175,876	11.54	(a)	2,871	(a)	....	....
45	Vermont	....	....	....	....	(a)	....	....	....
19	Virginia	17,858	246,623	13.81	(a)	7,100	(a)	....	....
12	Washington	4,011	112,749	28.11	....	28,551	493,165	171,845	45,205
21	West Virginia	(a)	(a)	14.18	....	2,645	(a)	....	(a)
24	Wisconsin	4,646	41,569	8.95	(a)	74,702	....	....	(a)
47	Wyoming	354	5,165	14.59	....	....	....	....	....
	Other States[b]	16,600	254,170	15.31	69,702	26,419	2,414,603	1,766,580	212,494
		584,482	6,935,600	11.87	[c]920,418	8,661,476	11,003,731	4,577,367	3,168,037
	Per cent of brick and tile products	....	6.42	......	.85	8.01	10.18	4.24	2.93
	Per cent of total of clay products	....	5.21	......	.69	6.50	8.26	3.44	2.38

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.
[c] Includes enameled brick, valued at $660,862, made in the following States: California, Illinois, Maryland, Missouri, New Jersey, and Pennsylvania.

Brick and tile products in the United States in 1908—Continued.

Rank.	State.	Tile, not drain (value).	Stove lining (value).	Fire brick. Quantity.	Fire brick. Value.	Fire brick. Average price per thousand.	Miscellaneous (value).[a]	Total value.	Percentage of total value.
				Thousands.					
17	Alabama			7,483	$122,354	$16.35	$10,616	$1,535,517	1.42
44	Arizona							104,992	.10
35	Arkansas			(b)	(b)	12.19		481,288	.44
8	California	$84,484	(b)	12,226	325,760	26.64	219,619	4,436,619	4.11
14	Colorado	(b)		10,195	206,161	20.22	167,967	1,920,674	1.78
27	Connecticut and Rhode Island		(b)	(b)	(b)	22.00		825,561	.76
42	Delaware							146,527	.13
39	District of Columbia						8,000	268,600	.25
40	Florida			(b)	(b)	17.76	70	233,162	.22
15	Georgia	(b)		3,296	53,466	16.22		1,917,960	1.77
38	Idaho and Nevada			(b)	(b)	40.00		339,356	.31
3	Illinois	124,425	(b)	15,984	250,444	15.67	8,928	10,752,160	9.95
6	Indiana	505,908		8,445	115,895	13.72	265,974	5,979,677	5.53
9	Iowa						21,583	4,050,787	3.75
10	Kansas	(b)		(b)	(b)	17.58	19,635	2,248,805	2.08
11	Kentucky	215,000		44,358	770,221	17.36		2,085,460	1.93
30	Louisiana						39,501	623,753	.58
34	Maine			(b)	(b)	15.00		542,730	.50
22	Maryland	(b)	$23,538	9,975	179,469	17.99	9,900	1,165,412	1.08
20	Massachusetts	104,386	169,811	1,716	63,241	36.85		1,397,636	1.29
16	Michigan	(b)					40,100	1,666,381	1.54
18	Minnesota			(b)	(b)	15.00		1,508,710	1.40
28	Mississippi			(b)	(b)	15.15	5,000	806,889	.75
7	Missouri	(b)	(b)	60,544	1,357,387	22.42	56,555	5,562,548	5.15
36	Montana	(b)		868	40,890	47.11		387,525	.36
25	Nebraska			(b)	(b)	25.00	16,518	946,516	.88
37	New Hampshire			(b)	(b)	30.00		371,640	.34
5	New Jersey	835,499	(b)	36,751	800,987	21.79	285,978	6,363,705	5.89
43	New Mexico			(b)	(b)	24.61	212	140,671	.13
4	New York	40,066	102,985	12,289	436,847	35.55	35,800	7,270,981	6.73
26	North Carolina			700	7,560	10.80		930,606	.86
41	North Dakota			(b)	(b)	25.57		206,222	.19
1	Ohio	1,438,042	(b)	84,427	1,339,810	15.87	444,901	15,915,703	14.73
32	Oklahoma			(b)	(b)	40.00	16,000	562,929	.52
33	Oregon			252	6,566	26.06		555,768	.51
2	Pennsylvania	337,948	129,686	222,362	4,252,325	19.12	571,832	13,566,479	12.55
31	South Carolina			2,128	30,257	14.22		606,779	.56
46	South Dakota							63,847	.06
23	Tennessee			1,821	21,029	11.55		1,123,802	1.04
13	Texas	(b)		3,796	69,039	18.19	10,142	1,941,589	1.80
29	Utah			1,168	35,595	30.48	6,245	655,067	.61
45	Vermont		(b)					89,064	.08
19	Virginia			(b)	(b)	15.39	3,450	1,499,130	1.39
12	Washington			1,407	42,045	29.88	3,991	2,083,688	1.93
21	West Virginia	49,220		2,602	38,943	14.97		1,177,915	1.09
24	Wisconsin	(b)						949,095	.88
47	Wyoming							52,282	.05
	Other States[c]	142,802	103,956	7,573	129,925	17.16		(d)	
		[e]3,877,780	529,976	552,366	10,696,216	19.36	2,268,517	108,062,207	100.00
	Per cent of brick and tile products	3.59	.49		9.90		2.10	100.00	
	Per cent of total of clay products	2.91	.40		8.03		1.70	81.13	

[a] Including adobes, assayer's supplies, brick for chemical purposes, burnt clay ballast, charcoal furnaces, chimney pipe, flues and tops, conduits, crucibles, curbing, flue lining, gas logs, glass house supplies, muffles, radial chimney brick, retorts, scarifiers sewer brick, sleeves and nozzles, stone pumps, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than three producers in one State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

[e] Includes roofing tile, valued at $806,609 (estimated), made in the following States: California, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, Ohio, and West Virginia.

These tables show the details, by States, of the production of the coarser clay products in 1907 and 1908. The total value of these products in 1908 was $20,736,688, or 16.10 per cent, less than in 1907; in 1907 it was $792,943, or 0.61 per cent, less than in 1906.

The value in 1908 for these products was the smallest since 1904, when it was $105,864,978. The value for 1908 was therefore $2,197,229, or 2.08 per cent greater than 1904.

The common building brick, as its name implies, is the most widely spread of all clay products, being reported from every State and Territory except Alaska. In 1908, 7,811,046,000 common brick were reported, valued at $44,765,614, a loss of 1,984,652,000 brick, or 20.26 per cent from 1907; the loss in 1907 from 1906 was 231,341,000 brick, or 2.31 per cent. The value of the common brick in 1908 was $44,765,614, compared with $58,785,461 in 1907, a loss of $14,019,847, or 23.85 per cent. Increases in output over 1907 were reported by only 6 States out of the 47 totals given, viz: Arizona, Idaho and Nevada, Montana, Oregon, South Dakota, and Washington. Of the 6 States showing increases in output 5 reported increases in value of the common brick and 1 (Washington) showed a small decrease in value. In 1907, 16 States reported increases. The States reporting increases in output in both years were: Arizona, Idaho and Nevada, and Washington. These are not important States in the clay-working industries, and the increases are all small. Among the important States in the production of common brick, Illinois, which stands first, fell off 375,583,000 brick, or 25.13 per cent; New York, which is second, showed a decline of 264,410,000, or 20.04 per cent; and Pennsylvania, which is third, reported a decrease of 263,086,000, or 26.84 per cent. In the value of common brick these States showed the following losses in 1908: Illinois, $1,665,125, or 25.62 per cent; New York, $1,990,369, or 28.21 per cent; Pennsylvania, $1,813,821, or 28.55 per cent. New York, while second in production, was first in value of product. Of New York's loss in product 191,952,000 brick, or 72.60 per cent, was in the Hudson River region, as shown elsewhere. Only two States reported as many as 1,000,000,000 common brick, Illinois and New York.

The average value per thousand for common brick in 1908 ranged from $3.97 in Kansas to $10.33 in Wyoming. These extremes, however, are in States of small outputs and have but little influence on the general average. The general average was $5.73. Tennessee was nearest—$5.72; in Illinois the average was $4.32; in New York, $4.80; Pennsylvania, $6.33; Ohio, $5.70; and New Jersey, $5.26. In value common brick constituted 41.43 per cent of the brick and tile products in 1908 and 33.61 per cent of all clay products; in 1907 these percentages were, respectively, 45.64 and 36.99.

Vitrified paving brick reported for 1908 numbered 978,122,000, valued at $10,657,475; in 1907 the product reported was 876,245,000, valued at $9,654,282, a gain in 1908 of 101,877,000, or 11.63 per cent, in number, and $1,003,193, or 10.39 per cent, in value. Ohio continues to be the leading producer, reporting 327,718,000 brick, valued at $3,232,335, or $9.86 per thousand, as compared with 264,571,000 in 1907, valued at $2,672,600, or $10.10 per thousand. This is a gain of 63,147,000 brick, or 23.87 per cent, and of $559,735 in value, or 20.94 per cent. Ohio reported 33.50 per cent of the total quantity of vitrified brick and 30.33 per cent of the total value;

in 1907 this State reported 30.19 per cent of the output and 27.68 per cent of the value. Illinois and Pennsylvania were second and third in value of product, the former reporting $1,622,496, or 15.22 per cent of the total, and the latter $1,038,254, or 9.74 per cent of the total. While Pennsylvania was third in value, it was fourth in quantity, being exceeded by Kansas, which reported 102,922,000, compared with Pennsylvania's 90,044,000. Kansas was fourth in value, reporting vitrified brick valued at $862,019. West Virginia was fifth in quantity of brick reported and sixth in value. While this product was reported from 30 States, in 16 States there were less than three producers; hence it was necessary to combine these figures under other States. In 1907, 32 States reported this variety of brick, figures for 18 being concealed. For 1907 Oregon and Wisconsin reported vitrified brick; for 1908 they reported none. The average value per thousand ranged in the important producing States from $8.38 in Kansas to $14.50 in New York, the average for the whole country being $10.90. In 1907, the average for the country was $11.02. In 1908 vitrified brick composed 9.86 per cent of the value of the brick and tile products, and 8 per cent of all clay products; in 1907 these figures were, respectively, 7.50 and 6.07.

The front brick reported in 1908 numbered 584,482,000, valued at $6,935,600, or $11.87 per thousand. This is a decrease of 1,461,000, or 0.25 per cent; the value decreased $393,760, or 5.37 per cent. As for several years, Pennsylvania, Ohio, and New Jersey are the leading front-brick producing States in the order named. These 3 States reported 48.48 per cent of the total number and 45.26 per cent of the total value in 1908. Indiana was fourth in both quantity and value in 1907 and 1908; Missouri was fifth in quantity in 1908 and sixth in value; and Colorado fifth in value and sixth in quantity. The average value per thousand ranged from $7.92 in Kansas to $29.64 in Oregon, the average for the whole country being $11.87. In 1907 the value ranged from $8.12 in Michigan to $37.13 in Massachusetts. Next to common brick front brick is the most widely spread product, it being reported from every State except 2. In 1908 this product was 6.42 per cent of the value of the brick and tile products and 5.21 per cent of all clay products; in 1907 these percentages were 5.69 and 4.61.

The drain-tile industry is one that flourished during 1908, notwithstanding the depression in other branches of the industry. The total value of this product reported for 1908 was $8,661,476, compared with $6,864,162 in 1907, a gain of $1,797,314, or 26.18 per cent. When it is considered that only one other clay product (vitrified paving brick) increased in 1908 over 1907, this large gain in one of the commoner products is remarkable. This product was reported from 39 States in 1908 and from 36 in 1907, Montana, North Dakota, and Oklahoma being added in 1908 to the list of producers. Another evidence of the increasing popularity of this material is the fact that although for 1907 it was necessary to conceal the totals for 12 States on account of there being less than three producers in each of these States, for 1908 with three more States reporting it was necessary to conceal the totals for only 10 States. Iowa, Indiana, Ohio, and Illinois were the leading producing States in the order named. Iowa showed a gain of $497,712, or 24.74 per cent; Indiana, $359,594, or 25.01 per cent; Illinois $390,686, or 37.89

per cent; and Ohio $292,121, or 20.38 per cent. These four States, with Michigan, a contiguous State, reported draintile to the value of $7,781,804, or 89.84 per cent of the total. Draintile was 8.01 per cent in value of the brick and tile products, and 6.50 per cent of all clay products in 1908; in 1907 these figures were 5.33 and 4.32, respectively.

Sewer pipe showed a slight decline, from $11,482,845 in 1907 to $11,003,731 in 1908, a loss of $479,114, or 4.17 per cent. It was reported from 27 States in 1908, but in only 10 were there a sufficient number of producers to enable the publication of State totals. In 1907 it was reported from 25 States. Ohio was the leading producer, reporting sewer pipe marketed in 1908 to the value of $3,918,971, a gain of $126,619, or 3.34 per cent over 1907. This State reported 35.61 per cent of the total product in 1908. Missouri, which was second in 1907 became third in 1908, being displaced by California, which was third in 1907. Pennsylvania was fourth in both years. These 4 States reported 59.04 per cent of the total in 1908. Illinois, Indiana, and Washington were also large producers of sewer pipe. These 7 States together reported 72.62 per cent of the total. Sewer pipe in 1908 was 10.18 per cent of the brick and tile products and 8.26 per cent of all clay products; in 1907 these figures were 8.92 and 7.22, respectively.

Architectural terra cotta is reported from few States owing to the skill required in its making and to the comparatively small demand for this material except in the largest and best buildings. For 1908 it was reported from 12 States, totals for only 5 of which could be given without disclosing individual returns. Massachusetts and Ohio, which reported this product for 1907, reported none for 1908. This product showed a large falling off from 1907—$1,449,610, or 24.05 per cent. New Jersey was the leading State, reporting a product valued at $1,039,856, a decrease of $682,211, or 39.62 per cent. Washington, a small producing State, nearly doubled its product in 1908. This product was 4.24 per cent of the brick and tile products and 3.44 per cent of all clay products; in 1907 these figures were 4.68 and 3.79. Illinois is one of the leading States in the production of this ware, but owing to there being less than three producers in the State, the total for 1908 could not be reported separately.

Fireproofing and hollow building tile or block, owing to their similarity in body and manufacture, have been combined for 1908. New Jersey was the leading producing State in these wares, reporting 26.08 per cent of the entire output. Ohio is the second largest producer, reporting 17.45 per cent of the total. These products are reported from 28 States, but in only 14 are there a sufficient number of producers to permit the publication of totals. These products were 2.93 per cent of the brick and tile products and 2.38 per cent of all clay products in 1908.

Tile, not drain, embraces roofing, floor, wall, and art tile. It was reported from 19 States, but totals could be given for only 10 States. Ohio was the largest producer of these wares, reporting products for 1908 valued at $1,438,042, a loss of 9.34 per cent. This State produced 37.08 per cent of the entire country. New Jersey was second, reporting 21.55 per cent of the total. These relative ranks have been maintained for several years. The value of these products was 3.59 per cent of brick and tile products and 2.91 per cent of all clay products in 1908; in 1907 these figures were, respectively, 3.53 and 2.86.

Stove lining was reported from 11 States in 1908 and from 12 in 1907, Georgia dropping out in the former year. Owing, however, to the small number of producers in many of the States, it was possible to give totals for only 4. Massachusetts was first, reporting a product valued at $169,811, and Pennsylvania second, with $129,686. Both States showed decreases in the value of products.

The fire-brick industry is one of the most important branches of the clay-working industries, fire brick being reported from 37 States in 1908. The figures given in this report for quantity represent the product reduced to the equivalent of the 9-inch fire brick. The quantity so reported for 1908 was 552,366,000, compared with 783,017,000 in 1907. This was a loss of 230,651,000 fire brick, or 29.46 per cent. The value decreased from $14,946,045 in 1907 to $10,696,216 in 1908, a decrease of $4,249,829, or 28.43 per cent. The average value per thousand increased from $19.09 in 1907 to $19.36 in 1908. Pennsylvania was the largest producer, reporting 222,362,000 fire brick, or 40.26 per cent of the total quantity, and $4,252,325, or 39.76 per cent of the value for 1908. This was a loss of 147,594,000 fire brick, or 39.90 per cent, and of $2,655,579, or 38.44 per cent; in 1907 this State reported 47.25 per cent of the fire brick of the whole country and 46.22 per cent of the value. Ohio, which was second in quantity, but third in value, reported a loss of 23,770,000 fire brick, or 21.97 per cent, and of $328,918, or 19.71 per cent. Missouri was third in quantity and second in value, reporting losses in both in 1908. Kentucky was fourth in quantity and fifth in value, New Jersey being fifth in quantity and fourth in value. The other States are comparatively small producers, Illinois being the largest in quantity, reporting 15,984,000 brick, valued at $250,444, though California's 12,226,000 fire brick were valued at $325,760. The range in average value per thousand was from $10.80 in North Carolina to $47.11 in Montana, with a general average of $19.36. As in other varieties of brick, these extremes are in States of small importance as producers. Fire brick composed 9.90 per cent of the value of the brick and tile products and 8.03 per cent of all clay products in 1908; in 1907 these percentages were, respectively, 11.60 and 9.40.

Heretofore Pennsylvania has been the leading producer of the materials embraced in the brick and tile of this classification; but in 1908 Ohio was the leading producing State in brick and tile as well as in pottery, reporting brick and tile wares valued at $15,915,703, or 14.73 per cent of the total. This was a loss of $891,928, or 5.31 per cent, from the 1907 value, when Ohio's products were 13.05 per cent of the total. Pennsylvania was for the first time second in 1908 in the value of brick and tile products, reporting wares valued at $13,566,479, a loss of $5,415,264, or 28.53 per cent. Pennsylvania's principal losses were in common building and fire brick. Pennsylvania's output was 12.55 per cent of the total in 1908 and 14.74 per cent in 1907. Illinois was third in both 1907 and 1908, reporting wares valued at $12,-216,323, or 9.48 per cent of the total, in 1907, as compared with $10,752,160, or 9.95 per cent of the total, in 1908; this was a loss of $1,464,163, or 11.99 per cent. New York was fourth in both years, reporting wares valued at $9,838,376, or 7.64 per cent of the total, in 1907, and at $7,270,981, or 6.73 per cent of the total, in 1908; this was a loss of $2,567,395, or 26.10 per cent. New Jersey was fifth in 1908 as in 1907, reporting products valued at $6,363,705 in 1908 and at $9,019,834 in 1907, a loss of $2,656,129, or 29.45 per cent. New Jersey's products composed 7 per cent of the brick and tile products in 1907 and 5.89 per cent in 1908. Missouri, which was sixth in 1907, became seventh in 1908, exchanging places with Indiana. Kansas rose from thirteenth in 1907 to tenth in 1908, Washington rose from fifteenth place in 1907 to twelfth in 1908, Georgia fell from tenth to fifteenth place, Massachusetts fell from sixteenth to twentieth place. There were no other changes in rank in the important States.

In 1908 there were 7 States contributing over $5,000,000 each—Illinois, Indiana, Missouri, New Jersey, New York, Ohio, and Pennsylvania. These States reported products in 1907 valued at $79,673,561 and in 1908 at $65,411,253, a loss of $14,262,308 in 1908, or 17.90 per cent. These States reported 61.86 per cent of the value of all brick and tile products in 1907 and 60.53 per cent in 1908.

HUDSON RIVER REGION.

The Hudson River region has long been known as the largest brick-making center in this country, if not in the world. This region includes 10 counties along the Hudson River, 9 in New York and 1 in New Jersey, and extends from New York City to Cohoes. The market for the brick made in this region is principally Greater New York and environs, which are easily accessible by water. As the building operations in the metropolis fluctuate, so will the brick product of the Hudson River region rise or fall.

The total number of brick marketed from this region in 1908 was 875,979,000, valued at $4,107,382, or $4.69 per thousand, as compared with 1,064,892,000 in 1907, valued at $5,515,585, or $5.18 per thousand—a decrease of 188,913,000 brick, or 17.74 per cent, and of $1,408,203, or 25.53 per cent, and a loss in price of 49 cents per thousand. This is the smallest quantity and value of brick reported from this region since 1903.

New York's portion was 93.67 per cent of the quantity and 93.19 per cent of the value of the product of the whole region. This product of 820,561,000 common brick, which was a decrease of 191,952,000, or 18.96 per cent, from 1907, constituted 77.78 per cent of New York's total output of common brick, and was greater than the output of common brick of any other State except Illinois. The value of New York's portion of the product of this region was $3,827,514, a decrease of $1,413,723, or 26.97 per cent. This value was exceeded in 1908 by the value of the common brick of only Illinois and Pennsylvania, and constituted 42.87 per cent of the total value of New York's clay products. In 1908 the value of the clay products in only 8 other States exceeded the value of New York's output from this region, viz, California, Illinois, Indiana, Iowa, Missouri, New Jersey, Ohio, and Pennsylvania. The value of New York's portion of this output was exceeded by 7 States in 1907, and by only 4 in 1906.

Of the counties included in this region Ulster was first in both quantity and value, reporting, for 1908, 182,167,000 brick, valued at $831,948. Rockland was second with 174,026,000 brick, valued at $800,603. In 1907 Ulster was first in quantity and second in value. Orange and Dutchess were third and fourth in both quantity and value in 1907 and 1908.

The average value per thousand for the whole region was $5.18 in 1907 and $4.69 in 1908. The average value for 1908 is the lowest since 1902, but is practically the same as in 1903, when it was $4.70. The rise and fall of prices of brick along the Hudson River is one of the most remarkable features of the brick-making industry. In 1902 the average value per thousand for common was $4.42; it rose rapidly to $6.99 in 1905, accompanying an increased output of nearly 56 per cent, as a result of the activity in building operations in Greater New York, and declined almost as rapidly, until in 1908 it was back to about what it was in 1903. In New York's portion of the region the average value was $4.66, which was a decline from $5.18 in 1907, and in New Jersey's portion the average was higher in both years than that in New York—$5.24 in 1907 and $5.05 in 1908. The average per thousand ranged in New York's portion in 1908 from $4.57 in Ulster to $5.55 in Rensselaer. In 1906 the average for the New York portion of the region was $6.03, and in 1905 it was $7.

In New Jersey's portion of the region conditions appear to have been more favorable and production and value there show slight increases in 1908. The quantity increased 3,039,000 brick, or 5.80 per cent, and the value $5,520, or 2.01 per cent, though the average value decreased from $5.24 to $5.05, both of which are above the average for the entire region.

The number of firms reporting decreased from 132 to 123, though in New Jersey's portion there was an increase of one. The largest number of firms reporting from this region was 135 in 1906.

Production of common brick in the Hudson River district from Cohoes to New York City in 1907 and 1908, by counties.

County.	1907.				1908.			
	Number of firms reporting.	Quantity (thousands).	Value.	Average price per thousand.	Number of firms reporting.	Quantity (thousands).	Value.	Average price per thousand.
Albany	11	62,685	$306,316	$4.89	12	55,677	$255,013	$4.58
Columbia	6	82,937	378,576	4.56	4	61,971	283,720	4.58
Dutchess	16	135,469	727,313	5.37	18	132,005	606,372	4.59
Greene	5	40,289	191,676	4.76	4	12,095	57,723	4.77
Orange	10	148,103	740,372	5.00	8	151,869	746,637	4.92
Rensselaer	7	17,681	95,236	5.39	6	10,949	60,724	5.55
Rockland	33	233,562	1,272,455	5.45	29	174,026	800,603	4.60
Ulster	25	235,584	1,217,613	5.17	24	182,167	831,948	4.57
Westchester	9	56,203	311,680	5.55	7	39,802	184,774	4.64
Total for New York	122	1,012,513	5,241,237	5.18	112	820,561	3,827,514	4.66
Bergen County, N. J	10	52,379	274,348	5.24	11	55,418	279,868	5.05
	132	1,064,892	5,515,585	5.18	123	875,979	4,107,382	4.69

POTTERY.

INTRODUCTION.

The pottery industry, in common with others, suffered severely from the business depression of 1907–8, as is shown in the figures that follow. Compared with 1907, which itself showed some decrease from 1906, the value of the pottery products in 1908 declined $5,007,919, or 16.61 per cent, or from $30,143,474 in 1907 to

$25,135,555 in 1908. This is the lowest value reported to this office since 1902, when it was $24,127,453, the highest value being in 1906, when it was $31,440,884.

The imports of pottery showed even a greater proportionate decrease than the domestic production, the decrease in 1908 being $3,062,821, or 22.54 per cent, as compared with an increase of $354,510, or 2.68 per cent, in 1907 over 1906. The proportion of domestic production to consumption, notwithstanding the stress of the times, showed an increase reaching 72.54 per cent in 1908 as compared with 70.82 in 1907.

The tendency toward the production of better ware noted in previous reports continued.

PRODUCTION.

In the following table will be found statistics of the production of pottery in the United States in 1907 and 1908, the former year being given for comparative purposes:

Value of pottery products in 1907, by varieties of products, by States.

Rank of State.	State.	Number of active firms reporting.	Red earthenware.	Stoneware and yellow and Rockingham ware.	C. C. ware, white granite, semi-porcelain ware, and semivitreous porcelain ware.	China, bone china Delft, and Belleek ware.
20	Alabama	22	$7,530	$20,215		
23	Arkansas	3	(a)	15,200		
14	California	13	42,856	39,382		
17	Colorado	6	1,931	35,644		
13	Connecticut	4	31,616	(a)		
	District of Columbia		(a)			
	Florida		(a)	(a)		
18	Georgia	15	18,440	15,445		
6	Illinois	24	37,045	898,267	(a)	
7	Indiana	18	5,075	45,579	(a)	
22	Iowa	6	8,250	(a)		
	Kansas			(a)		
11	Kentucky	11	27,546	139,075		
27	Louisiana	3	(a)			
	Maine			(a)		
8	Maryland	10	12,895	(a)	$348,890	
9	Massachusetts	16	166,978	17,693	(a)	
16	Michigan	6	54,474			
	Minnesota		(a)	(a)		
21	Mississippi	7	865	20,256		
15	Missouri	12	3,289	69,323		
	Montana		(a)			
	New Hampshire					
2	New Jersey	55	21,067	(a)	1,225,691	$1,135,885
4	New York	24	32,896	87,471	(a)	746,634
25	North Carolina	24	2,382	7,840		
1	Ohio	118	142,042	1,648,213	9,419,960	(a)
	Oregon		(a)	(a)		
5	Pennsylvania	40	164,096	380,361	531,634	(a)
24	South Carolina	6	4,450	9,900		
10	Tennessee	13	6,185	111,030		
12	Texas	19	6,759	149,414		
	Utah		(a)			
	Virginia					
19	Washington	4	2,500	28,195		
3	West Virginia	12		(a)	1,651,732	
26	Wisconsin	3	8,832			
	Other States [b]		35,466	542,098	735,773	48,150
		[c] 509	845,465	4,280,601	13,913,680	1,930,669
	Per cent of pottery products		2.80	14.20	46.16	6.41
	Per cent of total clay products		.53	2.69	8.75	1.22
	Number of firms reporting each variety		193	219	68	16

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.
[c] Includes fifteen firms not distributed.

Value of pottery products in 1907, by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
20	Alabama				$27,745	0.09
23	Arkansas				16,950	.06
14	California	([b])		$2,800	97,838	.32
17	Colorado			6,569	44,144	.15
13	Connecticut		([b])	18,500	123,116	.41
	District of Columbia				([c])	
	Florida				([c])	
18	Georgia				33,885	.11
6	Illinois		([b])	57,054	1,004,166	3.33
7	Indiana	$400,000	([b])	500	869,154	2.88
22	Iowa			3,500	18,882	.06
	Kansas				([c])	
11	Kentucky				166,621	.55
27	Louisiana			5,293	5,693	.02
	Maine				([c])	
8	Maryland			3,500	366,897	1.22
9	Massachusetts		([b])	23,100	302,744	1.00
16	Michigan			7,100	61,574	.20
	Minnesota				([c])	
21	Mississippi				21,121	.07
15	Missouri			5,575	78,187	.26
	Montana				([c])	
	New Hampshire			([b])	([c])	
2	New Jersey	3,615,685	$744,068	186,809	6,985,626	23.18
4	New York	([b])	626,032	51,582	1,934,498	6.42
25	North Carolina				10,222	.03
1	Ohio	226,000	933,256	1,130,678	13,533,199	44.90
	Oregon				([c])	
5	Pennsylvania	192,854		25,833	1,309,878	4.35
24	South Carolina				14,350	.05
10	Tennessee			50,000	167,215	.56
12	Texas				156,173	.52
	Utah				([c])	
	Virginia		([b])	([b])	([c])	
19	Washington				30,695	.10
3	West Virginia	378,000	([b])	78,985	2,159,132	7.16
26	Wisconsin				8,832	.03
	Other States[d]	50,683	310,415	38,688	[e] 594,937	1.97
		4,863,222	2,613,771	1,696,066	30,143,474	100.00
	Per cent of pottery products	16.13	8.67	5.63	100.00	
	Per cent of total clay products	3.06	1.65	1.07	18.97	
	Number of firms reporting each variety.	36	36	75		

[a] Including art and chemical pottery, craquelle porcelain, faïence, garden vases, Grueby, Hampshire, and Teco pottery, handmade tile, hanging baskets, incandescent mantle supplies, jardinieres and pedestals, pins, stilts, and spurs for potters' use; porcelain doorknobs and filter tubes, porcelain hardware trimmings, statuettes, stove crocks, tobacco pipes, toy marbles, turpentine cups, and umbrella stands.
[b] Included in "Other States."
[c] Included in [e] ($594,937).
[d] Includes all products made by less than three producers in one State.
[e] Made up of State totals of District of Columbia, Florida, Kansas, Maine, Minnesota, Montana, New Hampshire, Oregon, Utah, and Virginia. The totals for "Other States" is distributed among the States to which it belongs.

Value of pottery products in 1908, by varieties of products, by States.

Rank of State.	State.	Number of active firms reporting.	Red earthenware.	Stoneware, yellow and Rockingham ware.	White ware, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
19	Alabama	21	$15,058	$9,031		
18	Arkansas	5		24,500		
13	California	12	42,962	29,300		
17	Colorado	4	11,250	(a)		
14	Connecticut	4	12,000	(a)		
	District of Columbia		(a)			
24	Georgia	15	5,710	4,941		
6	Illinois	22	24,821	733,373	(a)	
7	Indiana	16	7,450	37,020	(a)	
22	Iowa	7	8,161	7,549		
	Kansas			(a)		
10	Kentucky	12	23,448	130,200		
27	Louisiana	3	(a)			
	Maine			(a)		
8	Maryland	9	9,267	(a)	(a)	
9	Massachusetts	15	150,148	15,409	(a)	
16	Michigan	6	54,659			
	Minnesota		(a)	(a)		
20	Mississippi	7	570	21,180		
15	Missouri	12	3,719	62,689		
	Montana		(a)			
	New Hampshire					
2	New Jersey	56	20,100	(a)	$1,137,701	$876,259
	New Mexico					
4	New York	25	31,645	44,713	(a)	622,548
23	North Carolina	31	775	12,587		
1	Ohio	118	138,431	1,468,197	7,228,636	(a)
	Oregon		(a)	(a)		
5	Pennsylvania	35	138,181	259,095	623,544	69,994
26	South Carolina	5	5,343	3,126		
12	Tennessee	9	(a)	56,532		
11	Texas	14	10,267	114,879		
28	Utah	3	3,450			
	Virginia					
21	Washington	4	2,450	(a)		
3	West Virginia	11		(a)	1,612,321	
25	Wisconsin	3	9,300			
	Other States [b]		28,735	484,520	871,945	12,219
		[c] 497	757,900	3,518,841	11,474,147	1,581,020
	Per cent of pottery products		3.02	14.00	45.65	6.29
	Per cent of total clay products		.57	2.64	8.61	1.19
	Number of firms reporting each variety		179	209	65	16

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.
[c] Includes 13 firms not distributed.

Value of pottery products in 1908, by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
19	Alabama				$24,089	0.10
18	Arkansas			$3,000	27,500	.11
13	California	(b)		(b)	87,126	.35
17	Colorado			(b)	49,407	.20
14	Connecticut		(b)	11,500	76,000	.30
	District of Columbia				(c)	
24	Georgia				10,651	.04
6	Illinois			45,376	806,954	3.21
7	Indiana	$350,000	(b)	20	760,490	3.03
22	Iowa			3,000	18,710	.07
	Kansas				(c)	
10	Kentucky				153,648	.61
27	Louisiana			5,741	6,171	.02
	Maine				(c)	
8	Maryland			3,000	275,687	1.10
9	Massachusetts		(b)	24,008	249,726	.99
16	Michigan			7,750	62,409	.25
	Minnesota				(c)	
20	Mississippi			100	21,850	.09
15	Missouri			2,500	68,908	.27
	Montana	(b)			(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	3,182,772	$559,556	123,262	5,949,991	23.67
	New Mexico			(b)	(c)	
4	New York	(b)	560,754	94,229	1,658,243	6.60
23	North Carolina				13,362	.05
1	Ohio	233,000	719,034	907,270	10,706,787	42.60
	Oregon			(b)	(c)	
5	Pennsylvania	175,384		10,305	1,276,503	5.08
26	South Carolina				8,469	.03
12	Tennessee			(b)	112,632	.45
11	Texas				125,146	.50
28	Utah				3,450	.01
	Virginia		(b)	(b)	(c)	
21	Washington				20,601	.08
3	West Virginia	385,000	(b)	71,000	2,083,821	8.29
25	Wisconsin				9,300	.04
	Other States[d]	47,434	169,661	108,991	[e] 467,924	1.86
		4,373,590	2,009,005	1,421,052	25,135,555	100.00
	Per cent of pottery products	17.40	7.99	5.65	100.00	
	Per cent of total clay products	3.28	1.51	1.07	18.87	
	Number of firms reporting each variety	36	31	76		

[a] Including art and chemical pottery, ceramic sculpture, craquelle porcelain, faïence, garden vases, Grueby, Hampshire, Indian, Pewabic, and Teco pottery, handmade tile, hanging baskets, incandescent mantle supplies, insulating materials, jardinieres and pedestals, majolica, pins, stilts, and spurs for potters' use; porcelain door knobs, filter tubes, shuttle eyes, and thread guides, porcelain hardware trimmings, tobacco pipes, toy marbles, turpentine cups, and umbrella stands.

[b] Included in "Other States."

[c] Included in (e) ($467,924).

[d] Includes all products made by less than three producers in one State.

[e] Made up of State totals of District of Columbia, Kansas, Maine, Minnesota, Montana, New Hampshire, New Mexico, Oregon, and Virginia. The total for "Other States" is distributed among the States to which it belongs.

As in former years, pottery products, except earthenware and stoneware, were produced in but few States. General ware, as in 1907, was reported from but 9 States; sanitary ware from but 8 States, Montana entering the list in 1908; and porcelain electrical supplies from but 8 States, a decrease of 1, Illinois dropping out.

Red earthenware, the commonest of pottery products, was reported from 30 States, a decrease of 2, Arkansas and Florida dropping out. Massachusetts was the leading State in this ware in 1908 as in 1907, reporting ware valued at $150,148 in 1908, as compared with $166,978 in 1907, a loss of $16,830. In 1906 Massachusetts reported ware of this kind valued at $171,160. Ohio, the leading State in the production of red earthenware in 1906, with wares valued at $206,258, was second in 1908, with wares valued at $138,431, closely followed by Pennsylvania, with wares valued at $138,181. The total value of this ware in 1908 was $757,900, as compared with $845,465 in 1907, a loss of $87,565, or 10.36 per cent. This product was reported by 179 producers in 1908 and by 193 producers in 1907. In 1908 it was 3.02 per cent of the pottery products and 2.80 per cent in 1907.

Stoneware, the next most widely distributed pottery product, including yellow and Rockingham ware, was reported from 28 States in 1908 and from 29 in 1907, Florida dropping out in 1908. Ohio, in 1908 as in 1907, was the leading State, reporting wares valued at $1,468,197, or 41.72 per cent of the total—a decrease of $180,016, or 10.92 per cent. Illinois was second in both 1907 and 1908. The total value of these wares was $3,518,841 in 1908 and $4,280,601 in 1907, a loss in 1908 of $761,760, or 17.80 per cent. The number of firms reporting decreased from 219 in 1907 to 209 in 1908. In point of value these wares are the third largest, being 14.20 per cent of all pottery products in 1907 and 14 per cent in 1908.

The wares embraced under the heading "C. C. ware, etc.," are commercially the most important, though they are reported from but few States. In 1908 these wares were valued at $11,474,147, as compared with $13,913,680 in 1907 and with $14,152,503 in 1906. This is a decrease in 1908 from 1907 of $2,439,533, or 17.53 per cent. The wares embraced by this column represent the general household wares and compose the larger portion of what is known as "pottery." Ohio is and has been for many years the leading producer, reporting in 1908 wares valued at $7,228,636, or 63 per cent of the total. In 1907 this State reported wares valued at $9,419,960, or 67.70 per cent of the whole. This is a decrease in 1908 of $2,191,324, or 23.26 per cent. West Virginia was second in both 1907 and 1908, reporting wares valued at $1,651,732 and $1,612,321, respectively, the loss in 1908 being only $39,411, or 2.39 per cent. In 1908 West Virginia's product constituted 14.05 per cent of the total value of these wares; in 1907 it was 11.87 per cent of the total. New Jersey was third in both years, reporting $1,137,701 in 1908, as compared with $1,225,691 in 1907, a decrease in 1908 of $87,990, or 7.17 per cent. These wares composed 45.65 per cent of the pottery in 1908, 46.16 per cent in 1907, and 45.01 in 1906. Three less producers reported in 1908 than in 1907, when there were 68.

China, including bone china, delft, and belleek ware, showed a decrease of $349,649 in 1908 from 1907. This was a decline of 18.11 per cent. In 1907 this product gained $142,893, or 7.99 per cent. These products are reported from only 4 States. New Jersey is the leading State in value of production, reporting $876,259, or 55.42 per cent of the total, as compared with $1,135,885 in 1907. The same number of producers, 16, reported china, etc., in 1907 and 1908. These wares composed 6.41 per cent of the pottery products of 1907 and 6.29 per cent of those of 1908.

Sanitary ware decreased in value from $4,863,222 in 1907 to $4,373,590 in 1908, a loss of $489,632, or 10.07 per cent. Eight States reported this ware, the leading one being New Jersey, which reported $3,182,772, or 72.77 per cent of the total; in 1907 its percentage of the total value was 74.35 per cent. West Virginia, which was third in 1907, became second in 1908, displacing Indiana. West Virginia and Ohio showed slight gains in the value of these wares in 1908, the increase being $7,000 in each State. The other States showed decreases. Sanitary ware was reported by 36 producers in 1908, and was 17.40 per cent of all pottery products; in 1907 the same number of producers reported, though the product was 16.13 per cent of the total.

The value of the electrical porcelain wares in 1908 declined $604,766, or 23.14 per cent, the largest proportional decline of any of the pottery products. Ohio is the largest producer, with New York and New Jersey nearly tied for second place. The value of the product in 1908 was 7.99 per cent of all pottery products, and was reported by 31 operators. In 1907 these figures were 8.67 and 36, respectively.

Ohio in 1908, as for many years, was the leading pottery State, reporting wares valued at $10,706,787, or 42.60 per cent of the whole. This is a decrease of $2,826,412, or 29.85 per cent, from 1907, when Ohio's wares were 44.90 per cent of the total. New Jersey was second with wares valued at $5,949,991, or 23.67 per cent of the total. This was a decrease of $1,035,635, or 14.82 per cent from 1907. West Virginia was third, reporting wares valued at $2,083,821, or 8.29 per cent of the total, which was a decrease of $75,311, or 3.49 per cent, from 1907. New York was fourth in both 1907 and 1908, the value of its product being $1,658,243 in 1908, a loss of $276,255, or 14.28 per cent, from 1907.

In the first 12 states there were only three changes in relative rank. Tennessee, which was tenth in 1907, became twelfth in 1908; Kentucky, which was eleventh in 1907, became tenth in 1908, and Texas, which was twelfth in 1907 was eleventh in 1908. The first 5 States—Ohio, New Jersey, West Virginia, New York, and Pennsylvania—produced 86.24 per cent of the total; the first 12 States, 96.13 per cent.

The number of firms reporting in 1908 was 497, a loss of 12 from 1907. Ohio had the largest number of producers, 118, the same number as that reporting for 1907. New Jersey reported 1 more producer in 1908 than in 1907, making her number 56; West Virginia reported 12 in 1907 and 11 in 1908; New York 24 in 1907 and 25 in 1908; and Pennsylvania 40 in 1907 and 35 in 1908.

The value of the white ware, exclusive of sanitary ware and porcelain electrical supplies, was $13,055,167 in 1908, as compared with $15,844,349 in 1907, a loss of $2,789,182, or 17.60 per cent. These products composed 51.94 per cent of all pottery products in 1908, and 52.57 per cent in 1907. If sanitary ware and electrical porcelain supplies be added, the value in 1908 would be $19,437,762, or 77.33 per cent of all pottery products—a loss in value from 1907 of $3,883,580, or 16.65 per cent. In 1907 these products were valued at $23,321,342, or 77.37 per cent of all pottery.

The following table shows the value of the pottery products of the United States from 1905 to 1908, by varieties:

Value of pottery products in the United States, 1905–1908, by varieties.

Year.	Number of operating firms reporting.	Red earthenware.	Stoneware, yellow and Rockingham ware.	White ware, including C. C. ware, etc.	China, bone china, delft, and belleek ware.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.	Total.
1905	533	$780,637	$3,969,016	$12,809,414	$1,558,730	$4,580,145	$2,253,061	$1,967,891	$27,918,894
1906	540	909,262	4,193,884	14,152,503	1,787,776	5,098,310	2,838,284	2,460,865	31,440,884
1907	509	845,465	4,280,601	13,913,680	1,930,669	4,863,222	2,613,771	1,696,066	30,143,474
1908	497	757,900	3,518,841	11,474,147	1,581,020	4,373,590	2,009,005	1,421,052	25,135,555

TRENTON, N. J., AND EAST LIVERPOOL, OHIO.

Although pottery products are reported from a large number of States and high-grade wares in only a few, two States, New Jersey and Ohio, stand out prominently as the leading States, producing in 1908, 66.27 per cent of all pottery products. In New Jersey 94.95 per cent of the total of the State was produced in Trenton; in Ohio, only 37.83 per cent of the total was produced in East Liverpool. The white ware industry in New Jersey is practically confined to Trenton and there seems to be no tendency to its spread in that State; in Ohio the tendency seems to be to scatter over the State and into West Virginia. As, however, these two cities are the leading pottery centers of the country, the following table has been prepared showing the details of production in them:

Value of pottery products of Trenton, N. J., and East Liverpool, Ohio, in 1907 and 1908, by varieties.

Variety.	1907.			1908.		
	Trenton.	East Liverpool.	Total.	Trenton.	East Liverpool.	Total.
Stoneware and yellow and Rockingham ware		$73,444	$73,444		$70,010	$70,010
White ware, C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware	$1,225,691	5,030,996	6,256,687	$1,137,701	3,539,683	4,677,384
China, bone china, delft, and belleek ware	1,135,885		1,135,885	876,259		876,259
Sanitary ware	3,265,625		3,265,625	2,997,148		2,997,148
Porcelain electrical supplies	744,068	458,940	1,203,008	559,556	307,109	866,665
Miscellaneous [a]	147,920	164,594	312,514	78,808	133,582	212,390
	6,519,189	5,727,974	12,247,163	5,649,472	4,050,384	9,699,856
Per cent of total pottery product	21.63	19.00	40.63	22.48	16.11	38.59

[a] Including porcelain door knobs, porcelain hardware trimmings, and pins, stilts, and spurs for potters' use.

This table shows that these two cities continue to be close rivals for the supremacy in the pottery industry of the United States. The balance in favor of Trenton for 1908 was $1,599,088, or 39.48 per cent, greater than that of East Liverpool; in 1907 Trenton's products were valued at $791,215, or 13.81 per cent, more than East Liverpool's; and in 1906 these figures were $638,711, or 10.38 per cent, more than East Liverpool's. From these figures it will be seen that Trenton is gradually drawing away from East Liverpool. There is no change in the variety of wares made in these cities; East Liverpool reporting no china or sanitary ware and Trenton reporting no stoneware, or yellow and Rockingham wares.

These two cities together produced 38.59 per cent of the value of the pottery of the whole country in 1908; in 1907 this percentage was 40.63; in 1905 it was 43.54.

CONSUMPTION.

The pottery imports into the United States were valued at $10,522,791, and the production at $25,135,555, a total of $35,658,346. After deducting the exports, domestic $983,760, and foreign $25,781, there appears to have been a net consumption of $34,648,805, of which the domestic production was 72.54 per cent. This is the highest proportion ever reached except in 1902, when it was 72.91. In 1907 the domestic production was 70.82 per cent of consumption, and in 1906 it was 72.26 per cent.

IMPORTS AND EXPORTS.

The following table shows the value of the imports of clay products from 1904 to 1908, inclusive. It will be noted that the value increased each year until 1908, when there was a decrease of $3,125,800, or 22.63 per cent. In 1907 there was an increase of $404,033, or 3.01 per cent, over 1906; and in 1906 the increase was $1,258,758, or 10.36 per cent, over 1905.

Value of earthenware, china, brick, and tile imported and entered for consumption in the United States, 1904–1908.

Year.	Pottery.				Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	China and porcelain, not decorated.	China and porcelain, decorated.	Total.		
1904	$81,951	$1,329,146	$9,859,144	$11,270,241	$218,170	$11,488,411
1905	100,618	1,157,573	10,717,871	11,976,062	172,079	12,148,141
1906	96,400	1,312,326	11,822,376	13,231,102	175,797	13,406,899
1907	113,477	1,315,591	12,156,544	13,585,612	225,320	13,810,932
1908	70,629	1,142,444	9,309,718	10,522,791	162,341	10,685,132

[a] Including Rockingham ware.

It will be noted that practically all of the imports are pottery, 98.48 per cent being pottery and 1.52 per cent brick and tile. In 1907 pottery composed 98.37 per cent of all imports, and 1.63 per cent were brick and tile. Of the pottery imports in 1908, 99.33 per cent was general ware and 0.67 per cent was of the lower grades. In 1907, these percentages were 99.16 and 0.84 per cent, respectively. Of these imports, brick and tile decreased $62,979, or 27.95 per cent, and the pottery showed a loss of $3,062,821, or 22.54 per cent. The general ware imports declined $3,019,973, or 22.42 per cent; earthenware, etc., decreased $42,848, or 37.76 per cent.

The following table shows the exports of clay products of domestic manufacture from the United States from 1904 to 1908, inclusive:

Exports of clay wares of domestic manufacture from the United States, 1904–1908.

Year.	Brick.				Pottery.			Grand total (value).
	Building.		Fire (value).	Total (value).	Earthen and stone ware (value).	China (value).	Total (value).	
	Quantity (thousands).	Value.						
1904	25,012	$179,866	$407,519	$587,385	$697,381	$94,358	$791,739	$1,379,124
1905	34,242	263,876	536,002	799,878	882,069	101,485	983,554	1,783,432
1906	27,758	247,625	637,441	885,066	1,003,969	114,481	1,118,450	2,003,516
1907	22,340	185,192	631,779	816,971	1,022,730	108,911	1,131,641	1,948,612
1908	12,038	113,243	[a] 550,243	663,486	906,266	77,494	983,760	1,647,246

[a] Includes all brick other than building brick.

This table shows that the value of the exports of domestic clay products decreased from $1,948,612 in 1907 to $1,647,246 in 1908, a loss of $301,366, or 15.47 per cent. In 1907 the loss from 1906 was $54,904, or 2.74 per cent.

The pottery exports showed a decrease of $147,881, or 13.07 per cent from 1907, and the bricks and tile exports declined $153,485, or 18.79 per cent, the total decrease in exports being $301,366, or 15.47 per cent. Of these totals the building brick composed 17.07 per cent and other brick 82.93 per cent. Of the pottery the high grade or "china" ware composed only 7.88 per cent, while the lower grade of pottery composed 92.12 per cent. In 1907 these percentages were 9.62 and 90.38, respectively. The average value per thousand of the building brick exported in 1908 was $9.41; in 1907, it was $8.29; and in 1906, $8.92.

CLAY PRODUCTS IN VARIOUS STATES.

The following table gives the statistics of clay products from 1904 to 1908, inclusive, for some of the more important clay-working States, and will be of interest to those who desire to compare the growth of the industries in these States for several years. Owing to the changes in the classification of the products in some of the minor items, the figures do not always represent solely the values of the products named, though the classification as given in the tables is the nearest that can be made without reconstructing them entirely. The item "Miscellaneous" under each State includes all products not otherwise classified and those which could not be published separately without disclosing individual returns.

Clay products of the United States, by States, from 1904 to 1908.

CALIFORNIA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	256,898,000	284,205,000	278,780,000	339,439,000	236,383,000
Value	$1,843,936	$1,961,909	$1,962,866	$2,483,062	$1,593,814
Average per M	$7.18	$6.90	$7.05	$7.32	$6.74
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	3,499,000
Value	(a)	(a)	(a)	(a)	$66,214
Average per M	$18.08	$19.23	$18.49	$15.79	$18.92
Front—					
Quantity	11,722,000	11,871,000	18,421,000	12,922,000	12,393,000
Value	$291,813	$302,872	$501,746	$283,375	$283,701
Average per M	$24.89	$25.51	$27.24	$21.93	$22.89
Fancy or ornamental. value	$27,037	$31,899	(a)	$150,165	$34,947
Fire do	$285,718	$290,878	$347,806	$374,378	$325,760
Stove lining do	(a)	(a)	(a)	(a)	(a)
Draintile do	$29,440	$27,852	$30,545	$53,997	$34,457
Sewer pipe do	$568,626	$663,044	$827,477	$1,086,916	$1,036,320
Architectural terra cotta do	$221,000	$215,160	$254,932	$528,623	$500,130
Fireproofing do	$51,125	$45,551	$98,968	$149,959	$188,221
Tile, not drain do	(a)	$34,679	$69,023	$107,492	$84,484
Pottery:					
Earthenware and stoneware, value	$45,005	$53,359	$62,980	$82,238	$72,262
Sanitary ware value		(a)	(a)	(a)	(a)
Miscellaneous do	$261,034	$237,944	$207,887	$440,332	$303,435
Total value	$3,624,734	$3,865,147	$4,364,230	$5,740,537	$4,523,745
Number of operating firms reporting	121	122	113	118	119
Rank of State	8	8	8	8	8

CONNECTICUT AND RHODE ISLAND.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	186,908,000	211,613,000	212,648,000	198,414,000	131,760,000
Value	$1,039,204	$1,329,220	$1,503,929	$1,240,575	$749,093
Average per M	$5.56	$6.28	$7.07	$6.25	$5.69
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.00	$19.00	$16.36	$24.23	$16.25
Front—					
Quantity	3,060,000	(a)	(a)	(a)	(a)
Value	$45,730	(a)	(a)	(a)	(a)
Average per M	$14.94	$14.01	$16.51	$15.44	$15.75
Fancy or ornamental. value	(a)	(a)			
Fire do	$43,500	(a)	(a)	(a)	(a)
Stove lining do	(a)	(a)	(a)	(a)	(a)
Fireproofing do					
Tile, not drain do	(a)				
Pottery: [b]					
Earthenware and stoneware, value	(a)	(a)	(a)	(a)	(a)
Miscellaneous vlaue	$87,175	$279,358	$243,276	$244,017	$152,468
Total value	$1,215,609	$1,608,578	$1,747,205	$1,484,592	$901,561
Number of operating firms reporting	43	42	42	43	41
Rank of Connecticut and Rhode Island	23	20	20	24	27

[a] Included in miscellaneous. [b] Produced by Connecticut alone.

Clay products of the United States, by States, from 1904 to 1908—Continued.

GEORGIA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	269,815,000	275,841,000	303,286,000	318,844,000	248,585,000
Value	$1,374,318	$1,444,479	$1,783,988	$1,807,148	$1,335,349
Average per M	$5.09	$5.24	$5.88	$5.67	$5.37
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$12.00	$14.00	$13.99	$12.50	$15.50
Front—					
Quantity	3,924,000	2,667,000	2,094,000	1,625,000	2,929,000
Value	$42,064	$28,676	$20,747	$16,450	$34,385
Average per M	$10.72	$10.75	$9.91	$10.12	$11.74
Fancy or ornamental. value	(a)	....	....	(a)	....
Fire do	$28,100	$73,050	$51,310	$82,391	$53,466
Stove lining do	(a)	....	....	(a)	....
Draintile do	$8,099	$13,500	$12,000	$8,050	(a)
Sewer pipe do	$165,068	$218,000	$221,000	$244,000	$253,664
Architectural terra cotta do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	(a)	(a)	(a)	(a)	(a)
Tile, not drain do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Earthenware and stoneware, value	$22,057	$21,890			
Yellow and Rockingham ware value	....	....	$20,257	$33,885	$10,651
Miscellaneous do	$281,230	$320,151	$291,322	$298,313	$241,096
Total value	$1,920,936	$2,119,746	$2,400,624	$2,490,237	$1,928,611
Number of operating firms reporting	103	95	99	106	108
Rank of State	12	12	13	13	16

ILLINOIS.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	999,310,000	1,125,024,000	1,195,210,000	1,494,807,000	1,119,224,000
Value	$5,167,165	$6,259,232	$5,719,906	$6,499,777	$4,834,652
Average per M	$5.17	$5.56	$4.79	$4.35	$4.32
Vitrified—					
Quantity	121,073,000	90,563,000	122,227,000	126,927,000	138,362,000
Value	$1,234,703	$973,247	$1,306,476	$1,405,821	$1,622,496
Average per M	$10.20	$10.75	$10.69	$11.08	$11.73
Front—					
Quantity	21,299,000	30,447,000	30,022,000	20,828,000	22,851,000
Value	$251,762	$348,354	$341,298	$266,270	$301,515
Average per M	$11.82	$11.44	$11.37	$12.78	$13.19
Fancy or ornamental. value	$11,733	$13,567	$11,635	(a)	(a)
Fire do	$217,008	$176,692	$236,032	$241,008	$250,444
Draintile do	$1,002,463	$1,051,852	$1,052,588	$1,031,192	$1,421,878
Sewer pipe do	$550,344	$580,538	$587,805	$662,487	$514,386
Architectural terra cotta do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	$324,264	$323,550	$409,171	$404,265	$264,986
Tile, not drain do	$194,471	(a)	(a)	(a)	$124,425
Pottery:					
Earthenware and stoneware, value	$801,946	$889,857			
Yellow and Rockingham ware value	(a)	(a)	$935,193	$935,312	$758,194
C. C., white granite ware, and semivitreous porcelain ware value	....	....	(a)	(a)	(a)
Miscellaneous do	$1,021,588	$1,744,897	$2,034,077	$1,774,357	$1,466,138
Total value	$10,777,447	$12,361,786	$12,634,181	$13,220,489	$11,559,114
Number of operating firms reporting	492	469	466	417	400
Rank of State	4	5	5	4	4

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

INDIANA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	283,707,000	279,073,000	307,076,000	251,766,000	224,454,000
Value	$1,677,714	$1,630,072	$1,778,270	$1,509,415	$1,221,910
Average per M	$5.91	$5.84	$5.79	$6.00	$5.44
Vitrified—					
Quantity	51,859,000	43,573,000	45,725,000	46,224,000	57,748,000
Value	$513,209	$474,600	$502,509	$548,448	$776,533
Average per M	$9.90	$10.89	$10.99	$11.87	$13.45
Front—					
Quantity	19,890,000	22,212,000	35,090,000	36,890,000	34,336,000
Value	$197,890	$231,353	$395,368	$437,796	$403,545
Average per M	$9.95	$10.42	$11.27	$11.87	$11.75
Fancy or ornamental. value	(a)	$15,520	$4,700	(a)	(a)
Fire do	$130,216	$163,728	$149,351	$160,373	$115,895
Stove lining do	(a)	(a)	(a)	....	....
Draintile do	$1,205,717	$1,267,691	$1,373,441	$1,437,735	$1,797,329
Sewer pipe do	$294,000	$430,680	$486,897	$487,537	$486,946
Architectural terra cotta do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	$210,800	$393,985	$323,015	$304,151	$359,817
Tile, not drain do	(a)	(a)	(a)	(a)	$505,908
Pottery:					
Earthenware and stoneware value	$65,390	$74,462	$73,324	$50,654	$44,470
C. C. ware, white granite, semiporcelain and semivitreous porcelain ware, value	(a)	(a)	(a)	(a)	(a)
Sanitary ware value	$425,000	$496,000	$435,000	$400,000	$350,000
Miscellaneous do	$1,182,653	$1,321,482	$1,636,359	$1,522,015	$677,814
Total value	$5,902,589	$6,499,573	$7,158,234	$6,858,124	$6,740,167
Number of operating firms reporting	465	441	419	392	369
Rank of State	6	6	6	7	6

IOWA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	207,041,000	193,259,000	168,871,000	157,618,000	135,678,000
Value	$1,440,758	$1,366,653	$1,118,709	$1,085,383	$904,308
Average per M	$6.96	$7.07	$6.62	$6.89	$6.67
Vitrified—					
Quantity	19,231,000	13,253,000	16,930,000	21,686,000	16,672,000
Value	$199,528	$134,802	$185,990	$223,193	$185,112
Average per M	$10.38	$10.17	$10.99	$10.29	$11.10
Front—					
Quantity	7,994,000	5,676,000	8,871,000	8,028,000	7,900,000
Value	$91,269	$60,669	$101,795	$96,316	$86,232
Average per M	$11.42	$10.69	$11.48	$12.00	$10.92
Fancy or ornamental. value	(a)	....	....	....	(a)
Fire do	(a)	$869	$930	$795	....
Stove lining do	(a)	....	....	....	....
Draintile do	$1,294,134	$1,509,226	$1,721,614	$2,011,793	$2,509,505
Sewer pipe do	(a)	(a)	(a)	(a)	$211,044
Fireproofing, terra-cotta lumber, and hollow building block or tile value	$161,658	$137,554	$162,664	$176,854	$129,003
Tile, not drain do	$4,300	(a)	....	....	....
Pottery:					
Earthenware and stoneware value	$66,050	$68,859	$54,600	$15,382	$15,710
Miscellaneous do	$203,156	$113,490	$122,725	$119,069	$28,583
Total value	$3,460,853	$3,392,122	$3,469,027	$3,728,785	$4,069,497
Number of operating firms reporting	327	306	304	276	263
Rank of State	9	9	9	9	9

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

KENTUCKY.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	138,677,000	147,702,000	142,185,000	143,731,000	110,545,000
Value	$796,074	$862,330	$881,879	$932,469	$687,365
Average per M	$5.74	$5.84	$6.20	$6.49	$6.22
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.91	$14.27	$14.13	$14.27	$13.26
Front—					
Quantity	2,178,000	11,558,000	11,893,000	7,926,000	11,067,000
Value	$20,571	$128,777	$109,771	$86,568	$119,785
Average per M	$9.44	$11.14	$9.23	$10.92	$10.82
Fire, value	$680,084	$739,059	$898,527	$940,415	$770,221
Stove lining, do	(a)	....	....	....	....
Draintile, do	$26,564	$28,865	$27,359	$32,723	$53,308
Sewer pipe, do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta, do	....	(a)	....	....	....
Fireproofing, do	(a)	....	....	....	$7,263
Tile, not drain, do	(a)	$296,949	$296,391	$255,054	$215,000
Pottery:					
Earthenware and stoneware, value	$157,613	$157,083	$167,209	$166,621	$153,648
Miscellaneous, value	$406,371	$193,287	$211,287	$197,514	$232,518
Total value	$2,087,277	$2,406,350	$2,592,423	$2,611,364	$2,239,108
Number of operating firms reporting	120	121	117	115	116
Rank of State	10	10	11	11	12

MARYLAND.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	160,279,000	210,446,000	204,238,000	166,768,000	141,071,000
Value	$1,048,850	$1,423,663	$1,267,771	$1,026,922	$828,981
Average per M	$6.54	$6.76	$6.21	$6.16	$5.88
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$10.08	$17.96	$15.60	$15.00	$13.06
Front—					
Quantity	2,245,000	1,426,000	2,266,000	1,597,000	936,000
Value	$37,537	$24,118	$31,968	$19,854	$13,498
Average per M	$16.72	$16.91	$14.11	$12.43	$14.42
Fancy or ornamental, value	(a)	(a)	(a)	(a)	$1,463
Fire, do	$235,136	$224,667	$266,980	$242,312	$179,469
Stove lining, do	(a)	$32,890	$32,200	$31,048	$23,538
Draintile, do	$2,848	$4,703	$3,315	$3,190	$3,895
Architectural terra cotta, do	(a)	(a)	(a)	(a)	(a)
Tile, not drain, do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Earthenware and stoneware, value	$13,440	$13,325	} $17,499	(a)	(a)
Yellow and Rockingham ware, value	(a)	(a)			
C. C. and white granite semiporcelain and semivitreous porcelain ware, value	$382,500	(a)	$352,000	$348,890	(a)
Miscellaneous, value	$151,746	$526,001	$164,806	$214,146	$390,255
Total value	$1,872,057	$2,249,367	$2,136,539	$1,886,362	$1,441,099
Number of operating firms reporting	63	68	70	63	65
Rank of State	13	11	15	18	22

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

MASSACHUSETTS.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	165,435,000	194,504,000	204,282,000	184,005,000	141,591,000
Value	$1,012,226	$1,264,787	$1,415,864	$1,294,918	$950,921
Average per M	$6.12	$6.50	$6.93	$7.04	$6.72
Vitrified—					
Quantity	(a)	....	....	....	....
Value	(a)	....	....	....	....
Average per M	$14.00	....	....	....	....
Front—					
Quantity	(a)	2,080,000	(a)	(a)	1,899,000
Value	(a)	$33,971	(a)	(a)	$34,055
Average per M	$21.67	$16.33	$22.17	$37.13	$17.93
Fancy or ornamental . value	(a)	(a)	(a)	(a)	(a)
Fire ..do	(a)	$68,180	$57,940	$74,115	$63,241
Stove lining ..do	(a)	$173,151	$186,815	$206,042	$169,811
Architectural terra cotta ..do	(a)	(a)	(a)	(a)	....
Fireproofing ..do	(a)	(a)	(a)	(a)	(a)
Tile, not drain ..do	$72,000	$82,000	$91,394	$123,220	$104,386
Pottery:					
Earthenware and stoneware, value	$193,633	$208,950	$189,370	$184,671	$165,557
C. C. and white granite ware, value	(a)	(a)	(a)	(a)	(a)
Miscellaneous ..value	$451,199	$219,418	$231,350	$245,854	$159,391
Total value	$1,729,058	$2,050,457	$2,172,733	$2,128,820	$1,647,362
Number of operating firms reporting	87	78	82	80	76
Rank of State	16	13	14	15	18

MICHIGAN.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	205,196,000	211,558,000	206,583,000	200,817,000	181,049,000
Value	$1,116,714	$1,152,505	$1,178,202	$1,181,015	$994,525
Average per M	$5.44	$5.45	$5.70	$5.88	$5.49
Vitrified—					
Quantity	(a)	6,112,000	6,229,000	7,911,000	6,165,000
Value	(a)	$81,706	$81,814	$94,601	$76,630
Average per M	$13.28	$13.37	$13.13	$11.96	$12.43
Front—					
Quantity	1,080,000	693,000	1,474,000	3,956,000	1,896,000
Value	$7,500	$5,995	$14,162	$32,116	$19,496
Average per M	$6.94	$8.65	$9.61	$8.12	$10.28
Fancy or ornamental . value	(a)	....	(a)	....	....
Fire ..do	(a)	(a)	(a)	(a)	....
Stove lining ..do	(a)	(a)	(a)	....	....
Draintile ..do	$208,088	$205,445	$314,098	$289,868	$327,630
Sewer pipe ..do	(a)	(a)	(a)	(a)	(a)
Fireproofing, terra cotta lumber, and hollow building tile, or blocks ..value	$8,080	(a)	$4,290	$6,386	$4,100
Tile, not drain ..do	....	....	....	(a)	(a)
Pottery:					
Earthenware and stoneware, value	$40,621	(a)	$43,510	$54,474	$54,659
Miscellaneous ..value	$333,510	$320,056	$208,401	$189,304	$251,750
Total value	$1,714,513	$1,765,707	$1,844,477	$1,847,764	$1,728,790
Number of operating firms reporting	168	154	142	136	132
Rank of State	17	17	18	19	17

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

MINNESOTA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	164,154,000	166,233,000	165,598,000	168,931,000	145,712,000
Value	$970,247	$977,837	$986,982	$1,045,874	$869,532
Average per M	$5.91	$5.88	$5.96	$6.19	$5.97
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$10.00	$14.54	$10.68	$12.00	$9.00
Front—					
Quantity	6,566,000	6,636,000	7,510,000	(a)	9,900,000
Value	$113,260	$85,300	$98,170	(a)	$118,860
Average per M	$17.25	$12.85	$13.07	$12.93	$12.01
Fancy or ornamental. value	(a)	....	....	(a)	(a)
Fire do	....	(a)	(a)	(a)	(a)
Draintile do	$11,100	$15,770	$41,779	$49,622	$70,161
Sewer pipe do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	(a)	(a)	(a)	(a)	$45,940
Pottery:					
Earthenware and stoneware, value	(b)	(b)	(b)	(b)	(b)
Miscellaneous value	$225,300	$420,479	$476,348	$594,437	$404,217
Total value	$1,319,907	$1,499,386	$1,603,279	$1,689,933	$1,508,710
Number of operating firms reporting	114	111	109	106	92
Rank of State	21	21	23	21	20

MISSOURI.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	271,370,000	316,002,000	257,292,000	264,462,000	219,526,000
Value	$1,690,460	$2,028,957	$1,810,304	$1,844,255	$1,465,311
Average per M	$6.23	$6.42	$7.04	$6.97	$6.67
Vitrified—					
Quantity	47,235,000	43,375,000	57,414,000	47,807,000	56,805,000
Value	$480,671	$470,935	$539,700	$462,341	$647,097
Average per M	$10.17	$10.86	$9.40	$9.67	$11.39
Front—					
Quantity	25,599,000	28,224,000	29,019,000	30,178,000	32,136,000
Value	$322,445	$362,996	$394,563	$387,455	$356,758
Average per M	$12.60	$12.86	$13.59	$12.84	$11.10
Fancy or ornamental. value	$32,967	$44,632	$30,689	$33,638	$25,035
Fire do	$925,520	$1,117,209	$1,324,895	$1,634,209	$1,357,387
Stove lining do	(a)	(a)	(a)	(a)	(a)
Draintile do	$80,479	$59,858	$64,063	$72,316	$76,865
Sewer pipe do	$1,176,679	$1,101,938	$1,208,236	$1,332,080	$962,116
Architectural terra cotta do	(a)	(a)	(a)	(a)	(a)
Fireproofing, terra cotta lumber, and hollow building tile or blocks value	(a)	(a)	(a)	(a)	$105,136
Tile, not drain do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Earthenware and stoneware, value	$69,327	$43,368	$69,500	$72,612	$66,408
Miscellaneous value	$702,956	$973,518	$1,254,325	$1,059,965	$569,343
Total value	$5,481,504	$6,203,411	$6,696,275	$6,898,871	$5,631,456
Number of operating firms reporting	232	224	190	172	161
Rank of State	7	7	7	6	7

[a] Included in miscellaneous.
[b] The value of pottery products for Minnesota could not be included in the State totals without disclosing the operations of individual establishments.

Clay products of the United States, by States, from 1904 to 1908—Continued.

NEW JERSEY.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	319,975,000	465,040,000	413,258,000	388,735,000	300,544,000
Value	$1,842,075	$3,090,809	$2,610,686	$2,289,883	$1,579,835
Average per M	$5.76	$6.65	$6.32	$5.89	$5.26
Vitrified—					
Quantity	4,953,000	991,000	(a)	(a)	(a)
Value	$66,813	$13,803	(a)	(a)	(a)
Average per M	$13.49	$13.93	$14.98	$13.31	$11.43
Front—					
Quantity	47,058,000	53,770,000	62,138,000	61,521,000	64,302,000
Value	$687,469	$852,744	$896,887	$825,767	$667,682
Average per M	$14.61	$15.86	$14.43	$13.42	$10.38
Fancy or ornamental. value	(a)	$1,975	$1,951	$4,605	$3,619
Enameled do	(a)	(a)	(a)	(a)	(a)
Fire do	$908,882	$1,393,448	$954,081	$947,472	$800,987
Stove lining do	(a)	(a)	(a)	(a)	(a)
Draintile do	$24,842	$24,315	$23,209	$21,869	$30,325
Sewer pipe do	$23,299	$56,576	(a)	(a)	(a)
Architectural terra cotta do	$1,412,023	$1,614,263	$1,682,022	$1,722,567	$1,039,856
Fireproofing, terra-cotta lumber, and hollow building tile or blocks value	$1,211,646	$1,308,075	$1,485,195	$1,159,467	$826,224
Tile, not drain do	$548,097	$585,130	$1,163,401	$1,050,085	$835,499
Pottery:					
Earthenware and stoneware value	$70,819	$70,825	$76,793	$77,488	(a)
Yellow and Rockingham ware value					
C. C. ware do	$325,959	(a)			
White granite ware do; Semivitreous porcelain ware value	$1,284,199	$1,288,926	$1,436,246	$1,225,691	$1,137,701
China do	$816,374	$816,917			
Bone china, delft, and belleek ware value	$162,500	$129,000	$1,065,986	$1,135,885	$876,259
Sanitary ware do	$2,878,621	$3,426,291	$3,742,045	$3,615,685	$3,182,772
Porcelain electrical supplies value	$302,293	$540,206	$783,549	$744,068	$559,556
Miscellaneous do	$738,136	$1,486,222	$1,440,218	$1,185,428	$773,381
Total value	$13,304,047	$16,699,525	$17,362,269	$16,005,460	$12,313,696
Number of operating firms reporting	161	163	175	165	165
Rank of State	3	3	3	3	3

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

NEW YORK.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	1,169,233,000	1,518,196,000	1,535,579,000	1,319,416,000	1,055,006,000
Value	$6,783,528	$10,297,214	$9,205,981	$7,056,453	$5,066,084
Average per M	$5.80	$6.78	$6.00	$5.35	$4.80
Vitrified—					
Quantity	14,490,000	12,076,000	10,787,000	18,516,000	14,570,000
Value	$189,281	$149,391	$163,969	$253,664	$211,290
Average per M	$13.06	$12.37	$15.20	$13.70	$14.50
Front—					
Quantity	19,104,000	12,610,000	23,625,000	12,265,000	9,721,000
Value	$263,150	$237,305	$351,824	$198,265	$135,342
Average per M	$13.77	$18.82	$14.89	$16.17	$13.92
Fancy or ornamental.value	(a)	(a)	....	(a)	(a)
Enameled.............do	....	....	(a)	....	....
Fire.............do	$381,784	$427,873	$451,783	$538,721	$436,847
Stove lining.............do	(a)	$133,383	$131,908	$129,467	$102,985
Draintile.............do	$139,876	$153,598	$153,237	$180,818	$275,681
Sewer pipe.............do	$125,510	(a)	(a)	(a)	$133,716
Architectural terra cotta...do	$785,978	$874,722	$967,987	$1,089,278	$709,360
Fireproofing.............do	$132,034	$117,577	$75,631	$73,064	$122,395
Tile, not drain.............do	$154,417	$164,445	$101,319	$43,726	$40,066
Pottery:					
Earthenware and stoneware.............value	$74,781	$83,780	$104,165	$120,367	$76,358
Yellow and Rockingham ware.............value	(a)	....			
C. C. and white granite ware.............value	(a)	(a)	(a)	(a)	(a)
China.............do	(a)	(a)	$657,817	$746,634	$622,548
Sanitary ware.............do	(a)	(a)	(a)	(a)	(a)
Porcelain electrical supplies.............value	$438,792	$617,663	$663,886	$626,032	$560,754
Miscellaneous.............do	$1,073,939	$1,229,396	$847,100	$716,385	$435,798
Total value	$10,543,070	$14,486,347	$13,876,607	$11,772,874	$8,929,224
Number of operating firms reporting	240	249	253	247	241
Rank of State	5	4	4	5	5

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

OHIO.

Product	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	455,936,000	514,419,000	550,422,000	495,025,000	369,410,000
Value	$2,708,456	$3,033,435	$3,243,157	$3,012,485	$2,105,910
Average per M	$5.94	$5.90	$5.89	$6.09	$5.70
Vitrified—					
Quantity	218,791,000	224,086,000	202,978,000	264,571,000	327,718,000
Value	$2,222,931	$2,055,120	$1,955,360	$2,672,600	$3,232,335
Average per M	$10.16	$9.17	$9.63	$10.10	$9.86
Front—					
Quantity	65,645,000	89,390,000	90,310,000	88,992,000	94,435,000
Value	$755,870	$1,074,007	$1,025,590	$1,033,434	$1,067,888
Average per M	$11.51	$12.01	$11.36	$11.61	$11.31
Fancy or ornamental . value	$64,514	$18,153	$38,218	$24,468	$39,309
Fire . do	$1,186,966	$1,427,919	$1,670,630	$1,668,728	$1,339,810
Stove lining . do	(a)	$49,538	$110,800	$22,416	(a)
Draintile . do	$1,143,957	$1,291,323	$1,520,748	$1,433,341	$1,725,462
Sewer pipe . do	$3,495,917	$3,550,160	$3,987,360	$3,792,352	$3,918,971
Architectural terra cotta . do	.....	.....	(a)	(a)	.....
Fireproofing, terra-cotta lumber, and hollow building tile or blocks . value	$788,825	$923,762	$1,159,021	$1,006,076	$552,887
Tile, not drain . do	$1,005,611	$1,188,460	$1,523,410	$1,586,174	$1,438,042
Pottery:					
Earthenware and stoneware . value	$1,226,973	$1,448,007	$1,787,990 (earthenware and stoneware, and Yellow and Rockingham ware)	$1,790,255 (earthenware and stoneware, and Yellow and Rockingham ware)	$1,606,628 (earthenware and stoneware, and Yellow and Rockingham ware)
Yellow and Rockingham ware . value	$231,994	$177,143			
C. C. ware . do	$503,945	$609,478	$9,735,072 (C. C., white granite, and semivitreous porcelain ware)	$9,419,960 (C. C., white granite, and semivitreous porcelain ware)	$7,228,636 (C. C., white granite, and semivitreous porcelain ware)
White granite ware . do	$7,422,196 (white granite and semivitreous porcelain ware)	$8,521,944 (white granite and semivitreous porcelain ware)			
Semivitreous porcelain ware . value					
China . do	$280,614	(a)	(a)	(a)	(a)
Sanitary ware . do	(a)	(a)	$285,000	$226,000	$233,000
Porcelain electrical supplies . value	$557,027	$879,207	$1,100,979	$933,256	$719,034
Miscellaneous . do	$2,051,987	$2,055,383	$1,870,830	$1,719,285	$1,414,578
Total value	$25,647,783	$28,303,039	$31,014,165	$30,340,830	$26,622,490
Number of operating firms reporting	819	792	784	736	706
Rank of State	1	1	1	1	1

a Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

PENNSYLVANIA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	856,963,000	1,036,777,000	1,027,541,000	980,102,000	717,016,000
Value	$5,439,116	$6,532,814	$6,586,374	$6,353,799	$4,539,978
Average per M	$6.35	$6.30	$6.41	$6.48	$6.33
Vitrified—					
Quantity	71,522,000	71,888,000	93,417,000	115,729,000	90,044,000
Value	$766,638	$750,389	$996,347	$1,232,718	$1,038,254
Average per M	$10.72	$10.44	$10.67	$10.65	$11.53
Front—					
Quantity	75,407,000	131,368,000	151,138,000	134,869,000	124,642,000
Value	$962,765	$1,683,031	$1,761,991	$1,526,565	$1,403,594
Average per M	$12.77	$12.81	$11.66	$11.32	$11.26
Fancy or ornamental. value	$23,317	$37,966	$40,880	$17,727	$49,199
Fire ... do	$5,477,475	$5,771,795	$6,854,640	$6,907,904	$4,252,325
Stove lining ... do	(a)	$180,353	$203,674	$179,218	$129,686
Draintile ... do	$8,646	$13,509	$9,113	$10,386	$14,904
Sewer pipe ... do	$834,646	$886,979	$985,635	$795,991	$578,800
Architectural terra cotta ... do	$349,317	$405,015	$367,353	$507,116	$389,596
Fireproofing, terra cotta lumber, hollow building tile or blocks ... value	$193,190	$352,107	$242,668	$244,773	$241,175
Tile, not drain ... do	$215,107	$310,931	$389,013	$406,269	$337,948
Pottery:					
Earthenware and stoneware, value	$504,221	$459,111			
Yellow and Rockingham ware ... value	(a)	(a)	$477,223	$544,457	$397,276
C. C. ware ... do	(a)	....	$845,366	$531,634	$623,544
White granite ware ... do	$707,809	$716,245			
Sanitary ware ... do	(a)	(a)	$186,560	$192,854	$175,384
Miscellaneous ... do	$1,339,616	$1,024,308	$1,827,774	$840,210	$671,319
Total value	$16,821,863	$19,124,553	$21,774,611	$20,291,621	$14,842,982
Number of operating firms reporting	529	516	514	487	466
Rank of State	2	2	2	2	2

TEXAS.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	197,033,000	202,070,000	211,842,000	243,853,000	194,551,000
Value	$1,157,130	$1,209,898	$1,307,199	$1,707,812	$1,285,857
Average per M	$5.87	$5.99	$6.17	$7.00	$6.61
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$8.81	$10.47	$10.00	$10.36	$10.81
Front—					
Quantity	5,645,000	8,001,000	8,492,000	11,494,000	10,411,000
Value	$58,734	$102,054	$110,189	$153,187	$154,298
Average per M	$10.40	$12.76	$12.98	$13.33	$14.82
Fancy or ornamental. value	$2,544	$18,127	(a)	....	....
Fire ... do	$30,208	$14,724	$45,557	$75,946	$69,039
Draintile ... do	(a)	....	$3,652	(a)	$5,275
Sewer pipe ... do	(a)	(a)	(a)	(a)	(a)
Tile, not drain ... do	(a)	....	(a)	....	(a)
Pottery:					
Earthenware and stoneware, value	$106,471	$100,788	$108,635	$156,173	$125,146
Miscellaneous ... value	$181,010	$273,354	$394,366	$464,443	$427,120
Total value	$1,536,097	$1,718,945	$1,969,598	$2,557,561	$2,066,735
Number of operating firms reporting	152	129	139	131	122
Rank of State	18	18	16	12	14

[a] Included in miscellaneous.

Clay products of the United States, by States, from 1904 to 1908—Continued.

VIRGINIA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	203,484,000	237,161,000	232,697,000	197,052,000	185,738,000
Value	$1,292,558	$1,572,442	$1,536,312	$1,285,374	$1,219,946
Average per M	$6.35	$6.63	$6.60	$6.52	$6.57
Vitrified—					
Quantity	(a)	(a)	....	....	....
Value	(a)	(a)	....	....	....
Average per M	$10.46	$10.80	....	....	....
Front—					
Quantity	21,077,000	22,155,000	25,385,000	19,989,000	17,858,000
Value	$344,891	$352,297	$392,130	$290,411	$246,623
Average per M	$16.36	$15.90	$15.45	$14.53	$13.81
Fancy or ornamental . value	$28,576	$20,363	(a)	(a)	(a)
Fire ... do	(a)	(a)	$21,110	(a)	(a)
Draintile ... do	$5,673	$4,500	$4,805	$6,250	$7,100
Pottery:					
Earthenware and stoneware, value	(a)	....	....	....	....
Porcelain electrical supplies, value	(a)	(b)	(b)	(b)	(b)
Miscellaneous ... value	$64,694	$44,976	$11,721	$29,300	$25,461
Total value	$1,736,392	$1,994,578	$1,966,078	$1,611,335	$1,499,130
Number of operating firms reporting	99	94	91	87	80
Rank of State	15	15	17	23	21

WEST VIRGINIA.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	68,133,000	69,228,000	74,833,000	58,102,000	47,402,000
Value	$469,501	$476,630	$469,527	$384,007	$300,776
Average per M	$6.89	$6.88	$6.27	$6.61	$6.35
Vitrified—					
Quantity	39,620,000	24,692,000	47,902,000	60,681,000	70,924,000
Value	$470,339	$263,449	$578,164	$952,060	$718,017
Average per M	$11.87	$10.67	$12.07	$15.69	$10.12
Front—					
Quantity	388,000	(a)	(a)	(a)	(a)
Value	$5,380	(a)	(a)	(a)	(a)
Average per M	$13.87	$16.67	$15.00	$15.16	$14.18
Fire ... value	$11,814	$26,868	$59,757	$34,438	$389,43
Stove lining ... do	(a)	....	....	....	....
Draintile ... do	$1,398	(a)	(a)	$1,211	$2,645
Sewer pipe ... do	(a)	(a)	(a)	....	(a)
Tile, not drain ... do	(a)	(a)	(a)	$52,429	$49,220
Pottery:					
Earthenware and stoneware, value	$18,923	$19,110	$23,200	(a)	(a)
C. C. and white granite ware, value; Semivitreous porcelain ware, value	$912,935	(a)	$1,047,770	$1,651,732	$1,612,321
Sanitary ware ... value	(a)	(a)	$387,000	$378,000	$385,000
Miscellaneous ... do	$184,259	$1,232,738	$217,894	$186,510	$154,814
Total value	$2,074,549	$2,018,795	$2,783,312	$3,640,387	$3,261,736
Number of operating firms reporting	64	62	65	63	60
Rank of State	11	14	10	10	10

a Included in miscellaneous.
b The value of pottery products for Virginia for 1905, 1906, 1907, and 1908 could not be included in the State total without disclosing individual figures.

Clay products of the United States, by States, from 1904 to 1908—Continued.

WISCONSIN.

Product.	1904.	1905.	1906.	1907.	1908.
Brick:					
Common—					
Quantity	186,292,000	186,531,000	170,496,000	158,602,000	129,041,000
Value	$1,230,620	$1,260,066	$1,109,386	$1,019,522	$830,249
Average per M	$6.61	$6.76	$6.51	$6.43	$6.43
Vitrified—					
Quantity				(a)	
Value				(a)	
Average per M				$8.04	
Front—					
Quantity	8,438,000	4,917,000	5,384,000	4,106,000	4,646,000
Value	$86,688	$49,275	$52,038	$43,387	$41,569
Average per M	$10.27	$10.02	$9.67	$10.57	$8.95
Fancy or ornamental. value	(a)	$1,048	(a)	(a)	(a)
Draintile ...do	$54,831	$57,576	$51,143	$49,832	$74,702
Pottery:					
Earthenware and stoneware, value	$13,075	$11,950	$11,470	$8,832	$9,300
Miscellaneous ...value	$5,780	$2,200	$3,305	$6,246	$2,575
Total value	$1,390,994	$1,382,115	$1,227,342	$1,127,819	$958,395
Number of operating firms reporting	159	157	147	138	121
Rank of State	20	24	25	26	24

[a] Included in Miscellaneous.

CLAY.

INTRODUCTION.

The clay-mining industry in 1908, in common with others, showed a marked decline in both quantity and value of the product mined and sold. The total quantity and value for 1908 was 1,723,901 short tons of clay, valued at $2,599,986, as compared with 2,183,679 short tons, valued at $3,448.548, in 1907. This was a decrease in tons mined of 459,778, or 21.06 per cent, and in value of $848,562, or 24.61 per cent, and is the smallest production since 1904, when 1,508,752 tons were reported, valued at $2,320,162. This was a large proportional decrease, but the imports of clay, as shown elsewhere, showed even larger proportional decreases of 26.27 per cent in quantity and 31.30 per cent in value. This loss was principally in fire clay, though all other varieties of clay shared the decreased value of output, except paper clay and brick clay, these two clays showing increases in value, though paper clay declined in quantity.

The clay given in these tables is only such as is sold as clay by the miner and does not include the clay burned into clay products by the miner. The clay thus sold is a small quantity compared with the quantity of clay consumed, and includes mainly clay used for pottery, paper clay, and fire clay. Potters, especially makers of high-grade ware, usually purchase their clay, and fire-brick makers do so to some extent. The makers of the coarser products generally mine their own clay, which is not included here.

PRODUCTION.

In the following tables will be found statements of the clay mined and shipped by the miner as such in 1907 and 1908:

Clay mined and sold in the United States in 1907, by States, in short tons.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous.[a]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama									79,668	$59,416					34,000	$12,100	113,668	$71,516
Arizona [b]	(c)	(c)			1,698	$5,373	(c)	(c)	1,624	10,634	(c)	(c)	(c)	(c)	2,277	3,234	35,841	195,791
California									73,138	90,327	4,436	$5,459	(c)	(c)	10,919	11,919	94,932	109,949
Colorado									22,396	27,312	(c)	(c)	36,205	$31,069	29,578	17,615	89,210	78,091
Georgia			28,503	$126,253					15,080	14,060	984	1,784	(c)	(c)	2,170	2,151	47,737	147,248
Illinois	(c)	(c)					(c)	(c)	66,525	55,545	23,633	20,150	8,500	7,139	24,787	20,079	123,775	105,703
Indiana					(c)	(c)			64,004	63,826	3,331	3,831			19,730	20,780	87,565	89,687
Iowa									3,732	2,841			(c)	(c)	6,055	1,535	10,012	4,691
Kentucky							(c)	(c)	37,415	41,877	(c)	(c)			5,808	8,687	47,732	68,528
Maryland	(c)	(c)							7,818	9,448	2,256	3,028	4,879	6,850	1,950	550	18,441	29,876
Massachusetts									1,800	4,298			6,367	2,327	2,707	2,757	10,874	9,382
Missouri	307	$2,194							167,043	428,349	2,510	1,673	(c)	(c)	425	10,625	171,302	443,553
Montana									6,835	12,384							6,835	12,384
New Jersey					(c)	(c)	3,666	$16,918	318,603	485,613	21,108	44,704	18,876	16,517	75,885	103,496	440,138	675,248
New Mexico									16,326	18,446							16,326	18,446
New York					(c)	(c)			699	5,412					1,001	1,381	4,255	11,902
North Carolina	11,035	85,505							(c)	(c)	143	93	(c)	(c)	50	50	11,938	86,491
Ohio					(c)	(c)			217,746	201,215	47,312	32,956	6,066	7,767	9,033	8,637	292,157	265,575
Pennsylvania	18,428	109,839	4,785	23,808					296,278	433,714	4,916	4,884	44,885	31,777	13,328	14,121	382,620	618,143
South Carolina			32,860	143,624					(c)	(c)					3,633	10,400	37,273	158,341
Tennessee					(c)	(c)	25,653	70,088	4,754	5,541	11,608	13,049	(c)	(c)	15,747	21,211	58,645	111,287
Texas									1,725	6,583	617	845	(c)	(c)	377	1,505	2,735	8,941
Utah									10,054	26,898							10,054	26,898
Vermont	(c)	(c)							(c)	(c)							8,045	46,943
Virginia	(c)	(c)							636	1,657			(c)	(c)	22	8	2,008	11,415
Washington					(c)	(c)			(c)	(c)	(c)	(c)			950	2,350	1,754	4,623
West Virginia									56,528	34,952	(c)	(c)					57,128	35,252
Wyoming			(c)	(c)											636	2,386	679	2,644
Other States [d]	17,875	142,773	43	258	18,627	32,552	23,094	108,509	4,035	14,350	2,206	4,120	10,737	8,557			(e)	(e)
	47,645	340,311	66,191	293,943	20,325	37,925	52,413	195,515	1,474,462	2,054,698	125,060	136,576	136,515	112,003	261,068	277,577	2,183,679	3,448,548
Average value per ton		7.14		4.44		1.87		3.73		1.39		1.09		0.82		1.06		1.58

[a] Including bentonite, plaster clay, sagger clay, sewer-pipe clay, shale, terra-cotta clay, wad clay, and clay for medicinal use.
[b] Including Delaware, Florida, Idaho, Michigan, Minnesota, North Dakota, Oklahoma, Oregon, South Dakota, and Wisconsin.
[c] Included in "Other States."
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Clay mined and sold in the United States in 1908, by States, in short tons.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous.[a]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama									68,289	$48,983			(b)	(b)	24,000	$12,000	93,289	$61,733
Arizona[c]	(b)	(b)					(b)	(b)	1,706	8,512					1,614	3,507	24,910	134,771
California									65,411	87,311	9,935	$8,959	(b)	(b)	2,000	2,500	80,586	99,094
Colorado									32,925	28,101	(b)	(b)	33,165	$24,218	2,949	5,161	69,578	58,380
Georgia			18,230	$87,540	(b)	(b)			13,805	9,005	666	2,025	1,118	3,024	4,096	4,433	37,916	106,028
Illinois									39,075	47,039	29,102	23,397	(b)	(b)	26,858	21,999	117,082	114,482
Indiana									59,841	55,187	4,614	5,614	(b)	(b)	8,060	8,300	74,015	72,101
Iowa									6,234	1,990			(b)	(b)	500	500	9,134	3,690
Kentucky							(b)	(b)	42,352	33,653	(b)	(b)	(b)	(b)	300	225	60,930	55,188
Maryland	(b)	(b)	(b)	(b)					4,581	9,807	1,125	1,538	(b)	(b)	2,575	2,225	11,881	28,395
Massachusetts									1,349	3,015			5,702	3,492	469	280	7,520	6,787
Michigan					1,882	$5,571									100	375	1,982	5,946
Missouri	138	$974							124,970	238,747	7,061	4,005	24,089	20,298	500	500	156,758	264,524
Montana									6,264	9,553			(b)	(b)			6,364	9,953
New Jersey							1,135	$5,514	234,579	382,373	8,358	15,109	25,495	27,854	42,665	76,353	312,232	507,203
New Mexico									18,840	27,929							18,840	27,929
New York					(b)	(b)			(b)	(b)					1,287	2,181	4,277	11,186
North Carolina	10,532	85,300									2,098	249			200	100	12,830	85,649
Ohio					(b)	(b)			151,416	125,684	49,957	30,804	38,360	14,652	1,804	1,423	242,737	174,063
Oregon									897	2,585	(b)	(b)					1,054	2,742
Pennsylvania	4,813	26,549	18,309	110,317					179,555	297,196	5,784	4,731	26,280	19,086	8,416	8,506	243,157	466,385
South Carolina			26,321	107,586					624	3,050							26,945	110,636
Tennessee					(b)	(b)	19,058	48,556	1,375	2,893	4,345	4,431			14,027	19,910	40,605	77,680
Texas	(b)	(b)							2,143	7,405	(b)	(b)	(b)	(b)	670	2,383	16,584	19,064
Utah									17,267	22,894					80	160	17,347	23,054
Vermont	3,793	29,398	(b)	(b)					(b)	(b)							4,474	34,092
Virginia	(b)	(b)							(b)	(b)					60	22	442	3,250
Washington					(b)	(b)			653	5,921	(b)	(b)			200	500	3,883	15,511
West Virginia									26,189	20,307	(b)	(b)			60	13	26,549	20,470
Other States[d]	9,373	74,022	1,650	5,500	8,205	16,799	20,645	79,700	1,239	6,999	1,147	1,528	56,347	41,951			(e)	(e)
	28,649	216,243	64,510	310,943	10,087	22,370	40,838	133,770	1,101,579	1,486,139	124,192	102,390	210,556	154,575	143,490	173,556	1,723,901	2,599,986
Average value per ton		7.55		4.82		2.22		3.28		1.35		0.82		0.73		1.21		1.51

[a] Including bentonite, pipe clay, shale, terra-cotta clay, wad clay, and clay for medicinal use.
[b] Included in "Other States."
[c] Including Delaware, Florida, Idaho, North Dakota, Wisconsin, and Wyoming.
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

The leading clay-producing State in 1908, as in 1907, in both quantity and value, was New Jersey, though there was a considerable falling off in both quantity and value, the clay reported in 1908 amounting to 312,232 short tons, valued at $507,203, a loss of 127,906 tons, or 29.06 per cent, and of $168,045, or 24.89 per cent. In 1908 New Jersey reported 18.11 per cent of the total quantity of clay produced in the country and 19.51 per cent of the total value; in 1907 this State reported 20.16 per cent of the total quantity of clay and 19.58 per cent of the value. Of the 312,232 tons of clay reported for 1908 by New Jersey, 234,579 tons, or 75.13 per cent, was fire clay, and of the value of the clay reported, $382,373, or 75.39 per cent, was for fire clay. Small quantities of ball and stoneware clay were reported from New Jersey, and brick clay to the value of $27,854 was sold. The average value per ton for all New Jersey clay in 1908 was $1.62, as compared with $1.53 in 1907.

Pennsylvania was the second State in the production of clay in 1907 and 1908 in both quantity and value, reporting 243,157 tons, or 14.11 per cent, of the total quantity reported for 1908, valued at $466,385, or 17.94 per cent of the total value. This was a loss of 139,463 tons, or 36.45 per cent, and of $151,758, or 24.55 per cent, from 1907. In this State also fire clay is the leading variety, 179,555 tons, or 73.84 per cent of the quantity and 63.72 per cent of the value being fire clay.

Ohio, the leading clay-working State, was third in quantity of clay mined and sold as such, reporting 242,737 tons, though it was fourth in value, reporting $174,063. Missouri was fourth in quantity and third in value. Ohio's loss from 1907 was 49,420 tons, or 16.92 per cent in quantity, and $91,512, or 34.46 per cent, in value. Missouri's loss in quantity was only 14,544 tons, or 8.49 per cent, while the value declined $179,029, or 40.36 per cent. The average value per ton for all kinds of clay in Ohio in 1908 was 72 cents; in Missouri the average value was $1.69.

In 1908 only 4 States, as given in the table, showed increases in the value of the clay mined, viz, Illinois, New Mexico, Texas, and Washington—Illinois gaining $8,779, or 8.31 per cent; New Mexico $9,483, or 51.41 per cent; Texas $10,123, or 113.22 per cent; and Washington $10,888, or 235.52 per cent. Seven States showed increases in quantity, viz, Kentucky, New Mexico, New York, North Carolina, Texas, Utah, and Washington. In 1907, 15 States showed increases in quantity, and 17 States showed increases in value.

Of the several varieties, paper clay and brick clay are the only ones which showed increases, paper clay increasing in value $17,000, or 5.78 per cent, while the quantity decreased slightly, 1,681 tons, or 2.54 per cent. Brick clay is the only variety which increased in both quantity and value, the increase in quantity being 74,041 tons, or 54.24 per cent, and in value $42,572, or 38.01 per cent. Fire clay is the most important variety judged from the quantity and value of the output, 1,101,579 tons, valued at $1,486,139, a loss, however, of 372,883 tons, or 25.29 per cent in quantity, and of $568,559, or 27.67 per cent in value. The value of fire clay in 1908 was 57.16 per cent of the value of all clay mined and sold in that year. New Jersey was the leading fire-clay producing State, reporting 234,579 tons, or 21.29 per cent of the total quantity, valued at $382,373, or 25.73 per cent of the total. Pennsylvania was second in both quantity and value in both years, while Ohio was third in quantity in both years and Missouri was third in value in both years.

The average value per ton for fire clay in the leading producing States was: Missouri, $1.91; New Jersey, $1.63; Ohio, $0.83; and Pennsylvania, $1.66.

Kaolin decreased $124,068, or 36.46 per cent, from 1907; slip clay, $15,555, or 41.02 per cent; ball clay, $61,745, or 31.58 per cent; stoneware clay, $34,186, or 25.03 per cent. North Carolina is the leading kaolin-producing State, though if the plastic white clays of Georgia and South Carolina be classified as kaolin, for which classification there seems to be much justification, the last State would be the leading one.

The average value per ton decreased for ball clay, fire clay, stoneware clay, and brick clay; for other varieties, viz, kaolin, paper clay, slip clay, and miscellaneous clays, there were slight increases; but as these clays are produced in relatively small quantities their higher averages were not sufficient to overcome the decreases, and the average value for all clay fell from $1.58 in 1907 to $1.51 in 1908.

IMPORTS.

The following table shows the imports of clay from 1904 to 1908, inclusive:

Classified imports of clay for consumption, 1904–1908, in short tons.

Year.	Kaolin or china clay.		All other clays.						Total.	
			Unwrought.		Wrought.		Common blue.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	160,046	$891,708	25,402	$123,241	1,363	$25,026	5,263	$50,364	192,074	$1,090,339
1905	187,803	1,019,650	30,661	151,583	1,560	38,036	5,909	54,390	225,933	1,263,659
1906	223,404	1,208,189	33,267	166,366	1,889	37,549	9,220	84,578	267,780	1,496,682
1907	239,923	1,582,893	31,196	145,698	2,520	81,155	12,378	110,686	286,017	1,920,432
1908	176,895	1,129,847	27,730	129,411	1,372	22,990	4,872	37,053	210,869	1,319,301

In 1907 the greatest quantity and value of clay imported was recorded. In 1908, in common with all industries, the imports of clay fell off. The decrease in the value of the total was $601,131, or 31.30 per cent; the quantity decreased 75,148 tons, or 26.27 per cent. Kaolin decreased in quantity 63,028 tons, or 26.27 per cent, and in value $453,046, or 28.62 per cent. The average value of kaolin imported in 1908 was $6.39 per ton; in 1907 it was $6.60; and in 1906 it was $5.41 per ton.

BUILDING OPERATIONS.

The following table shows the building operations of some of the leading cities of the country in 1907 and 1908. The increase or decrease in the cost of buildings erected in each city and the total decrease in 1908 are shown, together with the percentage of the total decrease; also in certain cities the number and cost of the so-called fireproof or fire-resisting buildings and of those of wood. In some instances more than one building is erected under the same permit, though in most cities one permit is issued for each building.

The building operations of the country may be regarded as an index of the prosperity of the nation, since building trades are the first to feel the effect of financial disturbance and are also prompt to respond to a revival of business. Judged by this standard the country had not recovered in 1908 from the panic of 1907.

Building operations in the leading cities of the United States in 1907 and 1908.

City.	1907. Number of permits or buildings.	1907. Cost of buildings.	1908. Number of permits or buildings.	1908. Cost of buildings.	Gain (+) or loss (−) in 1908.	Percentage of gain or loss in 1908.	Rank of cities in cost of buildings erected in 1908.
Allegheny, Pa	609	$2,224,541	(a)	(a)	(a)	(a)	(a)
Atlanta, Ga	4,169	4,554,771	4,153	$4,833,941	+ $279,170	+ 6.13	28
Baltimore, Md	3,129	8,250,677	2,893	7,554,709	− 695,968	− 8.44	20
Boston, Mass	3,546	19,223,226	2,632	11,253,712	− 7,969,514	−41.46	9
Brooklyn, N. Y	17,397	71,292,844	10,769	45,865,240	−25,427,604	−35.67	3
Buffalo, N. Y	3,049	8,742,082	2,788	6,847,000	− 1,895,082	−21.68	22
Cambridge, Mass	451	2,729,345	425	2,153,070	− 576,275	−21.11	44
Chicago, Ill	9,353	59,093,080	10,627	67,234,800	+ 8,141,720	+13.78	2
Cincinnati, Ohio	2,215	7,680,160	3,553	6,428,888	− 1,251,272	−16.29	23
Cleveland, Ohio	8,174	15,888,407	6,674	9,896,869	− 5,991,538	−37.71	18
Columbus, Ohio	2,173	4,181,260	1,698	3,400,273	− 780,987	−18.68	32
Dayton, Ohio	1,394	3,837,180	1,193	3,234,280	− 602,900	−15.71	35
Denver, Colo	2,509	6,349,604	3,117	10,098,020	+ 3,748,416	+59.03	14
Detroit, Mich	4,941	14,226,300	3,662	10,682,170	− 3,544,130	−24.91	11
Fall River, Mass	312	1,414,916	399	1,140,927	− 273,989	−19.36	48
Grand Rapids, Mich	1,174	2,053,755	1,064	2,181,759	+ 128,004	+ 6.23	43
Hartford, Conn	733	4,054,335	676	3,107,348	− 946,987	−23.36	37
Indianapolis, Ind	3,903	5,893,726	4,013	5,895,928	+ 2,202	+ .04	25
Jersey City, N. J	1,687	6,008,014	1,367	4,490,466	− 1,517,548	−25.26	30
Kansas City, Kans	944	1,472,279	792	1,108,472	− 363,807	−24.71	49
Kansas City, Mo	3,943	9,611,922	3,840	10,562,041	+ 950,119	+ 9.88	12
Los Angeles, Cal	7,599	13,304,696	7,371	9,931,377	− 3,373,319	−25.35	17
Louisville, Ky	2,634	3,078,404	2,909	2,914,141	− 164,263	− 5.34	39
Lowell, Mass	441	1,225,317	497	1,019,081	− 206,236	−16.83	50
Memphis, Tenn	2,592	4,957,999	2,519	3,300,508	− 1,657,491	−33.43	34
Milwaukee, Wis	3,625	10,771,244	4,169	10,065,669	− 705,575	− 6.55	16
Minneapolis, Minn	4,960	10,006,485	5,638	10,093,915	+ 87,430	+ .87	15
Nashville, Tenn	5,202	2,040,458	4,215	1,969,505	− 70,953	− 3.48	46
Newark, N. J	2,732	9,543,520	2,419	7,161,668	− 2,381,852	−24.96	21
New Bedford, Mass	682	2,256,000	774	2,872,300	+ 616,300	+27.32	40
New Haven, Conn	781	2,824,942	919	3,091,465	+ 266,523	+ 9.43	38
New Orleans, La	1,880	5,815,247	2,457	5,744,311	− 70,936	− 1.22	26
New York, N. Y	7,470	113,372,673	6,103	117,819,382	+ 4,446,709	+ 3.92	1
Oakland, Cal	4,507	8,207,983	3,614	6,320,563	− 1,887,420	−22.99	24
Omaha, Nebr	1,500	4,536,643	1,526	4,590,650	+ 54,007	+ 1.19	29
Philadelphia, Pa	15,359	36,352,075	13,363	28,152,265	− 8,199,810	−22.56	5
Pittsburg, Pa	3,631	12,740,762	[a] 4,023	[a] 13,136,387	−[a] 1,828,916	−12.22	8
Portland, Oreg	3,890	9,446,982	4,849	10,505,151	+ 1,058,169	+11.20	13
Providence, R. I	1,201	3,224,400	1,386	4,034,000	+ 809,600	+25.11	31
Reading, Pa	1,193	1,532,050	571	497,700	− 1,034,350	−67.51	51
Richmond, Va	701	1,914,184	1,330	3,169,431	+ 1,255,247	+65.58	36
Rochester, N. Y	1,420	6,752,615	1,302	4,975,317	− 1,777,298	−26.32	27
St. Joseph, Mo	824	1,667,563	678	1,717,723	+ 50,160	+ 3.01	47
St. Louis, Mo	8,554	21,893,167	9,119	21,190,369	− 702,798	− 3.21	6
St. Paul, Minn	1,892	6,321,937	[b] 2,270	7,625,538	+ 1,303,601	+20.62	19
San Francisco, Cal	6,437	56,574,844	6,729	31,668,341	−24,906,503	−44.02	4
Scranton, Pa	937	2,435,024	892	2,366,405	− 68,619	− 2.82	41
Seattle, Wash	10,478	13,572,770	7,901	13,777,329	+ 204,559	+ 1.51	7
Syracuse, N. Y	1,299	4,222,282	1,291	3,317,195	− 905,087	−21.44	33
Toledo, Ohio	1,176	3,400,665	1,065	2,081,448	− 1,319,217	−38.79	45
Washington, D. C	5,015	10,215,604	5,258	10,800,096	+ 584,492	+ 5.72	10
Worcester, Mass	1,028	3,068,896	1,102	2,286,261	− 782,635	−25.50	42
	187,445	646,059,855	174,594	566,165,404	−79,894,451	−12.37	....

[a] Statistics for Allegheny, Pa., which became a part of Pittsburg, Pa., February 1, 1908, are included under Pittsburg, and the loss and percentage of loss in 1908 are reckoned by a comparison of 1908 with the combined cost of buildings of the two cities in 1907.

[b] Estimated.

The foregoing table shows a comparison of the building operations in the cities given in 1907 and 1908, with the rank of each city in cost of buildings in 1908. Of these cities 33 showed decreases and 18 showed increases in cost. The total of the decreases was $103,880,879; of the increases, $23,986,428; a net decrease of $79,894,451. Of the cities that reported an increase Chicago showed the greatest, $8,141,720, and New York the next largest, $4,446,709. The proportionate increase in Chicago was 13.78 per cent, compared with 3.92 per cent in New York. While New York showed an increase, Brooklyn showed the largest decrease. New York City is by far the largest consumer of building materials and building labor in the United States. For several years, in fact since the publication of figures of building operations by this office, it has expended nearly twice as much in these operations as the next largest city. Denver showed the third largest gain in cost—$3,748,416, or 59.03 per cent. The largest proportionate gain for the year was reported by Richmond—65.58 per cent. Indianapolis and Omaha reported practically the same values for both years.

The total number of permits issued also decreased, the decline being from 187,445 in 1907 to 174,594 in 1908, a decrease of 12,851, or 6.86 per cent.

The city showing the greatest decrease in 1908 in cost of buildings was Brooklyn, which fell off in cost $25,427,604, or 35.67 per cent, though followed closely by San Francisco, which showed a decrease of $24,906,503, or 44.02 per cent. This decrease brings San Francisco down to what is probably its normal condition, the large increases in 1906 and 1907 being due to the reconstruction after the fire of 1906. (Owing to a clerical error in the compilation of the report for San Francisco for 1907 there has been a change in the figures for that city as published in the 1907 report. Those published here are given as correct by the building inspector of that city.) Philadelphia showed the third largest decrease, $8,199,810, or 22.65 per cent, followed by Boston with a decrease of $7,969,514, or 41.46 per cent. Reading showed the largest proportionate decrease, 67.51 per cent.

The number of permits ranged in 1908 from 13,363 in Philadelphia to 399 in Fall River. No statement of the number of permits or buildings for St. Paul in 1908 was obtained, hence the number has been estimated. The number of permits in some of the cities have shown considerable changes, namely, in Cincinnati there was an increase from 2,215 in 1907 to 3,553 in 1908, a gain of over 60 per cent, while the cost declined 16.29 per cent. In New York the permits decreased from 7,470 to 6,103, a loss of 18.3 per cent, while there was a small gain in the cost of buildings. In Reading the permits decreased 52.14 per cent, from 1,193 in 1907 to 571 in 1908, while the cost decreased 67.51 per cent.

The average cost of operations under the permits issued in New York was $15,177 in 1907 and $19,305 in 1908. In Chicago the average cost per permit was $6,318 in 1907 and $6,327 in 1908, while in Brooklyn, the third largest city in cost of buildings, it was a little over $4,000 in each year. In San Francisco the average cost was $8,789 in 1907 and $4,706 in 1908, thus showing that the buildings erected during the year after the fire were much more costly than those built in the following year; in 1905 the average cost was $3,371. The average cost per permit in Philadelphia was $2,367 in 1907 and $2,107 in 1908.

The relative rank of these cities in the cost of building operations is somewhat interesting. New York was first, reporting building operations costing more than its nearest competitor, Chicago, by $50,584,582, or over 75 per cent greater than the cost of Chicago's buildings. If the cost of Brooklyn operations, the third city in rank, were added to New York, the total would be $163,684,622, or nearly 30 per cent of the cost of the building operations of the 52 cities included in the table. San Francisco was fourth in rank, Philadelphia fifth, and St. Louis sixth. The seventh in rank was the small though apparently rapidly growing city of Seattle, which spent more for buildings in 1908 than Pittsburg, which was eighth, or Boston, which was ninth, and other cities much larger. The cause ascribed for this activity was the extremely low prices of building materials and labor in Seattle.

Character of buildings erected in the leading cities of the United States in 1908.

City.	Brick and stone.		Wood.	
	Number of permits or buildings.	Cost of buildings.	Number of permits or buildings.	Cost of buildings.
Atlanta, Ga	106	$2,131,975	1,325	$2,008,381
Baltimore, Md	2,218	6,645,354	128	485,220
Boston, Mass	167	5,293,350	680	3,259,075
Brooklyn, N. Y	4,669	33,250,380	2,068	6,578,486
Buffalo, N. Y	135	1,645,055	1,648	4,270,830
Cambridge, Mass	19	1,128,500	155	684,990
Chicago, Ill	8,208	55,964,800	2,419	11,270,000
Cincinnati, Ohio	558	4,237,660	667	1,267,145
Cleveland, Ohio	485	4,516,420	2,559	4,283,946
Columbus, Ohio	577	2,157,840	1,121	1,242,433
Dayton, Ohio	96	1,727,420	980	1,356,780
Denver, Colo	2,660	9,821,205	457	276,815
Detroit, Mich	374	3,494,180	2,694	5,901,170
Fall River, Mass	37	370,000	362	742,927
Grand Rapids, Mich	66	994,491	598	935,079
Hartford, Conn	109	2,239,900	304	672,390
Indianapolis, Ind	240	2,222,231	1,770	2,900,707
Jersey City, N. J	274	1,759,652	494	1,640,553
Kansas City, Kans	67	301,900	725	806,572
Kansas City, Mo	420	4,619,400	1,523	4,724,910
Los Angeles, Cal	201	2,536,415	4,679	6,470,263
Louisville, Ky	317	1,524,093	1,585	1,164,699
Lowell, Mass	13	326,250	205	471,420
Memphis, Tenn	99	1,175,304	985	1,696,728
Milwaukee, Wis	185	3,400,011	1,647	5,173,535
Minneapolis, Minn	248	2,967,965	2,906	5,562,745
Newark, N. J	574	1,484,612	1,845	5,677,056
New Bedford, Mass	16	1,153,500	574	1,605,100
New Haven, Conn	221	1,255,464	318	1,526,780
New York, N. Y	1,884	103,064,486	687	3,327,050
Omaha, Nebr	189	2,162,850	1,026	2,140,840
Philadelphia, Pa	6,778	22,420,435	45	66,700
Pittsburg, Pa	903	9,003,065	1,123	2,377,530
Portland, Oreg	121	2,704,190	3,436	7,035,420
Providence, R. I	65	1,888,550	824	1,729,600
Reading, Pa	209	459,950	....	....
Richmond, Va	408	2,504,312	412	384,292
Rochester, N. Y	138	815,387	1,164	3,694,900
St. Joseph, Mo	121	720,451	557	997,272
St. Louis, Mo	2,767	18,658,551	4,028	1,073,201
San Francisco, Cal	285	14,406,357	4,153	15,122,198
Scranton, Pa	42	841,470	473	1,235,605
Seattle, Wash	124	4,291,725	7,777	7,767,703
Syracuse, N. Y	50	999,950	627	1,754,905
Washington, D. C	1,080	7,432,299	766	2,122,300
Worcester, Mass	48	478,700	512	1,330,880
	38,571	353,198,055	65,031	136,817,131

This table shows the character of the buildings erected; that is, those of brick and stone or other fire-resisting material and those of wood.

Two cities reported by classes for 1908, Baltimore and Jersey City, that did not classify their buildings for 1907; and two cities included in the 1907 table, Nashville and St. Paul, did not report by classes for 1908; and two cities have been added to the table, New Bedford and Portland. Of the permits issued or buildings erected, as shown in the table, 37.23 per cent were for fire-resisting buildings and 62.77 per cent for wooden buildings. These percentages for 1907 were nearly the same, 39.12 per cent and 60.88 per cent, respectively, The relative costs, however, of these classes of buildings are reversed, the brick or fire-resisting buildings being 72.08 per cent of the total and the wooden 27.92 per cent. The average cost of brick or fire-resisting buildings was $9,157, and of wooden buildings, $2,104.

Chicago showed the largest number of brick buildings, 8,208, with an average cost of $6,818; Philadelphia the next largest number, 6,778, with an average cost of $3,308. Brooklyn was third in number of brick buildings. New York was seventh in number of brick buildings, though in cost of buildings of this class it is first. This city reported 1,884 buildings which cost $103,064,486, or nearly twice as much as Chicago's 8,208; the average cost of these buildings was $54,705. Lowell had the smallest number of brick buildings, 13, and New Bedford the next lowest number of brick buildings, 16, with the highest average cost, $72,094.

There were no wooden buildings erected in the Borough of Manhattan, those reported for New York being in the Bronx. The average cost of these buildings was $4,843. Seattle reported the largest number of permits for wooden buildings, 7,777, with an average cost of about $1,000. Los Angeles reported the next largest number of wooden buildings, 4,679, costing an average of $1,383. The greatest cost for wooden buildings was reported by San Francisco, where the average cost was $3,641. Chicago, which reported the largest number of brick buildings, was eighth in number of wooden buildings, with an average cost of $4,659. Philadelphia reported the smallest number of wooden buildings, 45, with an average cost of $1,482. There were none reported from Reading.

Of these cities, 22—Buffalo, Detroit, Fall River, Indianapolis, Kansas City, Kans., and Kansas City, Mo., Los Angeles, Lowell, Memphis, Milwaukee, Minneapolis, New Bedford, Newark, New Haven, Portland, Rochester, St. Joseph, San Francisco, Scranton, Seattle, Syracuse, and Worcester—reported wooden buildings costing more than the brick or stone buildings. In one city, Rochester, the wooden buildings were reported as costing more than four times as much as those of brick.

GLASS SAND, OTHER SAND, AND GRAVEL.

PRODUCTION.

Sand and gravel showed the reduction in quantity and value in 1908 which was to be expected for this year of unsettled commercial conditions. The production in 1908 was 37,216,044 short tons, valued at $13,270,032; in 1907 the output reported was 41,851,918 short tons, valued at $14,492,069—a decrease for 1908 of 4,635,874 short tons in quantity and of $1,222,037 in value. There was a decrease in quantity reported for all of these materials, and also a decrease in value for all except building sand and gravel, which increased in value but not enough to overcome the decrease in the other products.

The ordinary price of sand and gravel per ton varies from 8 to 10 cents to $1.50, although sands used for special kinds of glass and prepared by the producer for special purposes bring from $7 to $20 per ton. Gravel prepared for roofing or some other special purpose is valued as high as $3 per ton. This considerable difference in price per ton for sand and gravel is on account of the variety of treatment to which sand is subjected when taken from the pit or dredge. The price of sand or gravel loaded directly on the cars or barges is usually very low; but for sand hauled any considerable distance to a place of shipment, or for sand washed, dried, screened, and otherwise prepared for the market, the price is higher.

Glass sand and molding sand ordinarily command the highest prices, as specially prepared sand is required. A large quantity of sand and gravel is dredged from lakes and rivers at a very low cost, and much of this is used by railroads for filling and for ballasting tracks.

Pennsylvania leads in value of sand and gravel production, followed by Illinois, New York, and Ohio.

The unit of measurement given in the following table of production is the short ton. Much of the sand is reported as sold by the cubic yard, a cubic yard varying in weight from 2,300 to 3,000 pounds according to the condition of the sand and also to the custom of the locality. All of the glass sand is sold by the short ton, and also a considerable quantity of the molding, building, and other sands; hence the quantities reported were reduced to this unit.

Production of glass sand, other sand, and gravel in the United States in 1907 and 1908, by States and uses, in short tons.

1907.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sand.		Gravel.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	....	....	57,683	$25,698	161,073	$73,829	....	....	9,000	$3,000	6,720	$4,500	....	....	77,183	$62,845	311,659	$169,872
Arkansas	43	$32	43	20	120,434	57,197	....	....	20,356	6,208	....	....	1,707	$670	22,530	17,550	165,113	81,677
California	11,064	8,179	6,278	5,076	84,433	29,154	....	....	35,720	12,560	....	....	26,971	21,802	1,080,467	102,095	1,244,933	178,866
Colorado	2,000	2,500	20,168	6,986	2,897	944	500	$750	....	....	4,800	2,880	21,989	6,505	16,102	4,508	68,456	25,073
Connecticut	....	....	945	2,553	28,870	23,640	....	....	....	....	....	....	....	....	....	800	29,815	26,193
Delaware	....	....	28,610	12,687	15,285	9,500	....	....	49,250	19,700	....	....	53,000	21,200	1,137	800	147,282	63,887
Florida	....	....	3,643	1,641	8,000	2,000	....	....	....	....	....	....	....	....	4,155	2,968	15,798	6,609
Georgia	4,800	4,800	22,695	10,735	179,255	59,309	....	....	10,000	2,000	....	....	9,140	5,547	5,200	4,400	231,090	86,791
Illinois	235,716	152,619	372,884	237,149	1,067,776	419,450	6,668	2,667	113,742	29,091	16,000	12,350	940,746	133,090	1,797,459	381,237	4,550,991	1,367,653
Indiana	30,500	23,000	110,432	65,495	727,069	193,915	65	20	142,806	24,050	75,781	11,563	3,093,777	192,035	1,438,462	297,640	5,618,892	807,718
Iowa	....	....	6,633	7,508	214,005	69,856	....	....	25,945	5,285	3,000	1,200	93,405	9,771	118,796	16,881	461,784	110,501
Kansas	....	....	....	....	265,512	66,314	....	....	4,050	600	....	....	10,900	1,705	276,163	48,694	556,625	117,313
Kentucky	7,400	4,592	40,119	27,498	219,963	137,016	1,200	900	9,596	4,327	....	....	5,785	4,241	152,729	85,376	436,792	263,950
Louisiana	....	....	....	....	130,275	17,784	....	....	21,580	2,800	....	....	184,153	32,804	897,742	389,536	1,233,750	442,924
Maryland	13,370	13,215	4,600	5,100	394,203	144,308	....	....	....	....	....	....	680	830	175,006	104,595	587,759	268,048
Massachusetts	7,500	37,734	8,485	4,418	130,072	62,483	8,500	5,525	50	32	....	....	18,320	10,872	27,832	20,213	200,759	141,277
Michigan	4,300	8,600	54,172	24,190	451,646	157,150	6,000	3,000	1,534	153	3,858	3,133	173,724	12,187	329,407	81,182	1,024,641	289,595
Minnesota	....	....	24,575	27,324	87,437	38,577	....	....	2,587	259	50	25	17,505	9,117	285,538	55,048	417,692	130,350
Mississippi	....	....	447	295	68,700	21,500	....	....	900	600	....	....	3,150	650	96,218	52,818	169,415	75,863
Missouri	138,483	92,898	48,314	32,668	1,899,822	435,441	15,738	8,979	34,500	6,803	15,000	7,500	48,760	27,051	874,663	179,634	3,075,280	790,974
Nebraska	....	....	....	....	261,702	41,258	....	....	28,713	3,648	....	....	82,908	8,778	1,267	543	374,590	54,227
New Jersey	87,140	73,914	746,102	381,403	784,060	197,996	82,153	81,963	38,920	14,611	8,131	3,257	213,900	231,742	251,430	60,373	2,211,836	1,045,259
New Mexico	....	....	....	....	662	550	....	....	....	....	....	....	1,000	1,000	207,816	49,174	209,478	50,724
New York	....	....	693,293	539,674	3,633,726	925,028	24,086	7,826	47,862	23,385	2,997	1,436	46,235	18,624	806,697	251,548	5,254,896	1,767,521
North Carolina	....	....	885	570	3,500	1,580	110	18	....	....	....	....	....	....	250	20	4,745	2,191
Ohio	95,449	104,127	683,714	521,494	1,210,2[illegible]	442,469	13,077	9,046	41,257	15,585	122,801	98,235	125,901	40,010	677,377	285,071	2,978,801	1,516,037
Oklahoma	....	....	....	....	40,060	12,780	....	....	....	....	....	....	4,700	865	63,000	8,861	108,560	22,506
Oregon	....	....	2,250	1,300	197,542	1[illegible],708	....	....	....	....	....	....	....	....	304,350	164,414	504,142	289,422
Pennsylvania	370,977	489,989	561,980	398,691	2,288,586	855,567	44,662	51,245	194,986	145,935	103,127	63,078	701,101	430,893	1,534,029	347,170	5,799,448	2,782,568
South Carolina	3,000	2,400	512	248	1,062	670	....	....	....	....	....	....	875	700	375	400	5,824	4,418
Tennessee	....	....	39,155	26,141	372,936	155,031	....	....	41,550	11,552	14,843	9,310	9,081	3,775	316,799	107,402	794,364	313,211
Texas	....	....	4,934	3,471	171,125	94,725	....	....	1,875	1,200	....	....	6,025	5,793	99,525	37,105	283,484	142,294
Vermont	....	....	968	600	3,674	2,975	....	....	....	....	....	....	72,500	29,000	1,592	835	78,734	33,410
Virginia	1,246	4,535	50,627	30,377	158,715	67,160	....	....	10,239	4,603	10,059	4,227	24,334	9,958	13,002	2,952	268,222	123,812
Washington	....	....	3,600	8,500	140,610	62,375	....	....	500	300	....	....	....	....	259,250	108,625	403,960	179,800

West Virginia...	171,338	225,003	8,400	6,438	151,622	70,456	....	....	78,985	47,400	10,221	3,276	32,776	17,378	51,242	15,487	504,584	385,438
Wisconsin.......	2,970	1,930	72,348	42,683	335,420	124,122	210	136	21,618	2,162	4,000	5,600	55,485	4,844	475,608	98,917	967,659	280,394
Other States [a]...	....	....	3,000	2,120	27,475	14,865	....	....	11,803	2,646	16,000	8,000	15,778	5,756	476,009	20,316	550,065	53,703
	1,187,296	1,250,067	3,682,494	2,460,754	16,049,229	5,212,682	202,969	172,075	999,924	390,495	417,388	239,570	6,096,311	1,299,193	13,216,407	3,467,233	41,851,918	14,492,069

[a] Includes Arizona, Maine, Montana, South Dakota, Utah, and Wyoming.

Production of glass sand, other sand, and gravel in the United States in 1907 and 1908, by States and uses, in short tons—Continued.

1908.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sand.		Gravel.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama			57,370	$20,683	175,404	$66,805			16,250	$4,750			5,662	$3,048	93,448	$85,893	348,134	$181,179
Arizona																		(a)
Arkansas	2,065	$1,297	1,790	1,136	96,936	44,910			8,586	3,211			22,958	6,548	119,652	31,750	251,987	88,852
California	6,805	5,121	3,861	3,811	31,718	11,973	2,888	$2,310	21,299	4,298	3,750	$2,000	20,571	15,277	521,713	96,170	612,605	140,960
Colorado	1,000	1,250	1,112	970	11,608	3,662							449	234	9,562	4,460	23,731	10,576
Connecticut			1,272	2,135	9,885	5,185							2,500	1,100			13,657	8,420
Delaware			20	20	34,713	13,885			18,961	7,584	12,682	5,890	12,617	5,047			78,993	32,426
Florida			1,494	784	12,350	5,651									14,332	11,466	28,176	17,901
Georgia	3,950	3,180	10,668	10,336	174,547	44,141	412	281	5,625	1,500			10,795	5,282	23,850	16,268	229,847	80,988
Illinois	194,722	139,172	143,080	86,213	1,342,303	481,827	2,935	1,395	47,863	8,952	72,827	18,404	2,047,147	175,941	2,806,871	591,118	6,657,748	1,503,022
Indiana	18,000	13,950	48,915	32,608	1,098,703	277,757			50,706	6,460	26,031	4,369	939,131	84,539	1,092,469	276,125	3,273,955	695,808
Iowa			4,544	5,054	485,805	205,121	25	30	26,032	5,811	2,500	875	45,157	14,009	209,449	55,544	773,512	286,444
Kansas					261,557	49,667			4,291	698			17,626	3,011	36,676	10,952	320,150	64,328
Kentucky	5,990	4,283	29,740	17,692	280,891	144,317			3,381	1,754	795	525	14,151	9,771	303,350	157,438	638,298	335,780
Louisiana	2,695	1,911			163,675	54,089			8,563	3,113			78,100	15,700	564,407	178,500	817,440	253,313
Maine																		(a)
Maryland	14,000	13,700	1,750	3,900	452,347	189,881			1,700	1,055			8,350	5,402	324,087	190,228	802,234	404,166
Massachusetts	5,017	25,330	6,257	6,085	84,617	43,430	5,000	3,250					9,382	8,165	48,775	28,919	159,048	115,179
Michigan	17,000	34,000	4,584	2,892	474,238	228,395			1,991	319	3,329	3,828	29,187	6,850	312,262	94,081	842,591	370,365
Minnesota			23,212	21,756	124,575	62,994			5,403	864			7,465	3,669	289,651	67,376	450,306	156,659
Mississippi			337	320	27,687	14,588	375	405	625	655	625	655			132,928	65,496	162,577	82,119
Missouri	111,517	83,106	41,719	21,640	1,767,794	427,050	2,820	996	12,500	2,500	23,300	16,655	42,364	27,648	586,144	147,389	2,588,158	726,984
Montana																		(a)
Nebraska					439,200	67,275			12,484	2,889			62,032	8,964	13,250	1,300	526,966	80,428
New Jersey	56,775	46,379	358,688	186,544	1,216,549	274,418	58,798	60,667	41,248	16,437	8,045	3,474	124,611	42,923	275,747	81,336	2,140,461	712,178
New Mexico					1,500	1,850			250	400			1,000	5,000	5,500	4,800	8,250	12,050
New York	5,000	3,500	416,151	330,796	2,724,160	809,983	15,924	9,544	21,174	10,159			47,259	22,261	476,720	166,420	3,706,388	1,352,663
North Carolina			467	332	6,500	1,725									156	13	7,123	2,070
Ohio	92,487	94,825	343,154	244,164	1,198,933	434,592	12,287	9,881	31,450	14,512	64,980	58,938	48,663	26,228	704,756	255,238	2,496,710	1,138,378
Oklahoma			250	200	70,000	28,000							6,698	892	42,992	6,879	119,940	35,971
Oregon					251,353	316,044									364,681	208,940	616,034	524,984
Pennsylvania	405,028	484,353	359,161	262,467	1,596,610	691,316	16,884	16,987	127,967	82,954	54,709	33,887	621,916	391,562	938,167	239,530	4,120,442	2,203,056
South Carolina	1,970	1,596	441	269	3,931	1,470							62	75			6,404	3,410
South Dakota																		(a)
Tennessee			22,451	15,966	247,921	122,099	1,573	1,233	37,118	11,367	48,055	32,023	9,515	4,306	430,701	173,080	797,334	360,074
Texas			4,355	2,500	171,237	93,784			3,500	1,560			500	370	129,658	41,853	309,250	140,067
Utah									4,585	1,105			6,150	1,291	10,255	1,203	20,990	3,599

Vermont	....	....	719	486	2,125	1,950	....	....	....	....	....	....	77,500	38,750	562	450	80,906	41,636
Virginia	....	....	47,888	22,568	139,742	61,378	....	....	6,651	2,860	11,295	5,500	670	325	242,988	26,464	449,234	119,095
Washington	....	....	1,725	4,300	241,461	97,688	....	....	....	....	....	....	....	....	411,809	159,543	654,995	261,531
West Virginia	145,782	174,834	1,815	1,369	121,321	58,153	....	....	30,520	18,012	6,600	3,000	7,195	5,514	55,409	15,476	368,642	276,358
Wisconsin	3,750	2,812	41,687	32,806	418,231	152,768	1,757	879	23,171	3,707	....	....	12,651	4,328	360,800	115,455	862,047	312,755
Wyoming	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	(a)
Other States[b]	....	....	....	....	75,554	45,717	....	....	....	....	....	....	....	....	849,156	133,610	850,781	134,260
	1,093,553	1,134,599	1,980,677	1,342,802	16.037,681	5,635,538	121,678	107,858	573,894	219,486	339,523	190,023	4,340,034	944,030	12,729,004	3,695,696	37,216,044	13,270,032

[a] Included in other States.
[b] Includes Arizona, Maine, Montana, South Dakota, and Wyoming.

IMPORTS.

Sand valued at $77,574 was imported into the United States in 1908, as compared with imports valued at $94,871 in 1907, a decrease in 1908 of $17,297. In 1906 the value of the sand imported was $85,566.

LITERATURE.

Papers in which the character, distribution, relation to markets and fuel supplies, and methods of extraction and preparation of glass sand and other sands are discussed are listed below in the order of their dates:

Weeks, Joseph D., Glass materials: Mineral Resources U. S. for 1883 and 1884, U. S. Geol. Survey, 1885, pp. 958–973.

———, Glass materials: Mineral Resources U. S. for 1885, U. S. Geol. Survey, 1886, pp. 544–555.

Campbell, M. R., Description of the Brownsville-Connellsville quadrangles, Pennsylvania: Geologic Atlas U. S., folio 94, U. S. Geol. Survey, 1903, p. 49.

Coons, A. T., Glass sand: Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 1007–1015.

Burchard, E. F., Requirements of sand and limestone for glass making: Bull. U. S. Geol. Survey No. 285, 1906, pp. 452–458.

———, Glass sand of the middle Mississippi basin: Bull. U. S. Geol. Survey No. 285, 1906, pp. 459–472.

Stose, G. W., Glass-sand industry in eastern West Virginia: Bull. U. S. Geol. Survey No. 285, 1906, pp. 473–475.

Burchard, E. F., Glass-sand industry of Indiana, Kentucky, and Ohio: Bull. U. S. Geol. Survey No. 315, 1907, pp. 361–376.

———, Notes on glass sands from various localities, mainly undeveloped: Bull. U. S. Geol. Survey No. 315, 1907, pp. 377–382.

———, Production of glass sand, sand, and gravel in 1906: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 993–1000.

Randolph, B. S., The silica sand industry: Eng. and Min. Jour., December 28, 1907, pp. 1211–1212.

Kümmel, Henry B., and Gage, R. B., The glass-sand industry of New Jersey: Ann. Rept. New Jersey Geol. Survey for 1906, 1907, pp. 77–96.

Rock Products, An up-to-date Illinois (sand) plant; January 22, 1908, pp. 63–64.

The following three papers, arranged chronologically, contain much valuable information concerning molding sands. The last paper is probably the most complete that has yet been published concerning the sands of a particular area, and embodies tabulated results of considerable experimental work on the physical properties of the material.

Merrill, G. P., Guide to the study of the collections in the section of applied geology. Nonmetallic minerals: Rept. U. S. Nat. Mus. for 1899, 1901, pp. 474–477.

Eckel, Edwin C., Molding sand, its uses, properties, and occurrence: Twenty-first Rept. New York State geologist, 1901, pp. 91–96.

Kümmel, H. B., and others, Report upon some molding sands of New Jersey: Ann. Rept. State geologist of New Jersey for 1904, 1905, pp. 189–246.

Three papers recently issued by the United States Geological Survey which deal with sand and gravel as constituents of concrete are the following:

Burchard, E. F., Concrete materials produced in the Chicago district: Bull. U. S. Geol. Survey No. 340, 1908.

Humphrey, R. L., and Jordan, W., Jr., Portland cement mortars and their constituent materials: Bull. U. S. Geol. Survey No. 331, 1908.

Humphrey, R. L., The strength of concrete beams: Bull. U. S. Geol. Survey No. 344, 1908.

LIME.

By A. T. Coons.

PRODUCTION.

As with most other industries in 1908, the lime production decreased in both quantity and value of output. In 1907 shut downs in the latter part of the year reduced the total gain in value over the output of 1906 to a relatively small sum, while the tonnage produced showed a slight decrease. In 1908 many of the plants remained closed during the entire year and some plants ran but part of the time or with diminished force.

The total lime production of 1908 amounted to 2,766,873 short tons, valued at $11,091,186. These figures, compared with an output of 3,092,524 short tons, valued at $12,656,705, in 1907, show a decrease for 1908 of 325,651 short tons in quantity and of $1,565,519 in value. The average price per ton was $4.01 in 1908 and $4.09 in 1907.

In 1908 the number of lime burners reporting operations was 949; in 1907 it was 899. The increased number of operators in 1908 over 1907 is on account of the reports from a large number of small lime burners in Pennsylvania. These operations are carried on by farmers, who burn occasional kilns of lime to enrich the soil of their farms or to supply the demand of their neighbors. At one time almost every farmer throughout Pennsylvania who could get the stone burned an occasional kiln when his land needed liming. About eight or ten years ago this custom fell off, owing to the cheapness and convenience of patent fertilizers; for the last two or three years, however, there has been more lime used for the enrichment of land, with consequent increase of burners. The number of burners reporting in Pennsylvania in 1908 was 443; in 1907 it was 366, an increase in 1908 of 77. Exclusive of Pennsylvania there were 506 operators in 1908 and 533 in 1907—27 less in 1908 than in 1907.

Pennsylvania ranked first, both in quantity and in value of output, showing 21 per cent of the quantity and 16 per cent of the total value of lime manufactured in 1908. Notwithstanding the increased number of producers in Pennsylvania in 1908, there was a decrease in both quantity and value of output. Ohio, Wisconsin, Missouri, and Maine followed in rank of production.

In 1907 there were 43 States reporting a lime output; in 1908, 42 States. In 1908, 16 States reported an increased value of output, and 26 a decreased value.

The following table gives the value of the total lime production in the United States for the years 1897 to 1908, inclusive:

Value of lime produced in the United States, 1897–1908.

1897	$6,390,487	1903	$9,255,882
1898	6,886,549	1904	9,951,456
1899	6,983,067	1905	10,941,680
1900	6,797,496	1906	12,480,653
1901	8,204,054	1907	12,656,705
1902	9,335,618	1908	11,091,186

Detailed statistics of lime production during 1907 and 1908, by States, and rank of State according to value of output are given in the following table:

Quantity and value of lime burned in the United States in 1907 and 1908, by States, in short tons.

1907.

Rank of State.	State.	Quantity.	Value.	Average price per ton.	Number of operators.
11	Alabama	85,909	$368,902	$4.29	12
24	Arizona	12,825	84,262	6.66	5
22	Arkansas	33,472	159,566	4.77	11
6	California	84,981	691,851	8.14	27
33	Colorado	5,679	28,798	5.07	3
12	Connecticut	81,433	358,052	4.39	7
27	Georgia	18,349	70,826	3.85	6
29	Idaho	5,964	49,022	8.22	4
9	Illinois	124,784	559,305	4.48	22
13	Indiana	107,964	335,151	3.10	15
25	Iowa	19,944	84,011	4.21	8
37	Kansas	4,124	18,131	4.40	6
38	Kentucky	4,670	14,945	3.20	8
4	Maine	159,494	764,140	4.79	7
14	Maryland	103,423	324,316	3.14	41
8	Massachusetts	119,072	596,778	5.01	10
16	Michigan	65,822	276,534	4.20	12
23	Minnesota	20,450	88,900	4.35	4
3	Missouri	193,300	877,970	4.54	27
34	Montana	4,217	25,340	6.01	7
21	New Jersey	34,043	167,159	4.91	22
40	New Mexico	485	3,866	7.97	4
7	New York	137,111	652,205	4.76	39
36	North Carolina	5,000	24,010	4.80	4
2	Ohio	327,642	1,239,912	3.78	36
31	Oregon	4,095	39,738	9.70	6
1	Pennsylvania	655,166	2,075,842	3.17	366
35	South Dakota	3,673	24,895	6.78	4
17	Tennessee	66,699	263,323	3.95	16
20	Texas	38,101	186,372	4.89	9
28	Utah	12,671	68,085	5.37	13
18	Vermont	47,369	254,281	5.36	12
10	Virginia	115,155	447,307	3.89	26
19	Washington	35,913	238,568	6.64	9
15	West Virginia	107,895	290,298	2.69	34
5	Wisconsin	219,644	733,996	3.34	46
41	Wyoming	282	3,220	11.41	3
26	Florida	25,704	166,828	6.02	8
42	Hawaii			15.00	
43	Nevada			20.00	
39	Oklahoma			7.86	
32	Rhode Island			6.80	
30	South Carolina			5.43	
		3,092,524	12,656,705	4.09	899

Quantity and value of lime burned in the United States in 1907 and 1908, by States, in short tons—Continued.

1908.

Rank of State.	State.	Quantity.	Value.	Average price per ton.	Number of operators.
11	Alabama	83,411	$335,234	$4.02	13
26	Arizona	10,819	68,635	6.33	3
22	Arkansas	27,179	122,290	4.50	9
6	California	70,913	581,481	8.20	17
35	Colorado	5,615	28,179	5.02	3
12	Connecticut	62,070	307,895	4.96	3
28	Florida	11,822	62,915	5.32	6
30	Georgia	11,193	46,780	4.18	6
29	Idaho	7,373	57,020	7.73	5
10	Illinois	92,549	393,951	4.26	18
13	Indiana	95,988	293,579	3.06	12
24	Iowa	18,900	79,400	4.03	6
41	Kansas	1,558	8,086	5.19	4
37	Kentucky	6,206	21,322	3.44	8
5	Maine	141,934	661,453	4.66	6
14	Maryland	103,224	292,623	2.83	41
7	Massachusetts	107,813	566,022	5.25	10
15	Michigan	68,050	282,023	4.14	10
23	Minnesota	19,800	85,700	4.33	4
4	Missouri	167,060	701,321	4.20	28
32	Montana	5,121	32,981	6.44	6
21	New Jersey	32,700	134,722	4.12	21
8	New York	106,025	529,501	4.99	36
36	North Carolina	5,132	24,750	4.82	5
2	Ohio	279,080	975,661	3.50	34
34	Oregon	3,274	28,795	8.80	8
1	Pennsylvania	582,352	1,883,496	3.23	443
31	South Dakota	5,254	34,068	6.48	5
17	Tennessee	73,016	226,463	3.10	17
20	Texas	33,725	144,118	4.24	8
25	Utah	12,237	78,346	6.40	11
19	Vermont	32,691	170,205	5.21	10
9	Virginia	107,209	424,374	3.96	29
16	Washington	32,343	228,353	7.06	9
18	West Virginia	91,747	202,664	2.21	41
3	Wisconsin	235,538	831,792	3.53	44
42	Wyoming	392	4,246	10.83	4
27	Hawaii			15.00	
39	Nevada			13.00	
40	New Mexico	15,560	140,742	6.43	6
38	Rhode Island			7.11	
33	South Carolina			5.17	
		2,766,873	11,091,186	4.01	949

USES OF THE LIME PRODUCED.

In the following table the total lime production of 1907 and 1908 is classified according to the uses to which the product was put, as reported by the burners. Although this table is necessarily faulty on account of much of the product being handled by dealers or middlemen, which renders the manufacturers uncertain as to what use was made of their product, it is of interest as showing a comparative table of sales for the two years. The same manufacturer, as a rule, classifies his output the same each year.

Production of lime in the United States in 1907 and 1908, by uses, in short tons.

1907.

	Quantity.	Value.		Quantity.	Value.
Building lime	1,770,509	$7,754,404	Fertilizer	269,608	$712,410
Hydrated lime	140,135	657,636	Dealers—uses not specified	396,337	1,540,473
Alkali works	10,747	36,355	Other purposes [a]	118,310	436,128
Chemical works	173,422	691,096			
Paper mills	153,681	572,838			
Sugar factories	24,640	110,940		3,092,524	12,656,705
Tanneries	35,135	144,425			

Production of lime in the United States in 1907 and 1908, by uses, in short tons—Cont'd.

1908.

	Quantity.	Value.		Quantity.	Value.
Building lime	1,580,590	$7,000,904	Fertilizer	339,287	$927,827
Hydrated lime	136,441	548,262	Dealers—uses not specified	307,050	1,100,129
Alkali works	46,384	203,658	Other purposes [a]	67,232	268,153
Chemical works	73,119	259,190		2,766,873	11,091,186
Paper mills	169,831	540,559			
Sugar factories	24,255	149,631			
Tanneries	22,684	92,873			

[a] Includes lime for sand-lime brick, slag cement, steel works, glass works, smelters, sheep dipping, manufacture of soap, cyanide plants, glue factories, etc.

FUELS USED IN BURNING LIME.

With regard to the following table which shows the fuels used in burning lime, it must be remembered that only about two-thirds of the producers report the quantity of fuel used by them; and although the burners not included in this report are, in general, the small operators, notably in Maryland, Pennsylvania, and West Virginia, some of the larger firms have not as yet given satisfactory information cn this subject.

Kind and quantity of fuel used in burning lime in 1907 and 1908.

1907.

Kind of fuel used.		Quantity of fuel.	Quantity of lime burned.	Number of plants using.
			Short tons.	
Wood	cords	333,665	618,005	190
Shavings	short tons	9,827	20,149	2
Coal	do	520,726	1,287,855	487
Coke	do	3,436	30,535	7
Oil	barrels	26,374	15,815	9
Gas	cubic feet	157,721,000	28,510	7
Mixed fuels:				
Wood	cords	76,009	352,877	75
Coal	short tons	113,335		
Coal and coke	do	8,686	55,795	7
Coal	do	12,824	66,356	4
Gas	cubic feet	198,602,000		
Coal, shavings, and manure			12,657	1
			2,488,554	789
Unreported			603,970	110
			3,092,524	899

1908.

Kind of fuel used.		Quantity of fuel.	Quantity of lime burned.	Number of plants using.
Wood	cords	325,943	638,092	194
Coal	short tons	295,333	871,490	413
Coke	do	5,118	29,018	8
Oil	barrels	23,804	15,269	8
Gas	cubic feet	288,385,512	110,738	12
Mixed fuels:				
Wood	cords	77,957	449,837	76
Coal	short tons	97,287		
Coal and coke	do	9,157	35,700	6
Coal	do	5,000	30,130	2
Gas	cubic feet	141,666,000		
Oil and wood, wood and coke, blocks, sawdust, shavings			29,993	5
			2,210,267	724
Unreported			556,606	225
			2,766,873	949

The total quantity of the various kinds of fuel consumed in the domestic lime industry during 1907 and 1908 was, therefore, as follows:

Total fuel consumed in burning lime in 1907 and 1908.

	1907.	1908.		1907.	1908.
Wood..........cords..	409,674	409,805	Coke......short tons..	4,406	5,268
Shavings..short tons..	14,599	5,800	Gas.......cubic feet..	356,323,000	430,051,512
Coal............do....	646,885	397,620	Oil...........barrels..	26,374	23,884

The "gas" in this table includes both natural gas and producer gas.

HYDRATED LIME.

Lime-hydrating plants reported as in operation during 1906, 1907, and 1908 are classified by States in the following table. The output of hydrated lime reported was 120,357 short tons, valued at $479,079, in 1906; 140,135 short tons, valued at $657,636, in 1907; and 136,441 short tons, valued at $548,262, in 1908. The average price per ton was $3.98 in 1906, $4.69 in 1907, and $4.02 in 1908. Notwithstanding the decreased production for 1908 compared with 1907, there were more manufacturers reporting hydrating plants than in 1906 or 1907. Hydrated lime is used for all purposes, but these figures are collected to show the development of this comparatively recent industry.

Number of lime-hydrating plants in operation in 1906, 1907, and 1908, by States.

State.	1906.	1907.	1908.	State.	1906.	1907.	1908.
Alabama..........	1	1	1	Michigan..........	1	1	2
Arizona..........	1	1	1	Missouri..........		2	2
California..........		1	2	New Jersey..........			1
Colorado..........		1		New York..........	1	2	2
Connecticut..........	1			Ohio..........	8	9	11
Florida..........			1	Pennsylvania..........	8	6	11
Georgia..........	2	1	1	Tennessee..........			1
Illinois..........		1	1	Texas..........			1
Indiana..........	2	2	2	Virginia..........			1
Iowa..........	1			West Virginia..........	1	1	1
Kansas..........	1	1		Wisconsin..........	1	2	2
Maine..........	1	1	1				
Maryland..........			1	Total..........	30	33	46

IMPORTS AND EXPORTS.

The imports of lime for consumption in the United States in 1908 were 5,060 short tons, valued at $28,952, as against 15,388 short tons, valued at $86,304, in 1907, a decrease of 10,328 short tons in quantity and of $57,352 in value in 1908.

No lime was reported as exported in 1908. In 1907 the exports were valued at $90,379.

SAND-LIME BRICK.

PRODUCTION.

The following table shows the value of the sand-lime brick produced in the United States from 1903 to 1908, inclusive:

Value of production of sand-lime brick in the United States, 1903–1908.

Year.	Number of plants.	Value of product.	Year.	Number of plants.	Value of product.
1903	16	$155,040	1906	87	$1,170,005
1904	57	463,128	1907	94	1,225,769
1905	84	972,064	1908	87	961,226

The industry was begun in the United States by the establishment of a plant in Michigan City, Ind., in 1901, but during 1901 and 1902 the output was small, and not until 1903 did the industry become well established. From the small beginning in 1903 (the value of the products being reported at $155,040) the product increased each year in value until 1907, when it reached the maximum of $1,225,769. In common with other building materials there was a decrease in 1908 in the production of sand-lime brick to $961,226. The number of plants reporting made a rapid growth from 16 in 1903 to 94 in 1907, with a slight decrease in 1908.

The following tables show the production of sand-lime brick by States and kinds in 1907 and 1908:

Production of sand-lime brick in the United States in 1907 and 1908, by States.

1907.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Fancy brick.		Blocks, value.	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.	Quantity (thousands).	Value.		
Alabama, Kentucky, and Mississippi	5	8,840	$58,060	568	$5,000				$63,060
Arizona, North Dakota, and Washington	3	2,039	16,469	11	200			$300	16,969
Arkansas, Kansas, Minnesota, Nebraska, South Dakota, and Texas	13	20,442	144,028	2,754	31,319	40	$800		176,147
California	4	5,263	42,915	1,390	20,085			(a)	63,150
Colorado and Idaho	4	2,235	23,351	3,625	37,414	12	513	1,059	62,337
Delaware, Maryland, and Virginia	5	10,259	67,948	20	200				68,148
Florida	6	16,421	106,871	(a)	(a)				109,275
Georgia	4	11,167	78,086	(a)	(a)				89,582
Illinois and Wisconsin	4	8,854	51,241	390	3,120				54,361
Indiana	8	14,841	86,927	1,300	10,600				97,527
Iowa	3	6,295	45,471	(a)	(a)			(a)	55,618
Michigan	13	25,488	158,606	(a)	(a)				172,840
New Jersey	3	(a)	(a)	(a)	(a)				22,792
New York	6	10,925	64,904	1,173	10,558				75,462
North Carolina	3	4,068	29,458	755	9,350				38,808
Ohio	5	1,726	11,283						11,283
Pennsylvania	5	6,402	41,515	(a)	(a)				48,410
Other States [b]		630	3,780	5,186	60,375			3,963	(c)
Total	94	155,895	1,030,913	17,172	188,221	52	1,313	5,322	1,225,769
Average value per M			6.61		10.96		25.25		

[a] Included in other States.
[b] Includes all products made by less than three producers in one State to prevent disclosing individual operations.
[c] The total of other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Production of sand-lime brick in the United States in 1907 and 1908, by States—Continued.

1908.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Fancy brick.		Blocks, value.	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.	Quantity (thousands).	Value.		
Arizona, North Dakota, and Washington	4	1,031	$8,230	140	$3,100				$11,330
Arkansas, Kansas, Minnesota, Nebraska, South Dakota, and Texas	13	26,609	174,798	1,712	20,392			$800	195,990
California	6	3,732	27,223	1,958	27,671	(a)	(a)		56,494
Colorado, Idaho, and Montana	5	1,930	20,505	2,184	28,857	(a)	(a)	3,000	52,377
Delaware, Maryland, and Virginia	6	6,805	41,171	514	6,338	(a)	(a)		47,709
Florida	5	21,014	117,040						117,040
Georgia, Kentucky, and Mississippi	5	6,093	37,557	1,035	11,423				48,980
Ohio, Illinois, and Wisconsin	6	6,074	35,814	376	3,258				39,072
Indiana	5	9,792	48,413	(a)	(a)				54,413
Iowa	3	4,701	33,784	(a)	(a)			(a)	42,881
Michigan	10	21,997	131,827	(a)	(a)				138,809
New Jersey	4	840	6,270	1,192	14,549				20,819
New York	7	7,965	52,389	(a)	(a)	(a)	(a)		57,189
North Carolina	3	(a)	(a)	(a)	(a)				14,000
Pennsylvania	5	6,899	57,812	(a)	(a)				64,123
Other States [b]		1,450	10,500	3,040	32,116	98	$2,515	3,874	(c)
Total	87	126,932	803,333	12,151	147,704	98	2,515	7,674	961,226
Average value per M			6.33		12.16		25.66		

[a] Included in other States.
[b] Includes all products made by less than three producers in one State to prevent disclosing individual operations.
[c] The total of other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

The value of the product decreased in 1908 as shown by these tables $264,543, or 21.58 per cent; in 1907 there was an increase over 1906 of $55,764, or 4.77 per cent. In order to avoid disclosing individual operations it has been necessary to group certain States and Territories. Although thirty States reported in both 1907 and 1908, Alabama dropped out of the list in 1908 and Montana appeared.

Of the individual States, Michigan, as in 1907, was the leading State in 1908, and reported products valued at $138,809; Florida was second in both years. Florida and Pennsylvania showed increase in the value of products; California, Indiana, Iowa, Michigan, New Jersey, New York, and North Carolina showed decreases. Pennsylvania showed the largest increase, $15,713; and Indiana showed the largest decrease, $43,114. Of the State groups which are comparable, Arizona, North Dakota, and Washington showed a decrease of $5,639, and Arkansas, Kansas, Minnesota, Nebraska, South Dakota, and Texas showed an increase of $19,843. Delaware, Maryland, and Virginia showed a decrease of $20,439.

The largest number of plants was in Michigan, though the number decreased from 13 in 1907 to 10 in 1908; in Indiana also the number decreased by three, and in Florida by one. California showed an increase of two in the number of plants reporting, and New York and New Jersey an increase of one each.

The average price per thousand received for common brick in 1908 was $6.33, as against $6.61 in 1907 and $6.71 in 1906; for front brick the price was $12.16 in 1908, against $10.96 in 1907 and $10.42 in 1906. It will thus be seen that common brick has decreased and front brick increased in price. In 1908 common brick composed 83.57 per cent of the value of all products and front brick 15.37 per cent.

The value of the product in 1908 was nearly the same as that for 1905—$972,064 in the earlier and $961,226 in the later year. The number of firms reporting, 87, was the same in 1906 and 1908.

SLATE.

By A. T. Coons.

PRODUCTION.

Notwithstanding the unsettled conditions of trade, labor, and finance in the United States in 1908, the output of slate as reported to the United States Geological Survey increased in value $297,597—from $6,019,220 in 1907 to $6,316,817 in 1908. This value for 1908 is the largest reported for any year since the beginning of the compilation of slate statistics in 1879, when the output was valued at $1,231,221 and was composed entirely of roofing slate. The value for 1908, however, exceeded by only $59,932 that for 1903, which was $6,256,885. For a number of years previous to 1903 there was a decided and regular yearly increase in the value of the slate output in the United States. Strikes in the building trades during 1903 and 1904 checked the slate industry considerably, and although there has been an increase in output and value for each year since 1904 it has not been until 1908 that the value of output equaled that of 1903. During the last five years, or since the check given in 1903, the slate industry has had to contend with strikes in different quarry sections, the use of tiles, patent roofing processes, shingles, concrete, and cheaper grades of roofing material, and also with high price and scarcity of labor, increased cost of supplies, and a decrease in the slate export trade.

In 1908, as in 1907, nine States reported a commercial output of slate. These States in rank of output were Pennsylvania, Vermont, Maine, Virginia, New York, Maryland, California, New Jersey, and Arkansas. In 1907 the rank of output was Pennsylvania, Vermont, Maine, Virginia, Maryland, New York, California, Arkansas, and New Jersey. New York displaced Maryland and New Jersey displaced Arkansas in 1908.

All of the States except Maryland reported an increased production for roofing slate, both in quantity and value, in 1908. The decrease in Maryland was due largely to a slide in one of the chief quarries, resulting in a decrease of output for that quarry and for the State.

The statistics as given in this report represent the output of slate as reported directly to the survey by the quarrymen, and include the quantity and value of the roofing slate sold by them, the quantity and value of mill stock sold by them, and the value of a quantity of slate sold for other purposes.

As in the report for 1907, the quantity of rough and manufactured mill stock as sold by the quarrymen is given. These statistics for rough mill stock represent the rough slate sold by the quarrymen to the slate mills to be made into finished product, and those for manufactured mill stock represent the slate worked up by the quarrymen in their own mills and sold in the finished or partly finished condition. The values given represent the prices received f. o. b. at point of shipment for the material as sold by the quarrymen.

Roofing slate.—Of the total value of the slate production in the United States over 80 per cent represents roofing slate. In 1908 the production of roofing slate was reported as 1,333,171 squares, valued at $5,186,167; in 1907 the figures reported were 1,277,554 squares, valued at $4,817,769, an increase for 1908 of 55,617 squares in quantity and of $368,398 in value. The increase in average value per square from $3.77 in 1907 to $3.89 in 1908 was 12 cents.

The greater part of the slate quarried in the United States is for roofing purposes and is put on the market and sold by "squares," a square meaning a sufficient number of pieces of slate of any size to cover 100 square feet of roof, allowing a 3-inch lap. The sizes of slate in a square vary from 24 by 16 inches to 9 by 7 inches, and the number of pieces necessary for a square varies from 85 to 686, according to the size of the piece. The ordinary thickness of a piece is from one-eighth to three-sixteenths of an inch. The approximate weight per square of ordinary roofing slate is 650 pounds, and it is generally shipped in carload lots from 50 to 100 squares per car, according to the size of the pieces. The ordinary price per square of No. 1 slate varies from about $3.50 to $10 per square f. o. b. at quarries, and depends on the quality, the color, size, thickness, smoothness, straightness, and uniformity of the pieces. Some of the inferior slate, which is mottled or ribboned, sells as low as $2.50 per square, but specially prepared slate, with pieces carefully selected with regard to color, extra thickness and size, and extra cutting, sells as high as $30 per square. The red slate of New York commands the highest value per square for ordinary slate.

Mill stock.—The value of mill stock, including slate sold for all purposes other than roofing, decreased from $1,201,451 in 1907 to $1,130,650 in 1908, a decline of $70,801. The quarries of Pennsylvania, Vermont, and Maine furnish nearly all of the mill stock. Vermont decreased in quantity of output, and Pennsylvania and Maine decreased both in quantity and in value. The situation in Vermont was probably due to loss of trade caused by a strike in the quarries, which began in May, 1907, and lasted until May, 1908.

On account of the peculiar properties of slate it is adapted to various uses, and the mill stock includes slate used for blackboards, school slates, flooring, wainscoting, vats, sinks, laundry tubs, vaults, sanitary ware, refrigerator shelves, electrical switchboards; billiard, laboratory, and other table tops; mantels, hearths, well caps, etc. This material is generally sold in the form of slabs from 1 to 3 inches thick, the price varying from 4 cents to 30 and 40 cents per square foot, according to the work done on the slab. It is either sold by the quarryman to the milling companies, or milled and finished by quarrymen operating their own mills. It is noticeable that Lehigh and Northampton counties, Pa., report the only stock for school slates and blackboards. This is due to the fine cleavage qualities of the slate and to the thickness and size of the beds.

The following table shows the value of roofing and mill slate quarried in the United States in 1907 and 1908, by States and uses:

Value of roofing, mill, and other slate produced in the United States in 1907 and 1908, by States.

1907.

State.	Roofing slate.		Mill stock.						Other.	Total value.
			Manufactured.		Rough.		Total.			
	Number of squares.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
			Sq. feet.		Sq. feet.		Sq. feet.			
Arkansas									[a]$8,500	$8,500
California	7,000	$60,000								60,000
Maine	16,879	91,583	404,829	$145,023			404,829	$145,023		236,606
Maryland	21,815	113,665							2,395	116,060
New Jersey	2,000	8,000								8,000
New York	11,908	81,535	13,000	1,950			13,000	1,950		83,485
Pennsylvania	793,466	2,987,740	3,447,654	557,714	1,150,230	$63,039	4,597,884	620,753	[b]247,147	3,855,640
Vermont	385,314	1,301,576	698,317	141,130	265,594	34,553	963,911	175,683		1,477,259
Virginia	39,172	173,670								173,670
	1,277,554	4,817,769	4,563,800	845,817	1,415,824	97,592	5,979,624	943,409	258,042	6,019,220

1908.

State.	Number of squares.	Value.	Manufactured quantity.	Manufactured value.	Rough quantity.	Rough value.	Total quantity.	Total value.	Other.	Total value.
Arkansas									$2,500	$2,500
California	7,000	$60,000								60,000
Maine	20,151	115,682	285,299	$98,025			285,299	$98,025		213,707
Maryland	18,521	101,204							982	102,186
New Jersey, New York	18,485	130,439			1,500	$180	1,500	180		130,619
Pennsylvania	825,078	3,070,906	2,593,430	435,884	971,653	62,304	3,565,083	498,188	[c]333,864	3,902,958
Vermont	402,258	1,513,580	707,563	168,441	234,367	28,470	941,930	196,911		1,710,491
Virginia	41,678	194,356								194,356
	1,333,171	5,186,167	3,586,292	702,350	1,207,520	90,954	4,793,812	793,304	337,346	6,316,817

[a] Used chiefly for electrical supplies.
[b] Composed of 5,711,105 school slates, valued at $48,152, and 1,531,330 square feet of blackboard material, valued at $198,995.
[c] Composed of 5,036,147 school slates, valued at $42,364, and 2,388,886 square feet of blackboard material, valued at $291,500.

The following table shows the total value of the slate production of the United States from 1904 to 1908, inclusive:

Value of slate produced in the United States, 1904–1908, by States.

State.	1904.	1905.	1906.	1907.	1908.
Arkansas	$14,300	$10,000	$5,000	$8,500	$2,500
California	39,200	40,000	80,000	60,000	60,000
Georgia	4,500	7,500	5,000		
Maine	181,168	224,254	238,681	236,606	213,707
Maryland	133,972	151,215	130,969	116,060	102,186
New Jersey		5,360		8,000	130,619 (New Jersey and New York)
New York	71,543	66,646	72,360	83,485	
Pennsylvania	3,633,246	3,491,905	3,522,149	3,855,640	3,902,958
Tennessee	607				
Utah	300				
Vermont	1,408,151	1,352,541	1,441,330	1,477,259	1,710,491
Virginia	130,208	146,786	172,857	173,670	194,356
	5,617,195	5,496,207	5,668,346	6,019,220	6,316,817

The following table shows the value of slate for roofing purposes and for mill stock from 1904 to 1908, inclusive:

Value of roofing slate and mill stock, 1904–1908.

	Roofing slate.		Value of mill stock.	Total value.
	Number of squares.	Value.		
1904	1,233,757	$4,669,289	$947,906	$5,617,195
1905	1,241,227	4,574,550	921,657	5,496,207
1906	1,214,742	4,448,786	1,219,560	5,668,346
1907	1,277,554	4,817,769	1,201,451	6,019,220
1908	1,333,171	5,186,167	1,130,650	6,316,817

The following table shows the average price of roofing slate per square since 1902:

Average annual price per square of roofing slate for the entire country.

1902	$3.45	1906	$3.66
1903	3.88	1907	3.77
1904	3.78	1908	3.89
1905	3.69		

IMPORTS.

Practically no slate is imported into the United States. In 1907 slate valued at $5,404 was imported in the form of mantels, chimney-pieces, etc., including $208 for roofing slate; in 1908 the importations were valued at $7,227 for chimney-pieces, slates, slabs, mantels, etc.

EXPORTS.

In comparison with the total output, the value of roofing slate exported from this country in 1908 was very small, being only $197,216 compared with a value of $220,995 in 1907.

SLATE INDUSTRY BY STATES AND LOCALITIES.

The slate production of the United States is practically confined to the northeastern part of the country, the scattered deposits other than in this section being not yet fully developed or not showing an equal commercial output. The localities of the principal deposits, either producing in commercial quantities or in a greater or less state of development, are given below by States. Almost all of these deposits are described in Bulletin No. 275 of the United States Geological Survey.[a]

Arizona.—A deposit of slate occurs about 6½ miles north of Phoenix, Maricopa County. This deposit is owned by the Phoenix Slate Company, of Phoenix, but has not been developed.

Arkansas.—Although several companies have done more or less development work in Arkansas, little slate has been marketed, chiefly on account of lack of transportation facilities. The deposits are located in the west central part of the State, and development work

[a] Dale, T. Nelson, and others, Slate deposits and slate industry of the United States: Bull. U. S. Geol. Survey No. 275, 1906.

has been carried on in the counties of Polk, Montgomery, Garland, Salina, and Pulaski. Red slate, which has played such an important part in the New York slate industry, is also found in Arkansas. The slate is now used chiefly for electrical purposes, but it is also well adapted for use as a roofing slate.

California.—The slate output of California is confined to Slatington, Eldorado County, although there is a deposit near Merced, Mariposa County. The output was practically the same in 1908 as in 1907, and was used entirely for roofing slate.

Colorado.—A deposit of slate near Marble, Gunnison County, has been reported to the Survey, and it is stated that steps are being taken toward the development of the deposit, with a view to putting the slate on the market.

Georgia.—No commercial slate was marketed, but a considerable amount of development work was reported as being done on the deposits near Rockmart, Polk County, in 1908.

Maine.—The principal Maine slate deposits are in Piscataquis County, near the towns of Monson, Blanchard, and Brownville. Commercial slate, however, occurs near the town of Forks, Somerset County, but as this deposit has been open to the railroad only a short time no slate has been marketed.

The roofing slate production in this State increased somewhat in 1908, from 16,879 squares, valued at $91,583, in 1907 to 20,151 squares, valued at $115,682, in 1908, an increase of 3,272 squares in quantity and of $24,099 in value. The producers in general reported an increase in roofing slate, with better prices. Mill stock demand was, however, reported very dull, and this is evident from the decrease in production of 119,530 square feet in quantity and of $46,998 in value—from 404,829 square feet, valued at $145,023 in 1907 to 285,299 square feet, valued at $98,025 in 1908.

Maryland.—Only a very small part of the slate quarried in Maryland is used for purposes other than roofing, and while a good demand was reported for the slate, the output was less than in 1907, and the financial depression was seriously felt. A "slide" or "cave in" in one of the principal quarries curtailed the output to some extent. The roofing slate produced in 1908 amounted to 18,521 squares, valued at $101,204, a decrease of 3,294 squares and of $12,461, as compared with the output of 21,815 squares, valued at $113,665 in 1907. The average price per square was $5.46 in 1908 and $5.21 in 1907, an increase of $0.25 per square in 1908. The entire output was obtained from the Peach Bottom region at Cardiff, Harford County. Other deposits also occur in Montgomery and Frederick counties, but these have not been operated recently.

Nevada.—A deposit of black slate has recently been reported from near Winnemucca, Humboldt County, Nev., and a brief description of this slate is made a part of this report.

New Jersey.—The slate deposits of Sussex County, N. J., are a continuation of the Bangor-Slatington slate belt of Pennsylvania, and are worked in two localities, Newton and Lafayette, the old quarries at the latter place having recently been reopened and enlarged. Demand was reported good, and the output was larger than in 1907. The average price per square was $4 in 1907 and $4.05 in 1908. Besides the Sussex County locality there are also deposits in Warren County, but these have not recently been worked.

New York.—The slate deposits of Washington County, N. Y., are a continuation of the belt in Rutland County, Vt. The red slates of New York, which have contributed so much to the value of the New York slate output, are the only red slates now on the market, the red-slate deposits of Arkansas being not yet developed. Besides the red-slate deposits there are also the purple and green slates which mark the Vermont deposit. The average value of New York slate is particularly high on account of these red slates, whose price for ordinary slate is $11 per square; the price is often much higher on account of extra thickness and extra cutting of sizes made to order, which are sold up to $30 and sometimes up to $200 per square. The average price in 1908 was $8.10 against $6.85 in 1907, an increase of $1.25. The output in New York in 1908 increased both in quantity and value of output, and is confined almost entirely to roofing slate. The demand was reported very good, and several new operations were reported.

Pennsylvania.—The output of slate from this State was valued at $3,902,958 in 1908 and at $3,855,640 in 1907, showing the small increase of $47,318 for 1908. Notwithstanding this small increase the total output in 1908 amounted to 61.79 per cent of the total value of the slate produced in the United States. The roofing slate of this State represented 59.21 per cent of the value of the roofing slate produced in the United States, and the other slate represented 73.59 per cent of the value of all the other slate produced in the country.

The roofing-slate production increased from 793,466 squares, valued at $2,987,740 in 1907, to 825,078 squares, valued at $3,070,906 in 1908, a gain of 31,612 squares and of $83,166. The average price per square was $3.72 in 1908 and $3.77 in 1907, a decrease of 5 cents per square. Almost all of the producers reported the demand for roofing slate about the same as in 1907, with the general prices lower, although there was a larger demand with higher prices for small-sized slate.

The roofing slate in Pennsylvania comes from York, Lehigh, and Northampton counties. In 1908 Pennsylvania produced 61.89 per cent of the quantity of the roofing slate produced in the United States, and Northampton County produced 74.05 per cent of the Pennsylvania output and 45.83 per cent of the total quantity for the United States. Lehigh County represented 24.08 per cent of the Pennsylvania output and 14.90 per cent of the total quantity for the United States. Northampton and Lehigh slate is also used for mill stock and is the only school and blackboard slate in the United States. York County produces the so-called Peach Bottom slate. This slate belt is the same as that of Harford County, Md., and in 1908 the value of the output from York County was but little less than from the Maryland Peach Bottom region.

Besides roofing slate, Pennsylvania has a larger output of mill stock than any other State, and as before stated is the only State whose slate is fitted by its special properties for use as blackboards and school slates. The slate used for these purposes has been reported separately in 1907 and 1908.

The total value of mill stock, exclusive of school slates and blackboards, was $498,188; the value reported for 1907 was $620,753—a decrease of $122,565 for 1908. The quantity also decreased from 4,597,884 square feet in 1907 to 3,565,083 square feet in 1908—a decrease of 1,032,801 square feet. This is in accordance with reports of the producers, who state that there was much less demand for this material in 1908 than in 1907. They also state that the demand for blackboards increased, as is shown by the output of 2,388,886 square feet of blackboard material, valued at $291,500 in 1908, compared with 1,531,330 square feet, valued at $198,995 in 1907, an increase in 1908 of 857,556 square feet and of $92,505.

The school-slate production decreased from 5,711,105 slates, valued at $48,152 in 1907, to 5,036,147 slates, valued at $42,364 in 1908, a decrease of 674,958 slates and of $5,788 in value.

The following table shows in detail the production of slate in Pennsylvania, by counties and uses, in 1907 and 1908:

Production of slate in Pennsylvania in 1907 and 1908, by counties and uses.

County.	Roofing slate.		Mill stock.								Total value.
			Manufactured.		Rough.		Blackboards.		School slates.		
	Number of squares.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1907.			*Sq. ft.*		*Sq. ft.*		*Sq. ft.*		*Number.*		
York	14,769	$82,286	....	....	....	....	....	....	....	....	$82,286
Lehigh	222,752	841,389	287,920	$37,337	279,092	$27,388	731,218	$88,707	1,579,737	$12,792	1,007,613
Northampton	555,945	2,064,065	3,159,734	520,377	871,138	35,651	800,112	110,288	4,131,368	35,360	2,765,741
	793,466	2,987,740	3,447,654	557,714	1,150,230	63,039	1,531,330	198,995	5,711,105	48,152	3,855,640
1908.											
York	15,450	82,500	....	....	....	....	....	....	....	....	82,500
Lehigh	198,653	750,653	109,196	25,886	375,153	33,796	1,499,992	167,282	2,627,220	21,457	999,074
Northampton	610,975	2,237,753	2,484,234	409,998	596,500	28,508	888,894	124,218	2,408,927	20,907	2,821,384
	825,078	3,070,906	2,593,430	435,884	971,653	62,304	2,388,886	291,500	5,036,147	42,364	3,902,958

The quantity and value of blackboard and school slates given in this table does not necessarily represent the entire quantity and value of these articles made in 1908, but the quantity and value of the material sold as such by the quarrymen. It is possible that some of the rough mill stock sold to the slate mills by the quarrymen was used for these purposes. This office collects slate statistics from quarrymen and not from manufacturers. Were figures from dealers and slate-mill operators included, it would be almost impossible to avoid duplication. On the other hand, it is impossible to obtain the value of the rough slate stock from the quarryman who mills his own slate, as the only value the material has to him is its value at the completion of his work.

Tennessee.—Slate deposits more or less developed for commercial enterprise are found at Chilhowie, Blount County, Tellico Plains, Monroe County, and Johnson City, Washington County.

Utah.—A company has recently been formed to work the slate deposit near Provo City, Utah County, and it is possible that this slate may be put upon the market within a short time.

Vermont.—Vermont comes next to Pennsylvania in rank of slate production, and in 1908 produced 27.08 per cent of the value of the output of the United States as compared with 61.79 per cent produced by Pennsylvania. The principal slate belt of Vermont is in

Rutland County and adjoins the slate region of Washington County, N. Y. Slate is, however, also quarried near Northfield, Washington County, but not largely.

In May, 1907, a strike started among the quarrymen in Rutland County and lasted until May, 1908, and the production for both 1907 and 1908 was somewhat curtailed on this account. In 1907 the total value of the output was $1,477,259; in 1908 it was $1,710,491, a gain of $233,232. The increase was chiefly in the roofing-slate output which was reported as 385,314 squares, valued at $1,301,576 in 1907, and as 402,258 squares, valued at $1,513,580 in 1908, an increase of 16,944 squares and of $212,004. The average price per square in 1907 was $3.38; in 1908 it was $3.76. The increase in price per square was due to the making of a large number of squares of slate of extra thickness and with much additional cutting.

The output of mill stock increased in value in 1908 but decreased in quantity of output. In 1907 there were reported 963,911 square feet, valued at $175,683, and in 1908, 941,930 square feet, valued at $196,911, a decrease in quantity of 21,981 square feet and an increase in value of $21,228.

The operators in Vermont report more varied trade conditions than in any other State. Those affected by the strike report business as very badly crippled, both by the strike and by financial conditions; other quarrymen report good demand and increased production despite financial difficulties.

Virginia.—There was a small increase in the slate output of Virginia, which is all used for roofing slate, from 39,172 squares, valued at $173,670, in 1907, to 41,678 squares, valued at $194,356, in 1908, an increase of 2,506 squares and of $20,686 in value. The price per square was $4.66 in 1908 and $4.43 in 1907, an increase of $0.23 in 1908. All the producers report better demand, better labor conditions, and increased price per square, especially for the smaller sizes of slate. The output is from Esmont, Albemarle County; Snowden, Amherst County; and Arvonia, Buckingham County.

West Virginia.—The deposits of black slate near Martinsburg, Berkeley County, have never been worked.

GENERAL NOTE ON SLATE.

By T. Nelson Dale.

A general interest has been shown during 1908 in the slate industry and the different characteristics of slate in the United States. This interest has made it advisable to publish with the statistics of production two short extracts from Bulletin No. 275, of the United States Geological Survey, on the slate deposits and slate industry of the United States, showing the classification and the comparative characteristics of slate, and also a few general notes on the uses of the various kinds of slates.

CLASSIFICATION.[a]

The term slate, in ordinary usage, denotes a rock which has more or less perfect cleavage, adapting it to various commercial uses, and in which the constituent particles, with very few exceptions, can not be distinguished except in thin section under

[a] Dale, T. Nelson, and others: Slate deposits and slate industry of the United States: Bull. U. S. Geol. Survey No. 275, 1906, pp. 5-6.

a microscope. In contradistinction, a schist is a rock of sometimes identical chemical and mineralogical composition, but is either made up of coarser particles or possesses a wavy structure, or else is marked by both of these features. Both slates and schists may have originated in deposits of identical character, but they have undergone different processes.

Slates as above defined vary greatly in color—from black through various shades of gray to greens, reds, and purples of different hues. They vary also in luster—from having none to being almost as bright as mica itself. They vary greatly, not only in grade of fissility, but in surface texture, as seen by the unaided eye or determined by touch, and still more in microscopic texture, as seen in thin section. They differ also in mineralogical and chemical composition and in physical properties.

Slates divide themselves naturally into: (1) Those derived from aqueous sediments, and (2) those of igneous origin. The latter, however, are very exceptional. For commercial purposes the basis of classification of the aqueous sedimentary slates must be: First, structural, for the cost of their production and the degree of their strength depend primarily upon that; secondly, it must be mineralogical, for their durability depends upon their content of certain mineral constituents.

Those slates in which the particles have been merely compressed by weight or pressure and cemented by carbonates of lime and magnesia, by kaolin or different combinations of iron, and whose grade of fissility, strength, and elasticity are therefore low, must be distinguished from those in which, under metamorphic processes, the kaolin and feldspar have passed into mica, forming a more or less dense and regular crystalline fabric of overlapping scales and fibers inclosing any remaining sedimentary particles. Such slates necessarily possess a high grade of fissility and considerable strength and elasticity. The first group includes clay slates, the second mica slates or phyllite slates. Those in which the micaceous matrix is but partially formed, and which represent a transition from clay slate to mica slate, are more conveniently put into the clay-slate group. Thus, the dark-purple ("red") roofing slate of Penrhyn, in Wales, is a clay slate, and so also is the black slate of Martinsburg, W. Va.; but the French Ardennes slate, the Welsh Festiniog, and the Peach Bottom of Pennsylvania and Maryland, are all mica slate.

But mica slate includes slates of very different composition and structure, and therefore of properties and value. The first distinction to be made is based upon the amount of ferrous carbonate—whether or not it is sufficient to produce discoloration on continued exposure to the weather—for this is an important factor in the value of slates used for roofing. This distinction gives a group of fading and one of unfading slates, each of which can be further subdivided as to color. But each of these colors of fading and unfading mica slate embraces a wide range of texture. Some, like the Arkansas black and light-greenish slates, have a matrix of extremely fine sericite fibers, while the black slates of Arvonia, Va., and the Peach Bottom slates have a texture approaching that of a schist. Such differences in texture can not but result in difference of physical properties. The grades of texture are sufficiently designated by the words very fine, fine, medium, and coarse. There are also distinctions in the grade of fissility which do not always correspond to the grade of texture. These are conveniently numbered from 1 to 4, beginning with those of the best fissility. Finally there are differences in luster and amount of magnetite—differences which are purely specific. The general distinctions are formulated in the following table:

CLASSIFICATION OF SLATE.

(I) *Aqueous sedimentary.*
- (A) *Clay slates:* Matrix without any or with but very faint aggregate polarization.
- (B) *Mica slates:* Matrix with marked aggregate polarization.
  - (1) Fading: With sufficient $FeCO_3$ to discolor considerably on prolonged exposure.
    - (*a*) Carbonaceous or graphitic.
    - (*b*) Chloritic (greenish).
    - (*c*) Hematitic and chloritic (purplish).
  - (2) Unfading: Without sufficient $FeCO_3$ to produce any but very slight discoloration on prolonged exposure.
    - (*a*) Graphitic.
    - (*b*) Hematitic (reddish).
    - (*c*) Chloritic (greenish).
    - (*d*) Hematitic and chloritic (purplish).

(II) *Igneous.*
- (A) *Ash slates.*
- (B) *Dike slates.*

The scientific basis for these subdivisions will be seen in the table showing the microscopic and chemical analyses of the slates there named, and the application of this scheme to 13 kinds of American slates is also shown later.

COMPARATIVE CHARACTERISTICS.[a]

The following table shows the principal mineralogical, chemical, and physical characteristics of 38 kinds of slate described by the writer in Bulletin 275 as far as these manifestly bear upon their economic value. These slates are from Arkansas, California, Maine, Maryland, New York, Pennsylvania, Vermont, Virginia, and West Virginia. For full particulars and for scientific details the descriptions in Bulletin 275 should be consulted. The columns headed "strength" and "toughness" refer to the tests by Merriman, whose methods of experimentation are described on page 47 of Bulletin 275. Microscopic texture refers primarily to the matrix or body of the slate. By "crystalline" is meant that the matrix consists of interlacing and overlapping scales and fibers of muscovite, and is, therefore, a mica-slate or technically a phyllite-slate, although it may inclose unaltered particles of sedimentary origin. Such a slate should have, other things being equal, greater elasticity (toughness) and strength than one in which there is no such texture, or in which it is only incipient. The fineness or coarseness of this crystalline texture probably has a bearing upon the strength and toughness of the slate, but physical data are not sufficient to show this. The coarse-textured Peach Bottom slates, which really approach a mica schist, are the strongest of the 12 kinds of American slates tested, but they are less flexible than all the other kinds tested. In the grade of fissility 1 signifies a perfect slaty cleavage, 4 a very imperfect one. The column of chief mineral constituents includes only the 4 or 5 principal ones seen under the microscope, or whose presence has been otherwise determined, and these are given in the descending order of their probable abundance.

To these comparative data should be added the results of a few tests not easily tabulated.

Merriman's later corrosion tests show the following percentages of loss in weight after immersion in acid solution for 360 hours: Pennsylvania slates, 1.68 to 2.76; Peach Bottom, 1.11 to 1.29; red of New York and Vermont, 0.25. During this test the Pennsylvania slates become a grayish white, some of the Peach Bottom slates change but slightly, others are almost unaffected; the red slates likewise remain almost unaffected.[b]

E. H. S. Bailey's tests of porosity give these indices of porosity: "Hard Vein" Pennsylvania Chapman, 0.11–0.14; Daniels quarry, 0.14; Belfast quarry, 0.25; red of New York and Vermont, 0.21.[c]

J. F. Williams's tests of the compression of columns of slate 10 inches long by an inch in section with the cleavage vertical, show that the purplish of the unfading green series of Vermont stands 20,000 pounds; the unfading green, 16,020 pounds, and the red of New York and Vermont, 17,730 pounds.[d]

The following results of various tests of Maine (Monson) slate made at the United States Arsenal at Watertown, Mass., were republished from the War Department reports in the Twentieth Annual Report of the United States Geological Survey, Part VI (continued), 1899, page 395:

	Pounds.
Maximum fiber stress per square inch	7,671
Shearing test per square inch	2,192
Ultimate compressive strength per square inch	19,510

Coefficient of expansion, 0.000005.

The relative commercial value of several slates is an index of their physical characteristics. Mathews, in 1898, gave these prices for slates 14 by 7 inches, three-sixteenths thick, per square: Peach Bottom, $4.85; Northampton County, Pa., $3.50; Lehigh County, Pa., $3.40–$3.95; Maine (No. 1), $6.40; Arvonia, Va., $3.60; unfading green, Vermont, $4.50; red, New York, $11.[e]

The following prices per square for slates, No. 1 quality, 16 by 8 inches, f. o. b., were obtained by Doctor Day from producers for January, 1905: Peach Bottom, $6.35; Monson, Me., $7.20; red, New York, $11; Bangor, Pa., $5.75; Albion, Pa., $5; Pen Argyl, Pa., $4.75; Chapman, Pa., hard vein, $5.25; Slatington, Pa., $4.50 to $5; unfading green, Vermont, $4.50 to $5.25; sea green, Vermont, $3.50; Virginia, $5 to $5.50.

---

[a] Op. cit., pp. 124–125.
[b] Trans. Am. Soc. Civ. Eng., vol. 32, p. 538.
[c] Op. cit., p. 542.
[d] Op. cit., p. 132 (see Bibliography, p. 145 of Bulletin 275).
[e] Maryland Geol. Survey, vol. 2, p. 240.

Comparative characteristics of various slates.

[These slates are described in detail in Bulletin U. S. Geological Survey No. 275.]

State.	Locality, quarry, bed.	Color.	Cleavage surface.	Luster.	Magnetite.	Microscopic texture.	Grade of fissility.	Chief minerals.[a]	Carbonate.	Lime by analysis.	Strength, pounds per square inch.[b]	Toughness.[c]	Remarks.
Arkansas	Mena, Polk County	Black	Remarkably fine	Slight	Some	Crystalline, extremely fine, homogeneous.	1	Muscovite, carbon, quartz, pyrite	None				Strength, toughness, and behavior in freezing and thawing should be tested.
Do	do	Dark reddish	Roughish, speckled	Almost none	Very little	Crystalline, fine	3	Muscovite, hematite, kaolin, quartz	do				
Do	Mammotb Red and Lost Hannah, Polk County.	Reddish	Fine	None	do	do	t	Muscovite, hematite, kaolin, quartz, chlorite	do				Do.
Do	Mena, Polk County	Greenish gray	Roughish	Waxy	do	Crystalline, extremely fine, homogeneous.	3	Muscovite, quartz, kaolin, chlorite	do				Specimen shows two extra foliations, which will prove directions of weakness.
Do	Mammoth Red, Polk County.	Light greenish	Very fine	Almost none	Little	do	1	Muscovite, quartz, kaolin, chlorite	do				Strength, toughness, and behavior in freezing and thawing should be tested.
Do	Sec. 25, T. 3 S., R. 29 W., Polk County.	Dark-bluish gray	Fine	Slight	Very little	Crystalline, fine	2	Muscovite, quartz, pyrite, carbon	do				
Do	Sec. 30, T. 3 S., R. 28 W., Polk County.	Light gray	Roughisb	None	do	do	2	Muscovite, quartz, chlorite, kaolin	do				Some limonite staining from pyrite.
Do	Southwest Slate Mfg. Co., Polk County.	Very dark gray	Roughish, spangled	Almost none	do	Crystalline, coarse, granular.	3	Muscovite, quartz, carbon, pyrite	Some				Between a metamorphic grit and a slate.
California	Eureka quarry, Eldorado County.	do	Fine	Bright	do	Crystalline, fine	2	Muscovite, quartz, chlorite, carbon	do	0.98			Test given on p. 47, Bull. 275.
Maine	Merrill quarry, Brownville	do	Very fine	Very bright	Much	Crystalline, very fine	1	Muscovite, quartz, magnetite, pyrite	None		9,880	0.200	See p. 66, Bull. 275, on amount of magnetite. See tests on p. 66, Bull. 275.
Do	North Blanchard	do	Roughish	Slight	None	Crystalline, fine	3	Muscovite, chlorite, quartz, pyrite	do				Very sonorous.
Do	Monson Pond, Monson	do	do	Almost none	Very little	Crystalline, fine, but particles irregular.	3	Muscovite, quartz, chlorite, biotite	do	.52			Very sonorous. See tests on p. 63, Bull. 275.
Do	Maine Slate Co., of Monson	do	do	Bright	do	Crystalline, very fine	2	Muscovite, quartz, biotite, chlorite	do				Very sonorous.
Do	West Monson	do	Very fine	Somewhat bright	None	Crystalline, fine	2	Muscovite, quartz, chlorite, pyrite	do		9,130	.205	Very sonorous. See tests on p. 123, Bull. 275.
Maryland	Thurston	Dark purplisb	Slightly granular	do	do	Crystalline, fine, particles irregular.	3	Muscovite, chlorite, quartz, talc	do				Sonorousness very moderate; can be sawn with handsaw.
New York	Granville and Hampton	Reddish	Fine or roughish, speckled.	None	Some	do	3	Muscovite, quartz, hematite, kaolin, carb	Much	.11–5.11	9,220	.232	Becomes brighter on exposure. Little or no ferrous carbonate. Impact test shows 126.66 foot-pounds of work per pound of slate. See tests on pp. 49, 124, Bull. 275.
Do	do	Bright greenish	do	do	do	do	3	Muscovite, quartz, chlorite, carbon, magnetite	Less than red, usually.	1.43	8,050	.190	Said to be unfading. See tests on p. 123, Bull. 275.
Pennsylvania	Old Bangor, Northampton County.	Very dark gray	Fine	Almost none	Very little	Crystalline, fine	1	Muscovite, carb., quartz, kaolin	Quite a little	4.38	9,810	.3t2	Discolors on continued exposure. Impact tests of various Northampton and Lehigh County slates show from 3.50 to 5.44 foot-pounds of work per pound of slate. See tests on p. 124, Bull. 275.
Do	North Bangor, Northampton County.	do	do	do	Some	do	1	Muscovite, carb., quartz, kaolin	Mucb				Do.
Do	Albion, Pen Argyl	do	Roughish	do	do	do	1	Muscovite, carb., quartz, chlorite	Quite a little	4.09	7,150	.270	Do. (See p. 79, Bull. 275.)
Do	Alhion, Gray bed	Very dark greenisb	Roughish, granular	do	Little	do	1	Muscovite, carb., quartz, chlorite	do				
Do	Heimbach, Big bed, Northampton County.	Very dark gray, not bluish.	Somewhat fine	do	Extremely little.	do	1	Muscovite, carb., quartz, pyrite	Very much				Do.
Do	Heimbacb, Black bed	Bluish black	Roughish	None	Very little	do	1	Muscovite, carb., quartz, carbon	do				Discolors on continued exposure.
Do	East Bangor Consolidated, Nortbampton County.	Very dark bluish gray	Somewhat fine	Almost none	Some	do	1	Muscovite, carb., quartz, pyrite, chlorite	Much				In ribboned slate from this quarry the percentage of quartz would be higher than in the rest. Impact tests of various Northampton and Lehigh County slates show from 3.50 to 5.44 foot-pounds of work per pound of slate. See tests on p. 124, Bull. 275.
Do	Slatington, Lebigb County	do	do	do	Little	do	1	Muscovite, carb., quartz, kaolin	do	4.23			Discolors on continued exposure. Impact tests of various Northampton and Lehigh County slates show from 3.50 to 5.44 foot-pounds of work per pound of slate. See tests on pp. 47, 124, Bull. 275.
Do	Chapman "hard vein"	Very dark gray	Slightly roughish	Slight	Some	do	2	Muscovite, quartz, carb., pyrite	Quite a little	2.83–3.40	9,460	.212	Discolors less readily than any of the above Pennsylvania slates. Impact tests of various Northampton and Lehigh County slates show from 3.50 to 5.44 foot-pounds of work per pound of slate. See tests on p. 124, Bull. 275.
Pennsylvania-Maryland.	Peach Bottom	Very dark bluish gray.	Minutely granular	Very bright	do	Crystalline, coarse	2	Muscovite, quartz, graphite, andalusite, magnetite.	None	.t55–.48	1t,260	.93	Very sonorous. Impact tests show from 8.49 to 24.17 foot-pounds of work per pound of slate. See tests on p. 124, Bull. 275.
Vermont	Northfield, Vermont Black Slate Co.	Very dark gray	Very fine	do	Very little	Crystalline, very fine	1	Muscovite, quartz, pyrite, magnetite	Very little				Very sonorous.
Do	"Sea green"	Gray greenish	Fine	Waxy	do	do	1	Muscovite, quartz, carb., chlorite	Much	.63–2.20	7,250	.207	Becomes brownish gray on continued exposure. See tests on p. 123, Bull. 275.
Do	Purplish of "sea green"	Purplish brown	do	None	do	do	1	Muscovite, quartz, carb., hematite	Some	.50–.71			Discoloration less pronounced than that of "sea green."
Do	"Unfading green"	Greenish gray	Roughish	do	Some	Crystalline, irregular	2	Muscovite, quartz, chlorite, carb	Very little	.42–.56	6,410	.225	Preserves nearly all its color on continued exposure. See tests on p. 124, Bull. 275.
Do	Purplish of "unfading"	Purplish brown	do	do	do	do	2	Muscovite, quartz, chlorite, hematite	do				Do.
Do	Benson (prospect)	Bluish black	Somewhat fine	Slight	Very little	Crystalline, fine	2	Muscovite, quartz, carb., pyrite	Much	1.27			Sonorous. Probably "fading."
Virginia	Arvonia, Williams	Very dark greenish gray.	Minutely granular	Very bright	do	Crystalline, irregular	2	Muscovite, quartz, biotite, carb., carbon	Some		9,040	.227	Very sonorous. See tests on p. 123, Bull. 275.
Do	Arvonia, Fontaine	do	Granular	do	do	Crystalline, irregular, coarse.	2	Muscovite, quartz, biotite, carb., pyrite	do		9,850	.225	Do.
Do	Bremo (prospect)	Dark gray	Fine speckled	do	None	Crystalline, fine	1	Muscovite, quartz, pyrite, kaolin?	None				
Do	Snowden	Very dark gray	Minutely granular	Almost none	do	Crystalline, fine, irregular	2	Muscovite, quartz, chlorite, kaolin	Little				Very sonorous.
West Virginia	Martinsburg	Black, brownish hue	Roughish	None	Little	Not crystalline or imperfectly so, coarse.	3	Carb., muscovite, quartz, kaolin, pyrite, carbon	From some to much.	t.1t and over.			Analysis by W. C. Tilden. In some specimens muscovite equals the carbonate in amount.

[a] Carb. = carbonate; carbon. = carbonaceous matter or graphite.

[b] Tests by Merriman.

[c] Deflection, in inches, on supports 22 inches apart; tests by Merriman.

13250—09. (To face p. 530.)

In accordance with the scheme of classification of slates given previously, most of the slates whose characteristics are given on the preceding table are here arranged systematically:

(A) *Clay slates* (fading), Martinsburg, W. Va.

(B) *Mica slates.*

- (fading).
  - (*a*) Carbonaceous or graphitic (blackish). — Lehigh and Northampton Counties, Pa.; Benson, Vt.
  - (*b*) Chloritic (greenish). "Sea green," Vermont.
  - (*c*) Hematitic and chloritic (purplish). Purplish of Pawlet and Poultney, Vt.
- (unfading).
  - (*a*) Graphitic or carbonaceous (blackish).
    - Peach Bottom, Pa., and Md.
    - Arvonia, Va.
    - Northfield, Vt.
    - Brownville, Monson, Me.
    - North Blanchard, Me.
    - West Monson, Me.
  - (*b*) Hematitic (reddish). — Granville, Hampton, N. Y.; Polk County, Ark.
  - (*c*) Chloritic (greenish). "Unfading green," Vermont.
  - (*d*) Hematitic and chloritic (purplish). — Purplish of Fair Haven, Vt., Thurston, Md.

As will be seen by consulting the foregoing tables, the slates in the United States include a very wide range of varieties dependent upon color, texture, fissility, composition, etc. While nearly all of them possess one or two excellent features, few possess many such features, and none possess them all. Several are so conspicuous for their well-nigh perfect adaptation to certain uses that the demand for these slates is likely to increase with the growth of the country. Such are: The blackboard slates of the "soft vein" region in Pennsylvania, which owe their fitness not only to their dark shade, but also to their fine cleavage and the thickness of the beds, which makes it possible to split off large slabs of half inch thickness; the red roofing slates of New York and Arkansas, which owe their bright durable color to hematite; the "unfading green" slate of Vermont, which owes the durability of its color to its very small content of the triple carbonate of lime, iron, and magnesia; the very dark gray unfading roofing slates of the Peach Bottom district in Maryland and Pennsylvania, of Arvonia in Virginia, and of Brownville and Monson in Maine, which owe the durability of their shade to sparseness of carbonate and in cases to the presence of graphite, and their general qualities to a very high degree of metamorphism; the very dark gray mill-stock slates of Northfield in Vermont and of Monson in Maine, and the greenish and purplish mill-stock slates of Vermont; and lastly the "sea green" roofing slates of Vermont, and the very dark gray roofing slates of Northampton and Lehigh counties in Pennsylvania, which, owing to their abundant carbonate, fade more or less, sooner or later, but are less expensive. These Pennsylvania and Vermont slates will always be in demand on account of their cheapness, which is largely due to their great fissility.

The selection of a slate should manifestly be governed mainly by its adaptation for the purpose in view, as well as by considerations of cost and transportation. An increasing quantity of mill-stock slate is being used for electric switchboards, but for this use those varieties with a minimum amount of magnetite are necessarily chosen. It were well if the better qualities of slate were more widely used for inexpensive memorial tablets and gravestones, instead of marble, which in our climate is far less adapted to withstand the acids of the atmosphere. A comparison of half-century or century old exposed inscriptions on slate and marble will suffice to justify this suggestion. Some chemical process for the utilization of the large percentage of waste in slate quarrying is still being sought for, and more rational methods of prospecting for slate are coming into use.

The relation of the varied usefulness of slate to the character of its geologic history is quite as remarkable as that of coal or any other of the great nonmetallic products. Notwithstanding the intricacy of the chemical and mineral composition of slate, the controlling elements in the history of nearly all of it reduce themselves to the erosive and sedimentary action of rivers and seas, and the metamorphism, crystallization, and rearrangement of the resulting sediments under lateral crustal compression.

NOTE ON A "BLACK" ROOFING SLATE FROM NEVADA.

By T. Nelson Dale.

A dark blue gray, commercially "black" roofing slate has been recently reported to the United States Geological Survey from the Blue Mountains in Humboldt County, Nev., about 21 miles northwest of Winnemucca, and specimens of it said to have been collected from more or less weathered outcrops have been examined by the writer with the following result:

The slate is of dark bluish-gray color. To the unaided eye it has an extremely fine texture and very smooth, slightly lustrous cleavage surface. It contains some carbonaceous or graphitic matter and, as shown by magnet, a little magnetite. The sawn edges show neither pyrite nor magnetite. It does not effervesce with cold, dilute hydrochloric acid. It is sonorous, and has a very high grade of fissility. The cleavage face shows traces of "grain," but the slate breaks usually at angles of 50° to 70° and 30° to the apparent grain.

Under the microscope this slate shows a matrix of muscovite (sericite) with well-defined aggregate polarization, and is thus a mica slate. The cleavage is fine, although showing some minor irregularities in the size of particles. The quartz particles measure up to 0.06 millimeter in diameter; one plagioclase feldspar measured 0.04 millimeter. No pyrite was detected. The dark particles are nonmetallic and probably carbonaceous. Rather abundant scales of chlorite and of interleaved chlorite and muscovite measure up to 0.14 millimeter in length and to 0.05 millimeter in width. Rutile is very abundant both in single needles and more in net-shaped groups of twinned needles (sagenite) measuring to 0.02 millimeter across. There is a little limonite proceeding possibly from the magnetite and due to incipient weathering. No carbonate could be found.

The fissility of this slate is as great as that of the Northampton and Lehigh, Pa., slates, but its freedom from carbonate indicates that its color is more durable. This Nevada slate is of aqueous sedimentary origin, but has undergone metamorphism. Its characteristics, denoted like those in the table on a preceding page, are thus as follows: *Color:* Dark bluish gray. *Cleavage surface:* Very fine. *Luster:* Slight. *Magnetite:* A little. *Microscopic texture:* Crystalline fine. *Grade of fissility:* 1. *Chief minerals:* Muscovite, quartz, chlorite, carbon, rutile. *Carbonate:* None detected. *Remarks:* A large block should be tested by an experienced slate workman for grain and false cleavage.

STONE.

By A. T. Coons.

INTRODUCTION.

The stone industry for 1908 was marked by a decrease of $5,393,306 in value of output as compared with 1907. Contributing to this decrease was the noticeably smaller demand for furnace flux and for crushed stone for concrete. Each variety of stone, except granite, showed a decreased value of output.

In 1908 the total value of the Vermont stone output was greater than that for any other State. In previous years Pennsylvania has held first rank.

In compiling for 1908 the statistics of the various kinds of stone produced in the United States, the United States Geological Survey has had the cooperation of the following state surveys: Georgia, Illinois, Iowa, Kentucky, Maryland, Missouri, New Jersey, New York, North Carolina, and Virginia.

The figures presented in the following report, as in previous years, have to do with the stone produced and sold by the quarrymen and include only such manufactured product as is put on the market by the quarrymen themselves. This applies especially to dressed building stone, dressed monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to this manufactured product is the price received by the producer, free on board at point of shipment, and includes therefore the cost of labor necessary to dress the stone. The stone reported as sold rough includes stone sold as rough stock to monumental works, and to cut-stone contractors for building purposes; stone sold as riprap, rubble, and flux; and includes the value of only such labor as is required to get the stone out of the quarry in the shape required by the purchaser. The value given to this stone is the price received by the quarryman free on board at point of shipment. In case the stone is sold to local trade the value is given as the quarryman sells the material, generally at the quarry, but in some cases delivered, if this is done by the producer. In some instances a long haul to market or to the railroad increases the cost of the material, and therefore of the selling price. This is especially true in some of the Western States, where stone for furnaces and sugar factories has to be hauled over rough roads and sometimes for long distances.

UNIT OF MEASUREMENT.

Owing to the variety of uses to which stone is put there is no regular unit of measurement employed by the quarrymen, the stone being sold by the cubic yard, the cubic foot, the ton, cord, perch, rod, square foot, square yard, square, etc. Building and monumental stone, especially the dressed product, is usually sold by the cubic foot or the cubic yard, although this unit varies with the class of stone and with the locality; a large quantity of the rough stone is sold by the perch, cord, and ton. Rubble and riprap, including stone for heavy masonry, such as breakwater and jetty work, are generally sold by the cord and ton. Fluxing stone and stone for chemical purposes—as for alkali works, sugar factories, carbonic acid plants, paper mills, etc.—are sold by the long ton. Flagstone and curbstone are sold by the square yard and the square foot, the thickness being variable and depending on the order received by the quarrymen. Paving blocks are sold invariably by number of blocks, and as such have been tabulated and published for several years; these blocks, however, are not of uniform size, the value depending on the size and amount of labor necessary to cut the block into desired shape. Crushed stone is reported as sold by the cubic yard or ton, the short ton being more generally used. The weight of a cubic yard varies from 2,300 to 3,000 pounds, the average weight being 2,500 pounds. In certain localites this crushed stone is sold by the "square" of 100 square feet by 1 foot or 100 cubic feet to a square. It is also of interest to note the selling of crushed stone by the bushel, 21½ bushels representing a cubic yard of about 2,700 pounds. As most of the crushed-stone producers report the quantity according to some unit, it has been possible to convert the crushed stone into short tons, which unit represents the larger number of producers and is the most convenient.

The cards showing the production of building stone, monumental stone, rubble, and riprap, do not always report the quantity, and Vermont is as yet the only State for which the quantity as well as the value has been published.

DISTRIBUTION OF BUILDING STONE IN THE UNITED STATES.

The distribution of the various kinds of rock over the country is very unequal. This statement also applies to the demand for stone, both for building and for other purposes; and although one section of the country may contain material equally valuable for rock construction work as another, it is in the most thickly settled regions, the regions nearest to cheap transportation and to the markets of large cities, that the deposits of stone have been worked to supply other than small local trade. Where deposits have become well known, stone from them has been shipped all over the country, even into the markets and almost into the quarry centers of other equally well-known stone. In some cases this is on account of the greater fitness of outside stone for the purpose desired, but in many cases the outside stone is specified on account of taste in color, from a desire for stone other than that obtainable in the local market, and sometimes by preference given by builder or contractor on account of personal relations with the quarry section. The demand for stone, other than for local use, from regions not well known or regularly operated, is chiefly caused by special work in these sections, due to the building of locks, dams, breakwaters, the ballasting of tracks, making of roads, etc., where the necessity exists for a time only and the deposit fails to become a regular source of material from lack of market, transportation facilities, or necessary capital for development. To show the wide distribution of the various kinds of building stone and the localities where the different varieties of stone are now being quarried or may be quarried in the future, George P. Merrill, curator of geology in the United States National Museum, has compiled the following table giving the distribution of building stone by States:[a]

Alabama	Marble, limestone, granite, sandstone.
Arizona	Onyx marble, limestone, granite, trappean and volcanic rocks, and sandstones.
Arkansas	Marble, limestone, syenite, slate.
California	Serpentine (verdantique marble), onyx marble, marble, limestone, granite, volcanic rocks and tuffs, sandstone, slate.
Colorado	Marble, limestone, granite, trappean and volcanic rocks, sandstone, quartzite, rhyolite tuff.
Connecticut	Soapstone, serpentine (verdantique marble), marble, granite and gneiss, diabase, sandstone.
Delaware	Marble, gneiss.
Florida	Shell and oolitic limestone.
Georgia	Marble, granite, gneiss, sandstone, slate.
Idaho	Limestone, marble, granite, trappean and volcanic rocks, sandstone.
Illinois	Limestone and dolomite, sandstone.
Indiana	Limestone and dolomite, sandstone.
Iowa	Gypsum, limestone, dolomite, sandstone.
Kansas	Limestone, dolomite, sandstone.
Kentucky	Limestone, dolomite, sandstone, onyx marble.
Louisiana	Limestone, sandstone.
Maine	Soapstone, serpentine (verdantique marble), granite, gneiss, diabase, norite, gabbro, quartz, porphyry, sandstone, slate.
Maryland	Soapstone, serpentine (verdantique marble), marble, granite, sandstone, slate.
Massachusetts	Soapstone, serpentine (verdantique marble), marble, granite, gneiss, quartz porphyry, sandstone.
Michigan	Limestone, dolomite, granite, gneiss, sandstone, slate.
Minnesota	Limestone, dolomite, granite, gneiss, sandstone, slate.
Mississippi	Limestone, sandstone.
Missouri	Limestone, dolomite, granite, diabase, quartz porphyry, sandstone.
Montana	Limestone, dolomite, granite, gneiss, trappean and volcanic rocks, sandstone.
Nebraska	Limestone, dolomite, sandstone.
Nevada	Limestone, dolomite, granite, trappean and volcanic rocks, sandstone.
New Hampshire	Soapstone, limestone, granite, slate.
New Jersey	Serpentine, limestone, dolomite, marble, granite, gneiss, diabase, sandstone, slate.
New Mexico	Serpentine (ricolite) limestone, marble, trappean and volcanic rocks, sandstone, granite.
New York	Soapstone, serpentine (verdantique marble), limestone, dolomite, marble, granite, gneiss, norite, sandstone, slate.
North Carolina	Soapstone, serpentine, limestone, dolomite, marble, granite, gneiss, diabase, norite, sandstone.
North Dakota	Limestone, dolomite, sandstone.
Ohio	Limestone, dolomite, sandstone.
Oklahoma	Limestone, dolomite, sandstone, granite.
Oregon	Limestone, dolomite, granite, trappean and volcanic rocks, sandstone.

[a] Merrill, Geo. P., Stones for Building and Decoration, pp. 15-16.

Pennsylvania.....Soapstone, serpentine, limestone, dolomite, marble, granite, gneiss, diabase, quartz porphyry, sandstone, conglomerate, slate.
Rhode Island.....Limestone, dolomite, granite, gneiss.
South Carolina....Limestone, granite, gneiss.
South Dakota....Limestone, sandstone, quartzite.
Tennessee........Limestone, marble, granite, diorite, sandstone.
Texas............Limestone, marble, granite, trappean and volcanic rocks, sandstone.
Utah.............Limestone, marble, granite, trappean and volcanic rocks, sandstone.
Vermont..........Soapstone, serpentine (verdantique marble), marble, granite, gneiss, slate.
Virginia..........Soapstone, limestone, marble, granite, gneiss, diabase, sandstone, slate.
Washington.......Limestone, marble, granite, trappean and volcanic rocks, sandstone.
West Virginia.....Limestone, sandstone.
Wisconsin.........Dolomite, granite, gneiss, quartz porphyry, sandstone.
Wyoming.........Limestone, granite, trappean and volcanic rocks, sandstone.

PRODUCTION.

For simplicity of treatment the kinds of stone covered by the figures in this report are classified as granite, trap rock, sandstone, bluestone, limestone, and marble.

Granite includes true granites and other igneous rocks, as gneiss, mica schist, andesite, syenite, trachyte, quartz porphyry, lava, tufa, diabase, trap rock, basalt, diorite, gabbro, and a small quantity of serpentine. Rocks of these kinds are as a rule quarried commercially in quantities too small to permit their being tabulated separately, but the trap-rock output for California, Massachusetts, New York, New Jersey, and Pennsylvania represents an important industry, and it is therefore considered advisable to show the value of this stone separately. The trap rock from California includes a considerable quantity of basalt.

Sandstone includes the quartzites of South Dakota and Minnesota and the fine-grained sandstones of New York and Pennsylvania, known to trade as bluestone. As the bluestone is a product of a separate industry, its production is also shown apart from that of the other sandstone. Bluestone is also quarried in New Jersey and West Virginia, but this product is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulpstones made from sandstones quarried in Michigan, Ohio, and West Virginia. Neither does the total sandstone value include sandstone crushed into sand and used in the manufacture of glass and as molding sand.

Limestone does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement. It includes, however, a small quantity of stone sold locally as marble, and also in the crushed stone a quantity of material known as "chats," or the tailings from the zinc mines of Missouri, and some chert from Alabama.

Marble includes a small quantity of serpentine quarried and sold as marble in Georgia and Pennsylvania, and also a small quantity of the so-called "onyx" marble or travertine obtained from caves and other deposits.

The following table shows the value of the different kinds of stone produced in the United States from 1899 to 1908, inclusive:

Value of the different kinds of stone produced in the United States, 1899–1908.

Year.	Granite.	Trap rock.	Sandstone.	Bluestone.	Marble.	Limestone.	Total.
1899	$10,343,298	$1,275,041	$4,910,111	$815,284	$4,011,681	$13,889,302	$35,244,717
1900	10,969,417	1,706,200	5,272,865	1,198,519	4,267,253	13,556,523	36,970,777
1901	14,266,104	1,710,857	6,974,199	1,164,481	4,965,699	18,202,843	47,284,183
1902	16,083,475	2,181,157	9,430,958	1,163,525	5,044,182	20,895,385	54,798,682
1903	15,703,793	2,732,294	9,482,802	1,779,457	5,362,686	22,372,109	57,433,141
1904	17,191,479	2,823,546	8,482,162	1,791,729	6,297,835	22,178,964	58,765,715
1905	17,563,139	3,074,554	8,075,149	1,931,625	7,129,071	26,025,210	63,798,748
1906	18,562,806	3,736,571	7,147,439	2,021,898	7,582,938	27,327,142	66,378,794
1907	18,064,708	4,594,103	6,753,762	2,117,916	7,837,685	31,737,631	71,105,805
1908	18,420,080	4,282,406	5,831,231	1,762,860	7,733,920	27,682,002	65,712,499

From this table it will be seen that the stone output of the United States decreased $5,393,306 in value in 1908, or from $71,105,805 in 1907 to $65,712,499 in 1908. This decrease is easily explained by the unsettled financial conditions which affected trades, manufactures, and industries of all kinds during 1907 and 1908, and was not confined to stone alone; in fact, the greatest part of the decreased stone output was caused by the shutting down or decreased operation of iron furnaces using limestone for flux. Crushed stone, which for the last ten years has increased steadily, showed a considerable decrease in 1908, this decrease being confined to the stone crushed and sold for concrete. Stone used for various other purposes also decreased, but the decrease was not so marked as in the cases of furnace flux and crushed stone. In 1908, as in 1907, there was a noticeable decrease in the number of producers of stone, many of the small operators being idle and reporting the use of cheaper concrete instead of stone for local work. Most of the large operators, except those having special contracts, had decreased outputs. In 1908 granite was the only variety of stone showing an increased output, trap rock, sandstone, bluestone, and marble decreasing less than $1,000,000, while limestone fell off over $4,000,000, a loss due chiefly to decreased output of furnace flux.

Granite.—Granite represented 28.03 per cent of the total stone output in 1908. The increase in value was from $18,064,708 in 1907 to $18,420,080 in 1908, or $355,372. While granite for monumental work, paving blocks, curbing, flagging, and rubble increased somewhat in value, the decided increase was in the value of riprap, which included stone for breakwater and jetty work, an especially large increase being shown in the State of Washington.

Trap rock.—Trap rock decreased in value from $4,594,103 in 1907 to $4,282,406 in 1908, or $311,697. This stone represented 6.52 per cent of the total stone output in 1908. The trap-rock output is chiefly crushed stone.

Sandstone.—Sandstone, including bluestone, represented 11.56 per cent of the total output, and decreased in value from $8,871,678 in 1907 to $7,594,091 in 1908, a loss of $1,277,587. Bluestone produced in New York and Pennsylvania decreased in value from $2,117,916 in 1907 to $1,762,860 in 1908, or $355,056. Sandstone, exclusive of bluestone, decreased $922,531, or from $6,753,762 in 1907 to $5,831,231 in 1908.

Marble.—Marble, valued at $7,733,920 in 1908, represented 11.77 per cent of the total output and decreased in value but slightly in 1908 as compared with 1907, the decrease being $103,765 from $7,837,685, the value in 1907.

Limestone.—Limestone represented 42.12 per cent of the total stone production in 1908, the value being $27,682,002, as against $31,737,631 in 1907, a loss for 1908 of $4,055,629. This loss was chiefly in the value of furnace flux and crushed stone.

The following table shows the value of the various kinds of stone produced in 1907 and 1908, by States and Territories.

Value of various kinds of stone produced in 1907 and 1908, by States and Territories.

1907.

State or Territory.	Granite.	Trap rock.	Sandstone.	Marble.	Limestone.	Total value.
Alabama			$48,673	$85,475	$694,699	$828,847
Alaska				38,110		38,110
Arizona	$13,700		158,435		64,975	237,110
Arkansas	168,996		94,275		52,207	315,478
California	1,306,324	$1,029,749	437,738	183,285	177,333	3,134,429
Colorado	67,134		299,443		502,751	869,328
Connecticut	591,153	459,953	([a])		1,476	1,052,582
Delaware	158,192					158,192
Florida					15,000	15,000
Georgia	858,603			864,757	22,278	1,745,638
Hawaii	19,599					19,599
Idaho	25,942		24,001	([b])	15,900	65,843
Illinois			14,996		3,774,346	3,789,342
Indiana			15,425		3,624,126	3,639,551
Iowa			3,542		560,582	564,124
Kansas			46,831		813,748	860,579
Kentucky			98,450	12,500	891,500	1,002,450
Maine	2,146,420				1,350	2,147,770
Maryland	1,183,753		13,859	98,918	142,825	1,439,355
Massachusetts	2,328,777	432,604	243,323	212,438	1,837	3,218,979
Michigan			53,003		760,333	813,336
Minnesota	546,603		300,204		735,319	1,582,126
Missouri	136,405		35,289	([c])	2,153,917	2,325,611
Montana	102,050		39,216		124,690	265,956
Nebraska			11,609		312,630	324,239
New Hampshire	647,721					647,721
New Jersey	75,757	995,436	177,667		274,452	1,523,312
New Mexico	167,294		12,450	[d] 7,535	193,732	381,011
New York	289,722	915,395	[e][f] 1,978,117	911,951	2,898,520	6,993,705
North Carolina	906,476		4,105		22,328	932,909
North Dakota			3,260			3,260
Ohio			1,591,148		3,566,822	5,157,970
Oklahoma	24,550		43,403	16,805	189,568	274,326
Oregon	117,625		3,904		5,750	127,279
Pennsylvania	366,679	760,966	[f] 2,064,913	118,539	5,821,275	9,132,372
Rhode Island	674,148				750	674,898
South Carolina	129,377					129,377
South Dakota	690		143,585		11,600	155,875
Tennessee			16,523	688,148	385,450	1,090,121
Texas	122,158		108,047		267,757	497,962
Utah	5,240		24,298	2,500	306,344	338,382
Vermont	2,693,889			4,596,724	23,126	7,313,739
Virginia	398,426		([g])		362,062	760,488
Washington	562,352		295,585	([h])	62,317	920,254
West Virginia			[i] 197,926		855,941	1,053,867
Wisconsin	1,228,863		236,183		1,027,095	2,492,141
Wyoming	90		32,252		18,920	51,262
	[j] 18,064,708	4,594,103	[f] 8,871,678	7,837,685	31,737,631	71,105,805

[a] Small value included with New York.
[b] Small value included with New Mexico.
[c] Included in Missouri limestone.
[d] Includes small values for Idaho and Washington.
[e] Includes small value for Connecticut.
[f] Includes bluestone.
[g] Small value included with West Virginia.
[h] Small value included with New Mexico.
[i] Includes small value for Virginia.
[j] Includes small value for trap and other igneous rocks.

Value of various kinds of stone produced in 1907 and 1908, by States and Territories—Continued.

1908.

State or Territory.	Granite.	Trap rock.	Sandstone.	Marble.	Limestone.	Total value.
Alabama			$34,099	a $118,580	$479,730	a $632,409
Alaska				a 103,888		a 103,888
Arizona	$8,544		396,358		b 50,130	b 455,032
Arkansas	152,567		42,463		61,971	257,001
California	1,684,504	$979,139	330,214	60,408	237,320	3,291,585
Colorado	121,282		181,051	(a)	378,822	a 681,155
Connecticut	592,904	473,219	55,949		b 3,727	b 1,125,799
Delaware	195,761					195,761
Florida					41,910	41,910
Georgia	970,832			916,281	8,495	1,895,608
Hawaii	81,219					81,219
Idaho			33,394		36,000	69,394
Illinois			12,218		3,122,552	3,134,770
Indiana			3,342		3,643,261	3,646,603
Iowa			2,337		530,945	533,282
Kansas			67,950		403,176	471,126
Kentucky			78,732	(a)	810,090	a 888,822
Maine	2,027,508				(b)	b 2,027,508
Maryland	762,442		6,262	a 79,317	128,591	a 976,612
Massachusetts	2,027,463	508,672	241,462	175,648	1,950	2,955,195
Michigan			39,103		669,017	708,120
Minnesota	629,427		197,184		667,095	1,493,706
Missouri	157,968		17,954	(a)	2,130,136	a 2,306,058
Montana			51,564		134,595	186,159
Nebraska			c 15,815		330,570	c 346,385
Nevada			(c)			(c)
New Hampshire	867,028					867,028
New Jersey	125,804	1,079,514	154,422		172,000	1,531,740
New Mexico			c 10,410	(a)	(b)	a b c 10,410
New York	367,066	723,953	d 1,774,843	706,858	2,584,559	d 6,157,279
North Carolina	764,272		c 12,266	(a)	(b)	a b c 776,538
North Dakota			(c)			(c)
Ohio			1,244,752		3,519,557	4,764,309
Oklahoma	23,239		57,124		257,066	337,429
Oregon	271,869		(c)		6,230	c 278,099
Pennsylvania	324,241	517,909	d 1,368,784	102,747	4,057,471	d 6,371,152
Rhode Island	556,474				(b)	b 556,474
South Carolina	297,874					297,874
South Dakota			128,554		(b)	b 128,554
Tennessee			(c)	790,233	b 535,882	b c 1,326,115
Texas	190,055		154,948		314,571	659,574
Utah	5,229		25,097	(a)	253,088	a 283,414
Vermont	2,451,933			4,679,960	20,731	7,152,624
Virginia	321,530		(c)		280,542	c 602,072
Washington	870,944		464,587		31,660	1,367,191
West Virginia			127,149		645,385	772,534
Wisconsin	1,529,781		219,130		1,102,009	2,850,920
Wyoming			44,574		b 31,168	b 75,742
Other States	40,320					40,320
	e 18,420,080	4,282,406	7,594,091	7,733,920	27,682,002	65,712,499

a To prevent disclosure of individual production: Alabama includes Kentucky and Missouri; Alaska includes Colorado, New Mexico, and Utah; Maryland includes North Carolina.
b Arizona includes New Mexico; Connecticut includes Maine and Rhode Island; Tennessee includes North Carolina; Wyoming includes South Dakota.
c Nebraska includes North Dakota and Oregon; Nevada is included with New Mexico; North Carolina includes Tennessee and Virginia.
d Includes bluestone.
e Includes a small value for trap, basalt, and other igneous rocks.

The following table shows the rank of States and Territories in 1907 and 1908, according to value of production, and the percentage of the total produced by each State or Territory:

Rank of States and Territories in 1907 and 1908, according to value of production, and percentage of total produced by each State or Territory.

1907.				1908.			
Rank of State.	State or Territory.	Total value.	Percentage of total.	Rank of State.	State or Territory.	Total value.	Percentage of total.
1	Pennsylvania	$9,132,372	12.84	1	Vermont	$7,152,624	10.88
2	Vermont	7,313,739	10.29	2	Pennsylvania	6,371,152	9.70
3	New York [a]	6,993,705	9.84	3	New York	6,157,279	9.37
4	Ohio	5,157,970	7.25	4	Ohio	4,764,309	7.25
5	Illinois	3,789,342	5.33	5	Indiana	3,646,603	5.55
6	Indiana	3,639,551	5.12	6	California	3,291,585	5.01
7	Massachusetts	3,218,979	4.53	7	Illinois	3,134,770	4.77
8	California	3,134,429	4.41	8	Massachusetts	2,955,195	4.50
9	Wisconsin	2,492,141	3.51	9	Wisconsin	2,850,920	4.34
10	Missouri	2,325,611	3.27	10	Missouri	[h] 2,306,058	3.51
11	Maine	2,147,770	3.02	11	Maine	[h] 2,027,508	3.09
12	Georgia	1,745,638	2.46	12	Georgia	1,895,608	2.88
13	Minnesota	1,582,126	2.23	13	New Jersey	1,531,740	2.33
14	New Jersey	1,523,312	2.14	14	Minnesota	1,493,706	2.27
15	Maryland	1,439,355	2.02	15	Washington	1,367,191	2.08
16	Tennessee	1,090,121	1.53	16	Tennessee	[h] 1,310,651	1.99
17	West Virginia [b]	1,053,867	1.48	17	Connecticut	[h] 1,125,799	1.71
18	Connecticut [c]	1,052,582	1.48	18	Maryland	968,437	1.47
19	Kentucky	1,002,450	1.41	19	Kentucky	893,447	1.36
20	North Carolina	932,909	1.31	20	New Hampshire	867,028	1.32
21	Washington [d]	920,254	1.29	21	North Carolina	800,177	1.22
22	Colorado	869,328	1.22	22	West Virginia	772,534	1.18
23	Kansas	860,579	1.21	23	Colorado	[h] 740,253	1.13
24	Alabama	828,847	1.17	24	Michigan	[h] 708,120	1.08
25	Michigan	813,336	1.14	25	Texas	659,574	1.00
26	Virginia [e]	760,488	1.07	26	Alabama	627,011	.95
27	Rhode Island	674,898	.95	27	Virginia	[h] 602,072	.92
28	New Hampshire	647,721	.91	28	Rhode Island	[h] 556,474	.85
29	Iowa	564,124	.79	29	Iowa	533,282	.81
30	Texas	497,962	.70	30	Kansas	471,126	.72
31	New Mexico [f]	381,011	.54	31	Arizona	451,832	.69
32	Utah	338,382	.48	32	Nebraska	338,070	.51
33	Nebraska	324,239	.46	33	Oklahoma	337,429	.51
34	Arkansas	315,478	.44	34	South Carolina	297,874	.45
35	Oklahoma	274,326	.39	35	Utah	286,414	.44
36	Montana	265,956	.37	36	Oregon	[h] 286,414	.44
37	Arizona	237,110	.33	37	Arkansas	257,001	.39
38	Delaware	158,192	.22	38	Montana	[h] 225,709	.34
39	South Dakota	155,875	.22	39	Delaware	195,761	.30
40	South Carolina	129,377	.18	40	South Dakota	131,994	.20
41	Oregon	127,279	.18	41	Hawaii	81,219	.12
42	Idaho [g]	65,843	.27	42	Wyoming	72,947	.11
43	Wyoming	51,262		43	Idaho	[h] 69,394	.11
44	Alaska	38,110		44	Florida	41,910	.15
45	Hawaii	19,599		45	Alaska	[h] 40,343	
46	Florida	15,000		46	New Mexico	15,955	
47	North Dakota	3,260		47	Nevada	([h])	
				48	North Dakota	([h])	
		71,105,805	100.00			65,712,499	100.00

[a] Includes a small output of sandstone from Connecticut.
[b] Includes a small value of sandstone for Virginia.
[c] Exclusive of a small value for sandstone included with New York.
[d] Exclusive of a small value for marble included with New Mexico.
[e] Exclusive of a small value for sandstone included with West Virginia.
[f] Includes small values of marble for Idaho and Washington.
[g] Exclusive of a small value of marble included with New Mexico.
[h] To prevent disclosure of individual production, Alaska includes a small value for Nevada; Colorado for Missouri; Connecticut for Maine and Rhode Island; Montana for Idaho and Michigan; Oregon for North Dakota; and Tennessee for Virginia.

From this table it will be seen that the four ranking States in the production of stone are Vermont, Pennsylvania, New York, and Ohio. Prior to 1908 Pennsylvania had ranked first, followed by

Vermont, New York, and Ohio. For 1908, however, Pennsylvania and Vermont changed places, both decreasing in the total value of output, but Pennsylvania much more than Vermont. This was on account of the decreased production of crushed stone and of limestone for furnace flux in Pennsylvania. Vermont furnishes very little material of this class, and the production of this State, chiefly building and monumental stone, did not suffer so great a change. In 1907 Pennsylvania produced 12.84 per cent of the entire output and Vermont 10.29 per cent; in 1908 Vermont produced 10.88 per cent and Pennsylvania 9.70 per cent. New York and Ohio kept the same relative position, New York leading; but it is noticeable that while New York decreased in percentage of output Ohio remained exactly the same, although the total value for this State decreased somewhat.

Of the other leading States Illinois went from fifth place in 1907 to seventh place in 1908, Indiana from sixth to fifth, Massachusetts from seventh to eighth, and California from eighth to sixth. A noteworthy change in rank of production is that of Washington from twenty-first place in 1907 to fifteenth in 1908, a change caused by the large quantity of rock reported for use in rivers and harbors for jetty and breakwater work and the large demand in 1908 for paving blocks for the cities of Seattle and Tacoma.

The following table is given to show the values of the stone used for various purposes in 1907 and 1908. Only those values are given which are for uses common to two or more varieties of stone.

Value of granite, trap rock, sandstone, limestone, and marble used for various purposes in 1907 and 1908.

1907.

Kind.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$6,033,362	$4,338,819	$69,854	$819,621	$1,928,308	$3,110,762
Trap rock	48,203				182,490	4,280,554
Sandstone	3,154,783		1,185,879	1,380,516	884,843	987,528
Limestone	4,580,226		84,076	378,853	545,300	13,675,453
Marble	2,859,237	2,640,130				
	16,675,811	6,978,949	1,339,809	2,578,990	3,540,941	22,054,297

1908.

Kind.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$5,751,258	$4,551,061	$70,744	$942,722	$2,420,554	$2,445,268
Trap rock	40,543				184,125	4,002,220
Sandstone	2,605,381		1,067,334	1,025,259	654,896	906,317
Limestone	4,566,522		79,081	237,579	276,637	12,908,207
Marble	3,076,926	2,397,780				
	16,040,630	6,948,841	1,217,159	2,205,560	3,536,212	20,262,012

From this table may be seen more clearly than from the tables showing the separate productions of the various stones the setback to the stone industry in 1908.

The value of stone sold for building purposes decreased from $16,-675,811 in 1907 to $16,040,630 in 1908, or $635,181. This decrease was for all varieties of stone, except marble, which showed a somewhat increased value for this purpose. This decrease of building stone output in 1908 was, however, small compared with the decrease for 1907, which was $4,005,814 as compared with the total for 1906. In 1908 granite represented 35.86 per cent of this building stone, limestone 28.47 per cent, marble 19.18 per cent, and sandstone 16.24 per cent, the percentage for marble being greater than for sandstone, which was not the case heretofore.

Monumental stone decreased $30,108 in value in 1908. Of the monumental stone 65.49 per cent was granite and 34.51 per cent marble in 1908, granite increasing and marble decreasing slightly as compared with 1907.

Flagstone decreased $122,650 in value in 1908. Sandstone represented 87.69 per cent of the total output, and 59.18 per cent of the sandstone used for flagging was bluestone from New York and Pennsylvania.

Curbstone decreased $373,430 in value in 1908. Sandstone represented 46.49 per cent of this output, granite 42.74 per cent, and limestone 10.77 per cent. Bluestone from New York and Pennsylvania constituted 19.47 per cent of the curbstone.

Paving stone decreased in value $4,729 in 1908. Limestone and sandstone decreased largely in the paving-stone output, while granite increased largely, producing 68.45 per cent of the total output in 1908 as against 54.46 per cent in 1907. Trap rock also showed a slight gain in the paving-block output.

Crushed stone lost $1,792,285 in 1908. In 1907 the increase over the 1906 output, which was valued at $17,467,486, amounted to $4,586,811. This remarkable decrease followed upon a steady increase in the crushed-stone industry for the last ten years and was due to the financial depression, the decrease being in value of stone used for concrete and railroad ballast, while roadmaking, less influenced by the money market, showed an increase in demand. The beginning of the crushed-stone industry was practically about ten or fifteen years ago, when the demand for good roads in the northeastern States and the convenience of good material for this purpose in the trap-rock deposits in the New England and Middle Atlantic States led to the use of this material in larger quantities and for other purposes than on roads and in railroad ballasting.

The steady increase in value of crushed stone for the last ten years is well shown in the following table, which gives a comparison between this material and stone used for building purposes. The building stone shows more or less fluctuation, while, until 1908, the crushed stone had shown a steady increase.

Value of building stone and of crushed stone, 1899–1908.

Year.	Building stone (rough and dressed).	Crushed stone.	Year.	Building stone (rough and dressed).	Crushed stone.
1899	[a] $10,741,927	$4,692,343	1904	$18,883,455	$15,530,122
1900	10,672,598	6,525,368	1905	20,240,809	16,419,614
1901	15,112,600	8,560,432	1906	20,681,625	17,467,486
1902	20,790,341	11,480,959	1907	16,675,811	22,054,297
1903	19,795,491	13,188,938	1908	16,040,630	20,262,012

[a] Does not include stone sold rough for building.

The following table shows the quantity and value of crushed stone produced in the United States in 1907 and 1908, by States and Territories and by uses:

Production of crushed stone in 1907 and 1908, by States and Territories and by uses, in short tons.

1907.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	10,000	$5,000			45,164	$21,287	55,164	$26,287
Arizona					25,062	41,645	25,062	41,645
Arkansas	6,537	6,983	5,000	$5,000	164,956	179,617	176,493	191,600
California	849,869	629,114	265,038	96,214	525,938	479,592	1,640,845	1,204,920
Colorado	1,000	900	23,978	21,580	41,342	20,715	66,320	43,195
Connecticut	393,842	222,206	149,321	74,660	283,110	148,435	826,273	445,301
Delaware	60,535	40,298	58,153	36,668	51,610	41,628	170,298	118,594
Florida	6,000	15,000					6,000	15,000
Georgia	39,027	25,407	310,969	152,847	82,078	61,051	432,074	239,305
Hawaii					9,850	7,599	9,850	7,599
Idaho	11,631	17,392					11,631	17,392
Illinois	1,517,425	958,032	788,894	499,204	1,576,256	1,118,919	3,882,575	2,576,155
Indiana	972,695	476,711	323,650	134,932	120,289	60,918	1,416,634	672,561
Iowa	101,696	69,817	158,651	77,571	186,636	118,682	446,983	266,070
Kansas	87,208	76,420	733,511	357,820	122,903	55,469	943,622	489,709
Kentucky	417,823	292,241	691,405	292,714	76,718	54,917	1,185,946	639,872
Maine	1,688	1,511	750	325	33,437	19,926	35,875	21,762
Maryland	366,910	348,875	164,800	103,147	429,598	499,337	961,308	951,359
Massachusetts	423,905	315,221	85,920	42,860	394,005	326,864	903,830	684,945
Michigan	225,522	131,708	90,279	46,516	191,167	97,762	506,968	275,986
Minnesota	183,021	156,026	42,592	36,398	182,224	153,937	407,837	346,361
Missouri	673,659	444,685	532,050	284,158	549,972	454,433	1,755,681	1,183,276
Nebraska	63,221	55 824	65,148	53,584	145,757	121,027	274,126	230,435
New Hampshire	5,300	3,975			21,887	14,349	27,187	18,324
New Jersey	735,681	578,640	323,682	210,247	304,168	235,129	1,363,531	1,024,016
New Mexico	375	300	783,961	342,546			784,336	342,846
New York	2,500,143	1,827,416	958,506	466,890	956,080	601,605	4,414,729	2,895,911
North Carolina	97,907	62,939	364,369	175,847	145,014	106,497	601,290	345,283
Ohio	2,367,125	1,245,296	975,735	414,653	666,757	306,277	4,009,617	1,966,226
Oklahoma	4,600	4,000	243,137	146,747	26,335	16,405	274,072	167,152
Oregon	101,484	80,205	5,888	1,744	5,110	7,450	112,482	89,399
Pennsylvania	1,236,037	785,445	1,701,152	1,075,160	1,136,540	693,354	4,073,729	2,553,959
Rhode Island	22,040	25,480			5,500	5,550	27,540	31,030
South Carolina	26,097	25,887	10	17	6,250	4,500	32,357	30,404
South Dakota	28,000	14,000			10,500	10,500	38,500	24,500
Tennessee	26,250	13,994	270,923	118,911	69,498	41,530	366,671	174,435
Texas	103,915	64,318	171,927	79,843	47,267	48,858	323,109	193,019
Vermont	8,558	7,688			4,050	4,850	12,608	12,538
Virginia	126,775	96,937	138,221	63,073	214,021	200,286	479,017	360,296
Washington	10,550	17,930	1,000	500			11,550	18,430
West Virginia	36,048	18,406	573,454	272,887	70,565	49,012	680,067	340,305
Wisconsin	763,383	506,957	73,006	36,026	417,405	233,477	1,253,794	776,460
Wyoming	100	60			450	375	550	435
	14,607,582	9,669,244	11,075,080	5,721,289	9,345,469	6,663,764	35,028,131	22,054,297

Production of crushed stone in 1907 and 1908, by States and Territories and by uses, in short tons—Continued.

1908.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	99,330	$43,028	3,250	$1,500	21,446	$16,651	124,026	$61,179
Arizona	200	100	5,000	2,500	4,726	4,220	9,926	6,820
Arkansas	11,779	9,123			124,450	109,171	136,229	118,294
California	983,644	719,362	260,440	200,751	622,290	502,947	1,866,374	1,423,060
Colorado			4,000	2,000	8,541	6,210	12,541	8,210
Connecticut	370,735	201,540	200,000	100,000	317,702	156,840	888,437	458,380
Delaware	80,235	69,462	52,377	37,065	29,904	25,922	162,516	132,449
Florida	10,733	9,660					10,733	9,660
Georgia	4,396	3,291	28,832	11,443	68,647	52,666	101,875	67,400
Hawaii	28,269	22,035			42,814	49,219	71,083	71,254
Illinois	1,284,812	729,217	771,430	384,827	1,716,912	851,889	3,773,154	1,965,933
Indiana	1,177,435	622,726	262,819	95,165	159,211	77,011	1,599,465	794,902
Iowa	107,211	75,806	42,545	28,687	266,628	181,708	416,384	286,201
Kansas	68,100	48,550	168,789	99,306	107,006	78,540	343,895	226,396
Kentucky	469,818	350,577	525,055	235,802	57,035	35,928	1,051,908	622,307
Maine	3,517	2,557	300	150	11,285	9,818	15,002	12,525
Maryland	280,189	268,821	115,772	68,267	137,719	161,107	533,680	498,195
Massachusetts	587,338	456,413	76,800	39,963	310,494	248,330	974,632	744,706
Michigan	324,842	188,910	82,000	33,900	162,234	75,600	569,076	298,410
Minnesota	87,014	66,609	56,355	44,793	156,306	125,536	299,675	236,938
Missouri	1,275,926	732,823	232,777	130,296	459,668	357,509	1,968,371	1,220,628
Montana			1,511	756			1,511	756
Nebraska	56,037	51,007	17,651	16,010	195,669	173,449	269,357	240,466
Nevada	1,415	218					1,415	218
New Hampshire	5,219	6,329			13,235	10,126	18,454	16,455
New Jersey	774,764	609,324	482,644	254,550	360,536	266,874	1,617,944	1,130,748
New Mexico	570	385			500	350	1,070	735
New York	2,929,488	1,647,210	518,981	282,133	1,085,679	643,822	4,534,148	2,573,165
North Carolina	146,436	123,954	52,433	33,612	32,560	27,333	231,429	184,899
Ohio	2,834,076	1,477,429	826,649	354,505	557,045	285,316	4,217,770	2,117,250
Oklahoma	4,000	2,000	206,111	107,574	204,483	132,101	414,594	241,675
Oregon	175,058	158,051			4,815	6,718	179,873	164,769
Pennsylvania	1,414,652	930,812	1,055,043	579,480	909,745	604,137	3,379,440	2,114,429
Rhode Island	25,618	27,476			3,433	3,838	29,051	31,314
South Carolina	35,000	30,300	33,000	27,500	38,000	35,000	106,000	92,800
South Dakota	7,500	6,000			3,000	2,500	10,500	8,500
Tennessee	322,213	202,416	131,794	56,439	107,278	60,350	561,285	319,205
Texas	115,732	110,058	207,180	122,360	17,402	13,066	340,314	245,484
Utah	59	14	250	125	150	263	459	402
Vermont	15,775	17,916	1,250	1,000	2,070	2,535	19,095	21,451
Virginia	81,420	51,829	222,921	117,245	183,215	129,540	487,556	298,614
Washington	37,129	29,616			2,849	2,280	39,978	31,896
West Virginia	145,393	73,979	408,268	199,899	62,341	35,152	616,002	309,030
Wisconsin	787,823	541,048	72,335	47,363	401,492	263,063	1,261,650	851,474
Wyoming					3,225	2,430	3,225	2,430
	17,170,900	10,717,981	7,126,562	3,716,966	8,973,740	5,827,065	33,271,202	20,262,012

From this table it will be seen that New York, producing 12.70 per cent; Ohio, 10.45 per cent; Pennsylvania, 10.44 per cent; Illinois, 9.70 per cent; California, 7.03 per cent; Missouri, 6.02 per cent; and New Jersey, 5.59 per cent of the total crushed-stone output of the United States, were the principal crushed-stone producing States in 1908. Each of these had an output valued at more than $1,000,000.

In 1907 the rank and percentage was as follows: New York, 13.13 per cent; Illinois, 11.68 per cent; Pennsylvania, 11.58 per cent; Ohio, 8.92 per cent; California, 5.46 per cent; Missouri, 5.37 per cent; and New Jersey, 4.64 per cent.

In 1908 these States, except California, Missouri, and New Jersey, showed a decreased percentage of the total output, Illinois changing from second place to fourth.

The following table shows the quantity and value of crushed stone produced in the United States in 1907 and 1908, by uses and kinds of stone:

Quantity and value of crushed stone produced in the United States in 1907 and 1908, by kinds and uses, in short tons.

1907.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite	1,262,069	$1,060,658	1,447,406	$714,574	1,375,973	$1,335,530	4,085,448	$3,110,762	$0.76
Traprock	3,265,249	2,435,152	1,181,260	680,897	1,626,963	1,164,505	6,073,472	4,280,554	.70
Limestone	9,619,178	5,860,977	8,122,342	4,144,345	5,791,377	3,670,131	23,532,897	13,675,453	.58
Sandstone	461,086	312,457	324,072	181,473	551,156	493,598	1,336,314	987,528	.74
Total	14,607,582	9,669,244	11,075,080	5,721,289	9,345,469	6,663,764	35,028,131	22,054,297	......
Average price	....	.66	....	.52	....	.71	....	.63	......

1908.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite	1,429,814	$1,207,666	693,020	$384,215	976,808	$853,387	3,099,642	$2,445,268	$0.79
Trap rock	3,386,415	2,313,693	1,121,769	682,875	1,550,010	1,005,652	6,058,194	4,002,220	.66
Limestone	11,910,760	6,880,893	5,095,109	2,530,738	5,907,625	3,496,576	22,913,494	12,908,207	.56
Sandstone	443,911	315,729	216,664	119,138	539,297	471,450	1,199,872	906,317	.76
Total	17,170,900	10,717,981	7,126,562	3,716,966	8,973,740	5,827,065	33,271,202	20,262,012	......
Average price	....	.62	....	.52	....	.65	....	.61	......

As shown by this table the quantity and value of the crushed stone output in 1908 was 33,271,202 short tons, valued at $20,262,012, a decrease of 1,756,929 tons in quantity and of $1,792,285 in value from the output of 1907. The average price per ton declined from 63 cents in 1907 to 61 cents in 1908. The decrease for 1908 was in marked contrast to the increase of 5,488,279 tons in quantity and of $4,586,811 in value for 1907 over 1906, when the output was 29,539,852 short tons, valued at $17,467,486. Crushed granite decreased 985,806 tons in quantity and $665,494 in value. The average price per ton advanced from 76 cents in 1907 to 79 cents in 1908.

Crushed trap rock fell off 15,278 short tons and $278,334. The average price per ton declined from 70 cents in 1907 to 66 cents in 1908.

Crushed limestone lost 619,403 short tons and $767,246. The average price per ton declined from 58 cents in 1907 to 56 cents in 1908.

Crushed sandstone decreased 136,442 short tons and $81,211. The average price per ton was 74 cents in 1907 and 76 cents in 1908.

Crushed stone used for road making increased 2,563,318 short tons in quantity and $1,048,737 in value. The average price per ton, however, declined from 66 cents in 1907 to 62 cents in 1908. The only increase in crushed-stone product in 1908 was in the stone used for road making, and in 1907 the largest increase in crushed-stone output was for road making.

Crushed stone for railroad ballast decreased 3,948,518 short tons in quantity and $2,004,323 in value. The average price per ton was the same in 1907 as in 1908, 52 cents.

Crushed stone for concrete decreased 371,729 short tons in quantity and $836,699 in value. The average price per ton declined from 71 cents per ton in 1907 to 65 cents per ton in 1908.

EXPORTS AND IMPORTS.

The following figures, compiled from statistics furnished by the Bureau of Statistics of the Department of Commerce and Labor, give the value of the exports and imports of stone for the calendar years 1907 and 1908:

Exports of stone from the United States in 1907 and 1908.

Kind.	1907.	1908.
Marble and stone, unmanufactured	$407,193	$249,184
All others	681,798	754,067
	1,088,991	1,003,251

Imports of stone into the United States in 1907 and 1908.

Kind.	1907.	1908.	Kind.	1907.	1908.
Marble:			Granite:		
In block, rough, etc.	$1,040,333	$831,099	Dressed	$166,524	$187,229
Sawed or dressed	1,132	2,428	Rough	8,779	6,384
Slabs or paving tiles	50,718	89,371	Total	175,303	193,613
All other manufactures	257,456	180,751			
Mosaic cubes	49,893	35,053	Stone (other):		
Total	1,399,532	1,138,702	Dressed	26,003	12,345
Onyx:			Rough	38,761	56,565
In block, rough, etc.	57,795	71,979	Total	64,764	68,910
All other manufactures	7,678	9,822	Grand total	1,705,072	1,483,026
Total	65,473	81,801			

These tables show a decrease of $85,740 in the value of the exports of stone during 1908, and a decrease also in the value of imports of $222,046.

The value of the exports decreased in 1907 also in comparison with 1906, but imports increased in value.

GRANITE.

Total production.—The figures given in this report as representing the value of the granite production in the United States include also the values of small quantities of gneiss, mica schist, lava, tuff, trachyte, andesite, syenite, quartz porphyry, trap, basalt, and allied igneous rocks. The quantities of these allied rocks quarried are too small to tabulate separately. Trap rock in the States of California, Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania, however, represents an industry sufficient by itself to make it advisable to tabulate this stone separately, and its value is not included in the grand total of granite.

The value of the granite output in the United States was in 1908 $18,420,080; in 1907 the value was $18,064,708, an increase for 1908 of $355,372. As noted previously, granite is the only variety of stone showing an increased value of output in 1908. In 1907, as compared with 1906, when the output was valued at $18,562,806, there was a decrease of $498,098. This decrease being practically the same as the increase for 1908, the granite industry would appear to be in about the same condition as before the business troubles of 1907 and 1908.

Granite for monumental stone, curbstone, flagging, rubble, and crushed stone for road making increased slightly in value; but granite for paving blocks and for riprap showed considerable increase. Building stone decreased somewhat in value, and crushed stone for concrete and for railroad ballast showed a marked decrease.

In 1907 the rank in output of States producing granite to the value of $500,000 or more was Vermont, Massachusetts, Maine, California, Wisconsin, Maryland, North Carolina, Georgia, Rhode Island, New Hampshire, Connecticut, Washington, and Minnesota; in 1908, Vermont, Maine, Massachusetts, California, Wisconsin, Georgia, Washington, New Hampshire, North Carolina, Maryland, Minnesota, Connecticut, and Rhode Island. Of these States, California, Wisconsin, Georgia, Washington, New Hampshire, Minnesota, and Connecticut showed an increased output; and Vermont, Maine, Massachusetts, North Carolina, Maryland, and Rhode Island decreased in value of production.

In 1907 there were six States with an output valued at over $1,000,000. In 1908 Maryland dropped below $1,000,000, and Maine exchanged places with Massachusetts, although the production was almost identical for the two States. Washington showed a remarkable increase in output, occasioned by the large quantities of stone used for breakwater, jetty, and harbor repair work. A large quantity of this stone is basalt. Although remaining in fifth place, Wisconsin reported a large increase in paving-block output. New Hampshire increased in value of monumental, building, and paving stone. Georgia increased in the output of curbstone and flagstone. Maine increased in building stone and paving blocks, but decreased in monumental stone. Vermont decreased in value of dressed building stone. Massachusetts decreased in value of building and paving stone and increased somewhat in value of monumental stone. The decreased output of Maryland was due to a considerable loss in value of crushed stone for concrete. The decrease in value for North Carolina was due to decrease in dressed building stone. Of the other States, Colorado, Delaware, Hawaii, Missouri, New Jersey, New York, Oregon, South Carolina, and Texas increased in value of output, and Arizona, Arkansas, Idaho, Montana, New Mexico, Oklahoma, Pennsylvania, Utah, and Virginia decreased. Arizona, Colorado, Hawaii, Oregon, Utah, and Washington include some basalt and volcanic rock, and trappean rocks in their production; other States, notably Delaware, Georgia, Maryland, Pennsylvania, and Virginia, include some gneiss, trap rock, syenite, mica schist, diabase, etc.

Building stone.—Granite used as building stone, including rough and dressed stone as sold by producers, was valued at $5,751,258 in 1908, a decrease of $282,104, as compared with 1907. In 1907 the decrease from 1906, when the total output was $8,430,022, was $2,396,660. In 1906, the increase over 1905, when the total output was $7,243,219, was $1,186,803.

The rough building stone sold by the granite quarrymen was valued at $1,379,106 in 1908, and at $1,280,769 in 1907, an increase of $98,337 in this class of material. Maine, Pennsylvania, Massachusetts, Maryland, and North Carolina reported the greatest values for rough building stone sold, all these States reporting a decreased output except Maryland and North Carolina, which increased in value for this product.

The dressed stone sold for building by the quarrymen was valued at $4,372,152 in 1908 and at $4,752,593 in 1907, a decrease of $380,441. In 1907 the decrease was $1,906,511 compared with 1906. In 1907 for this output the report was as follows: Vermont, $1,009,353; Maine, $1,007,572; Massachusetts, $907,119; California, $485,778. There was therefore, in 1908, an increase of $48,417 for Maine and of $234,055 for California, and a loss of $333,286 for Vermont and of $186,323 for Massachusetts.

Monumental stone.—Granite sold for monumental purposes by quarrymen, including rough and dressed stone, was valued at $4,551,061 in 1908 and at $4,338,819 in 1907, a gain of $212,242. Of the total, $2,226,619 was the value of the rough stock and $2,324,442 the value of the dressed stone sold by the producers. In 1907 the rough stock sold was valued at $2,239,327, and the dressed stone at $2,099,492, a decrease for 1908 of $12,708 for rough stock and an increase of $224,950 for the finished stone. Vermont was the largest producer of both rough and dressed stone. Massachusetts ranked next in production of rough stock, followed by Rhode Island and New Hampshire. In 1908 Minnesota showed an increased output of dressed monumental stone and ranked after Vermont and was followed by Wisconsin and Rhode Island.

Paving blocks.—The paving-block industry increased in value from $1,928,308 in 1907 to $2,420,555 in 1908, a gain of $492,247. Wisconsin, Maine, and Massachusetts were the largest producers of this class of material.

Curbstone.—Granite curbing in 1908 was valued at $942,722, and in 1907 at $819,621, a gain of $123,101 for 1908. Georgia, California, North Carolina, Massachusetts, and Maine were the largest curbstone-producing States in 1908.

Flagstone.—Granite used for flagging was principally from Georgia in 1908. The total output was valued at $70,744 in 1908 and at $69,854 in 1907.

Rubble.—Granite reported as used for rubble was valued at $718,120 in 1908, practically the same value as for 1907, which was $717,998.

Riprap.—Granite sold for riprap increased in value from $620,033 in 1907 to $1,232,684 in 1908, a gain of $612,651. Washington, California, Connecticut, South Carolina, and Texas showed the largest output of this stone, which was used in riprap and in construction of breakwaters and jetty work in various rivers and harbors.

Crushed stone.—The total granite crushed-stone output was valued at $2,445,268 in 1908, as against $3,110,762 in 1907, a decrease in 1908 of $665,494. These figures represent an output of 3,099,642 short tons in 1908 and of 4,085,448 short tons in 1907, a loss in 1908 of

985,806 short tons. Of the total 1908 output 1,429,814 tons, valued at $1,207,666, was for road making; 693,020 tons, valued at $384,215, for railroad ballast; and 976,808 tons, valued at $853,387, for concrete. These figures for 1907 were as follows: 1,262,069 tons, valued at $1,060,658, for road making; 1,447,406 tons, valued at $714,574, for railroad ballast; and 1,375,973 tons, valued at $1,335,530, for concrete—an increase of 167,745 tons in quantity and of $147,008 in value for road making; a decrease of 754,386 tons in quantity and of $330,359 in value for railroad ballast; and a decrease of 399,165 tons in quantity and of $482,143 in value for concrete. The total average price per ton was 76 cents in 1907 and 79 cents in 1908. The average price per ton for road making was 84 cents in 1908 and 84 cents in 1907; for railroad ballast it was 55 cents in 1908 and 49 cents in 1907; for concrete 87 cents in 1908 and 97 cents in 1907. Maryland, California, Virginia, and North Carolina had the largest values for crushed granite in 1908, Maryland reporting the greatest value for road making and concrete, and New Jersey the greatest value for railroad ballast.

The following table shows the value of the production of granite, including a small output of igneous rocks, in the United States from 1904 to 1908, inclusive:

Value of granite, etc., produced in the United States, by States and Territories, 1904–1908.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Arizona	$2,500	$3,700	$32,042	$13,700	$8,544
Arkansas	52,616	90,312	118,903	168,996	152,567
California	1,180,415	1,161,330	740,784	1,306,324	1,684,504
Colorado	91,132	73,802	65,402	67,134	121,282
Connecticut	558,334	636,364	974,024	591,153	592,904
Delaware	245,272	178,428	146,346	158,192	195,761
Georgia	942,466	971,207	792,315	858,603	970,832
Hawaii	22,042	33,550	23,346	19,599	81,219
Idaho		1,500	400	25,942	(a)
Indian Territory	5,152	1,800			
Maine	2,400,509	2,713,795	2,560,021	2,146,420	2,027,508
Maryland	815,471	957,048	883,881	1,183,753	762,442
Massachusetts	2,554,748	2,251,319	3,327,416	2,328,777	2,027,463
Minnesota	405,956	481,908	626,069	546,603	629,427
Missouri	155,716	180,579	150,009	136,405	157,968
Montana	33,890	126,430	114,005	102,050	(a)
Nevada	1,200				
New Hampshire	927,487	838,371	818,131	647,721	867,028
New Jersey	37,197	76,758	101,224	75,757	125,804
New Mexico				167,294	
New York	196,685	134,425	304,048	289,722	367,066
North Carolina	297,749	564,578	778,847	889,976	764,272
Oklahoma	26,930	18,920	18,847	24,550	23,239
Oregon	235,213	85,330	58,961	117,625	271,869
Pennsylvania	471,528	450,619	349,453	366,679	324,241
Rhode Island	684,952	556,364	622,812	674,148	556,474
South Carolina	382,428	297,284	247,998	129,377	297,874
South Dakota	900			690	(a)
Texas	348,317	132,193	168,061	122,158	190,055
Utah	7,980	13,630	4,948	5,240	5,229
Vermont	2,447,979	2,571,850	2,934,825	2,693,889	2,451,933
Virginia	510,788	452,390	340,900	398,426	321,530
Washington	422,508	681,730	459,975	562,352	870,944
Wisconsin	724,422	825,625	798,213	1,228,863	1,529,781
Wyoming	557		600	90	(a)
Other States	440				40,320
Total	17,191,479	17,563,139	18,562,806	18,064,708	18,420,080

[a] Included in other States.

The following table shows the value of the granite, including small values for trap and other igneous rocks, produced in the United States in 1907 and 1908, by States and Territories and by uses.

Value of granite and other igneous rocks produced in the United States in 1907 and 1908, by States and Territories and uses.

1907.

State or Territory.	Sold in the rough.			Dressed for building.	Dressed for monumental work.	Made into paving blocks.	Curbing.	Flagging.
	Building.	Monumental.	Other.					
Arizona	$700				$3,000			
Arkansas							$10,973	
California	35,322	$49,216	$6,018	$485,778	80,397	$133,013	107,138	$2,018
Colorado	10,516	18,041		1,490	34,937		2,150	
Connecticut	31,928	26,302	838	110,600	112,393	37,666	24,551	2,357
Delaware	1,649	45		1,470		12,763	8,004	450
Georgia	89,675	31,100	17,050	76,252	1,000	151,181	215,758	5,515
Hawaii								
Idaho		1,800			5,000		1,750	
Maine	318,816	60,263	23,482	1,007,572	166,789	355,462	139,148	18,742
Maryland	107,694	13,657	240	55,781	8,928	56,585	23,279	13,406
Massachusetts	267,984	337,016	39,327	907,119	66,578	319,037	87,898	4,632
Minnesota	8,829	69,936	1,200	52,248	264,333	20,741	22,991	3,768
Missouri	342	34,530		8,550	16,675	15,966		
Montana	2,000	2,000		51,000	13,000	700	4,700	2,000
New Hampshire	49,831	90,352	36	224,269	133,601	74,978	43,944	2,865
New Jersey	4,858	105	500	8,075	300	1,456		
New Mexico								
New York	6,800	4,000		31,567	7,089		1,686	
North Carolina	50,062	16,010	50	319,821	41,120	65,379	63,061	4,236
Oklahoma	4,750	6,000	500	7,000	700		150	
Oregon	3,910	3,100	120	1,250	9,200	8,600	1,510	18
Pennsylvania	189,837	8,846	1,256	60,863		21,310	7,086	
Rhode Island	8,125	172,396	642	172,041	200,573	85,091	50	
South Carolina	9,425	50,515		900		5,253	18,491	25
South Dakota				690				
Texas	8,739	15,447		14,747	44,460	25	780	
Utah	782	1,658	2,000		800			
Vermont	29,764	1,122,063	6,334	1,009,353	515,859	5,330	2,721	
Virginia	19,350	8,039		13,275	9,787	18,072	6,000	
Washington	7,660	34,145	16,750	126,782	1,677	917	25,802	
Wisconsin	11,331	62,745	70,753	4,100	361,296	538,783		9,822
Wyoming	90							
	1,280,769	2,239,327	187,096	4,752,593	2,099,492	1,928,308	819,621	69,854

State or Territory.	Rubble.	Riprap.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona	$200					$9,800	$13,700
Arkansas	25,271	$13,160	$6,000		$113,592		168,996
California	191,996	36,991	79,254	$5,220	40,713	53,250	1,306,324
Colorado							67,134
Connecticut	114,178	118,830	7,000		3,510	1,000	591,153
Delaware	3,033	12,184	40,298	36,668	41,628		158,192
Georgia	26,954	925	25,000	152,297	60,896	5,000	858,603
Hawaii					7,599	12,000	19,599
Idaho			17,392				25,942
Maine	17,025	2,998	1,511	325	19,926	14,361	2,146,420
Maryland	77,901	7,266	282,310	41,266	490,378	5,062	1,183,753
Massachusetts	118,308	43,900	70,585	1,086	63,297	2,010	2,328,777
Minnesota	15,379	16,700	8,373	14,000	48,105		546,603
Missouri		8,375	16,424	100	35,443		136,405
Montana	20,650	6,000					102,050
New Hampshire	5,572	3,949	3,975		14,349		647,721
New Jersey	500		11,890	45,880	2,193		75,757
New Mexico				167,294			167,294
New York	762	4,900	70,750	19,300	35,591	107,277	289,722
North Carolina	6,823	2,941	53,939	175,847	106,497	690	906,476
Oklahoma	650	3,600			1,200		24,550
Oregon	614		80,103	1,744	7,450	6	117,625
Pennsylvania	19,801	100	28,117	2,726	9,711	17,026	366,679
Rhode Island	448	1,002	25,480		5,550	2,750	674,148
South Carolina	13,939	25	25,887	17	4,500	400	129,377
South Dakota							690
Texas		10,600	16,000		11,360		122,158
Utah							5,240
Vermont	25	9	2,431				2,693,889
Virginia	16,350	28,852	59,937	50,804	167,960		398,426
Washington	40,818	281,936	17,930			7,935	562,352
Wisconsin	801	14,790	110,072		44,082	288	1,228,863
Wyoming							90
	717,998	620,033	1,060,658	714,574	1,335,530	238,855	18,064,708

Value of granite and other igneous rocks produced in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1908.

State or Territory.	Sold in the rough.			Dressed for building.	Dressed for monumental work.	Made into paving blocks.	Curbing.	Flagging.
	Building.	Monumental.	Other.					
Arizona	$5,844			$100	$2,500			
Arkansas	100				40		$945	
California	58,743	$44,694	$80,146	719,833	53,784	$66,079	123,568	
Colorado	6,495	27,353	850	50,000	36,584			
Connecticut	33,833	23,218	8,051	117,242	58,672	14,951	25,324	$999
Delaware	1,228			947	12,492	6,050	5,579	96
Georgia	60,850	27,450	1,300	125,350	9,500	135,510	346,383	36,000
Hawaii								
Maine	293,371	63,799	8,382	1,055,989	111,774	368,715	75,247	7,558
Maryland	119,094	6,824	11,600	48,407	3,273	71,316	26,003	3,869
Massachusetts	180,063	358,830	50,436	720,796	115,386	261,880	91,430	2,897
Minnesota	55,243	33,600	3,050	34,453	346,389	35,750	17,462	1,954
Missouri	728	35,455	240	12,500		75,320		
New Hampshire	92,738	111,253	2,300	355,628	136,772	103,833	35,379	520
New Jersey	11,910	8,869	1,050	5,548	8,550	2,674		
New York	11,441	7,166	1,200	63,276	14,625	98,273	2,400	
North Carolina	109,919	29,822		144,261	46,834	122,488	99,070	8,258
Oklahoma	400	3,300		10,400	3,000	400	2,000	
Oregon	12,973	940	1,205	5,428	45,000	40,000	225	
Pennsylvania	164,008	6,172	173	38,531	3,066	23,628	11,259	586
Rhode Island	5,272	149,638	820	71,613	262,376	29,651	577	399
South Carolina	12,699	52,565	45	12,012	18,697	12,277	11,670	100
Texas	13,790	42,026		2,109	51,280	300	12,750	
Utah	917	2,900		337	1,000			
Vermont	79,711	1,095,223	3,472	676,067	582,051	1,547	3,836	
Virginia	26,769	12,664	1,000	11,500	22,303	10,173	6,130	
Washington	11,151	29,620		37,702	41,294	255	38,035	
Wisconsin	9,271	45,838		34,123	337,200	939,485	5,350	5,508
Other States	545	7,400	875	18,000			2,100	2,000
	1,379,106	2,226,619	176,195	4,372,152	2,324,442	2,420,555	942,722	70,744

State or Territory.	Rubble.	Riprap.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona			$100				$8,544
Arkansas	$29,476	$22,635	6,500		$92,771	$100	152,567
California	51,833	164,323	178,073	$41,470	101,612	346	1,684,504
Colorado							121,282
Connecticut	210,170	92,931	2,000		3,890	1,623	592,904
Delaware	35,571	1,349	69,462	37,065	25,922		195,761
Georgia	119,516	36,000	2,500	9,543	50,518	10,412	970,832
Hawaii		900	22,035		49,219	9,065	81,219
Maine	6,726	12,326	2,557	150	9,818	11,096	2,027,508
Maryland	60,359	7,751	206,505	32,923	143,838	20,680	762,442
Massachusetts	106,461	8,733	82,501	9,268	33,942	4,840	2,027,463
Minnesota	18,490	34,056	10,141	17,000	21,149	690	629,427
Missouri		3,771	6,051		15,741	8,162	157,968
New Hampshire	7,865	3,482	6,329		10,126	803	867,028
New Jersey	150	600	8,200	72,195	6,058		125,804
New York	15,119	733	102,040	28,837	21,906	50	367,066
North Carolina	4,933	730	114,474	33,612	27,333	22,538	764,272
Oklahoma	2,000			39	1,700		23,239
Oregon	709	600	158,051		6,718	20	271,869
Pennsylvania	6,674	14,696	28,261	1,909	11,595	13,683	324,241
Rhode Island	393	421	27,476		3,838	4,000	556,474
South Carolina	9,475	73,984	30,300	27,500	35,000	1,550	297,874
Texas	25	63,974	1,080		2,721		190,055
Utah		75					5,229
Vermont	385		8,641	1,000			2,451,933
Virginia	18,270	16,336	21,670	71,704	102,936	75	321,530
Washington	7,432	672,278	29,616		1,821	1,740	870,944
Wisconsin	5,488		76,703		70,815		1,529,781
Other States	600		6,400		2,400		40,320
	718,120	1,232,684	1,207,666	384,215	853,387	111,473	18,420,080

The following table shows the quality and value of granite paving blocks produced in the United States in 1907 and 1908, by States:

Number and value of granite paving blocks produced in 1907 and 1908, by States and Territories.

State or Territory.	Paving blocks.			
	1907.		1908.	
	Number.	Value.	Number.	Value.
California	2,674,307	$133,013	1,657,600	$66,079
Connecticut	854,134	37,666	292,485	14,951
Delaware	298,073	12,763	121,000	6,050
Georgia	5,410,000	151,181	4,735,770	135,510
Maine	6,292,753	355,462	8,005,662	368,715
Maryland	901,225	56,585	692,538	71,316
Massachusetts	5,995,040	319,037	6,134,648	261,880
Minnesota	315,000	20,741	532,750	35,750
Missouri	336,007	15,966	1,826,742	75,320
Montana	10,000	700		
New Hampshire	1,782,406	74,978	2,842,206	103,833
New Jersey	43,426	1,456	96,956	2,674
New York			1,573,777	98,273
North Carolina	1,115,859	65,379	3,679,745	122,488
Oklahoma			5,900	400
Oregon	200,000	8,600	1,000,000	40,000
Pennsylvania	442,500	21,310	529,037	23,628
Rhode Island	1,643,360	85,091	567,416	29,651
South Carolina	239,086	5,253	351,250	12,277
Texas	800	25	6,000	300
Vermont	171,000	5,330	58,200	1,547
Virginia	685,100	18,072	358,664	10,173
Washington	13,921	917	3,000	255
Wisconsin	9,136,584	538,783	13,399,882	939,485
Total	38,560,581	1,928,308	48,471,228	2,420,555
Average value per thousand		50.00		49.94

This table shows a considerable gain in the granite paving-block industry—from 38,560,581 blocks, valued at $1,928,308, in 1907 to 48,471,228 blocks, valued at $2,420,555, in 1908, a gain of 9,910,647 blocks and of $492,247 in 1908. The average price per thousand, however, remained practically the same, $50 for both years. These figures include the blocks made by "motions" operators and sold through large firms.

Granite production of Vermont.—In 1907 a detailed statement of the granite output of Vermont in 1906 and 1907 was prepared for inclusion in the forthcoming report on the granites of Vermont by T. Nelson Dale (Bull. U. S. Geol. Survey No. 404). The figures for 1907 are presented again, together with a like statement for 1908.

The following table shows the production of granite in Vermont in 1907 and 1908 by counties and uses.

Production of granite in Vermont in 1907 and 1908, by counties.

1907.

County.	Number of firms reporting.	Building.			
		Rough.		Dressed.	
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.
Washington and Orange	39	35,543	$25,239	100,081	$234,583
Windsor	4			204,076	774,460
Caledonia and Orleans	9	3,300	1,400		
Windham	3	4,450	3,125	325	310
Total	55	43,293	29,764	304,482	1,009,353
Average value per cu. ft			.68		3.31

Production of granite in Vermont in 1907 and 1908, by counties—Continued.

1907—Continued.

County.	Monumental.				Paving.		Other purposes.	Total value.
	Rough.		Dressed.					
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
Washington and Orange	1,144,263	$1,037,993	136,103	$503,759	5,000	$150	$3,645	$1,805,369
Windsor	1,847	3,254	3,000	12,000				789,714
Caledonia and Orleans	143,427	77,816					1,751	80,967
Windham	3,371	3,000	40	100	166,000	5,180	6,124	17,839
Total	1,202,908	1,122,063	139,143	515,859	171,000	5,330	11,520	2,693,889
Average value per cu. ft.		.93		3.70				

1908.

County.	Number of firms reporting.	Building.			
		Rough.		Dressed.	
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.
Washington and Orange	39	15,896	$9,871	129,230	$429,967
Windsor	3	63,537	59,054	52,866	244,850
Caledonia and Orleans	9	12,753	3,999		
Windham	3	12,050	6,787	1,225	1,250
Total	54	104,236	79,711	173,321	676,067
Average value per cu. ft			.76		3.90

County.	Monumental.				Paving.		Other purposes.	Total value.
	Rough.		Dressed.					
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Value.	
Washington and Orange	1,094,619	$1,015,006	164,706	$576,551	50,400	$1,262	$14,443	$2,047,100
Windsor	12,000	6,000						309,904
Caledonia and Orleans	117,560	66,580	1,000	5,000			2,175	77,754
Windham	11,750	7,637	200	500	7,800	285	716	17,175
Total	1,235,929	1,095,223	165,906	582,051	58,200	1,547	17,334	2,451,933
Average value per cu. ft.		.89		3.51				

TRAP ROCK.

Besides the trap rock given in the following tables there is a small quantity contained in the figures on granite under those States in which trap rock does not form enough of an industry to warrant the separate publication of the figures. The California output of trap rock includes a considerable quantity of basalt.

The total output of trap rock in 1908 was valued at $4,282,406; in 1907 it was $4,594,103, a loss of $311,697 in 1908. The chief decrease was in crushed stone, which forms the basis of the trap-rock industry and which decreased in value from 6,073,472 short tons, valued at $4,280,554, in 1907, to 6,058,194 short tons, valued at $4,002,220, in 1908, a decrease of 15,278 short tons in quantity and of $278,334 in value, a noticeable decrease in value rather than in quantity. The average price per ton in 1907 was 70 cents and 66 cents in 1908. There was a slight increase in the paving-block output, and a decrease in the trap used for building.

New Jersey had the largest output of trap rock in 1908, followed by California, New York, Pennsylvania, Massachusetts, and Connecticut in the order named. In 1907 California, on account of large demand for crushed stone to repair roads damaged by the earthquake of 1906, took first rank, followed by New Jersey, New York, Pennsylvania, Connecticut, and Massachusetts.

In the different crushed-stone products there was a decrease in the stone for road making and concrete, and a slight increase in stone for railroad ballast. New Jersey showed the largest production of stone for road making in 1908, Pennsylvania for railroad ballast, and California for concrete.

The following table shows the value of the trap-rock output in the United States in 1907 and 1908, by States and uses:

Value of trap produced in the United States in 1907 and 1908, by States and uses.

1907.

State.	Building.	Paving.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
California	$4,600	$132,345	$435,241	$89,031	$356,427	$12,105	$1,029,749
Connecticut	6,052	15,110	215,206	74,660	144,825	4,100	459,953
Massachusetts	20,947		225,983	41,774	141,370	2,530	432,604
New Jersey	5,369	31,126	557,655	161,367	224,587	15,332	995,436
New York		1,500	764,582	7,367	107,090	34,856	915,395
Pennsylvania	11,235	2,409	236,485	306,698	190,206	13,933	760,966
	48,203	182,490	2,435,152	680,897	1,164,505	82,856	4,594,103

1908.

State.	Building.	Paving.	Road making.	Railroad ballast.	Concrete.	Other.	Total.
California	$722	$114,996	$423,798	$148,154	$285,380	$6,089	$979,139
Connecticut	7,594	8,125	199,540	100,000	152,950	5,010	473,219
Massachusetts	12,235		348,108	30,695	117,134	500	508,672
New Jersey	11,399	58,169	578,570	182,355	235,967	13,054	1,079,514
New York			567,908	20,580	107,234	28,231	723,953
Pennsylvania	8,593	2,835	195,769	201,091	106,987	2,634	517,909
	40,543	184,125	2,313,693	682,875	1,005,652	55,518	4,282,406

The following table shows the quantity and value of trap paving blocks produced in the United States in 1907 and 1908, by States:

Number and value of trap paving blocks produced in the United States, 1907–8, by States.

State.	Paving blocks.			
	1907.		1908.	
	Number.	Value.	Number.	Value.
California	2,494,989	$132,345	2,765,587	$114,996
Connecticut	474,580	15,110	232,160	8,125
New Jersey	1,107,000	31,126	1,665,983	58,169
New York	50,000	1,500		
Pennsylvania	55,900	2,409	63,000	2,835
Total	4,182,469	182,490	4,726,730	184,125
Average price per thousand		41		38.95

SANDSTONE.

The decrease of $1,277,587 in the output of sandstone for 1908, when the value of the output was $7,594,091 as contrasted with a value of $8,871,678 in 1907, was a much larger decrease than for previous years, although the value of the sandstone production has been on the decrease since 1903, when it was $11,262,259. The total value for 1908 is the smallest since 1900, when the value was $6,471,384.

New York, Pennsylvania, and Ohio, with total values, respectively, of $1,774,843, $1,368,784, and $1,244,752 in 1908, were the leading sandstone-producing States. In 1907 the rank and output of these States were, Pennsylvania, $2,064,913; New York, $1,978,117; and Ohio, $1,591,148. Each of these States showed a decrease for 1908, but New York exceeded Pennsylvania in value of output and ranked first. The next States in rank in 1908 were Washington, Arizona, California, Massachusetts, and Wisconsin, with values of production ranging from $464,587 to $219,130; in 1907 the corresponding States were California, Minnesota, Colorado, Washington, and Massachusetts, with values ranging from $437,738 to $243,323. The greater number of sandstone-producing States showed a decreased value of output; but Washington and Arizona had a marked increase in value of output. The value of sandstone in Washington in 1908 was $464,587; in 1907 it was $295,585, an increase for 1908 of $169,002. This increase was due to a large demand for paving blocks during the improvement and extension of streets in the cities of Seattle and Tacoma. The output of Arizona was valued at $396,358 in 1908; in 1907 it was $158,435, an increase of $237,923 for 1908. This was accounted for by the large quantity of stone, reported as a fine-grained sandstone, quarried and used at Roosevelt in the work on the irrigation dam.

In New York and Pennsylvania a part of the sandstone output is known to the trade as bluestone, the production of which is given in a separate table.

Building stone.—Sandstone for building purposes, including rough and dressed stone, decreased in value from $3,154,783 in 1907 to $2,605,381 in 1908, a loss of $549,402. Pennsylvania, New York, and Ohio produced most of the building stone, each State showing a decreased output for 1908.

Ganister.—Ganister reported from Pennsylvania, Wisconsin, Colorado, Maryland, Ohio, and Illinois was valued at $175,325 in 1908 as against $308,520 in 1907, a decrease in 1908 of $133,195.

Paving.—Notwithstanding a considerable increase in value in the State of Washington the total value of the paving stone decreased $229,947—from $884,843 in 1907 to $654,896 in 1908. Besides Washington, New York and Minnesota were large producers of this product.

Curbing.—Sandstone for curbing was valued at $1,025,259 in 1908; in 1907 the value was $1,380,516, a decrease of $355,257 for 1908. New York, Ohio, and Pennsylvania, the principal producers of this material, showed marked decreases in value. The New York and Pennsylvania output was chiefly bluestone.

Flagging.—New York, Ohio, and Pennsylvania were the chief States producing flagstone, and although the New York output increased somewhat, the output from the other States showed such decided decreases that the total decrease amounted to $118,545—from $1,185,879 in 1907 to $1,067,334 in 1908.

Rubble.—Rubble increased in value $113,328—from $556,440 in 1907 to $669,768 in 1908.

Riprap.—Sandstone sold for riprap increased in value from $289,419 in 1907 to $370,161 in 1908, a gain of $80,742.

Crushed stone.—There was a decrease in value in crushed stone of $81,211—from $987,528 in 1907 to $906,317 in 1908. The quantity decreased from 1,336,314 short tons in 1907 to 1,199,872 short tons in 1908, a decrease of 136,442 tons. The average price per ton in 1908 was 76 cents; in 1907 it was 74 cents.

The following table shows the value of the sandstone production in the United States from 1904 to 1908, inclusive, by States and Territories:

Value of sandstone production in the United States, 1904–1908, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	$12,788	$28,107	$40,467	$48,673	$34,099
Arizona	91,960	65,558	33,149	158,435	396,358
Arkansas	63,950	58,161	55,703	94,275	42,463
California	735,662	685,668	642,166	437,738	330,214
Colorado	281,142	453,029	286,544	299,443	181,051
Connecticut	117,696	62,618	(a)	(a)	55,949
Idaho	9,320	22,265	11,969	24,001	33,394
Illinois	47,377	29,115	19,125	14,996	12,218
Indiana	22,681	15,421	30,740	15,425	3,342
Indian Territory		2,198	615		
Iowa	9,300	9,335	5,600	3,542	2,337
Kansas	130,516	79,617	42,809	46,831	67,950
Kentucky	93,622	280,579	125,123	98,450	78,732
Louisiana	8,315				
Maryland	8,998	12,984	9,533	13,859	6,262
Massachusetts	320,861	367,461	260,721	243,323	241,462
Michigan	74,868	123,123	65,395	53,003	39,103
Minnesota	319,209	294,640	285,433	300,204	197,184
Missouri	44,455	27,686	20,951	35,289	17,954
Montana	64,232	45,116	37,462	39,216	51,564
Nebraska	142	120	6,899	11,609	[b] 15,815
Nevada	10,558	1,500			(c)
New Jersey	236,426	294,719	215,142	177,667	154,422
New Mexico	133,390	101,522	42,574	12,450	[d] 10,410
New York	[e] 1,755,524	[e] 1,831,756	[e,f] 1,905,892	[e,f] 1,978,117	[e] 1,774,843
North Carolina	250	4,483	3,531	4,105	[g] 12,266
North Dakota		1,055	44	3,260	(h)
Ohio	1,808,062	1,744,472	1,426,645	1,591,148	1,244,752
Oklahoma	2,995	12,914	40,246	43,403	57,124
Oregon	6,186	1,229	25,950	3,904	(h)
Pennsylvania	[e] 2,641,510	[e] 2,487,939	[e] 2,724,874	[e] 2,064,913	[e] 1,368,784
South Dakota	338,970	193,408	145,966	143,585	128,554
Tennessee	24,868	8,715	14,136	16,523	(i)
Texas	209,313	123,281	111,533	108,047	154,948
Utah	70,168	43,429	137,529	24,298	25,097
Virginia	13,522	2,000	5,100	(j)	(i)
Washington	88,185	124,910	169,500	295,585	464,587
West Virginia	287,381	171,309	113,369	[k] 197,926	127,149
Wisconsin	158,503	161,741	181,986	236,183	219,130
Wyoming	30,986	33,591	24,715	32,252	44,574
	10,273,891	10,006,774	9,169,337	8,871,678	7,594,091

a Included in New York.
b Includes North Dakota and Oregon.
c Included with New Mexico.
d Includes Nevada.
e Includes bluestone.
f Includes Connecticut.
g Includes Tennessee and Virginia.
h Included with Nebraska.
i Included with North Carolina.
j Included in West Virginia.
k Includes a small value for Virginia.

The following table shows the value of the sandstone production of the United States in 1907 and 1908, by States and Territories, and uses:

Value of sandstone production in the United States in 1907 and 1908, by States and Territories and uses.

1907.

State or Territory.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama							$4,095
Arizona	$3,113						60,427
Arkansas	3,680	$800		$525	$16,095	$950	4,325
California	14,318	215,453		4,761	3,950	3,600	20,207
Colorado	67,020	10,283	$35,100	25,638	36,987	46,974	32,792
Connecticut							
Idaho	12,739	5,525					5,737
Illinois	6,464	4,120	1,900	375		50	1,639
Indiana	5,600	2,000		977	325	73	4,850
Iowa	2,765						606
Kansas	11,037	600		28	13,112	20,027	1,204
Kentucky	37,210	38,170		2,700	1,120	3,000	8,601
Maryland	1,769	30	10,200		1,643		100
Massachusetts	38,779	52,729		750			10,215
Michigan	33,561	10,918				528	7,900
Minnesota	9,438	109,270		78,211	19,440	1,968	32,450
Missouri	17,292	7,911		50	150	325	2,940
Montana	8,550	26,357					2,829
Nebraska	1,409						400
New Jersey	83,513	30,750	455	840	240	4,800	47,000
New Mexico	2,640	1,460			50	100	7,900
New York	144,673	401,742		368,697	621,934	361,383	22,454
North Carolina		2,650					455
North Dakota	3,200			60			
Ohio	228,777	373,224	5,500	1,408	336,974	469,072	45,041
Oklahoma	8,758	160		16	85	210	5,354
Oregon	3,306	48			21		
Pennsylvania	181,914	469,233	206,661	145,629	315,307	270,227	116,109
South Dakota	17,288	14,745		60,015	335	584	19,458
Tennessee	795	13,000			90		2,240
Texas	12,680	12,562			450		11,200
Utah	5,353	1,002		15,660			583
Virginia							
Washington	16,680	95,640		175,285			750
West Virginia	46,263	59,609		3,085	12,038		42,021
Wisconsin	56,566	86,267	48,704	333		1,408	25,156
Wyoming	18,850	2,525			170	600	9,402
	1,106,000	2,048,783	308,520	884,843	1,380,516	1,185,879	556,440

Value of sandstone production in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1907—Continued.

State or Territory.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
Alabama	$44,578					$48,673
Arizona	250			$41,645	$53,000	158,435
Arkansas	1,350	$375		66,025	150	94,275
California	2,880	108,244	$163	64,162		437,738
Colorado	4,064	900	21,580	18,095	10	299,443
Connecticut						(a)
Idaho						24,001
Illinois	418				30	14,996
Indiana	1,600					15,425
Iowa	171					3,542
Kansas					823	46,831
Kentucky	2,022	1,572		1,130	2,925	98,450
Maryland				117		13,859
Massachusetts		18,653		122,197		243,323
Michigan	96					53,003
Minnesota	8,364	31,510		1,978	7,575	300,204
Missouri	3,600				3,021	35,289
Montana	1,246				234	39,216
Nebraska	9,750			50		11,609
New Jersey		5,550		4,519		177,667
New Mexico		300				12,450
New York	1,933	35,549		8,225	11,527	b c 1,978,117
North Carolina					1,000	4,105
North Dakota						3,260
Ohio	54,222	12,357	21,200	21,118	22,255	1,591,148
Oklahoma	2,700		26,000		120	43,403
Oregon	427	102				3,904
Pennsylvania	99,518	75,496	88,960	80,986	14,873	c 2,064,913
South Dakota	15,360	14,000			1,800	143,585
Tennessee		94			304	16,523
Texas	15,555		21,850	33,750		108,047
Utah					1,700	24,298
Virginia						(d)
Washington	6,730		500			295,585
West Virginia	4,901	240	1,220	27,845	704	e 197,926
Wisconsin	7,534	7,455		1,381	1,379	236,183
Wyoming	150	60		375	120	32,252
	289,419	312,457	181,473	493,598	123,750	8,871,678

a Included in New York.
b Includes Connecticut.
c Includes bluestone.
d Included in West Virginia
e Includes small output for Virginia.

Value of sandstone production in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1908.

State or Territory.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama							$3,450
Arizona	$4,600	$6,500				$38	378,500
Arkansas	4,158	850			$13,800	625	2,650
California	26,326	79,050			4,925	700	9,505
Colorado	56,767	17,534	$14,861	$14,895	13,480	32,510	23,668
Connecticut	5,901	50,048					
Idaho	13,605	11,932					7,857
Illinois	6,174	3,265	700	75			538
Indiana	500	150			200	192	2,300
Iowa	1,737						460
Kansas	12,780	500			15,265	16,020	300
Kentucky	29,337	46,699		275	15	300	1,560
Maryland	2,850	106	2,419				
Massachusetts	59,229	52,300					3,150
Michigan	15,100	18,813					5,190
Minnesota	5,795	25,693		81,104	24,129	1,849	28,859
Missouri	2,820	7,556			52	292	1,772
Montana	40,755	3,674					3,830
Nebraska	7,016	3,419				100	525
Nevada							
New Jersey	72,693	28,905			250	2,900	22,998
New Mexico	900	1,230			50	580	7,122
New York	217,968	270,853		231,789	420,404	456,091	2,230
North Carolina	4,000	6,600					1,250
North Dakota							
Ohio	157,074	282,370	1,575	7,000	330,045	326,593	19,819
Oklahoma	8,149	960			50	100	7,033
Oregon							
Pennsylvania	136,084	362,388	111,870	16,310	199,800	226,940	66,470
South Dakota	46,093	9,875		48,700	250	360	7,893
Tennessee							
Texas	11,490	33,300			1,200		6,290
Utah	13,117	100		5,775	75		5,705
Virginia							
Washington	1,375	99,656		248,973			1,062
West Virginia	37,941	32,393			1,269	1,144	27,123
Wisconsin	82,705	27,460	43,900				14,458
Wyoming	23,563	12,600					6,201
	1,108,602	1,496,779	175,325	654,896	1,025,259	1,067,334	669,768

Value of sandstone production in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1908—Continued.

State or Territory.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
Alabama	$20,599			$10,000	$50	$34,099
Arizona			$2,500	4,220		396,358
Arkansas	3,725	$250		16,400	5	42,463
California	3,050	92,306	8,427	103,955	1,970	330,214
Colorado	40			6,210	1,086	181,051
Connecticut						55,949
Idaho						33,394
Illinois	122	1,200			144	12,218
Indiana						3,342
Iowa	65			40	35	2,337
Kansas		18,750		3,985	350	67,950
Kentucky	100			446		78,732
Maryland	363			524		6,262
Massachusetts	1,025	25,804		97,254	2,700	241,462
Michigan						39,103
Minnesota	4,755	8,204	7,404	8,392	1,000	197,184
Missouri	4,900				562	17,954
Montana	2,931				374	51,564
Nebraska	4,755					*a* 15,815
Nevada						(*b*)
New Jersey		4,260		22,316	100	154,422
New Mexico	75	253			200	*c* 10,410
New York	19,335	34,828	4,986	42,257	74,102	*d* 1,774,843
North Carolina					416	*e* 12,266
North Dakota						(*f*)
Ohio	32,716	40,555	4,970	38,800	3,235	1,244,752
Oklahoma	1,045		5,200	34,582	5	57,124
Oregon						(*f*)
Pennsylvania	33,273	53,279	75,778	66,037	20,555	*d* 1,368,784
South Dakota	4,883	6,000		2,500	2,000	128,554
Tennessee						(*g*)
Texas	58,230	27,000	7,038	850	9,550	154,948
Utah			125		200	25,097
Virginia						(*g*)
Washington	113,062			459		464,587
West Virginia	10,591	3,040	2,710	10,213	725	127,149
Wisconsin	50,521				86	219,130
Wyoming				2,010	200	44,574
	370,161	315,729	119,138	471,450	119,650	7,594,091

a Includes North Dakota and Oregon.
b Included with New Mexico.
c Includes Nevada.
d Includes bluestone.
e Includes Tennessee and Virginia.
f Included with Nebraska.
g Included with North Carolina.

BLUESTONE.

Bluestone as quarried in New York and northeastern Pennsylvania forms an important industry. Because of the peculiar method of quarrying bluestone, it has been found that the best figures of production are obtained from the dealers who buy the stone from the numerous small quarrymen, mostly farmers, who get out this stone at unoccupied intervals. The dealers usually quarry for themselves also, and are better able to give the entire quantity of stone bought and sold than are the small producers. The principal channels to market for this stone are the Erie Railroad, the New York, Ontario and Western Railway, and Hudson River, although some is shipped on other railroads.

The output for 1908 decreased in value. Producers and dealers generally reported lack of demand, with consequent lack of production, on account of financial conditions. The total value for 1908 was $1,762,860; for 1907 it was $2,117,916, a decrease in 1908 of $355,056.

Building stone increased in value $16,404, from $585,341 in 1907 to $601,745 in 1908. Stone for all other purposes decreased in value. As stated previously, bluestone in 1908 represented 59.18 per cent of the total output of flagging and 19.47 per cent of the total output of curbing for the entire United States. Both New York and Pennsylvania decreased in total value of output, although New York increased in value of building and crushed stone, while Pennsylvania decreased in value of all products.

The following table shows the value and uses of the bluestone produced in New York and Pennsylvania in 1907 and 1908:

Value and uses of bluestone produced in New York and Pennsylvania in 1907 and 1908.

1907.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
New York	$374,369	$468,045	$431,663	$2,675	$79,803	$1,356,555
Pennsylvania	210,972	253,523	128,740	54,552	113,574	761,361
	585,341	721,568	560,403	57,227	193,377	2,117,916

1908.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
New York	$415,652	$413,920	$313,319	$9,219	$68,852	$1,220,962
Pennsylvania	186,093	217,690	116,197	6,985	14,933	541,898
	601,745	631,610	429,516	16,204	83,785	1,762,860

MARBLE.

The figures for marble here presented include, for some of the States, the value of quantities of serpentine (verde antique marble) and "onyx" marble. The serpentine (verde antique marble) included is simply that form of serpentine which, from its use as ornamental stone for interior decorative work in buildings, answers the purpose of marble. The Georgia and Pennsylvania figures in this report include this stone. Onyx marble, or cave onyx, is included in the production of Kentucky and New Mexico in this report.

In 1908 the commercial output of marble was from Vermont, Georgia, Tennessee, New York, Massachusetts, Alabama, Pennsylvania, Maryland, California, Colorado, Alaska, North Carolina, Kentucky, New Mexico, Utah, Missouri, and Idaho, named in order of value of output. In 1907 the producing States, according to rank, were Vermont, New York, Georgia, Tennessee, Massachusetts, California, Pennsylvania, Maryland, Alabama, Alaska, Oklahoma, Kentucky, New Mexico, Utah, Washington, and Idaho, with a quantity for Missouri included with limestone. In 1908 Colorâdo and North Carolina reentered as productive States, and Oklahoma and Washington dropped out. Vermont, Tennessee, and Georgia increased in value of output; the other States decreased.

The marble output in the United States was valued at $7,733,920 in 1908; in 1907 the output was valued at $7,837,685, a loss of $103,765 for 1908.

The chief uses of marble are for building stone, exterior and interior work, and for monumental purposes.

Building stone.—The value of building marble, rough and dressed, as sold by the producer, was $3,076,926 in 1908, an increase of $217,689 over the value for 1907, which was $2,859,237. The total for 1908 includes $747,488 for rough building and $2,329,438 for dressed building; in 1907, the rough building marble sold was valued at $954,092 and the dressed building stone at $1,905,145, a decrease in 1908 of $206,604 for rough stock and an increase of $424,293 for dressed marble.

Vermont produces most of the building marble, the value of whose output in 1908 was $1,558,954, or 50.67 per cent of the total output of building marble. This was chiefly dressed stone. The percentage for Vermont in 1907 was 42.12 and the value was $1,204,212.

New York, whose marble output is chiefly dressed building stone, produced 17.78 per cent of the total building stone, at a value of $546,945. The Georgia output, which is principally rough stone, was valued at $468,981 and represented 15.24 per cent of the total.

Monumental stone.—Monumental marble was valued at $2,397,780 in 1908 and at $2,640,130 in 1907, a decrease of $242,350 for 1908. In 1908 the value of rough stock was $554,354 and of dressed monumental stone $1,843,426; the corresponding figures for 1907 were $596,130 for rough monumental stock and $2,044,000 for dressed monumental stone, a decrease in 1908 of $41,776 in value of rough stock and of $200,574 for dressed stone. Vermont, with a value of $1,848,444, produced 77.09 per cent of the total monumental marble; Georgia produced 10.82 per cent; and New York, with 4.57 per cent, ranked third. The Vermont stone was chiefly dressed stone, the Georgia material was rough stone, and the New York value was practically evenly divided between rough stone and dressed stone.

Interior work.—Vermont, Tennessee, and California produced most of the marble used for interior decoration, the total value for 1908 being $1,943,750, as against $1,900,952 for 1907, a gain in 1908 of $42,798. The Vermont output represents 60.93 per cent, the Tennessee output 28.37 per cent, and the California output 2.61 per cent of the total marble produced for interior work.

Other marble.—Rough stone for other purposes includes waste marble sold to lime burners, to carbonic acid factories, to pulp mills, to iron furnaces for flux, and for road making, etc., and dressed stone includes stone for mosaics, electrical work, etc.

The Alabama output was from Gantts Quarry and from the vicinity of Talladega, in Talladega County.

The Alaska output was from Marble Island, near Shakan, and from Calder, Prince of Wales Island. It is reported that eastern capital is to begin development in the Alaska marble field in the near future.

The Arizona Marble Company reports the opening and development of marble quarries near Bowie (Teveston post-office), Cochise County, Ariz. A description of the marble deposits in Cochise County is given in Bulletin No. 380 of the United States Geological Survey.[a]

---

[a] Paige, Sidney, Contributions to economic geology, 1908, pt. 1: Bull. U. S. Geol. Survey No. 380, 1909, pp. 299-311.

The decrease in value of California marble in 1908 was $122,877. The value of the output was $60,408 in 1908 and $183,285 in 1907. The producing localities in 1908 were Vallecito, Calaveras County, and Columbia, Tuolumne County. Development and assessment work was reported on quarry property at Inyo, Inyo County; Topaz, Mono County; and near Victorville and Redlands, San Bernardino County.

For the first time in several years Colorado reported a marble output. It was from Marble, Gunnison County, where after several years of development work the Colorado-Yule Marble Company and the Crystal River Marble Company have begun to put their material on the market. Development work was also reported in 1908 on a marble or onyx deposit near Salida, Chaffee County.

In 1907 New York exceeded Georgia, but in 1908 Georgia took second place and New York fourth. The output for Georgia in 1908 was valued at $916,281, and represented about 800,000 cubic feet of stone; in 1907 the total value was $864,757, and the quantity reported was about 807,000 cubic feet, an increase in value for 1908 of $51,524 and a decrease in quantity of about 7,000 cubic feet. Most of the Georgia marble is sold in the rough to the manufacturers.

The small output of marble reported from near Basin, Cassia County, Idaho, was used to supply local demand for cemetery stone.

The onyx marble reported from Kentucky was from near Cave City, Barren County.

The Maryland output was from Cockeysville and Loch Raven, Baltimore County.

The Massachusetts output was from Ashley Falls, Lee, and North Adams, Berkshire County, and from Westfield, Hampden County. Quarrying was also reported as carried on at South Egremont, Berkshire County, although no material was put on the market.

The marble reported from Missouri was quarried at Phoenix, Greene County, and quarry development was reported on marble property at Cassville, Barry County.

Sample blocks of marble were reported from Nevada as quarried at Luning, Esmeralda County, and at Las Vegas, Lincoln County, although none was marketed.

The "onyx" marble reported from New Mexico in 1908 was from Alamogordo, Otero County.

New York decreased $205,093 in value of output in 1908, or from $911,951 in 1907 to $706,858 in 1908. About 280,000 cubic feet were sold for building and monumental work, and besides this about 30,000 long tons were sold for flux, crushed stone, and other uses.

The marble reported from North Carolina in 1908 was quarried at Murphy, Cherokee County.

There is included in the Pennsylvania output a quantity of serpentine (verde antique marble), used chiefly for interior decorations. This serpentine is quarried near Easton, Northampton County. The other marble is quarried at West Grove, Chester County, in Derry Township, Dauphin County, and at King of Prussia, Montgomery County. There was a decrease of $15,792 in the output for 1908, which fell from $118,539 in 1907 to $102,747 in 1908.

A marble deposit near Westminster, Oconee County, S. C., was reported to this office as opened in 1908 with a view to placing the product on the market.

Tennessee, ranking third in 1908 as against fourth in 1907, increased in value of marble output from $688,148 in 1907 to $790,233 in 1908, a gain of $102,085. The 1907 value was represented by 400,393 cubic feet and the 1908 value by 476,795 cubic feet, a gain for 1908 of 76,402 cubic feet.

A marble deposit near Alpine, Brewster County, Tex., has been reported as opened during 1908, but no marble was placed on the market.

The small quantity of marble quarried in Utah in 1907 was from Beaver, Beaver County, and was for monumental work.

Vermont in 1907 produced 58.65 per cent of the marble output of the United States. In 1908, with a small increase in the total output for the State, Vermont produced 60.51 per cent of the total for the United States. The Vermont production increased $83,236 in value, from $4,596,724 in 1907 to $4,679,960 in 1908, The quantity reported for 1907 was about 1,450,000 cubic feet; in 1908 the quantity reported was about 1,250,000 cubic feet, a decrease in production of about 250,000 cubic feet, though with an increase in value. The Vermont marble is used for building, monumental, and interior decorative work, ornaments, mosaic work, electrical work, etc., and is practically all sold as dressed stone.

ONYX MARBLE.

In order to comply with repeated requests concerning onyx marble, the following brief description is given. A more detailed statement may be found in a report on onyx marbles by George P. Merrill, curator of geology, United States National Museum.[a]

The name onyx, as applied to marble, is not to be taken as meaning precious onyx, a variety of quartz closely allied to agate. The "onyx marble" included in this report differs from ordinary marble chiefly in manner of deposition in the earth, both being essentially carbonate of lime. The ordinary marble is a crystalline form of common limestone, formed by metamorphism; onyx marble is a name given to two varieties of calcite or travertine formed by deposition from aqueous solutions of calcium carbonate, which from the manner of deposition contains bands of wavy lines similar to the banded structure of the precious onyx. One form of onyx marble is found in the stalactite and stalagmite formations so familiar in caves and is a deposit from the cold water charged with calcium carbonate, which seeps through the cracks in the roof or floor of a limestone cavern. This is usually called cave onyx. The other form of onyx marble is the one that is formed from hot springs by the precipitation of calcareous matter from an oversaturated solution of calcium carbonate. This is generally called onyx marble.

The physical differences between these two varieties are found in the fact that the onyx marbles are translucent and the cave onyxes are generally opaque. The onyx marble is generally more brilliantly colored and more beautiful than the cave onyxes; the onyx marble is especially noted for its uniformity of structure and homogeneous texture, but the cave onyxes often show a fibrous structure and are

[a] The onyx marbles; their origin, composition, and uses, both ancient and modern: Rept. U. S. Natl. Mus. for 1893, pp. 539-585, pls. 1-18.

made up of concretionary layers which scale off. The coloring in each is due to the presence or absence of impurities in the water, such as oxides of iron, aluminum, manganese, etc. The cave onyxes generally contain fewer impurities than the onyx marbles. It is of interest to note in connection with onyx marbles and cave onyxes that the best of the onyx is found in regions either formerly subjected to volcanic action or closely connected with hot springs or deposits associated with hot springs, like those in California, Arizona, Utah, New Mexico, and Lower California.

The chief beauty, and therefore value, of the onyx marble consists in the nearly perfect uniformity of texture and structure, the translucency which gives the appearance of depth, and the delicacy of the coloring. The various colors of the stone show translucent whites, delicate greens shading to very dark greens, delicate pinks, light browns and chocolates, amber, ocher, yellow, brilliant red, orange, lemon, and often veining of other colors. The coloring is in some cases not uniform throughout and generally has a wavy effect, with sometimes alternating bands of light and dark shades. The white onyx marbles are sometimes called and sold under the name of alabaster. The true alabaster is, however, a variety of gypsum and is softer and less durable than the onyx marble.

The value of a deposit of onyx depends on the size and thickness of the stone that can be obtained from it, as well as on the coloring and texture of the stone. It is generally cut in slabs, but is also sold in rough blocks suitable for carving or being made into columns.

This stone takes a high polish and is easily worked. The price commanded in the market is determined by the beauty of the stone, the size of the block or slab, the amount of work necessary to put it in shape, the difficulty of quarrying or obtaining it, and the difficulty of transportation. The cave onyxes seldom yield blocks or slabs sufficiently large and uniform in texture to make them very valuable, except for small ornaments and interior work where large pieces are not required.

The best known quarries of onyx in America are in Mexico; from them large and beautiful slabs are obtained, and the small pieces when carved and polished are made into ornamental pieces and sold in various forms as souvenirs. The principal deposits are near Veracruz and the City of Mexico, at Tecali, near the city of Puebla, and in the district of Tehuacan. Also on Mexican territory are the onyx deposits of Lower California, near the Gulf coast, which are probably the most important in Mexico. Egypt, Algiers, Persia, Italy, France, Spain, Germany, and the caves of Gibraltar also have more or less valuable deposits of this stone, the Egyptian and Algerian product being generally known as alabaster.

The onyx marble of the United States, except perhaps that of California and Arizona, is not considered as good as the Mexican article in color or in fineness of texture and is more expensive for the reason that labor is cheaper in Mexico and that in Mexico the quarries have been opened long enough to have transportation facilities. In most cases in the United States the onyx is found in territory which is but little developed and in which both labor and transportation are high, and the deposits are owned by firms and individuals who have not the means necessary to develop them. The principal deposits in the United States are in Arizona, Arkansas, California, Colorado, Idaho, Connecticut, Missouri, Montana, New Mexico, South Dakota, Utah, Virginia, Tennessee, Texas, and Washington; cave onyxes, however, are found in nearly all of the large limestone-producing States.

California and Arizona were the first States to report any production of onyx, but at the present time no material, except for samples, is being taken out in these States.

In Arizona the best known deposits are at Bigbug, Mayer, and Cave Creek in Yavapai County. The colors of the Arizona quarries vary considerably, and the stone here is exceptionally beautiful.

In California the most important deposit is found at Musick, San Luis Obispo County, where the stone is a creamy white, with bands or clouds of red, chocolate brown, smoky black, etc. It is also reported as occurring at Suisun, Solano County; Sulphur Creek, Colusa County; in San Bernardino, Siskiyou, Los Angeles, Kern, Placer, Tehama, San Diego, Sonoma, Tulare, Lake, and Mono counties, although these deposits are but little known and not at all developed.

In New Mexico deposits have been worked commercially near Alamogordo, Otero County, and have been reported near Silver City, Grant County, and at White, Lincoln County.

The Kentucky deposits of cave onyx at Cave City, in Barron County, have been worked for commercial purposes.

Virginia has deposits of cave onyx, as well as onyx marbles, although little has been put on the market.

The following table shows the value of the marble production in 1907 and 1908 by States and Territories and uses:

Value of the marble product, 1907 and 1908, by States and Territories and uses.

1907.

State or Territory.	Rough.			Dressed.					Total.
	Building.	Monumental.	Other purposes.	Building.	Monumental.	Ornamental.	Interior decoration.	Other purposes.	
Alabama	$67,780		$1,226	$4,537	$8,900		$2,500	$532	$85,475
Alaska	35,250				2,660		200		38,110
California	20,054	$3,100	1,500	429	4,500		153,702		183,285
Georgia	385,704	334,600	76,700	47,753	18,000		2,000		864,757
Idaho									(a)
Kentucky							12,500		12,500
Maryland	25,653	6,400	2,040	41,750	10,180		10,000	2,895	98,918
Massachusetts	242		2,493	61,800	35,050	$811	97,542	14,500	212,438
Missouri									(b)
New Mexico	2,000	1,050	560	1,500	1,000	200	625	600	c 7,535
New York	147,119	68,565	19,624	590,515	66,286		10,000	9,842	911,951
Oklahoma	15,000	1,325					480		16,805
Pennsylvania	17,667	1,250	3,800	53,587	17,235			25,000	118,539
Tennessee	111,185	10,500	39,500	25,500	3,000		427,463	71,000	688,148
Utah					2,500				2,500
Vermont	126,438	169,340	226	1,077,774	1,874,689	24,039	1,183,940	140,278	4,596,724
Washington									(a)
	954,092	596,130	147,669	1,905,145	2,044,000	25,050	1,900,952	264,647	7,837,685

a Included in New Mexico. b Included in limestone. c Includes Idaho and Washington.

Value of the marble product, 1907 and 1908, by States and Territories and uses—Cont'd.

1908.

State or Territory.	Rough.			Dressed.					Total.
	Building.	Monumental.	Other purposes.	Building.	Monumental.	Ornamental.	Interior decoration.	Other purposes.	
Alabama	$898		$2,500	$113	$4,650		$77,000	$33,419	[a]$118,580
Alaska	38,500	$1,688		45,000	7,200	$500	10,600	400	[b] 103,888
California	8,100	1,250					50,782	276	60,408
Colorado									(c)
Georgia	368,981	342,000	78,800	100,000	17,500			9,000	916,281
Kentucky									(d)
Maryland	1,050	8,425	4,652	65,190					[e] 79,317
Massachusetts	1,888			110,856	19,786		34,660	8,458	175,648
Missouri									(d)
New Mexico									(c)
New York	74,538	56,200	30,421	472,407	53,292		20,000		706,858
North Carolina									(f)
Pennsylvania	13,444			54,803	9,000	7,000	15,000	3,500	102,747
Tennessee	83,764	10,755	37,575	78,440	17,590		551,449	10,660	790,233
Utah									(c)
Vermont	156,325	134,036	190	1,402,629	1,714,408	18,006	1,184,259	70,107	4,679,960
	747,488	554,354	154,138	2,329,438	1,843,426	25,506	1,943,750	135,820	7,733,920

[a] Includes Kentucky and Missouri.
[b] Includes Colorado, New Mexico, and Utah.
[c] Included in Alaska.
[d] Included in Alabama.
[e] Includes North Carolina.
[f] Included in Maryland.

The following table shows the value of the marble produced in the United States from 1904 to 1908, inclusive, by States and Territories:

Value of marble produced in the United States, 1904–1908, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	(a)		$85,000	$85,475	[b] $118,580
Alaska	(a)	$710	(c)	38,110	[d] 103,888
Arizona	(a)				
Arkansas	(a)	1,000	16,900		
California	$87,659	95,540	103,048	183,285	60,408
Colorado					(e)
Connecticut	(a)				
Georgia	690,714	774,550	919,356	864,757	916,281
Idaho				(f)	
Kentucky				12,500	(g)
Maryland	73,814	138,404	176,495	98,918	[h] 79,317
Massachusetts	183,388	166,360	271,934	212,438	175,648
Missouri	(a)		(i)	(i)	(g)
Nevada			5,000		
New Mexico	4,250	2,200	500	[j] 7,535	(e)
New York	565,987	795,721	557,954	911,951	706,858
North Carolina	2,741				(k)
Oklahoma				16,805	
Pennsylvania	90,390	97,887	171,632	118,539	102,747
Tennessee	505,259	582,229	635,821	688,148	790,233
Utah	3,950	1,150	1,400	2,500	(e)
Vermont	4,004,669	4,410,820	4,576,913	4,596,724	4,679,960
Washington	23,098	60,000	59,985	(f)	
Wyoming	2,000	2,500	1,000		
Other States	[l]59,916				
	6,297,835	7,129,071	7,582,938	7,837,685	7,733,920

[a] Included in other States.
[b] Includes Kentucky and Missouri.
[c] Included in Washington.
[d] Includes Colorado, New Mexico, and Utah.
[e] Included in Alaska.
[f] Included in New Mexico.
[g] Included in Alabama.
[h] Includes North Carolina.
[i] Included in limestone.
[j] Includes Idaho and Washington.
[k] Included with Maryland.
[l] Includes Alabama, Alaska, Arizona, Arkansas Connecticut, and Missouri.

The following table shows the various uses to which the marble quarried in 1903, 1904, 1905, 1906, 1907, and 1908 was put:

Distribution and value of output of marble, 1903–1908, among various uses.

Use.	1903.	1904.	1905.	1906.	1907.	1908.
Sold by producers in rough state	$2,454,263	$2,599,052	$2,987,542	$1,795,169	$1,697,891	$1,455,980
Dressed for building	1,111,072	988,671	1,168,450	1,559,925	1,905,145	2,329,438
Ornamental purposes	51,359	21,554	13,643	44,523	25,050	25,506
Dressed for monumental work	1,062,339	1,211,389	1,170,279	2,214,872	2,044,000	1,843,426
Interior decoration in buildings	663,553	1,257,963	1,682,651	1,722,445	1,900,952	1,943,750
Other uses	20,100	219,206	106,506	246,004	264,647	135,820
	5,362,686	6,297,835	7,129,071	7,582,938	7,837,685	7,733,920

LIMESTONE.

This report does not include the value of stone burned into lime and put on the market and sold as lime, except in cases where the stone is quarried by manufacturing plants and ultimately burned into lime and used in the manufacturing process. This applies especially to stone quarried by sugar factories and alkali works, which make no accounting for the lime, but measure the stone quarried. A large quantity of limestone used in the manufacture of Portland cement is also excluded from these figures; the value of this stone enters into and is included in the value of the cement.

The figures for Missouri include a quantity of material known as "chats." This is the product obtained in the concentration of zinc ores. The impurity in these ores is chiefly chert, and these cherty tailings, generally known as chats, have been found to answer exceedingly well as a road material, for railroad ballast, and for concrete. Although this material has a very small value at the mine, when shipped it takes the place of stone valued at 50 cents a cubic yard, and it has been valued accordingly. The chats may be purchased at the mine for $1 per car, the purchaser doing the loading and paying the transportation. The railroads take large quantities at this rate for use as ballast, and it is also used for making roads and in all kinds of concrete work. The collection of statistics of this material for 1908 is the first that has been made. The Alabama figures include a considerable quantity of chert used for road-making purposes.

The commercial output of lime is given separately in a succeeding chapter of this report.

The total limestone output decreased $4,055,629 in value, from $31,737,631 in 1907 to $27,682,002 in 1908. In 1907 there was an increase of $4,410,489 over the value for 1906, which was $27,327,142. The output for 1908 was therefore but slightly in excess of the output for 1906. The large increase in 1907 was chiefly in crushed stone, which gained in value $2,602,188, and in blast-furnace flux, which gained $1,531,797. In 1908, the large decrease was chiefly in blast-furnace flux, which decreased in value $3,239,248, and in crushed stone, which decreased $767,246. Other decreases in value were rough building stone, paving stone, curbstone, flagstone, and stone for other purposes. Dressed building stone, rubble, riprap, stone for sugar factories, and crushed stone for road making increased in value.

The chief States producing limestone in 1908 were, in order of rank of value, Pennsylvania, Indiana, Ohio, Illinois, New York, and Missouri, each reporting over $2,000,000. In 1907 the rank of production for these States was Pennsylvania, Illinois, Indiana, Ohio, New York, and Missouri; Indiana and Ohio passed Illinois in 1908 and took second and third places, respectively, while Illinois fell to fourth place. The combined output of these 6 States in 1908 amounted to $19,057,536, or 68.84 per cent of the total; in 1907 these States produced $21,839,006, or 68.81 per cent of the total. Of these 6 leading States Indiana showed a small increase of output for 1908, but in spite of this the decrease of $2,781,470 for the 6 combined States was over one-half of the total decrease in the limestone output. States reporting a value of over $500,000 in 1908 were Wisconsin, Kentucky, Michigan, Minnesota, West Virginia, Tennessee, and Iowa; in 1907 these States ranked as follows: Wisconsin, Kentucky, West Virginia, Kansas, Michigan, Minnesota, Alabama, Iowa, and Colorado. In 1908 Kansas, Alabama, and Colorado dropped from this class of States, and Tennessee, with an increased output of crushed stone for road making, entered it.

In 1907 31 States and Territories increased and 10 States and Territories decreased in value of limestone output; and in 1908 16 States increased and 26 States decreased in value of limestone output.

Building stone.—Limestone for building purposes, including rough and dressed stone sold by producers, decreased in value $13,704, from $4,580,226 in 1907 to $4,566,522 in 1908. In 1907 the decrease from the 1906 value, $5,098,631, was $518,405. Rough building stone sold by quarrymen in 1908 was valued at $2,305,367, and dressed stone at $2,261,155; the figures for 1907 were rough stone, $2,593,875, and dressed stone, $1,986,351—a decrease in 1908 of $288,508 for rough building stone and an increase of $274,804 for dressed building stone.

Indiana, with a total output of building stone valued at $2,487,039, produced 54.46 per cent of the total building limestone in 1908; in 1907 the output was $2,378,008, or 51.92 per cent of the total, an increase in 1908 of $109,031. This building stone is quarried principally in Lawrence and Monroe counties, and is well known as "Bedford limestone" from the town of Bedford, Lawrence County, which with Bloomington, Monroe County, forms the shipping center for this stone. This "Bedford" stone is chiefly used for building stone, although some is sold for flagstone, curbstone, monumental stone, crushed stone, furnace flux, and some—not included in this report—is used for lime and for cement. Exclusive of 93,085 tons of stone, valued at $42,150, used for riprap, crushed stone, furnace flux, etc., the total quantity and value of limestone produced in Lawrence County in 1908 was 5,199,996 cubic feet, valued at $1,498,-822; Monroe County produced 8,620 tons, valued at $1,719, for flux, etc., and 3,147,097 cubic feet, valued at $880,218, of other stone. The total for the two counties, exclusive of the flux, etc., was therefore 8,347,093 cubic feet, valued at $2,379,040. In 1907, the total output of these two counties was 7,849,027 cubic feet, valued at $2,321,892, a gain in 1908 of 498,066 cubic feet, and of $57,148.

In 1907 the quantity from these two counties, not included in the above figures, was 256,960 tons, valued at $110,525, a decerase in 1908 in this class of material of 155,255 tons in quantity and of $66,656 in value. The low price per ton, as represented by the production of Monroe County, was due to the low price obtained for waste stone sold for flux. In 1908 the total quantity for the two counties included 5,373,992 cubic feet of stone sold rough, of which 3,442,440 cubic feet, valued at $767,763, were for Lawrence County and 1,931,552 cubic feet, valued at $298,993, for Monroe County. In 1907 there were 4,930,055 cubic feet of rough stone sold. This gives an increase for 1908 of 443,937 cubic feet for rough stock. In 1908 the two counties reported 2,983,101 cubic feet of dressed stone, of which 1,757,556 cubic feet, valued at $731,059, were from Lawrence County, and 1,225,545 cubic feet, valued at $581,225, from Monroe County. In 1907 the quantity of dressed stone sold was 2,918,972 cubic feet, an increase of 64,129 cubic feet for 1908. In 1907 the total value for Lawrence County was $1,413,280, and for Monroe County $908,612—a gain in 1908 of $85,542 for Lawrence County and a decrease of $28,394 for Monroe County. Most of this stone was for building purposes, but there is included a small quantity for rubble, curbstone, and flagstone. The average price per cubic foot in 1907 was 30 cents; in 1908, 29 cents.

Missouri ranked next to Indiana in output of building limestone, the value of the output being $603,597 as against $538,114 for 1907, a gain in 1908 of $65,483. This stone is principally from Carthage, Jasper County.

Paving.—Limestone for paving decreased in value $268,663, from $545,300 in 1907 to $276,637 in 1908. Pennsylvania and Illinois usually produce most of the limestone used for paving, but in 1908 there was comparatively little produced in Illinois, and Pennsylvania decreased in value of output.

Curbing.—There was a decrease of $141,274 in the curbstone output in 1908, or from $378,853 in 1907 to $237,579 in 1908. Indiana furnishes most of this material.

Flagging.—A decrease of $4,995 marked the limestone output for flagging in 1908, or from a value of $84,076 in 1907 to $79,081 in 1908. Most of this stone was from Wisconsin.

Rubble.—Rubble increased in value $335,315, from $1,067,445 in 1907 to $1,402,760 in 1908. Ohio, Illinois, Missouri, and Minnesota reported the largest productions.

Riprap.—Riprap increased in value $231,794, from $620,328 in 1907 to $852,122 in 1908. Illinois, Missouri, Wisconsin, and Minnesota produced most of this stone in 1908.

Crushed stone.—Limestone for crushed stone shows a higher value than any other limestone product; it is used for road making, railroad ballast, concrete, paving, etc. In 1908 this output was 22,913,494 short tons, valued at $12,908,207, a decrease of 619,403 short tons in quantity and of $767,246 in value for 1908 as compared with 1907, when the figures were 23,532,897 short tons, valued at $13,675,453. In 1907 the increase over 1906, when the output was reported as 20,286,589 short tons, valued at $11,073,265, was 3,246,308 short tons in quantity and $2,602,188 in value.

In 1908 the total was divided into 11,910,760 short tons, valued at $6,880,893, for road making; 5,095,109 short tons, valued at

$2,530,738, for railroad ballast; and 5,907,625 short tons, valued at $3,496,576, for concrete, which compared with the itemized output for 1907—road making, 9,619,178 tons, valued at $5,860,977; railroad ballast, 8,122,342 tons, valued at $4,144,345; concrete, 5,791,377 tons, valued at $3,670,131—shows an increase of 2,291,582 tons in quantity and of $1,019,916 in value for road making, a decrease of 3,027,233 tons in quantity and $1,613,607 in value for railroad ballast, and an increase of 116,248 tons in quantity and a decrease of $173,555 in value for concrete. It is possible that the stone for road making includes some stone used for concrete, some of the operators reporting that they were unable to subdivide, except approximately, their total output of crushed stone, not knowing the exact use which was to be made of the stone. The average price per short ton was 56 cents in 1908 compared with 58 cents in 1907.

Ohio ranked first in 1908 in the production of crushed limestone, followed by Illinois, New York, Pennsylvania, Missouri, Indiana, Wisconsin, Kentucky, and Tennessee, in the order named. In 1907 Illinois held first place, followed by Ohio, New York, Pennsylvania, Missouri, Indiana, Kentucky, Wisconsin, and Kansas, in the order named. In 1908 the values reported by these 9 States ranged from $2,032,925 to $328,685, and represented 82.60 per cent of the total crushed limestone output; in 1907 the values for the 9 States ranged from $2,576,155 to $489,709, and represented 83.46 per cent of the total crushed limestone. Ohio, New York, Illinois, Missouri, Pennsylvania, Indiana, Wisconsin, Kentucky, Tennessee, and Michigan, named according to value of output, produced the greater part of the stone for road making, a considerable increase being noted in Tennessee, due to a large quantity of stone crushed locally for new roads. Most of the railroad ballast was furnished by Illinois, Ohio, Pennsylvania, Kansas, and New York, named according to rank of output. Concrete stone was principally from Illinois, although large values were reported by New York, Pennsylvania, Missouri, Ohio, and Wisconsin.

Furnace flux.—Next to crushed stone, limestone sold for furnace flux shows the largest value. This product, on account of the shutting down of a large number of iron furnaces late in 1907, showed a large decrease in both quantity and value of output. The output in 1907 was 17,119,297 long tons, valued at $9,144,489; in 1908 the output dropped to 11,091,442 long tons, valued at $5,905,241, a decrease of 6,027,855 long tons in quantity and of $3,239,248 in value. In 1907 the increase over 1906, when the output was 16,077,202 long tons, valued at $7,612,692, was 1,042,095 tons in quantity and $1,531,797 in value. The average price per ton was 53 cents in 1908 and 1907, and 47 cents in 1906. Pennsylvania, Ohio, Illinois, Alabama, West Virginia, and Colorado were the principal States producing this class of stone. All the States show a decreased output, except California and Illinois.

Other purposes.—Stone reported as sold to sugar refiners increased in value from $316,860 in 1907 to $361,186 in 1908, a gain of $44,326. Stone for other purposes includes stone quarried and used by alkali works in New York and Michigan, stone sold to glass factories, to paper mills, to carbonic acid plants, for making whiting and mineral wool, and also a small quantity sold to farmers for burning into lime to be used as a fertilizer, it being impossible to get the lime value for this stone. This output decreased $231,934, in value—from $1,324,601 in 1907 to $1,092,667 in 1908.

The following table shows the value of limestone produced in the United States in 1907 and 1908, by States and Territories and uses:

Value of the production of limestone in the United States in 1907 and 1908, by States and Territories and uses.

1907.

State or Territory.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$5,200	$12,375	$11,100			$11,113	$23,970
Arizona	200						
Arkansas	10,373	33,069				3,157	
California	9,400					225	
Colorado							
Connecticut							
Florida							
Georgia	1,860	500		$200		245	
Idaho							
Illinois	83,408	26,022	150,193	12,031	$5,916	363,045	77,627
Indiana	1,168,476	1,209,532	3,202	204,750	21,432	20,188	12,980
Iowa	108,992	34,663	23,411	1,345	3,682	72,232	46,146
Kansas	92,206	49,172	53,885	51,663	4,052	42,613	18,078
Kentucky	106,293	71,938	3,515	23,555	1,663	2,467	8,730
Maine							
Maryland	2,100		1,767	20	150		50
Massachusetts	100						
Michigan	15,120	100	56,500			1,433	1,234
Minnesota	151,985	112,993	3,065	4,264	8,267	109,928	98,529
Missouri	205,436	332,678	2,218	14,104	12,699	218,827	152,090
Montana	6,160						
Nebraska	21,050	29				16,983	17,833
New Jersey	700						
New Mexico	300		180				
New York	176,746	41,202	25,304	14,869	6,630	21,453	8,380
North Carolina	13,328						
Ohio	114,250	4,495	17,027	2,228	440	70,851	63,434
Oklahoma	4,105	2,175	9,000	7,855	877	2,663	19,566
Oregon	3,000	500		100			600
Pennsylvania	113,919	2,315	143,013	2,272	6,820	27,805	11,220
Rhode Island							
South Dakota	1,100						
Tennessee	9,275	9,497	2,672	3,542	30	11,100	4,018
Texas	31,295	1,948	8,388	1,075		32,150	21,650
Utah	10,855	445					475
Vermont	9,598	364		107		850	
Virginia	3,170	1,130	500				
Washington							
West Virginia	420						
Wisconsin	110,955	39,209	30,360	34,873	11,418	38,117	33,718
Wyoming	2,500						
	2,593,875	1,986,351	545,300	378,853	84,076	1,067,445	620,328

Value of the production of limestone in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1907—Continued.

State or Territory.	Crushed stone. Road making.	Crushed stone. Railroad ballast.	Crushed stone. Concrete.	Flux.	Sugar factories.	Other.	Total.
Alabama	$5,000		$21,287	$604,654			$694,699
Arizona				64,775			64,975
Arkansas	608	$5,000					52,207
California	6,375	1,800	18,290	48,376	$88,116	$4,751	177,333
Colorado			2,620	397,244	102,887		502,751
Connecticut				1,476			1,476
Florida	15,000						15,000
Georgia	407	550	155	18,080		281	22,278
Idaho				6,900	9,000		15,900
Illinois	958,032	499,204	1,118,919	423,315	8,151	48,483	3,774,346
Indiana	476,711	134,932	60,918	279,838		31,667	3,624,126
Iowa	69,817	77,571	118,682			4,041	560,582
Kansas	76,420	357,820	55,469	50		12,320	813,748
Kentucky	290,669	292,714	53,787	14,489		21,680	891,500
Maine						1,350	1,350
Maryland	66,565	61,881	8,842			1,450	142,825
Massachusetts				1,737			1,837
Michigan	131,708	46,516	97,762	109,429	22,234	278,297	760,333
Minnesota	116,143	22,398	103,854	119	2,675	1,099	735,319
Missouri	428,261	284,058	418,990	43,612	317	40,627	2,153,917
Montana				118,080	450		124,690
Nebraska	55,824	53,584	120,977	11,700	13,635	1,015	312,603
New Jersey	3,545	3,000	3,830	262,873		504	274,452
New Mexico		175,252			18,000		193,732
New York	956,535	440,223	450,799	343,866		412,513	2,898,520
North Carolina	9,000						22,328
Ohio	1,232,939	393,453	285,159	1,134,793	4,800	242,953	3,566,822
Oklahoma	4,000	120,747	15,205			3,375	189,568
Oregon					1,375	175	5,750
Pennsylvania	445,347	676,776	412,451	3,829,967		149,370	5,821,275
Rhode Island				750			750
South Dakota			10,500				11,600
Tennessee	13,900	118,911	41,530	169,775		1,200	385,450
Texas	48,318	57,993	3,748	59 394		1,798	267,757
Utah				266,789	27,600	180	306,344
Vermont	5,257		4,850	535		1,565	23,126
Virginia	37,000	12,269	32,326	275,517		150	362,062
Washington				53,868	1,200	7,249	62,317
West Virginia	18,166	271,667	21,167	528,587		15,934	855,941
Wisconsin	389,430	36,026	188,014	73,901		41,074	1,027,095
Wyoming					16,420		18,920
	5,860,977	4,144,345	3,670,131	9,144,489	316,860	1,324,601	31,737,631

Value of the production of limestone in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1908.

State or Territory.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$912	$18,300				$1,620	$20,750
Arizona	1,800	4,500				700	
Arkansas	15,654	43,432				327	
California	614	90					
Colorado							
Connecticut							565
Florida	5,250	25,000				2,000	
Georgia	1,518		$1,020				
Idaho	4,200						
Illinois	49,193	21,253	2,576	$3,850	$3,227	366,490	152,582
Indiana	1,102,375	1,384,664	2,354	155,173	11,712	18,983	11,473
Iowa	63,277	24,858	4,146	3,355	4,661	84,554	48,405
Kansas	63,893	50,644	15,182	8,800	3,625	19,151	19,730
Kentucky	77,561	43,727	13,900	5,387	2,236	13,621	14,355
Maine							
Maryland	13,105		100		50	150	
Massachusetts	1,950						
Michigan	7,276		10,825	300	100	15,907	1,574
Minnesota	140,241	102,924	24,750	6,890	10,841	93,435	98,616
Missouri	254,286	349,311	4,380	4,421	6,758	138,448	107,243
Montana	12,126						
Nebraska	23,029	451		27		22,680	30,892
New Jersey	425						
New Mexico							
New York	123,973	128,415	27,473	7,974	2,295	34,766	39,982
North Carolina							
Ohio	70,884	12,460	8,824	1,055	605	488,492	61,823
Oklahoma	4,815	844		500	1,008	7,848	39,139
Oregon	100						
Pennsylvania	80,222	13,388	128,454	9,930	1,413	24,239	7,176
Rhode Island							
South Dakota							
Tennessee	7,884	3,680	1,315	3,213	190	12,579	21,233
Texas	23,662	2,280		480		4,375	44,088
Utah	32,358	3,200	519			5,951	25,000
Vermont	7,102		285	75	1,053		
Virginia	1,870	2,950		79	110		3,377
Washington							
West Virginia	10,800						
Wisconsin	97,172	24,784	30,534	26,070	29,197	46,444	104,119
Wyoming	5,840						
	2,305,367	2,261,155	276,637	237,579	79,081	1,402,760	852,122

Value of the production of limestone in the United States in 1907 and 1908, by States and Territories and uses—Continued.

1908—Continued.

State or Territory.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$43,028	$1,500	$6,651	$386,874		$95	$479,730
Arizona	350		350	42,430			[a] 50,130
Arkansas	2,373					185	61,971
California	25,185	2,700	12,000	86,945	$104,676	5,110	237,320
Colorado		2,000		276,140	100,172	510	378,822
Connecticut				1,488		1,674	[b] 3,727
Florida	9,660						41,910
Georgia	791	1,900	2,148	946		172	8,495
Idaho					31,800		36,000
Illinois	728,017	384,827	851,889	540,718	3,893	14,037	3,122,552
Indiana	622,726	95,165	77,011	139,703		21,922	3,643,261
Iowa	75,806	28,687	181,668		750	10,778	530,945
Kansas	29,800	99,306	74,555			18,490	403,176
Kentucky	350,577	235,802	35,482	11,283		6,159	810,090
Maine							([c])
Maryland	62,316	35,344	16,745	210		571	128,591
Massachusetts							1,950
Michigan	182,510	33,900	73,200	56,841	32,594	253,990	669,017
Minnesota	48,264	20,389	95,995	100	4,425	20,225	667,095
Missouri	726,772	130,296	341,768	14,678	5,970	45,805	2,130,136
Montana		756		116,071	5,642		134,595
Nebraska	51,007	16,010	173,449	11,700	1,250	75	330,570
New Jersey	18,294		2,533	149,301		1,447	172,000
New Mexico							([d])
New York	942,434	227,730	472,425	205,758	1,080	370,254	2,584,559
North Carolina							([e])
Ohio	1,436,874	349,535	246,516	635,354	2,500	204,635	3,519,557
Oklahoma	2,000	102,335	95,819			2,758	257,066
Oregon				130	6,000		6,230
Pennsylvania	653,503	300,702	419,518	2,324,173	20,034	74,719	4,057,471
Rhode Island							([c])
South Dakota							([f])
Tennessee	211,896	56,439	60,350	142,573		14,530	[g] 535,882
Texas	81,978	115,322	9,495	31,266		1,625	314,571
Utah	14		263	161,383	24,400		253,088
Vermont	9,275		2,535	334		72	20,731
Virginia	30,159	45,541	26,604	169,847		5	280,542
Washington				26,410		5,250	31,660
West Virginia	70,939	197,189	24,939	337,742		3,776	645,385
Wisconsin	464,345	47,363	192,248	25,935		13,798	1,102,009
Wyoming			420	8,908	16,000		[h] 31,168
	6,880,893	2,530,738	3,496,576	5,905,241	361,186	1,092,667	27,682,002

[a] Includes New Mexico.
[b] Includes Maine and Rhode Island.
[c] Included with Connecticut.
[d] Included with Arizona.
[e] Included with Tennessee.
[f] Included with Wyoming.
[g] Includes North Carolina.
[h] Includes South Dakota.

The following table shows the value of limestone, by States, from 1904 to 1908, inclusive:

Value of limestone from 1904 to 1908, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.
Alabama	$498,723	$532,103	$579,344	$694,699	$479,730
Arizona	250	135	40	64,975	[a] 50,130
Arkansas	106,147	154,818	48,844	52,207	61,971
California	74,670	49,902	80,205	177,333	237,320
Colorado	124,600	289,920	373,158	502,751	378,822
Connecticut	830	1,558	1,171	1,476	[b] 3,727
Florida	34,278	5,800	1,450	15,000	41,910
Georgia	15,200	9,030	16,042	22,278	8,495
Idaho	5,900	14,105	12,600	15,900	36,000
Illinois	2,690,822	3,511,890	2,942,331	3,774,346	3,122,552
Indiana	2,789,500	3,189,259	3,725,565	3,624,126	3,643,261
Indian Territory	6,076	5,512	44,622	....	....
Iowa	442,585	451,791	493,815	560,582	530,945
Kansas	799,286	923,389	849,203	813,748	403,176
Kentucky	692,417	744,465	795,408	891,500	810,190
Maine	2,955	7,428	2,000	1,350	([c])
Maryland	128,421	149,402	170,046	142,825	128,591
Massachusetts	7,566	65,908	10,750	1,837	1,950
Michigan	501,708	544,754	656,269	760,333	669,017
Minnesota	517,940	555,401	632,115	735,319	667,095
Missouri	2,277,969	2,238,164	1,988,334	2,153,917	2,130,136
Montana	109,765	103,123	141,082	124,690	134,595
Nebraska	236,780	225,119	276,381	312,630	330,570
New Jersey	76,710	147,353	221,141	274,452	172,000
New Mexico	....	7,200	125,493	193,732	([d])
New York	1,636,255	1,970,968	2,204,724	2,898,520	2,584,559
North Carolina	12,088	16,500	30,583	22,328	([e])
Ohio	2,406,355	2,850,793	3,025,038	3,566,822	3,519,557
Oklahoma	92,246	163,412	127,361	189,568	257,066
Oregon	5,390	8,600	7,480	5,750	6,230
Pennsylvania	3,708,750	4,499,503	4,865,130	5,821,275	4,057,471
Rhode Island	312	300	678	750	([c])
South Carolina	225	....	....	....	....
South Dakota	3,954	6,653	10,400	11,600	([f])
Tennessee	288,053	401,622	481,952	385,450	[g] 535,882
Texas	252,745	171,847	239,125	267,757	314,571
Utah	170,447	232,519	248,868	306,344	253,088
Vermont	9,653	11,095	14,728	23,126	20,731
Virginia	165,459	212,660	260,343	362,062	280,542
Washington	71,857	52,470	49,192	62,317	31,660
West Virginia	460,303	671,318	628,602	855,941	645,385
Wisconsin	738,684	804,081	891,746	1,027,095	1,102,009
Wyoming	15,090	23,340	53,783	18,920	[h] 31,168
	22,178,964	26,025,210	27,327,142	31,737,631	27,682,002

[a] Includes New Mexico.
[b] Includes Maine and Rhode Island.
[c] Included with Connecticut.
[d] Included with Arizona.
[e] Included with Tennessee.
[f] Included with Wyoming.
[g] Includes North Carolina.
[h] Includes South Dakota.

The following table shows the production of limestone for furnace flux in 1907 and 1908, by States, in long tons:

Production of furnace flux in 1907 and 1908, by States, in long tons.

State or Territory.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Alabama	939,437	$604,654	582,958	$386,874
Arizona	115,714	64,775	70,718	42,430
California	38,225	48,376	78,305	86,945
Colorado	672,801	397,244	441,490	276,140
Connecticut	3,735	1,476	2,564	[a] 1,488
Georgia	30,825	18,080	1,522	946
Idaho	4,100	6,900	....	....
Illinois	970,158	423,315	1,209,326	540,718
Indiana	577,052	279,838	272,505	139,703
Kansas	50	50	....	....
Kentucky	31,752	14,489	21,947	11,283
Maryland	....	....	421	210
Massachusetts	3,560	1,737	....	....
Michigan	128,926	109,429	104,186	56,841
Minnesota	135	119	100	100
Missouri	55,371	43,612	18,524	14,678
Montana	236,200	118,080	216,964	116,071
Nebraska	18,000	11,700	18,000	11,700
New Jersey	465,018	262,873	318,455	149,301
New York	584,964	343,866	357,194	205,758
Ohio	2,497,616	1,134,793	1,444,412	635,354
Oregon	....	....	104	130
Pennsylvania	7,178,508	3,829,967	4,350,381	2,324,173
Rhode Island	500	750	....	([b])
Tennessee	299,247	169,775	260,294	142,573
Texas	93,531	59,394	43,716	31,266
Utah	372,896	266,789	209,708	161,383
Vermont	535	535	334	334
Virginia	541,610	275,517	289,369	169,847
Washington	80,295	53,868	43,640	26,410
West Virginia	1,063,772	528,587	666,087	337,742
Wisconsin	114,764	73,901	62,718	25,935
Wyoming	....	....	5,500	8,908
Total	17,119,297	9,144,489	11,091,442	5,905,241
Average price per ton	....	.53	....	.53

[a] Includes Rhode Island. [b] Included with Connecticut.

SURVEY PUBLICATIONS ON BUILDING STONE AND ROAD METAL.

The following list comprises the more important publications on building stone and road metal by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The annual volumes on Mineral Resources of the United States contain not only statistics of stone production but occasional discussions of available stone resources in various parts of the country. Many of the Survey's geologic folios also contain notes on stone resources that may be of local importance.

ALDEN, W. C. The stone industry in the vicinity of Chicago, Ill. In Bulletin No. 213, pp. 357–360. 1903. 25c.

BAIN, H. F. Notes on Iowa building stones. In Sixteenth Ann. Rept., pt. 4, pp. 500–503. 1895.

BASTIN, E. S. (See Leighton, Henry, and Bastin, E. S.)

BURCHARD, E. F. Concrete materials produced in the Chicago district. In Bulletin No. 340, pp. 383–410. 1908.

CLAPP, F. G. Limestones of southwestern Pennsylvania. Bulletin No. 249. 1905.

COONS, A. T. Stone. In Mineral Resources U. S. for 1907, pt. 2, pp. 563–605. 1908.

DALE, T. N. The slate belt of eastern New York and western Vermont. In Nineteenth Ann. Rept., pt. 3, pp. 153–200. 1899. $2.25.

——— The slate industry of Slatington, Pa., and Martinsburg, W. Va. In Bulletin No. 213, pp. 361–364. 1903. 25c.

——— Notes on Arkansas roofing slates. In Bulletin No. 225, pp. 414–416. 1904. 35c.

——— Slate investigations during 1904. In Bulletin No. 260, pp. 486–488. 1905. 40c.

——— Note on a new variety of Maine slate. In Bulletin No. 285, pp. 449–450. 1906. 60c.

——— Recent work on New England granites. In Bulletin No. 315, pp. 356–359. 1907.

——— The granites of Maine. Bulletin No. 313. 202 pp. 1907.

——— The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island. Bulletin No. 354. 228 pp. 1908.

——— The granites of Vermont. Bulletin No. 404. (In press.)

——— The granites of Connecticut. (In preparation.)

DALE, T. N., and others. Slate deposits and slate industry of the United States. Bulletin No. 275. 154 pp. 1906. 15c.

DARTON, N. H. Marble of White Pine County, Nev., near Gandy, Utah. In Bulletin No. 340, pp. 377–380. 1908.

——— Structural materials near Portland, Oreg., and Seattle and Tacoma, Wash. Bulletin No. 387. — pp. 1909.

DILLER, J. S. Limestone of the Redding district, California. In Bulletin No. 213, p. 365. 1903. 25c.

ECKEL, E. C. Slate deposits of California and Utah. In Bulletin No. 225, pp. 417–422. 1904. 35c.

HILLEBRAND, W. F. Chemical notes on the composition of the roofing slates of eastern New York and western Vermont. In Nineteenth Ann. Rept., pt. 3, pp. 301–305. 1899. $2.25.

HOPKINS, T. C. The sandstones of western Indiana. In Seventeenth Ann. Rept., pt. 3, pp. 780–787. 1896.

——— Brownstones of Pennsylvania. In Eighteenth Ann. Rept., pt. 5, pp. 1025–1043. 1897.

HOPKINS, T. C., and SIEBENTHAL, C. E. The Bedford oolitic limestone of Indiana. In Eighteenth Ann. Rept., pt. 5, pp. 1050–1057. 1897.

HUMPHREY, R. L. The fire-resistive properties of various building materials. Bulletin No. 370. 99 pp. 1909.

KEITH, A. Tennessee marbles. In Bulletin No. 213, pp. 366–370. 1903. 25c.

LEIGHTON, HENRY, and BASTIN, E. S. Road materials of southern and eastern Maine. Bulletin No. 33, Office of Public Roads, Department of Agriculture. 1908. (May be obtained from Department of Agriculture.)

RIES, H. The limestone quarries of eastern New York, western Vermont, Massachusetts, and Connecticut. In Seventeenth Ann. Rept., pt. 3 (continued), pp. 795–811. 1896.

SHALER, N. S. Preliminary report on the geology of the common roads of the United States. In Fifteenth Ann. Rept., pp. 259–306. 1895.

——— The geology of the road-building stones of Massachusetts, with some consideration of similar materials from other parts of the United States. In Sixteenth Ann. Rept., pt. 2, pp. 277–341. 1895.

SIEBENTHAL, C. E. The Bedford oolitic limestone [Indiana]. In Nineteenth Ann. Rept., pt. 6, pp. 292–296. 1898.

——— (See also Hopkins, T. C., and Siebenthal, C. E.)

SMITH, G. O. The granite industry of the Penobscot Bay district, Maine. In Bulletin No. 260, pp. 489–492. 40c.

BUILDING STONE STATISTICS.

The statistical reports on the production of stone, etc., will be found in the following volumes of Mineral Resources of the United States.

1882. Structural Materials, pp. 450–464, 50c.
1883–4. Structural Materials, pp. 662–670, 60c.
1885. Structural Materials, by H. H. Sproull, pp. 396–413, 60c.
1886. Structural Materials, by Wm. C. Day, pp. 517–566, 40c.
1887. Structural Materials, by Wm. C. Day, pp. 503–534, 50c.
1888. Structural Materials, by Wm. C. Day, pp. 516–557, 50c.
1889–90. Stone, by Wm. C. Day, pp. 373–440, 50c.
1891. Stone, by Wm. C. Day, pp. 456–473, 50c.
1892. Stone, by Wm. C. Day, pp. 704–711, 50c.
1893. Stone, by Wm. C. Day, pp. 543–602, 50c.
1894. 16th Annual Report, U. S. Geological Survey, pt. 4, Nonmetallic Products. Stone, by Wm. C. Day, pp. 436–510.
1895. 17th Annual Report, U. S. Geological Survey, pt. 3 continued, Nonmetallic Products, except Coal. Stone, by Wm. C. Day, pp. 759–811.
1896. 18th Annual Report, U. S. Geological Survey, pt. 5 continued, Nonmetallic Products, except Coal. Stone, by Wm. C. Day, pp. 948–1068.
1897. 19th Annual Report, U. S. Geological Survey, pt. 6 continued, Nonmetallic Products, except Coal and Coke. Stone, by Wm. C. Day, pp. 205–309.
1898. 20th Annual Report, U. S. Geological Survey, pt. 6 continued, Nonmetallic Products, except Coal and Coke. Stone, by Wm. C. Day, pp. 269–464.
1899. 21st Annual Report, U. S. Geological Survey, pt. 6 continued, Nonmetallic Products, except Coal and Coke. Stone, pp. 333–360.
1900. Stone, pp. 661–691, 70c.
1901. Stone, pp. 641–666, 70c.
1902. Stone, pp. 665–701.
1903. Stone, pp. 755–789, 70c.
1904. Stone, pp. 801–841.
1905. Slate, by A. T. Coons, pp. 1011–1017; Stone, by A. T. Coons, pp. 1021–1067, $1.
1906. Slate, by A. T. Coons, pp. 1001–1005; Stone, by A. T. Coons, pp. 1007–1041.
1907. Slate, by A. T. Coons, pt. 2, pp. 557–562; Stone, by A. T. Coons, pt. 2, pp. 563–605, 50c.
1908. Slate, by A. T. Coons, with general note on the Classification and Characteristics of Slate, by T. Nelson Dale; Stone, by A. T. Coons.

ABRASIVE MATERIALS.

By W. C. Phalen.

INTRODUCTION.

The abrasive materials included in this report are millstones and buhrstones, grindstones and pulpstones, oilstones and scythestones, corundum and emery, abrasive quartz and abrasive feldspar, garnet, infusorial earth and tripoli, pumice, and the artificial abrasives carborundum, alundum, and crushed steel. Of some of these materials only a small part of the entire product is actually used for abrasive purposes. In this report, so far as it has been possible, there is included, with the exception of tripoli and possibly infusorial earth, only that part of the product that is actually used for abrasive purposes. Thus under grindstones and pulpstones, which are obtained from sandstone, only a small percentage of the stone that is quarried is used in the manufacture of abrasives, the remainder being used chiefly in the building industry; also, as stated on another page, only a small proportion of the crystalline quartz and feldspar produced is used in the abrasive industry. A large part of the tripoli mined in Missouri is used in the filter-stone industry. Practically all the raw material mined or quarried for millstones, pumice, corundum, emery, and garnet (except the gem garnet) is used for abrasive purposes.

Fairly detailed descriptions of the occurrence and mode of preparation of the different abrasive materials have appeared in preceding reports of the United States Geological Survey. Thus, in the report for 1907, a detailed description was given of the method of preparing millstones from the Esopus conglomerate in Ulster County, N. Y., the center of the millstone industry in that State, and also of the mode of preparing Missouri tripoli for use in filter stones. In the present report the garnet deposits in New York are treated at some length, as well as the occurrence of pumice in the central Western States, and a detailed description is given of the methods employed in the manufacture of scythestones at Pike, N. H. A detailed description of the manufacture and technology of alundum, among the artificial abrasives, is also given.

The following table gives the value of all the natural abrasive material produced in the United States during the years 1904 to 1908, inclusive. The value of the production for 1908 showed a decline of $606,698 as compared with that of 1907. There was an increase in the value of pumice, but a decrease in the value of all other abrasives. The general decline in the abrasive industry was in keeping with the general industrial depression of the year.

Value of natural abrasives produced in the United States, 1904–1908.

Kind of abrasive.	1904.	1905.	1906.	1907.	1908.
Oilstones and scythestones	$188,985	$244,546	$268,070	$264,188	$217,284
Grindstones and pulpstones	881,527	777,606	744,894	896,022	536,095
Buhrstones and millstones	37,338	37,974	48,590	31,741	31,420
Pumice	5,421	5,540	16,750	33,818	39,287
Infusorial earth and tripoli	44,164	64,637	72,108	104,406	97,442
Abrasive quartz and feldspar	74,850	88,118	121,671	126,582	79,146
Garnet	117,581	148,095	157,000	211,686	64,620
Corundum and emery	57,235	61,464	44,310	12,294	8,745
	1,407,101	1,427,980	1,473,393	1,680,737	1,074,039

Natural abrasives were produced in 23 States in 1908, the same number as in 1907. The list of States follows, together with the material produced by each:

List of States producing abrasives in 1908.[a]

ARKANSAS: Oilstones.
CALIFORNIA: Infusorial earth.
CONNECTICUT: Infusorial earth, quartz, and feldspar.
GEORGIA: Infusorial earth.
ILLINOIS: Tripoli.
INDIANA: Oilstones.
KANSAS: Pumice.
MARYLAND: Infusorial earth and quartz.
MASSACHUSETTS: Emery, infusorial earth, and quartz.
MICHIGAN: Scythestones and grindstones.
MINNESOTA: Feldspar.
MISSOURI: Tripoli and grindstones.
MONTANA: Grindstones.
NEBRASKA: Pumice.
NEW HAMPSHIRE: Scythestones.
NEW YORK: Emery, garnet, infusorial earth, and millstones.
NORTH CAROLINA: Millstones.
OHIO: Grindstones, pulpstones, oilstones, and scythestones.
PENNSYLVANIA: Millstones and quartz.
VERMONT: Scythestones.
VIRGINIA: Millstones.
WEST VIRGINIA: Grindstones.
WISCONSIN: Quartz.

Under the head of artificial abrasives are included alundum, carborundum, and crushed steel. The production of these substances from 1905 to 1908, inclusive, is given in the following table:

Production and value of artificial abrasives in the United States, 1905–1908.

Year.	Quantity in pounds.	Value.	Year.	Quantity in pounds.	Value.
1905	9,820,000	$701,400	1907	14,632,000	$1,027,246
1906	11,774,300	777,081	1908	8,698,000	626,340

[a] The writer wishes to acknowledge the cooperation of the state geologists of Illinois, Maryland, New York, North Carolina, and Virginia in the collection of statistics of abrasives.

The total estimated value of all abrasive materials consumed in the United States for the years 1904 to 1908, inclusive, is given in the following table.

Total value of all abrasive materials consumed in the United States, 1904–1908.

Year.	Natural abrasives.	Artificial abrasives.	Imports.	Total value.
1904	$1,407,101	$830,926	$547,804	$2,785,831
1905	1,427,980	701,400	654,821	2,784,001
1906	1,473,393	777,081	909,964	3,160,438
1907	1,680,737	1,027,246	754,140	3,462,123
1908	1,074,039	626,340	476,073	2,176,452

BUHRSTONES AND MILLSTONES.

The production of buhrstones and millstones in the United States in 1908 was valued at $31,420, substantially the same production as in 1907.

The market for millstones has been greatly curtailed of late years. The table given on a subsequent page shows that recently the industry has dwindled very much and that the value of the production for 1908, as well as for 1907, closely approximates what it was at the beginning of the present decade. The explanation of this falling off in the millstone industry is due to the introduction of superior forms of grinding machinery, chiefly rolls, ball mills, etc. The roller-mill process is now used almost exclusively in grinding wheat. Some corn and mustard mills in the Southern States still use handmade millstones. A part of the product is sold to the cement and talc manufacturers and to grinders of quartz and mineral paints.

The production of millstones, as usual, came from but four States, namely, New York, North Carolina, Pennsylvania, and Virginia. Though stone suitable for buhrstones and millstones is found in other States, there was no production from them reported to this office.

Millstone industry in New York.—New York has led for many years in the production of millstones and chasers, the latter term being applied to stones which run on edge. The raw material is obtained in Ulster County, southeastern New York, and is known as Esopus stone, Esopus being an early name for Kingston, which was formerly the main point of shipment. The material suitable for millstones is quarried from the Shawangunk conglomerate, which is found near the western base of Shawangunk Mountain in the Valley of Rondout River. The material suitable for millstones is exceedingly scanty, being confined in linear extent to a strip extending from High Falls on the north to Kerhonkson on the south, a distance of approximately 10 miles. Beyond these limits the texture and other properties of the rock have been found unsuitable for the highest grade of stones.

The methods employed in quarrying the rock are simple. The rock is pried or split out, advantage being taken of the joint planes, especially the concentric surface joints. The tools used are the ordinary hand drill, together with plugs and feathers. Blasting is often resorted to, but the charges of powder are usually light. The rough stones thus obtained are quarry dressed and finished, these operations being performed entirely by hand, the chief tools employed being the bull point and hammer. The operation of drilling the "eye" is performed by centering the stone and then drilling from the center of both faces inward. In many stones the eye is square. To fashion a square eye, a round eye is first drilled out and then squared up. A few of the men engaged in the industry make a modification of the regular millstone for use in the grinding of paint. In this modification the ordinary millstone is cut in halves and an iron casting is placed between the halves, which are then joined together by an iron band.

Chasers are larger than the regular millstones. They are used for heavier work as in grinding quartz, feldspar, barytes, etc., and as already mentioned, they run on edge. Though they are made with a diameter as short as 24 inches, they are usually turned out with diameters ranging from 50 to 84 inches, and as much as 22 inches in thickness. These chasers are run on pans paved with blocks of Esopus conglomerate, which are usually roughly cubical with edges about a foot in length. In grinding quartz in such pans the chasers are used in the preliminary crushing; then rough blocks, usually three in number, are either attached to or carried along by lateral arms, which in turn are joined to a vertical revolving shaft. By the circular movement of these blocks, the material placed in the pan is ground to powder.

In the following table is given the value, by States, of the millstones, buhrstones, and chasers produced in the United States from 1904 to 1908, inclusive:

Value of buhrstones produced in the United States, 1904–1908, by States.

State.	1904.	1905.	1906.	1907.	1908.
New York	$24,585	$25,915	$28,848	$23,072	$18,341
Virginia	4,759	8,186	15,611	4,684	7.954
North Carolina	6,500	2,522	1,507	1,969	4,052
Pennsylvania	1,494	1,351	2,624	2,016	1,073
	37,338	37,974	48,590	31,741	31,420

The following table gives the value of millstones and buhrstones produced in the United States since 1880:

Value of buhrstones and millstones produced in the United States, 1880–1908.

1880	$200,000
1881	150,000
1882	200,000
1883	150,000
1884	150,000
1885	100,000
1886	140,000
1887	100,000
1888	81,000
1889	35,155
1890	23,720
1891	16,587
1892	23,417
1893	16,639
1894	13,887
1895	22,542

1896	$22,567
1897	25,932
1898	25,934
1899	28,115
1900	32,858
1901	57,179
1902	59,808
1903	52,552
1904	37,338
1905	37,974
1906	48,590
1907	31,741
1908	31,420

IMPORTS.

The value of the imports of buhrstones and millstones into the United States has decreased materially in the last two years. In 1908 the value was approximately two-thirds that of 1907 and a little more than half that of 1906. This marked decrease in 1908 was in the value of the rough material, as the value of the material made up into millstones was nearly three times that of 1907. The table showing the value of imports from 1904 to 1908 follows:

Value of buhrstones and millstones imported into the United States, 1904–1908.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1904	$30,117	$2,269	$32,386	1907	$26,431	$877	$27,308
1905	30,478	938	31,416	1908	16,075	2,567	18,642
1906	32,921	277	33,198				

GRINDSTONES AND PULPSTONES.

PRODUCTION.

The value of the production of grindstones and pulpstones during 1908 amounted to $536,095, a decrease of $359,927 as compared with the production of 1907. This is the lowest value of these commodities reported to the Survey in recent years. The production came as usual from the following States: Ohio, Michigan, West Virginia, Montana, and Missouri. Wyoming has not produced any grindstones since 1906. In the following table is given the value of the production of grindstones and pulpstones during the last five years:

Value of the production of grindstones and pulpstones, 1904–1908.

	1904.	1905.	1906.	1907.	1908.
Grindstones	$820,207	$726,536	$694,894	$846,522	$495,495
Pulpstones	61,320	51,070	50,000	49,500	40,600
	881,527	777,606	744,894	896,022	536,095

In the following table are given the values of the grindstones and pulpstones produced in the United States from 1904 to 1908, by States:

Value of grindstones and pulpstones produced in the United States, 1904–1908, by States.

State.	1904.	1905.	1906.	1907.	1908.
Ohio	$767,552	$644,315	$644,720	$764,276	$482,128
Michigan	112,500	111,500	78,500	(a)	(a)
West Virginia, Missouri, and Montana	[b] 1,475	[b] 21,791	[b] 21,674	131,746	53,967
	881,527	777,606	744,894	896,022	536,095

[a] Included with West Virginia, etc.
[b] Including a small production from Wyoming in 1904, 1905, and 1906.

The value of the production of pulpstones and grindstones in the United States from 1880 to 1908, inclusive, is shown in the following table:

Value of grindstones and pulpstones produced in the United States, 1880–1908.

1880	$500,000	1895	$205,768
1881	500,000	1896	326,826
1882	700,000	1897	368,058
1883	600,000	1898	489,769
1884	570,000	1899	675,586
1885	500,000	1900	710,026
1886	250,000	1901	580,703
1887	224,400	1902	667,431
1888	281,800	1903	721,446
1889	439,587	1904	881,527
1890	450,000	1905	777,606
1891	476,113	1906	744,894
1892	272,244	1907	896,022
1893	338,787	1908	536,095
1894	223,214		

IMPORTS.

The value of the imports of pulpstones and grindstones has shown a steady increase up to 1907, when there was a decided falling off. The decrease in 1908 from 1907 closely approximated that of 1907 from 1906. The figures of imports for the last five years are given in the following table:

Value of pulpstones and grindstones imported and entered for consumption in the United States, 1904–1908.

1904	$93,152	1907	$111,495
1905	113,752	1908	80,382
1906	134,136		

CANADIAN PRODUCTION.

The value of the production of grindstones in Canada during 1908 amounted to $45,128, as compared with $60,376 in 1907. In the table following is given the value of the Canadian production of grindstones during the last five years:

Value of production of grindstones in Canada, 1904–1908.

1904	$42,782	1907	$60,376
1905	57,200	1908	45,128
1906	61,624		

OILSTONES AND SCYTHESTONES.

PRODUCTION.

The production of oilstones and scythestones in the United States during 1908 amounted to $217,284, as compared with $264,188 in 1907, a decrease of $46,904, or nearly 18 per cent. The production of oilstones and whetstones is from Arkansas, Indiana, and Ohio, and the first State mentioned produces the largest part of the output. Scythestones are manufactured from material found in New Hampshire, Vermont, Ohio, and Michigan.

In the following table is given the value of the oilstones and scythestones from 1891 to 1908:

Value of oilstones and scythestones produced in the United States, 1891–1908.

1891	$150,000	1900	$174,087
1892	146,730	1901	158,300
1893	135,173	1902	221,762
1894	136,873	1903	366,857
1895	155,881	1904	188,985
1896	127,098	1905	244,546
1897	149,970	1906	268,070
1898	180,486	1907	264,188
1899	208,283	1908	217,284

The scythestone industry in New Hampshire.—Scythestones are manufactured by the Pike Manufacturing Company at Pike Station, in the northwestern part of New Hampshire, near Connecticut River.

The raw material from which the stones are made is a fine-grained, thinly laminated, micaceous sandstone, whose quartz grains occur in definite layers separated by thin layers of mica flakes. Associated with this material occurs rock in which the quartz particles occur in rather coarser grains and in lenses rather than in layers. The quartz particles in the rock may give place entirely to argillaceous material. When the quartz grains become coarse and irregularly disposed and when argillaceous material is present the rock is unfit for abrasive purposes and is discarded. Besides the planes of schistosity, there are developed at right angles to them splendid joint planes. Such a plane normal to the plane of schistosity is known as a "foot," and the stone between an upper and a lower "foot" is known as a "bent" of stone. After the stone is shattered by the blasting the "bent" is pried out. The quarries are not extensive in area and are bounded by stone known as "hard head," which apparently may be almost any foreign stone hard to work and unfit for scythestones.

The raw material is found generally in peculiar wedge-shaped lenses striking northeast-southwest. The broader end of the lenses is toward the southwest, and they pinch out and taper to the northeast. The methods of quarrying are briefly as follows: The covering of clay, which averages but a few feet in thickness, is plowed up, shoveled into cars, carried off a short distance, and dumped. After this surface stripping, holes are drilled with a steam drill to depths varying from 6 to 12 feet, and the rock is loosened by blasting, the charge of powder used varying with the depth of the hole from 4 pounds to 10 pounds. The rock loosened along the plane of schistosity is then pried out in big, irregularly shaped pieces. These slabs vary in thickness, but are generally less than 1 foot thick. The largest slabs thus secured are broken up into smaller rectangular slabs, which are piled up and reserved for the winter, when quarrying is suspended and the workmen are compelled by reason of the excessive cold to work indoors. This material is known by the name of "timber." The smallest slabs are worked up at once in the warm season. They are first cut into the rough rectangular slabs known as "timber." The "timber" is split into thinner slabs, approximately the thickness of the finished stones, and then by the aid of knives and hammers these slabs are, in turn, broken into oblong rectangles, which is the raw material from which the finished scythestone is made directly.

This raw material is hauled in wagons from the quarry to the town of Pike, a mile distant, where it is ground into the finished stones. The operations involved in grinding are simple. Several rough stones have their rough edges ground smooth by pressing them together against a horizontally revolving wheel covered with coarse sand obtained near by. Pressure is exerted by hand or by heavy iron blocks. The individual stones are next taken and manipulated by hand until ground into the requisite shape. This is accomplished on the same wheel used in the preliminary grinding. The wheel or table on which the grinding is done is made of wood, and into it are driven steel wedges or "butts" obtained from nail factories. The grinding is thus accomplished on what amounts practically to a steel surface.

IMPORTS AND EXPORTS.

The value of the imports of hones, whetstones, and oilstones in 1908 amounted to $44,304, as compared with $89,939 in 1907. This importation, which was slightly less than half that of the preceding year, and but slightly more than half that of the year 1906, is the lowest recorded in several years. The importation is in part offset by the exportation of Arkansas oilstones and New Hampshire scythestones, the value of which, however, can not be given, since no separate record of them is kept. The following table shows the value of all kinds of hones, oilstones, and whetstones imported into the United States in the last five years:

Value of imports of hones, oilstones, and whetstones, 1904–1908.

1904	$61,609	1907	$89,939
1905	65,753	1908	44,304
1906	83,863		

CORUNDUM AND EMERY.

Practically all the corundum and nearly all the emery now used in the United States is imported, and the industries in which these two abrasives are factors are now mainly manufacturing industries. To escape the duty, emery is imported crude as ballast from Greece and Turkey; corundum comes mainly from Canada in pulverized form.

In 1908 the output of emery in the United States came from but two localities, Chester, Mass., and Peekskill, N. Y. The emery at Chester is considered of good quality, but operations at this locality are practically suspended. The Ashland Emery and Corundum Company continues to pick over the old dumps during the warmer months and to mine a small quantity of ore from the old pockets during the winter. No exploratory work, so far as known, has recently been undertaken, and the mill is in operation only part of the time.

The deposits of emery near Peekskill, Westchester County, N. Y., are located about 4 miles southeast of the town and a few miles east of Hudson River. It is reported that the deposits were first exploited for iron ore. The emery occurs in a series of igneous rocks intruded into metamorphic sedimentary rocks. To these intrusions the name "Cortlandt series" has been applied. They include rocks belonging mainly to the norite, diorite, and peridotite classes. The emery deposits, according to G. H. Williams,[a] are simply segregations of the basic oxides in the norite, the components of the latter rock occurring in even the purest emery ore. A study of the thin section of the material from these deposits has revealed the presence of hercynite (iron spinel), magnetite, garnet, and corundum, some of the corundum being pale blue and perfectly transparent. Of these minerals, H. C. Magnus[b] states that hercynite forms in some cases nearly 100 per cent of the material and in others corundum makes up more than 50 per cent of it. Hercynite is inferior in hardness to corundum, being 8 in the scale of hardness, while corundum is 9. This softness, however, is in part compensated by a readier cleavage, which causes hercynite to present fresh, sharp cutting edges.

The deposits of emery vary considerably in size. They are all worked by open cuts, which vary in width and depth with the size of the ore body. The ore is blasted out by light charges of explosives and is broken up and roughly cobbed before shipment to the mill. The subsequent mill treatment consists in cleansing and grading the rough cobbed material for use in the form of emery powder, emery paper and cloth, and emery wheels. It has been claimed that the Westchester material is very serviceable when made into wheels with a vitreous bond, but in general the selection of a bond depends upon the work to be accomplished, and the work to be accomplished should always be stated when ordering the wheel.

There was no production of corundum reported to the United States Geological Survey in 1908. It is understood, however, that certain of the old mines located in Clay County, N. C., which have been closed down for the last few years, have come into new hands and will soon be worked, rather with the object, however, of finding gem materials than abrasive materials. A find of corundum has been reported west of Statesville, N. C.

PRODUCTION.

The production of emery in the United States in 1908 amounted to only 669 short tons, valued at $8,745, a decrease of nearly 30 per cent from the output of 1907. The value per ton in 1908 was $13.07 as compared with $11.58 in 1907. These figures represent the value of the rough material as it comes from the quarries at the point of shipment. All the emery mined at Peekskill is shipped to other points for grinding and manufacture into finished forms, after which, of course, its value is greatly increased. The following table gives

[a] Am. Jour. Sci., 3d ser., vol. 33, 1887, pp. 33 et seq.
[b] Twenty-third Rept. State Geologist, New York State Mus., 1903, pp. 163–172.

the value and quantity of the corundum and emery produced in the United States since 1881, the figures for the last two years, however, representing the value of emery only:

Annual production of corundum and emery, 1881–1908, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1881	500	$80,000	1895	2,102	$106,256
1882	500	80,000	1896	2,120	113,246
1883	550	100,000	1897	2,165	106,574
1884	600	108,000	1898	4,064	275,064
1885	600	108,000	1899	4,900	150,600
1886	645	116,190	1900	4,305	102,715
1887	600	108,000	1901	4,305	146,040
1888	589	91,620	1902	4,251	104,605
1889	2,245	105,567	1903	2,542	64,102
1890	1,970	89,395	1904	1,916	56,985
1891	2,247	90,230	1905	2,126	61,464
1892	1,771	181,300	1906	1,160	44,310
1893	1,713	142,325	1907	1,069	12,294
1894	1,495	95,936	1908	669	8,745

IMPORTS.

Imported emery comes from Asia Minor, Turkey, and the island of Naxos, Greece. According to Mr. E. L. Harris, United States consul at Smyrna, Asia Minor, Turkey,[a] all the mines in Asia Minor which are now worked are located from 50 to 200 miles southeast of the city of Smyrna. At the mining operations near the city all of the visible emery has been removed, and the cost of extraction is almost doubled from the fact that the workings are so far below the surface. Mining operations are conducted in the most primitive fashion. In the case of the deposits remote from Smyrna, the ore is brought by camels and less frequently by mules and donkeys. The value of emery varies from $17 to $19 per ton at the point of shipment. The yearly shipments average 20,000 tons from Turkey and 7,000 tons from Naxos. Sixty per cent of this goes to the United States. The table following gives the quantity and value of emery and corundum imported into the United States from all foreign sources in the last five years:

Emery and corundum imported into the United States, 1904–1908.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Long tons.*			
1904	2,281,193	$109,772	7,054	[b]$138,931	$11,721	$260,424
1905	3,209,915	143,729	11,073	185,689	18,007	347,425
1906	4,655,668	215,357	13,841	286,386	19,339	521,082
1907	4,282,228	186,156	11,235	211,192	15,282	412,630
1908	1,735,366	89,702	8,084	146,105	12,592	248,399

[a] Mining World, December 28, 1907.
[b] Including emery rock valued at $7,338.

CANADIAN CORUNDUM.

Canadian corundum is mined chiefly by two companies, the Ontario Corundum Company and the Canadian Corundum Company (Limited). The deposits of corundum occur in pinkish syenite and nepheline syenite, and are located in the Province of Ontario. The Canadian Corundum Company (Limited) during a part of 1907 treated only corundum from its Craig mine at Craigmont, Ragland Township, Renfrew County, Ontario, where mining operations were begun in 1900.[a] In the following table are given the quantity and value of Canadian corundum during the last five years:

Production of Canadian corundum, 1904–1908.

1904.......short tons..	919	$101,050	1907.......short tons..	1,892	$177,922
1905............do....	1,644	149,153	1908............do....	1,039	100,389
1906............do....	2,274	204,973			

ABRASIVE QUARTZ AND FELDSPAR.

The production of crystalline quartz and of feldspar used for abrasive purposes in the United States in 1908 amounted to 11,725 short tons, valued at $79,146, as compared with 17,435 short tons, valued at $126,582, in 1907. This shows a decrease in 1908 of 5,710 short tons in quantity and of $47,436 in value. The States producing abrasive quartz in 1908 were Connecticut, Wisconsin, Maryland, Pennsylvania, Massachusetts, and New York, named in the order of their importance as producers of this material.

A considerable quantity of the product obtained in Connecticut and Minnesota and reported as crystalline quartz is feldspar, used for abrasive purposes and in the manufacture of cleaning and scouring soaps.

In the following table is given the production of abrasive quartz from 1895 to 1903 and that of abrasive quartz and feldspar since that time:

Production of abrasive crystalline quartz, 1895–1908.

1895.....short tons..	9,000	$27,000	1902.....short tons..	15,104	$84,335
1896............do....	6,000	18,000	1903............do....	8,938	76,908
1897............do....	7,500	22,500	1904............do....	[b]31,940	[b]74,850
1898............do....	8,312	23,990	1905............do....	[b]19,039	[b]88,118
1899............do....	13,600	39,000	1906............do....	[b]24,082	[b]121,671
1900............do....	14,461	40,705	1907............do....	[b]17,435	[b]126,582
1901............do....	14,050	41,500	1908............do....	[b]11,725	[b]79,146

ABRASIVE GARNET.

The production of garnet for abrasive purposes in 1908 amounted to only 1,996 short tons, valued at $64,620, as compared with 7,058 short tons, valued at $211,686, in 1907. This is a notable decrease and is to be explained in part by the general business depression and in part by the invasion of the field by artificial abrasives; furthermore, overproduction in 1907 coupled with a declining market was probably the most potent factor in the decline. The average price per ton of the garnet was $32.37. The garnet mined came from New York.

---

[a] Haultain, E. T., Canadian Mining Journal, August 1, 1907, pp. 291–296.
[b] Includes feldspar used for abrasive purposes.

The following table gives the quantity and value of abrasive garnet produced in the United States for the years 1895 to 1908, inclusive:

Production of abrasive garnet, 1895–1908.

1895.....short tons..	3,325	$95,050	1902.....short tons..	3,926	$132,820
1896............do....	2,686	68,877	1903............do....	3,950	132,500
1897............do....	2,554	80,853	1904............do....	3,854	117,581
1898............do....	2,967	86,850	1905............do....	5,050	148,095
1899............do....	2,765	98,325	1906............do....	4,650	157,000
1900............do....	3,185	123,475	1907............do....	7,058	211,686
1901............do....	4,444	158,100	1908............do....	1,996	64,620

NOTES ON THE ABRASIVE GARNET INDUSTRY.

New York.[a]—The production of garnet for abrasive purposes is a well-established industry in the Adirondack region of New York. The seat of the industry is in Warren and Essex counties, near the upper Hudson River valley, and North Creek, the terminus of the Adirondack branch of the Delaware and Hudson Railroad, is the principal point of shipment.

The garnet produced is almandite, the iron-aluminum variety with the symbol $3FeO.Al_2O_3.3SiO_2$. Ordinarily garnet has a hardness of 6.5 to 7.5, but it is claimed that the Adirondack garnet is harder than this, occurring from 7.5 to 8 in the scale, thus lying intermediate between quartz (7) and corundum (9). According to Newland,[b] the garnet is usually associated with amphibolite, which occurs in lens-shaped bodies in a country rock of acidic gneiss. The amphibole has been metamorphosed, as is usual with garnet-bearing rocks. The mineral occurs in crystals ranging from an inch upward in diameter, and the larger crystals have been so strained and shattered by compression that they readily crumble into small fragments.

In working the deposits the country rock is broken down by the ordinary quarry methods of picking or blasting. The rock is then crushed sufficiently fine to release the garnets, and the product is washed. The garnet is recovered either by hand sorting or by mechanical means. Some difficulty has in the past been encountered in separating the garnet from the accompanying hornblende, but the North River Garnet Company has solved the difficulty by employing crushers and then concentrating on a special type of jigs.

The output is used in the shoe and wood-working industries and sold in the form of garnet paper. The mineral does not possess any distinct mineral cleavage, but there is a rather distinct parting parallel to the dodecahedral faces which is usually well developed in the Adirondack mineral. This insures a smooth surface for attachment to the cloth or paper and at the same time leaves a sharp cutting edge. The resultant efficiency is said to be much greater than that of ordinary sandpaper.

The garnet is obtained from four localities, viz: The North River Garnet Company's works are so located on Thirteenth Lake, Warren County, as to be used throughout the year. There is an immense body of garnet rock here, with a quarry face nearly 150 feet high. The material is crushed and concentrated mechanically. Recently

[a] The notes on the garnet industry in New York have been largely compiled from the reports of D. H. Newland contained in bulletin of the New York State Museum devoted to the mining and quarrying industry.

[b] The mining and quarry industry of New York State: Bull. New York State Mus. No. 102, 1906, p. 11.

the company added another unit to its separating plant, and it is now able to turn out a much larger quantity of crystalline garnet than ever before. At Gore Mountain and Garnet Peak the American Glue Company and H. H. Barton & Son Company have been at work. The garnet at these deposits is separated by hand cobbing, and operations are not conducted during the winter months. The remaining locality is on the east slope of Mount Bigelow, 5½ miles south of Keeseville, near Lake Champlain. The occurrence was described in detail in the report for 1907.[a]

New Hampshire.—No production of garnet from New Hampshire in 1908 was reported to the Survey, but a deposit was reported near Danbury, which has been tested and found to be of good quality. A company is being formed, it is understood, to work the deposit.

INFUSORIAL EARTH AND TRIPOLI.

PRODUCTION.

In previous reports on the production of abrasives in the United States it has been the custom to combine the statistics of infusorial earth and tripoli. So far as our present information goes, the two substances are quite different in origin and to a certain extent in their uses.

Some of the Missouri tripoli is, and always has been, used for abrasive purposes, but much of it is used in the manufacture of filter stones. The Illinois product is employed in the paint industry, as a wood filler, for enameling purposes, etc. No attempt has heretofore been made to procure from producers of tripoli a definite statement of the exact proportion used for abrasive purposes, nor has any attempt been made to get at the tonnage of rough tripoli blocks worked up into filter stones. Even if this tonnage had been found, it would be impossible to value the product on a uniform basis, and thus to obtain a reliable ratio between quantity and value, for the reason that the price of filter stones varies and is dependent not only on the size of the stones, but also on the amount of work done on each. For this reason it has been decided to give simply the value of the production of infusorial earth and tripoli and to omit the tonnage.

In the following table are given the quantity and value of infusorial earth and tripoli produced in the United States from 1880 to 1906 and the value of these products in 1907 and 1908:

Production of infusorial earth and tripoli, 1880–1908.

1880.......short tons..	1,833	$45,660
1881............do....	1,000	10,000
1882............do....	1,000	8,000
1883............do....	1,000	5,000
1884............do....	1,000	5,000
1885............do....	1,000	5,000
1886............do....	1,200	6,000
1887............do....	3,000	15,000
1888............do....	1,500	7,500
1889............do....	3,466	23,372
1890............do....	2,532	50,240
1891............do............		21,988
1892............do............		43,655
1893............do............		22,582
1894............do....	2,584	11,718
1895.......short tons..	4,954	$20,514
1896............do....	3,846	26,792
1897............do....	3,833	22,835
1898............do....	2,733	16,691
1899............do....	4,334	37,032
1900............do....	3,615	24,207
1901............do....	4,020	52,950
1902............do....	5,665	53,244
1903............do....	9,219	76,273
1904............do....	6,274	44,164
1905............do....	10,977	64,037
1906............do....	8,099	72,108
1907............do............		104,406
1908............do............		97,442

[a] Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 618.

NOTES ON INFUSORIAL EARTH.

Infusorial earth in 1908 was mined for market in the following States: California, Connecticut, Illinois, Maryland, Massachusetts, Missouri, and New York.

Diatomaceous or infusorial earth resembles chalk or clay in its physical properties, but can be distinguished at once from chalk by the fact that it does not effervesce when treated with acids. It is generally white or gray in color, but may be brown or even black when mixed with much organic matter. Owing to its porosity it has great absorptive powers. Chemically, it is a variety of opal.

Heretofore the principal uses of infusorial earth have been largely for abrasive purposes, in the form of polishing powders, scouring soaps, etc., but of late its uses have been considerably extended. Owing to its porous nature it has been used in the manufacture of dynamite as a holder of nitroglycerin. The porous structure also renders it a nonconductor of heat, which property, in connection with its lightness in weight, has extended its use as a packing material for safes, steam pipes, and boilers, and as a fireproof building material in general. The California product, according to Arnold and Anderson,[a] may be cut into any shape desired and, like the Missouri tripoli, may be used as a filter stone. The material is quarried for building stone in southern California, for which purpose it seems to be well adapted, especially in that region of earth tremors, owing to its elasticity and because the minimum amount of damage is likely to result from the falling of so light a material.

In Europe, especially in Germany, it has of late years found extended application. It has been used in the preparation of artificial fertilizers, especially in the absorption of liquid manures; in the manufacture of water glass, of various cements, of glazing for tiles, of artificial stone, of ultramarine and various pigments, of aniline and alizarine colors, of paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papier-maché, and a variety of other articles, and there is a large and steadily growing demand for it.

The material is first roasted superficially in large rooms in order to destroy all organic matter and to expel nearly all water present. It is then transferred to flame or muffle furnaces and heated at a higher temperature. Care is observed, however, not to raise the temperature too high, as the absorptive power is destroyed by overburning. The earth is then ground to a fine powder between rollers and sieved; at this stage it should contain less than 1 per cent of moisture. The product is put into sacks and used the same day or before moisture can be reabsorbed. Where all the precautions required for use in the manufacture of dynamite need not be observed, a prolonged drying in chambers supplied with steam pipes usually suffices. In the United States a new use of the material is reported in the manufacture of records of talking machines. For this purpose it is boiled with shellac, and the resulting product has the necessary hardness to give good results.

Among the newer deposits reported to the Survey during the year is one from Blaine County, Idaho. The deposit is located about 25

---

[a] Bull. U. S. Geol. Survey No. 315, 1907, p. 446.

miles west of the Oregon Short Line Railroad in the Smoky mining district. There is a good wagon road to the deposit, which is reported as lying in a blanket form, 40 feet thick and outcropping about 300 feet. Still another deposit has been reported from near Tonopah, Nev.

IMPORTS.

There is an importation of infusorial earth and tripoli into the United States each year which is not separately recorded by the Department of Commerce and Labor, but which is included with rotten stone used for similar purposes. The value of the imports of rotten stone and tripoli for the last five years has been as follows: 1904, $23,022; 1905, $18,986; 1906, $25,990; 1907, $27,121; and 1908, $17,252. No record is kept of the number of tons of this material imported.

CANADIAN PRODUCTION.

The Canadian production during 1908 was 30 short tons of tripoli, valued at $195.

PUMICE.

PRODUCTION.

The pumice produced in the United States in 1908 amounted to 10,569 short tons, valued at $39,287, an increase of 2,457 tons in quantity and of $5,469 in value as compared with the production of 1907. The average price per ton decreased 45 cents from $4.17 in 1907 to $3.72 in 1908. The production of pumice in the United States for the last five years is given in the following table:

Production of pumice in the United States, 1904–1908, in short tons.

Year.	Quantity.	Value.	Price per ton.
1904	1,530	$5,421	$3.54
1905	1,832	5,540	3.02
1906	12,200	16,750	1.37
1907	8,112	33,818	4.17
1908	10,569	39,287	3.72

IMPORTS.

The value of the imports of pumice into the United States in 1908 was $67,094, less by $18,553 than in 1907. The figures of the imports for the last five years are given in the following table:

Value of pumice imported into the United States, 1904–1908.

1904	$77,211	1907	$85,647
1905	77,489	1908	67,094
1906	111,695		

NOTES ON DEPOSITS OF PUMICE.

The pumice produced in the United States comes chiefly from deposits[a] in Harlan and Lincoln counties in Nebraska. Deposits are also known in South Dakota, Wyoming, Idaho, Oregon, Colorado, Kansas, Oklahoma, and Iowa.

The term "pumice" is applied to a form of acid volcanic rock, which may be either massive or in a finely comminuted state. The former variety of pumice is largely imported from the Lipari Islands, a group of volcanic islands north of Sicily in the Mediterranean Sea. It owes its peculiar porous, vesicular, or pumiceous condition to the rapid expansion of included moisture or gases due to sudden release of pressure at the time of its ejection from the volcano. This expansion may be carried to such an extent that the rock is completely shattered, and the resultant finely powdered material may be carried to unknown distances by wind and air currents and then deposited in beds often several feet in thickness. The latter explanation is that usually assigned to the material composing the deposits in Harlan and Lincoln counties, Nebr.

Wyoming.—Darton and Siebenthal[b] have described a bed of volcanic ash in the NW. ¼ sec. 6, T. 13 N., R. 73 W., a mile southeast of Sportsmans Lake in the Laramie Basin, Wyoming.

Idaho.—Volcanic ash or dust was reported during the year near American Falls, Idaho.

Oregon.—Fragmental pumice is very abundant in the vicinity of Crater Lake, Oregon, and has been described by J. S. Diller.[c] It occurs also in the vicinity of Fort Klamath about 20 miles southeast of Crater Lake in the flat country. Both deposits will probably be made accessible in the near future by a branch railroad of the Southern Pacific Company that leaves the main line at Weed, near the west base of Mount Shasta. The railroad is already approaching Klamath Falls, which is not far south of old Fort Klamath.

ARTIFICIAL ABRASIVES.

Under the head of artificial abrasives are included carborundum, crushed steel, and alundum. The total production of these substances, by years, since 1904 is given in the following table:

Production of artificial abrasives in the United States, in pounds, 1904–1908.

Year.	Quantity.	Value.
1904	11,870,380	$830,926
1905	9,820,000	701,400
1906	11,774,300	777,081
1907	14,632,000	1,027,246
1908	8,698,000	626,340

[a] Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 628.
[b] Bull. U. S. Geol. Survey No. 364, 1907, p. 65.
[c] Prof. Paper U. S. Geol. Survey No. 3, 1902, pp. 40–41.

CARBORUNDUM.

Carborundum is manufactured by a single firm in the United States, the Carborundum Company, of Niagara Falls, N. Y. The foreign demand for this abrasive has increased so rapidly within the last few years that the company has constructed a plant at Düsseldorf, Germany, for the manufacture of carborundum wheels and abrasive articles. The factory began operations in February, 1907.

Carborundum is manufactured by fusing in the intense heat of the electric furnace a mixture of granulated coke, very pure glass sand, and sawdust. The two materials first mentioned are the purest obtainable. The coke is the carbonaceous residue from the distillation of petroleum; the sand used is the purest glass sand. The sawdust is added entirely for mechanical purposes, namely, to make the mixture porous and thus to avoid explosions of the carbon monoxide produced during the course of the reaction. The fundamental reaction takes place between the sand (silica) and the coke (carbon), resulting in the production of a carbide of silicon or carborundum. The details of the furnace construction and operation have been described by F. A. J. Fitzgerald,[a] and will not be considered here.

It is reported[b] that the company "will increase its extensive plant during 1909 by the addition of a four-story brick and steel structure. The new building will be 225 feet in length and 60 feet in width. One entire floor is to be given over to the manufacture of carborundum, sharpening stones, hones, scythestones, and other specialties. The other floors will be used for the mixing and wheel molding departments and for the storage rooms.

"During the past year the company has added several new lines to its manufactured products. These include garnet paper and cloth, used largely in the wood and furniture trade, and emery paper and cloth, used in finishing metal and machinery parts. Plans are under way to have the company cover the entire abrasive field with its products, and as these plans mature they will result in a still larger plant and a greater working force."

ALUNDUM.

The abrasive known as "alundum" is manufactured from bauxite by the Norton Company at Niagara Falls. The crude bauxite is first calcined to drive off combined water. This is accomplished in a rotary calciner 60 feet long, heated by two gas producers. The machine at Niagara Falls is continuously acting and will calcine 40 tons of bauxite per day.

The ore after calcination is ready for the electric furnaces. These are conically shaped pots which stand on cars and are heated by vertical electrodes, which are gradually raised as the molten bauxite fills the furnace. In the furnace room 2,000 electric horsepower are used. It is said that the temperature attained in the furnace ranges from 5,000° to 6,000° F. The dimensions of the furnaces are calculated so that the fusion shall not extend to the water-cooled shell. During the fusion iron is reduced from the bauxite as a result of the

---

[a] Electro-chem. and Metallurg. Industry, February, 1906.
[b] The Iron Age, January 21, 1909.

reducing action of the electrodes. This iron, containing 5 to 12 per cent silicon, is sold to the steel makers. These masses, which are called "pigs," each contain about 3 tons of abrasive material.

After the completion of the fusion, the furnace is taken to a position under an electric crane, which removes the solidified mass and places it on the cooling floor until it is cool enough to handle. The mass is then broken up and fed to a crusher, after which the alundum passes through a reel which removes all the fine dust, which is re-fused. The product which has gone over the reel is passed over a sorting belt, where the material not up to the standard is picked out. The resulting product in fragments about the size of a man's fist is then loaded on cars and sent to the company's plant at Worcester, Mass., where it is subjected to the various operations necessary for use in the alundum wheels.

One of the recent applications of alundum is as a refractory material. The substance melts at 2,300° C., and has a very low coefficient of expansion, if it has any at all. It is, moreover, very inert chemically, and tests made in the basic open-hearth furnaces show that it is not appreciably affected by slags in these processes. The lining of a Deville furnace does not show deterioration after repeated burns at 1,800° C. It remains to be proved just how much better alundum is than other standard refractories, as its cost will necessarily be quite high. It is believed, however, that for many special purposes it will prove of great value.

CRUSHED STEEL.

The method of manufacturing crushed-steel abrasives has been described by M. M. Kann, secretary and treasurer of the Pittsburg Crushed Steel Company,[a] and by Pratt.[b]

In the manufacture of crushed-steel abrasives, high-grade crucible steel is heated to nearly white heat, and is then quenched in a bath of cold water. The fragments of steel thus produced are then crushed to particles varying from fine powder up to one-sixth of an inch, more or less, in diameter. The crushed product is then classified and tempered, being then known as "diamond crushed steel," "diamond steel emery," and "steelite."

The chief use of crushed steel is in the stone, brick, glass, and metal trades, the size of the steel used depending on the character of the stone to be cut, rubbed, ground, or polished.

---

[a] Proc. Am. Assoc. Adv. Sci., Pittsburg meeting, July, 1903.
[b] Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, p. 1013.

ARSENIC.

By Frank L. Hess.

INTRODUCTION.

During 1908 arsenic was produced in a commercial way at only two places in the United States—by the American Smelters Securities Company at its Everett (Washington) plant and by the Washoe Copper Company at the Washoe Smelter, Anaconda, Mont.

The Everett plant produced most of its arsenic from arsenical ores mined in California and Washington, with a smaller quantity from flue dusts shipped from smelters at Helena, Mont., and Murray, Utah. Many of the California gold ores are arsenical, and at Monte Cristo, Wash., considerable quantities of auriferous arsenic sulphides, realgar and orpiment, are mined. The flue dust collected at Helena is from various Montana ores, and that obtained at Murray is mainly from Tintic copper ores. The arsenic produced at the Washoe smelter was but a small fraction of the amount passing through the flues. Were even half of the arsenic fumes made at this smelter saved, the plant could more than supply the whole demand of this country for arsenic and its compounds. The production was in the form of white arsenic or arsenic trioxide.

Neither the arsenic plant at Mineral, Lewis County, Wash., nor that at Brinton, Floyd County, Va., operated during the year, and nothing was done on the New York deposits.

PRODUCTION AND IMPORTS.

The production and importation of arsenic, white arsenic, and arsenic sulphides, and of London purple and Paris green, since 1904, are given in the following table. The production of each year is composed only of white arsenic (arsenic trioxide) or the white arsenic content of the ore produced. As only two companies produced arsenic during 1908, the figures can not be tabulated separately.

Production and imports of arsenic, 1901–1908.

Year.	Production of white arsenic.		Imports.			
			White arsenic, metallic arsenic, and arsenic sulphides.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.
1901	300	$18,000	3,495	$316,525	....	....
1902	1,353	81,180	4,055	280,055	....	....
1903	611	36,691	4,179	294,602	....	....
1904	36	2,185	3,400	243,380	28,498	$985
1905	754	35,210	3,838	256,540	44,931	1,118
1906	737	63,460	3,987	350,045	311,293	21,347
1907	1,751	163,000	5,164	574,998	133,422	21,919
1908	....	....	4,964	430,400	195,000	30,764

Besides these importations, sheep dip, a large part of which is arsenical, was imported to the value of $19,696 in 1907 and of $1,389 in 1908. One of these dips consists of sodium arsenide, arsenic sulphide, and sulphur. Under customs regulations no record is kept of importations of arsenic compounds known by the trade names of Scheele's green, lead arsenate, lead arsenite (pink arsenoid), barium arsenoid (white arsenoid), green arsenoid, aniline arsenate, or other arsenic salts than those given above. The arsenic trioxide imported in 1908 amounted to 168 tons, valued at $13,263.

PRODUCTION IN FOREIGN COUNTRIES.

The principal producing countries are Germany, Spain, Portugal, France, England, Turkey, and Canada. The figures obtainable are largely in terms of ore carrying an unknown percentage of arsenic, and are thus too indefinite to be serviceable. The output of white arsenic from Germany, Spain, and England probably exceeds considerably in each case that from the United States.

PRICES.

In New York City prices for white arsenic (arsenic trioxide), as given by the Oil, Paint and Drug Reporter, opened in January at 5⅝ to 6 cents per pound, and gradually fell until in November 3 cents was reached, "and perhaps a shade lower." In December a rise of one-fourth to three-fourths cent took place. These prices, of course, apply to large lots. Red arsenic (red sulphide of arsenic) sold during the first three months of 1908 at 8 to 8¼ cents per pound, and during the remainder of the year at about one-fourth cent less.

Paris green prices for 1908 were fixed by the manufacturers to take effect April 27, and were as follows:[a]

The new prices are quoted below, together with a comparison of last year's (1907) figures, in quantities of 10,000 pounds or more.

Prices of Paris green for 1907 and 1908, New York, cents per pound.

	1907.	1908.
Arsenic kegs	25	21½
100-pound to 175-pound kegs	25½	22
14, 28, and 56 pound kits	26½	23
2 and 5 pound boxes	26½	23½
1-pound boxes	27	24½
½-pound boxes	28	25½
¼-pound boxes	29	26½

In quantities from 5,000 to 10,000 pounds, ½ cent per pound advance; from 1,000 to 5,000 pounds, 1½ cents per pound advance; from 500 to 1,000 pounds, 2½ cents per pound advance; less than 500 pounds, 3½ cents per pound advance.

USES.

Among the principal uses of arsenic are as the trioxide in glass, as Paris green in pigments, and as insecticides. The use of Paris green in paint is somewhat limited, as, like practically all arsenic compounds, it is poisonous. As an insecticide it is used largely by gardeners and farmers. If pure, it is comparatively harmless to plant life, owing to

[a] Oil, Paint and Drug Reporter, New York, vol. 73, April 27, 1908, p. 23.

its insolubility, but the trioxide is often present in some quantity, and if Paris green is then used largely it is fatal to plants, especially in dry climates, where it is not soon washed off by rains. Paris green is a copper aceto-arsenide and should contain:

	Per cent.
Arsenic trioxide (As_2O_3)	58.65
Copper oxide (CuO)	31.29
(C_2H_3O)	10.06

It is made by boiling verdigris, a mixture of basic acetates of copper, with arsenic trioxide. Scheele's green, a copper-hydrogen-arsenite, containing—

	Per cent.
Arsenic trioxide (As_2O_3)	52.32
Copper oxide (CuO)	42.37
Water (H_2O)	4.81

is also used as an insecticide.

London purple, also much used as an insecticide—

is a by-product in the manufacture of aniline dyes, and is thought to be composed mainly of calcium arsenite with some coloring impurity, mostly rosaniline arsenite. Besides London purple, there are two other preparations, Paris and English purple, which have practically the same composition. London purple analyzed by the New Jersey Experiment Station gave this analysis:

Analysis of London purple.

	Per cent.
Water (H_2O)	3.27
Arsenic trioxide (As_2O_3)	41.44
Lime (CaO)	24.32
Alumina (Al_2O_3) Iron oxide (Fe_2O_3)	3.37
Sulphuric anhydride (SO_3)	.31
Dye, by difference	27.97

It is made by boiling a waste product consisting of dye and arsenious oxide with lime to make the insoluble calcium arsenite.[a]

In metallurgy arsenic has but little use. It makes lead hard, and arsenical work lead from the silver-lead smelters is sometimes used for shot. Arsenic, as the trioxide or sulphide, is introduced into lead for making shot and bullets. The presence of arsenic, unless in minute quantity, in brass or bronze makes them brittle, though small quantities of less than 0.5 per cent give cleaner castings and a greater ductility to Muntz metal.[b]

A number of arsenic salts and oxides are used medicinally, among them the bromide, iodide, trisulphide, trioxide, sodium arsenate, and potassium arsenate. Realgar, the disulphide, both natural and artificial, is used as a paint pigment in calico printing and dyeing; in tanning; and, as it burns with an intense white light, in pyrotechnics. Orpiment, the trisulphide, called also king's yellow, is used as a paint pigment, and as a reducing agent in chemical work. The trioxide is used in paints; for preserving hides, both for taxidermists and in the leather industry; as an antiseptic; in killing animal pests; and in the preparation of volumetric solutions. Sodium arsenate is used in dyeing with turkey-red oil and in printing fabrics; the arsenite in making soaps for use on skins and hides. Potassium arsenite is used as a reducer for silver in the manufacture of mirrors.

[a] Haywood, J. K., The adulteration and analysis of the arsenical insecticides: Jour. Am. Chem. Soc., vol. 22, 1900, pp. 571-572.
[b] Sperry, E. S., Mech. Eng., vol. 17, 1906, pp. 763-764.

BORAX.

By Charles G. Yale.

INTRODUCTION.

California continues to be the only State in the Union which produces borax in commercial quantities. The total quantity of crude tons mined, however, is falling off for the reason that the operators have ceased mining the low-grade "marsh" material and are confining themselves to working colemanite ledges, the ore in which carries high percentages of anhydrous boric acid. When, in 1907, the market price of refined borax became very low, all the borax mines in the State were closed down except one, as it no longer paid to handle the low-grade material in which most of them were working. Even some of those mines which were working material of a reasonably good grade, as in Ventura County, were compelled to cease operations, the cost of long hauls to railroad stations being such as to preclude any profit, while the market price of refined borax was so low. None of the mines which were closed in 1907 has since resumed operations, though one new one has reached a productive stage and become a factor in the market.

PRODUCTION.

In 1908 the production of borax in the United States was 25,000 short tons, valued at $975,000, all from two mines in Inyo and Los Angeles counties. The decrease in tonnage as compared with that of 1907 was over 50 per cent, or 27,850 tons; the decrease in total value was $146,520. In these figures the crude material mined is taken as the basis of quantity, and the percentage of anhydrous boric acid in the ore is taken as the basis of value. The colemanite or borate of lime mined varies in richness of anhydrous boric acid, not only in different mines but in any single mine, and it is necessary to obtain the percentages in order to determine value of tonnage.

The statistics of production of borax in California from 1895 to 1908, inclusive, are given in the following table, the values for the years 1903 to 1908, inclusive, being based on the anhydrous boric-acid content of the corresponding number of crude tons of colemanite or borate of lime:

Production of borax in California, 1895–1908.

1895	short tons	5,959	$595,900
1896	do	6,754	675,400
1897	do	8,000	1,108,000
1898	do	8,000	1,120,000
1899	do	20,357	1,139,882
1900	do	25,837	1,013,251
1901	do	23,231	1,012,118
1902	short tons	[a] 20,004	$2,538,614
1903	do	[b] 34,430	661,400
1904	do	[b] 45,647	698,810
1905	do	[b] 46,334	1,019,154
1906	do	[b] 58,173	1,182,410
1907	do	[b] 52,850	1,121,520
1908	do	[b] 25,000	975,000

[a] Refined product. [b] Crude product.

IMPORTS.

The following table shows the imports of borax and borates into the United States from 1902 to 1908, inclusive:

Imports of borax and borates into the United States, 1902–1908, in pounds.

Year.	Borax.		Borates, calcium, and sodium (crude) and refined sodium borate.		Boric acid.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	684,537	$20,795	186,807	$12,002	822,907	$30,439
1903	68,978	5,727	146,654	13,280	693,619	28,011
1904	153,952	10,569	89,447	6,630	708,815	27,658
1905	166,960	8,802	20,395	1,626	676,105	22,372
1906	791,425	27,343	57,711	2,436	986,021	33,200
1907	2,268,065	77,258	2,959	175	534,524	23,547
1908	641,632	22,058	40	4	385,064	14,702

REVIEW OF THE BORAX INDUSTRY IN 1908.

The demand for borax in its various uses does not increase, and the output of the mines is limited to what may be considered the normal consumption. It is to be noted, however, that imports of foreign material are falling off materially, the needs of the United States being very fully met by the output of the California mines. This output could be steadily increased did the consumption of the substance warrant. Efforts are made to stimulate the consumption of borax along all possible lines, and a number of new uses in various commercial forms have been found. In some well-known industrial uses, however, the demand has been materially lessened.

It is scarcely necessary to attempt to make any extended review of the borax industry in 1908, especially by locality, since the mining of the substance has been confined to two producing properties. The principal one of these is the Pacific Coast Borax Company, which now confines its operations to the Lila C. colemanite mine, in the Death Valley section of Inyo County, Cal. The properties formerly operated by this company in San Bernardino County, in the vicinity of Daggett, have been given up entirely and the plants removed. The crude material mined at the Lila C. mine is shipped direct by rail to the refineries in New Jersey. Most of the colemanite obtained in 1908 was shipped just as it was mined, though a few million pounds of low-grade stuff were calcined before shipment in order to concentrate it and reduce freight cost. The only other productive mine in the State in 1908 was that of the Sterling Borax Company, near Lang Station, in Los Angeles County. This is a new mine, which only became productive in 1908. Its product is colemanite, which is shipped crude to refineries in New Jersey. This company is virtually a combination which includes not only the productive mine named, but the Ventura County mines of the Frazier Borate Company, or Stauffer Chemical Company, the Lang and Death Valley deposits of the American Borax Company, and the refining companies at Chicago, San Francisco, and New Brighton.

The property near Lang Station is in a favorable situation for labor, transportation, etc. A number of mining claims in that section are mined by this company.

The Borax Properties (Limited), an English company, now owns a group of borax claims in Belleville district, as well as the properties of the Palm Borate Company at Otis, 5 miles from Daggett, San Bernardino County. Although more or less work has been done by this company, there was no output in 1908, but it is expected to become productive in 1909. The borax mines of Russell Brothers, on Frazier Mountain on the northern edge of Ventura County near the Kern County boundary, after an idleness of two years, are expected to resume operations in the latter part of 1909. These claims are between the Sterling and the Columbus mines, which have also been closed for some time. Aside from the properties mentioned no other borax mines in California were active in 1908, or promised to be active in 1909.

FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.

FLUORSPAR.

PRODUCTION.

Three States, Colorado, Illinois, and Kentucky, and one Territory, Arizona, produced fluorspar in the year 1908, Arizona having again become a producer for the first time since 1904. The production in Colorado and Kentucky decreased; that of Illinois showed an increase. No production has been reported from Tennessee since 1906. Colorado produced gravel spar and Arizona lump spar; the total quantity produced was 745 short tons, valued at $4,518, an average price of $6.06 per ton. With reference to the Colorado product, it should be stated that this figure represents the value on board cars at the railroad shipping points, and includes the cost of a long wagon haul, $2 to $3 per ton. In the preceding annual report on the production of fluorspar, Mineral Resources of the United States, 1907, Part II, page 639, the average value of Colorado spar was given as $3.45 per short ton, based on the average value of the spar at the mines. There was thus actually little change in value since 1907. In 1908 Illinois produced 21,332 short tons of gravel spar, valued at $96,315, or $4.05 per short ton on board cars. In this connection it should be remarked that the largest producing fluorspar mines in this State are near railroad or river transportation; therefore, the cost of long wagon hauls has not entered into the reported value of this product. The production of lump spar in Illinois was 6,189 short tons, valued at $33,267, or $5.37 per ton. The ground spar produced from this State amounted to 4,206 short tons, valued at $43,256, or $10.28 per ton. Kentucky reported a total production of 6,323 short tons of spar, valued at $48,642, distributed as follows: Two thousand eight hundred and forty short tons of gravel spar, valued at $14,226, or approximately $5 per ton; 307 short tons of lump spar, valued at $1,828, or $5.95 per ton; and 3,176 short tons of ground spar, valued at $32,588, or $10.26 per ton. These prices are f. o. b. shipping points, and since in many cases the spar has to be hauled distances of 6 to 15 miles from the mines to the railroad, the average prices charged are a little higher than in Illinois.

The financial stringency of the last quarter of 1907 seriously affected the fluorspar industry far into the year 1908. Several mines in Kentucky and Illinois which have been steady producers for years were idle throughout 1908. Others which were operated at less than their full capacity during the first half of 1908 were obliged practically to close down during the late summer and autumn on account of low water in Ohio River, a condition which prevented supplies being brought in and spar being shipped out of all places dependent on river transportation.

The demand for fluorspar necessarily depends primarily on the activity in the steel, glass, and enameling industries. All these industries curtailed their production in 1908. It is estimated that fully 80 per cent of the fluorspar production is consumed by the steel industry and chiefly in the basic open-hearth charges. The following figures show the considerable reduction in output of steel in 1908 as compared with 1907:

Production of open-hearth steel in 1907–8, in long tons.[a]

	Basic.	Acid.	Total.
1907	10,279,315	1,270,421	11,549,736
1908	7,140,425	696,304	7,836,729

[a] Ann. Statist. Rept., Am. Iron and Steel Association, Philadelphia, Pa., April 26, 1909.

Low prices during 1908 resulted in the accumulation of considerable stocks of spar at the end of that year. At the Illinois mines there were 3,965 short tons in stock, and in Kentucky 12,899 short tons remained unsold at the close of 1908. Better conditions have prevailed during the first half of 1909 in the industries on which fluorspar mining is dependent, and the orders booked by the fluorspar-producing companies indicate that the trade for 1909 will be more nearly normal.

The following table gives the quantities and values of the different grades of fluorspar marketed in the United States in 1907 and 1908:

Fluorspar marketed in 1907 and 1908, in short tons.

State.	Gravel.		Lump.		Ground.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1907.								
Colorado	3,300	$11,400					3,300	$11,400
Illinois	18,610	83,259	3,038	$22,828	3,480	$35,884	25,128	141,971
Kentucky	14,276	71,376			6,782	62,595	21,058	133,971
Total	36,186	166,035	3,038	22,828	10,262	98,479	49,486	287,342
1908.								
Colorado	[a] 745	4,518					745	4,518
Illinois	21,332	96,315	6,189	33,267	4,206	43,256	31,727	172,838
Kentucky	2,840	14,226	307	1,828	3,176	32,588	6,323	48,642
Total	24,917	115,059	6,496	35,095	7,382	75,844	38,795	225,998

[a] Includes a small production of lump spar from Arizona.

The annual production of fluorspar in the United States since 1883 is given in the following table:

Production of fluorspar in the United States, 1883–1908.

1883____short tons__	4,000	$20,000	1896____short tons__	6,500	$52,000
1884_________do____	4,000	20,000	1897_________do____	5,062	37,159
1885_________do____	5,000	22,500	1898_________do____	7,675	63,050
1886_________do____	5,000	22,000	1899_________do____	15,900	96,650
1887_________do____	5,000	20,000	1900_________do____	18,450	94,500
1888_________do____	6,000	30,000	1901_________do____	19,586	113,803
1889_________do____	9,500	45,835	1902_________do____	48,018	271,832
1890_________do____	8,250	55,328	1903_________do____	42,523	213,617
1891_________do____	10,044	78,330	1904_________do____	36,452	234,755
1892_________do____	12,250	89,000	1905_________do____	57,385	362,488
1893_________do____	12,400	84,000	1906_________do____	40,796	244,025
1894_________do____	7,500	47,500	1907_________do____	49,486	287,342
1895_________do____	4,000	24,000	1908_________do____	38,795	225,998

IMPORTS.

Heretofore fluorspar has been imported into the United States duty free, and it has therefore been impossible to obtain the statistics of the importations. Large quantities of gravel spar produced at a low cost from the tailings of lead mines and from the gob in abandoned mines in England has been shipped to this country as ballast at a very low freight rate. The material thus produced is high in silica, and is almost entirely consumed by open-hearth steel makers. It competes with the American gravel spar in the Eastern States as far west as Pittsburg and practically fixes the market price. According to Fohs [a] the imports of English spar to the United States in 1906 probably reached 30,000 short tons. The same authority states further that the total freight cost of spar from English mines to American ports is about $2.50 per ton and only $1.60 additional to Pittsburg. This latter figure is open to some question, however, since he states that the published rate is $2.60. It is estimated that the imports of fluorspar from Great Britain and all other countries in 1908 were not in excess of 22,000 short tons.

FLUORSPAR CONCENTRATION.

Many inquiries have been received by the Survey regarding the processes involved in the preparation of fluorspar for the market. A brief outline is therefore presented herewith of the equipments and methods employed in the Kentucky-Illinois district for preparing gravel spar. It is adapted from Chapter V, Bulletin No. 9, of the Kentucky Geological Survey, in which a very full illustrated description of washers and mills is given.[b]

METHODS OF CLEANING FLUORSPAR.

In the preparation of fluorspar for the market three processes may be involved—washing, crushing and separating from other minerals

[a] Fohs, F. Julius, Fluorspar deposits of Kentucky: Bull. Kentucky Geol. Survey No. 9, 1907, p. 19.
[b] Fohs, F. Julius, Fluorspar deposits of Kentucky: Bull. Kentucky Geol. Survey No. 9, 1907; price, 80 cents. It is suggested that persons interested procure this bulletin.

and rocks, and grinding; sometimes the first process only; again, the first and second; while a small part undergoes all three of the processes.

WASHING.

Log and gravity washers are chiefly in use in Kentucky, while Illinois mills make use of cylindrical washers, washing trommels, and automatically sprayed shaking screens. In some of the mills the rougher jig serves merely as a washer—a practice inexplicable when the cost between a serviceable washer and a 5 or 6 cell jig is compared.

Log washers.—The log washer, consisting usually of an octagonal log to which iron blades are attached, is now commonly used. It is from 12 to 18 feet in length and 12 inches in diameter. The blades in most cases are set so that one blade is 1 inch beyond the preceding one. Where the fluorspar is mixed with a great deal of clay and is dirty, they are set the width of a blade or 4 inches beyond the one preceding, thereby permitting slower movement. When still slower movement is desired, either the number of revolutions is reduced, which is preferable, or every other blade is left off. The logs are inclined usually from 1° to 3°, the latter being the most satisfactory, and are run commonly from 12 to 14 revolutions per minute, and again as high as from 25 to 40. The troughs in which the washers are set are 2 feet deep and of like width. Single logs are used at some of the mines; others have two sets side by side; while still others have them placed tandem; for uncommonly dirty fluorspar a 2-inch stream of water is applied to the upper end, while at the lower end a man is stationed to shovel the product in. A single washer requires 1½ horsepower to operate it. The cost of washing averages 25 cents per ton. When properly manipulated, the log washer is more efficient and cheaper than the gravity washer.

Gravity washer.—The gravity washer consists of an inclined trough about 1 foot wide, the sides flanging toward the top. These troughs are 8 to 10 inches deep, and constructed of inch planks, usually of oak. The bottom and sides may be lined with sheet iron. Such troughs are from 25 to 75 feet in length. At the upper end the trough is deepened and widened so as to form a bin having a capacity of 50 to 100 tons, into which the spar may be dumped. The bin and trough are inclined 10° to 12°, the former less than the latter. The whole is elevated a sufficient height to give room for settling boxes, either by arranging the washer so that the ore may be dumped into it directly from the shaft tub by belt and cup elevators or by taking advantage of a steep slope. The height at the lower end is usually about 6 feet. A steady 1½ to 2 inch stream of water, sometimes two, is sprayed with hose upon the fluorspar in the bin; sometimes by boys employed for the purpose, and again simply from a pipe. A walk way is provided on each side, on which a boy or man may walk to loosen with a hoe or rod any clogged fluorspar.

The gravity washer is but little used now in the district. The cost of washing by it is 25 to 35 cents per ton, which higher price some claim is compensated by its cleaning better the very dirty fluorspar. This, in comparison with the work done by the log washer, appears not to be the case, the log doing equally good or better work; the losses are also greater with gravity than with log washers. In fact, a great deal depends on the manner in which either is handled.

Other washers.—At mines where the spar is semiclean, shaking screens with automatic sprays are utilized. These sprays are made by arranging a row of holes, 3 or 4 inches apart, in $\frac{1}{2}$-inch or 1-inch pipes, set parallel 6 inches apart, so as to cover surface of screen at an elevation of about 18 inches above the screen. In addition there is sometimes used a cylindrical iron washer, with a spiral of sheet iron 6 inches wide lining the cylinder, into which the spar is first admitted. Such washers are about 12 feet in length. While they wash the spar very well, they are superfluous. Both this form and a shaking-screen washer are employed for semiclean spar, either alone being sufficient. The shaking screen requires less space, being only 6 to 7 feet long.

At certain mills washing trommels are employed, of round perforated metal, with cups attached. These are 6 feet in length. These are efficient for the character of fluorspar they handle, which is not very dirty.

Summing up, the log washer appears preferable for dirty vein stuff, while the sprayed shaking screen or washing trommel is preferable for the cleaner product.

Screens.—Most of the washers have only one screen at the end, though in some cases two are used for two sizes. In the case of gravity washers where two are placed at the end, they are stationed at the end of each trough, two troughs branching off from the main trough, while on the sides of the latter one or more screens may also be placed to gain capacity. The screens vary, $\frac{1}{2}$, $\frac{5}{8}$, and 1 inch being most commonly used. Grizzlies, made from iron bars, inverted rails, or inch wood strips, are also used for this purpose. Screens and grizzlies are commonly not over 4 feet in length and inclined 30° to 40°.

The screens placed at the base of the washers are ordinarily of the stationary type, while at some of the mills a shaking screen is employed. The washing trommel acts partly as a screen itself. The undersize from these form one size and the oversize another where two sizes only are made in the case of gravel fluorspar. Most of the gravel spar is then ready to be hauled to storage dumps or bins to await shipment. In some cases it is first hand picked, sometimes in the bin at the base of the washer screen, again on a plank table built just under it, or an iron-sheathed wooden picking belt, or a white rubber belt conveyor. At one mill the man shoveling into the crusher serves as picker. Usually from two to four men are employed. The treatment for gravel and lump products is somewhat similar. The lead and No. 1 lump are picked out to go to separate bins; limestone and barite are also picked out if least abundant; and the No. 2 fluorspar, or that to be milled, goes over at the end of the belt. The last two products change places according as one or the other is most abundant. In some cases the lumps containing zinc sulphides or carbonate are picked out and dropped into separate chutes.

The treatment described is all that is necessary for preparing natural gravel for market, or No. 1 lump for grinding, in case other minerals are not present in such quantities as to require more elaborate treatment. If more elaborate treatment is required, the foregoing always precedes as preliminary treatment.

FLUORSPAR IN COLORADO.

INTRODUCTORY STATEMENT.

As shown in the bibliography the fluorspar deposits of Kentucky and Illinois have received considerable attention. Little, however, has been published regarding the Colorado deposits. As a matter of general interest the following notes, based on a hasty reconnaissance by the writer in September, 1908, are presented.

In Colorado and other Western States fluorspar occurs commonly in small quantities in connection with metalliferous veins. In eastern Colorado, in a narrow belt extending more than 150 miles from north to south, just within the front range of the Rocky Mountains, from Boulder County on the north to Custer County on the south, fluorspar occurs in considerable quantities. In several places it forms the major part of the filling of fissure veins, the metalliferous minerals being practically of negligible quantity. The fluorspar veins, where studied, cut granites and gneisses of pre-Cambrian age that have been intruded by later dikes, many of which are of quartz porphyry.

The fluorspar industry in Colorado is yet in its infancy. In milling the precious metals some fluorspar is obtained in the tailings, although but little of such spar can be saved. Where the veins are wholly of fluorspar and thick enough to yield an important tonnage attempts have been made to mine the spar itself, although but little investment has been made for mine equipment. All the deposits thus far worked are situated 12 to 16 miles from a railroad. Gravel spar is the only grade that can be prepared by hand cobbing and sorting. Much of the spar heretofore produced has failed to fulfill the requirements of the market, on account of the presence of wall rock and vein materials that are difficult to remove without special machinery. The lowest grade of spar acceptable must contain at least 80 per cent CaF_2, with silica less than 15 per cent. There is at present a local demand for more spar than can be produced in the State at the present rate of production. Colorado spar is fairly free from objectionable sulphides, and the basic open-hearth steel plant of the Colorado Fuel and Iron Company at Pueblo consumes practically all the output of the State, and about twice as much more of this essential fluxing material is brought from Illinois and Kentucky. The price paid for Colorado spar is $6 a short ton for spar that carries 85 per cent CaF_2, f. o. b. cars at Boulder, Morrison, and Westcliffe. A premium of 20 cents per ton for each per cent of CaF_2 above 85 per cent brings the price of 90 per cent spar up to $7 per ton, and a deduction of 20 cents per ton for each per cent of CaF_2 below 85 per cent reduces the price of 80 per cent spar to $5 per ton.

NEEDS OF THE INDUSTRY.

Simple and economical methods of cleaning the spar and better transportation facilities are the things most needed by the fluorspar industry in Colorado. There seems but little prospect of bringing railroads any nearer to the present working properties for some time, but discoveries of new deposits of fluorspar nearer to railroads are likely to follow. The general improvement of wagon roads would be possible and beneficial.

The principal foreign materials that must be separated from the Colorado fluorspar in order to raise its grade, are quartz, clay, granitic rock from walls and breccias, and siliceous gouge—in general, siliceous and aluminous materials, whose specific gravities are a little lower than that of fluorspar. It would seem feasible to raise the grade of most of the Colorado material at least to the minimum limit, and of the best grade to at least 90 per cent CaF_2, by the application of some of the simpler washing processes now employed in the Kentucky-Illinois district. The problem in Colorado is to save only the fluorspar (except in rare instances where ores of lead, copper, zinc, or the precious metals may be present) and to put quartz, sand, rock, clay, etc., into the tailings. The differences in specific gravity (fluorspar 3.13, quartz 2.65, feldspar 2.7) are relatively slight; therefore, the most perfect separation would involve a practically perfect sizing system of screens and jigs. Such elaborate equipment is probably out of the question at present in Colorado for several reasons, chief among which are (*a*) that the quantity of spar in sight does not promise to warrant very large operations; (*b*) that water is not abundant at most of the fluorspar prospects, and washing operations could probably be carried on only during part of the year; (*c*) that the cost of haulage is so great as to cut down profits to so low a margin that returns on large investments could hardly be hoped for. A much cleaner product, however, might be procured by coarsely crushing the spar, running it down a gravity washer or through a log washer to remove the clay and sand, and subsequently picking out the large fragments of quartz and rock. The picking could be done on a table or belt. One such outfit would suffice to handle the whole output of each district in the State.

PRODUCING DISTRICTS.

There are three localities in Colorado where fluorspar is produced for the market, viz, at Jamestown, Boulder County, at Evergreen, Jefferson County, and near Rosita, Custer County.

Jamestown.—At Jamestown the country rock is generally granitic, of pre-Cambrian age. The granite is intruded by several dikes of quartz porphyry, which carries fluorine in quantities, ranging from a trace to 30 per cent, and is cut by many veins in which the vein material is principally crystalline fluorspar, with quartz and pockets of decomposed silica and feldspathic clay. There are veins carrying sulphides and tellurides also in the vicinity, but these are not worked for fluorspar. The fluorspar veins here are notable for their lack of metalliferous minerals. The mineralized zone that carries fluorspar in abundance extends northwest and southeast for about 2 miles, with Jamestown near the middle point. The width of the zone is about half a mile. The valley of Jim Creek cuts through this area and affords outcrops of the fluorspar veins and other mineralized dikes and veins. Within a radius of 1 mile from the center of the village there have been located ten or more groups of claims on which fluorspar veins appear to be abundant. The fluorspar veins occupy fissures, and the walls and vein material seem to have suffered some modification by movements which have resulted to some extent in the brecciation of the material. The wall and vein materials are thus more or less intermixed, and the veins appear to be faulted in places so as to be offset. The fluorspar veins range in thickness from a few inches to 15 feet, the usual thickness being from $2\frac{1}{2}$ to 5 feet. Veins less than 1 foot thick can hardly be worked profitably, and there are few that exceed 6 feet in thickness. Thicknesses greater than 6 feet are generally due to local swellings or to intersections of two or more veins. The fluorspar veins according to strike fall into two groups, those striking northeast and those striking northwest, the former group predominating. The veins are nearly vertical, or dip at angles of 75° or more. The veins show faint banding or ribbon structure, but this in many cases has been obscured by brecciation.

The fluorspar in this locality is generally dark colored, ranging from greenish brown to dark purple, although there is some light-colored, fairly clear, glassy spar obtainable. A singular characteristic of the dark spar is that on exposure to sunlight and air the dark color bleaches to pale purple, light blue, or white in a few months. This is true of the spar on the surface of outcropping veins as well as of mined material thrown out on stock piles. The spar that has been opened is mostly near the surface and it is generally much fractured, rather porous, and somewhat brecciated. The cracks, pores, and cavities are filled with decomposed quartz and feldspathic material, and these, together with the vein quartz and wall material that are necessarily included in mining, greatly reduce the grade of the spar. The material as mined carries 70 to 85 per cent CaF_2.

Although mining of fluorspar has been carried on near Jamestown for six years, the development work thus far accomplished consists mainly of surface cuts and adits not more than 100 feet long. Much of this work has simply been done as assessment work from year to year, in order to prove title to the claims. Overhead stoping from the adits has opened the spar in places to vertical distances of 30 feet. One shaft has been sunk on a fluorspar vein. It is reported that this shaft is 112 feet deep and that from it levels were driven north and south on the vein at depths of 50 to 100 feet, and that the spar has been mined out to the second level by overhead stoping. In September, 1907, this shaft was inactive and partly filled with water. All the fluorspar workings here, except this shaft, are well above the level of ground water and are easily drained.

The statistics of production of fluorspar from Colorado were not obtained at the beginning of the industry; hence it is probable that considerably more spar has really been mined in that State than has been recorded by the Survey, whose Colorado returns date back to 1905 and total less than 6,000 tons. The total quantity produced by the Jamestown districts, according to rough estimates made by men familiar with the locality, amounts to about 8,700 short tons. On the majority of claims only assessment work is done from year to year, the crude spar that is mined being hand cobbed or perhaps hand screened and allowed to accumulate until the weather and roads are favorable for hauling. The product is of the grade known as "gravel" in Illinois and Kentucky. The spar must be hauled to Boulder, a distance of about 13.5 miles by road, which is mostly down grade. The cost of hauling is about $3 per ton.

Evergreen.—Near Evergreen, Jefferson County, along Bear Creek, is an area of pre-Cambrian granite gneiss in which fluorspar occurs in true veins, associated with lead, zinc, and copper minerals in minor quantities. Besides the veins in which fluorspar is the major constituent, there are quartz veins carrying minor quantities of fluorspar as well as metallic sulphides.

On the northwest side of Cub Creek, a branch of Bear Creek, at a point about three-fourths of a mile southwest of Evergreen post-office, a prospect has been opened on a fluorspar vein, ranging from 1 foot 6 inches to 4 feet 6 inches in thickness and averaging about 2½ feet of spar. The vein strikes N. 30° W. and dips 70° SW. The vein fills a fissure which cuts across the sheeting of the granite. This vein is reported to be traceable for about 1 mile to the southeast and for a greater distance to the northwest. The Augusta mine, formerly worked for ores of copper, is nearly in the same strike, about one-third of a mile southeast of the fluorspar prospect. The walls of the vein show movement. Strained and mashed biotite granite occurs between the vein material and the walls of the fissure, and fragments of it penetrate the vein material at the edges. Within the vein there are in places bands of white quartz 1 to 3 inches thick and bands of siliceous biotitic rock 3 to 6 inches thick. Along the foot wall the vein carries small quantities of lead and copper ores. Sphalerite (zinc sulphide) is reported to occur below ground-water level. The fluorspar is banded parallel to the walls, and its color ranges from amethyst to deep purple, from pale to deep green, and in a few places it is greenish yellow.

The spar is mined from hillside open cuts and drifts on the outcrop, and the vein has been reached also by a crosscut about 250 feet long, below which a winze about 25 feet deep was sunk, and from this a lower level was driven a few feet. The spar is mined by hand, hoisted to the surface by windlass, hand cobbed, the metalliferous minerals saved, and the products hauled 12½ miles, mostly down grade, to the Colorado and Southern Railway at Morrison. The haulage costs $2 per ton.

In September, 1908, mining was in progress, but shipments were suspended owing to washouts on the Bear Creek road. Some fluorspar was mined here in the seventies and carted 28 miles to Central City, where it was used in smelting gold and silver. The present workings were opened in December, 1907. The total production since then has been about 200 short tons. The material is now used by the Colorado Fuel and Iron Company, at Pueblo.

Rosita.—About 7 miles southeast of Rosita, Custer County, near one of the branches of Antelope Creek, a vein carrying fluorspar has been discovered, from which some spar has been produced for the market. The rocks in the vicinity are pre-Cambrian granite and gneiss and later eruptives. The fluorspar occurs as a shoot in a fissure vein cutting the crystalline rocks. The vein strikes N. 20° E. to N. 30° E. and dips about 75° SE. The shoot is a well-defined tabular sheet of ore, pitching northwest. It pinches and swells locally, and terminates on its lower right hand margin in siliceous vein rock. It is also slightly faulted, as shown in one of the upper workings. The thickness of the vein varies from 16 inches to 4 feet, and the irregularity is more pronounced in the hanging wall than in the foot wall. The thickness of the spar ranges generally from 2 to 3 feet, and the average thickness of the workable material averages about 2½ feet. Between the wall rock and the workable spar there is in places a band of brecciated siliceous rock 4 to 8 inches thick, cemented by fluorspar, and generally there is also clay gouge from half an inch to 6 inches thick. The spar is light green to brown in color, and more rarely bluish. It is rather finely fractured and is also jointed. Filling the fracture and joint planes are films and seams of brown smooth clay, but the material is relatively free from quartz and siliceous matter except near the walls of the vein.

About one-fourth of a mile northeast of the outcrop of the fluorspar vein and striking nearly at right angles to the latter, copper-bearing veins have been opened. Fluorspar is present as a minor gangue material.

The workings from which the fluorspar is obtained consist of one tunnel 7 feet high and two drifts, respectively, 80 feet and 100 feet above the tunnel, all driven in the direction of the strike of the vein. There is one additional level 13 feet below the lower drift. The tunnel was driven from the outcrop 200 feet in barren vein material, and the ore shoot was reached about 50 feet higher in an upraise, driven from the tunnel. The spar is worked by stoping in the levels, and is milled down the upraise to the tunnel, out of which it is trammed by hand to a storage bin. Only hand methods of cleaning the ore are employed, and the product is hauled by wagons to the Denver and Rio Grande Railroad at Westcliffe, a distance of about 16 miles, the first 6 or 7 miles of which are over a rather hilly road.

The fluorspar thus far shipped from the Rosita district has generally been kept well above the standard, as shown by the analyses on another page. The product, nearly 1,000 short tons, has been purchased by the Colorado Fuel and Iron Company at Pueblo, on the same conditions with regard to grades and prices that have applied to this product elsewhere in Colorado. The same problems confront the producers, viz, the production of a spar that shall carry 80 per cent or more CaF_2 without entailing a large proportion of waste or a large expense in cleaning and transporting it to the railroad.

CONCLUSIONS.

The more important points brought to notice by this reconnaissance are (*a*) that the fluorspar deposits are fissure veins that probably extend to considerable depths; (*b*) that the veins are of moderate thickness as compared with those of the Ohio River or Kentucky-Illinois district, and that the quantity of spar probably does not warrant any but simple and inexpensive equipment for cleaning and concentrating; (*c*) that the fluorspar is generally free from sulphides, and that although some of the run-of-mine material is acceptable in the crude state, the greater part of it needs some cleaning in order to render it marketable; (*d*) that there is a steady local demand for more spar than is yet produced in the State; (*e*) that the geologic conditions appear favorable for the occurrence of much more fluorspar than has yet been discovered, and that further prospecting for the mineral is therefore to be encouraged.

ANALYSES.

The following table gives analyses of fluorspar from Colorado, Kentucky, and Illinois:

Analyses of fluorspar (generally carload lots) from Colorado, Kentucky, and Illinois.

Locality.	CaF_2.	SiO_2.	$Al_2O_3+Fe_2O_3$.	$CaCO_3$.	MgO.	Authority.
Rosita, Colo	86.75	9.3	4.2			Colorado Fuel and Iron Co.
	81.55	13.3	5.1			Do.
	82.25	12.6	5			Do.
	84.3	11.6	n. d.			Do.
	60.9	27	n. d.			Do.
Jamestown, Colo	76.05	19.8	4.2			Do.
	83.76	12.2	4			Do.
	85.9	10.5	3.75			Do.
	79.06	15.24	5.26			Do.
	86.75	8.60	4.46			Do.
Marion, Ky	84.25	2.98	1.28	10.28		Do.
	87.8	3.10	2.06			Do.
	90.02	4.72	1.5			Do.
	92.7	2.5	.64			Do.
	96.01	1.9	1.88			Do.
	94.72	1.22	.98	1.82	0.68	Lackawanna Steel Co.
	95.63	1.32	.93	.38	1.22	Do.
Fairview, Ill	88.85	3.4	1.45			Carnegie Steel Co.

FLUORSPAR IN ENGLAND.

PRODUCTION.

The production of fluorspar from the counties of Derby and Durham, England, 1907, was 49,462 long tons, valued at $113,431, as compared with 41,849 long tons, valued at $97,442, in 1906. This considerable increase is of interest to American producers, for, although the 1908 figures are not yet available, it is probable that much of the spar imported from England to this country in 1908 was mined in 1907. The average value per ton in 1907 was $2.29, which was a reduction of 4 cents per ton, as compared with the value in 1906. The value of the spar per short ton would be only slightly more than $2, and this as compared with the average value of American gravel spar of $4.60 f. o. b. indicates clearly that there is a great difference in the cost of production in the two countries.

OCCURRENCE.[a]

In England fluorspar occurs abundantly in the Carboniferous limestone and its associated shale, limestone, and sandstone of the Yoredale group, and the whole of the present British production comes from these strata, where it is found as the gangue of metalliferous veins. It is usually associated with calcspar, quartz, or barytes, though this is not universally the case.

Until 1902 the bulk of the output came from Durham, from the mines of the Weardale Lead Company; but since that year Derbyshire has gone rapidly ahead, and Durham now takes second place. This has been brought about chiefly through the working of the old

[a] The Engineer, London, August 21, 1908, pp. 185–187.

lead-mine dumps, in which the fluorspar exists as the waste material from lead-mining operations dating from remote times. At present there are about 20 workings for fluorspar in Derbyshire, and with the exception of one or two at Ashover, in the isolated mining district in the eastern part of the county, these are all in the northern district, Great Longstone, Eyam, and Bradwell being the principal points of activity. The great master vein on Longstone Edge, known in the west as the "High Rake" and in the east as the "Deep Rake," is a considerable producer of fluorspar, which is now being got from virgin ground as well as extracted from old dumps. From veins closely associated with the Deep Rake, it is also being got, notably from the Salad Hole (originally spelled "Sallet") mine and the Red Rake mine. The High Rake has yielded large quantities of lead ore in the past, a good deal from open-surface workings, the vein being in places as much as 14 yards in width.

In the Eyam district the old mine heaps on the great vein which runs nearly east and west from Tideswell Moor to Eyam are being exploited, more particularly at the Eyam end, where four or five workings are now in progress, the most accessible of which is at the old Glebe mine dumps, close to Eyam Church. At Bradwell, nearer Castleton, considerable activity is being displayed in fluorspar mining, in the resuscitation of lead mining, and in the quarrying and mining of calcspar and limestone. Until recently the bulk, in fact, practically all the fluorspar has been got in Derbyshire from the old mine dumps, an operation which can not be called "mining," being merely an elaboration of the "hillocking" which has for long been carried on for fluorspar and barytes by miners working on their own account. It is certain, however, if the present demand continues—and there seems little doubt of this—that regular mining will be more and more entered upon, as the hillocks or dumps can not, of course, be considered inexhaustible. Indeed, in one or two places already mining for fluorspar is being carried on, especially where the prospects of finding lead also seem favorable; and in this connection the Red Rake mine at Calver and the Nunley mine at Bradwell may be mentioned. Where the gangue is salable it is possible to drive levels and open stopes in search of lead at no loss, even if the metal is not present in paying quantity. With regard to values, it is noticeable that in the home-office statistics the Derbyshire output was valued at £1 per ton in 1905, and at 10 shillings per ton in 1906. These figures, however, must be taken with a good deal of reserve, the spar being by no means uniform in quality, as the large clean crystalline blocks are superior to the smalls, which form a considerable part of the output. Moreover, in view of the fact that at some of the dump workings a mixture of fluorspar with calcspar and other minerals is sent away to be more carefully separated elsewhere, it is clear that the valuation given can only approximate accuracy.

In the county of Durham the whole of the output of fluorspar comes from the neighborhood of Weardale. It has been stated that Durham now comes second to Derbyshire in point of output, but the great advance made in 1906 and continued more recently indicates that the industry will be a permanent and increasing one. Although one or two other firms are also engaged in the business, more particularly as regards old mining dumps, the principal producer is the Weardale

Lead Company, at whose various mines fluorspar is a regular vein stuff. The spar is by no means confined to the main limestone, from which the bulk of the lead ore is at present obtained, but is being mined of exceptional purity in the hazle or sandstone beds between the main limestone and the Tyne bottom limestone. As a producer of best quality spar in bulk the Sedling mine of the Weardale Lead Company is in the front rank. For some time the mineral was obtained mainly from the old dumps, but these are now exhausted, and the present production comes entirely from the mine. The Sedling vein, which is 8 feet to 15 feet in thickness, is now worked at a depth of 70 fathoms, the winding of the ore being effected by a water wheel, an interesting survival of old practice. In the Jermyn Street Museum are fine crystallized specimens of fluorspar which have come from Weardale. In Teesdale the lead mines have yielded fluorspar only in insignificant quantities, and no working of it is on record, as is the case also in Swaledale and Wensleydale, farther south, where lead mining was once such an important industry.

Apart from a certain employment in glass and enameling works and in the preparation of hydrofluoric acid, the bulk of the present production of fluorspar is used as a flux in the metallurgical industries. It is now some ten years since it came into regular use in Germany in connection with the manufacture of ferromanganese and ferrosilicon, and this practice is now general in England and America. It enables a fluid slag to form at a low temperature, and also reduces the sulphur and phosphorus contents. It has also an increasing application in foundry work, and altogether there is little reason to condemn the optimism of those who see a great future for the mineral when its potentialities become even more widely recognized than is the case to-day. As to the quality of fluorspar, purity is, of course, a matter of importance, especially freedom from silica, and careful selection of the mineral as it comes from the dumps or the mine is made before it is offered for sale. This naturally means that considerable variations in price are to be met with. An impurity which has to be especially guarded against is galena, the lead ore with which the fluorspar is so intimately associated in the mine. Although it is freed as much as possible from galena, the sellers of fluorspar refuse to give any guaranty as to its absence, and probably few shipments are entirely free from it. With regard to what is perhaps the most generally known form of fluorspar, it may be mentioned that the greatly increased production of which we have spoken has not affected in any way the artistic business carried on at the famous Blue John mine at Castleton, Derbyshire, where the fluorspar has unique characteristics.

Fluorspar mining in England depends so much on the iron and steel industries that it was in a somewhat stagnant state in the summer of 1908, and owing to the accumulation of stock there was no immediate prospect of a return to the activity of 1907.

CRYOLITE.

IMPORTS AND PRICES.

No cryolite was reported to have been produced in the United States in 1908. Cryolite is aluminum-sodium fluoride, and is used chiefly in the manufacture of sodium salts, of opal and alabaster glass, of porcelain and enameled ware, and as a flux in the electrolytic aluminum process. The mineral is quarried in Greenland, and there were imported into the United States in 1908, 1,124 long tons, valued at $16,445, as compared with 1,438 long tons, valued at $28,902, in 1907.

Wholesale prices on cryolite at the close of 1908 and the first part of 1909 were 6½ to 6¾ cents per pound.

LITERATURE ON FLUORSPAR AND CRYOLITE.

For details as to geologic relations, mining developments, and notes on the technology of the preparation and uses of fluorspar the reader is referred to the following papers:

Bain, H. F. The fluorspar deposits of southern Illinois: Bull. U. S. Geol. Survey No. 255, 1905.[a] 15c.

———. Principal American fluorspar deposits: Min. Mag., August, 1905, pp. 115–119.

Betts, Anson G. The manufacture of hydrofluoric acid: Mineral Industry, 1906, pp. 330–332.

Burchard, E. F. Production of fluorspar and cryolite in 1906: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1063–1067.[a]

Canby, H. S. The cryolite of Greenland: Ninteenth Ann. Rept. U. S. Geol. Survey, pt. 6 [continued], 1898, pp. 615–617.

Egglestone, William Morley. The occurrence and commercial uses of fluorspar: Trans. Inst. Min. Eng., vol. 35, pt. 2, London, England, May, 1908, pp. 236–268.

Emmons, S. F. Fluorspar deposits of southern Illinois: Trans. Am. Inst. Min. Eng., vol. 21, 1893, pp. 31–53.

The Engineer (London). Fluorspar: Issue of August 21, 1908, pp. 185, 187.

Fohs, F. Julius. Flourspar: Eng. and Min. Jour., January 6, 1906, pp. 45–46.

———. Fluorspar deposits of Kentucky, with notes on production, mining, and technology of the mineral in Bull. Kentucky Geol. Survey No. 9, 1907.

———. Kentucky fluorspar and its value to the iron and steel industries: Trans. Am. Inst. Min. Eng., April, 1909, pp. 411–423. (For abstracts see also Mining World, June 26, 1909, pp. 1217–1220, and Iron Age, May 27, 1909, pp. 1692–1693.)

Iron Trade Review. Fluorspar in iron and steel metallurgy: Issue of September 3, 1908, pp. 401–403.

Miller, Arthur M. The lead and zinc bearing rocks of central Kentucky: Bull. Kentucky Geol. Survey No. 2, 1905.

Phenis, Albert. Kentucky fluorspar, lead, and zinc: Mfrs. Record, November 22, 1906, p. 467.

Priehaüsser, M. Die Flussspatgänge der Oberpfalz: Zeitschr. prakt. Geologie, July, 1908, pp. 265–269.

Ulrich, E. O., and Smith, W. S. T. The lead, zinc, and fluorspar deposits of western Kentucky: Prof. Paper U. S. Geol. Survey No. 36, 1905.

Watson, Thomas L. Lead and zinc deposits of Virginia: Bull. Virginia Geol. Survey No. 1, 1905, p. 42.

Wheeler, G. D. Zinc in Crittenden County, Ky.: Eng. and Min. Jour., vol. 74, 1902, pp. 413–414.

[a] Out of stock, but usually accessible in libraries of cities, technical schools, and universities, and for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

GYPSUM AND GYPSUM PRODUCTS.

By Ernest F. Burchard.

CONDITION OF THE TRADE.

The characteristic features of the trade in gypsum products in the year 1908 were a moderately decreased demand and lower prices than have prevailed at any time within the last three years. While the financial stringency of 1907 and its resultant effects on the industrial world are factors that have adversely influenced the gypsum market, the conditions noted are not to be wholly ascribed to these factors. The general decrease in the price of Portland cement, lumber, steel, brick, and other structural materials to a certain extent stimulated building operations, so that proportionately the output of gypsum was not curtailed so greatly as was that of many other mineral products. The prices were seriously affected by the industrial depression, it is true, but the general decrease in price is more directly due to the very active competition that is becoming characteristic of the gypsum business. Keen competition involving price cutting, introduction of specialties, more liberal advertising, and an aggressive campaign for trade on the part of the well-established companies have resulted in the suspension of many of the smaller plants not physically or financially fitted to withstand the strain. Concentration of interests has naturally followed. Many small plants, meritoriously situated, with good supplies of raw material, have been taken over through lease or purchase by firms that control groups of mills.

A geographic analysis of conditions is not only of interest, but is essential to a just estimate of this industry at large. In the group of Rocky Mountain and Pacific States, including Alaska, the business as a whole showed a slight increase in tonnage of manufactured products, but a small loss in total value. In Michigan the total gypsum mined slightly exceeded that for 1907, but this excess was evidently not taken up by the sales end of the industry. All the other producing localities showed moderate decreases in manufactured products and considerable decreases in values.

The three largest producers are, in order, Michigan, New York, and Iowa. Texas, Ohio, Oklahoma, Kansas, and California are also important producers.

New developments.—Seven new plants were added to the list of producers in 1908, two of these being in New York, and the remainder in Arizona, New Mexico, Nevada, and Colorado. In addition, nine new mills were in various stages of construction, but not in operation. Most of these mills were in the West and Southwest.

One of the new developments is of considerable scientific as well as commercial interest. Attention has been called in the last two annual volumes of Mineral Resources, as well as in Survey Bulletin No. 223, on the gypsum deposits of the United States, to the fact that there are in the Southwest, notably in Arizona and New Mexico, deposits of gypsum sand.[a] This sand is white to faint pink in color and is composed of fine grains of gypsum that have been broken down by stream action and water from outcrops of rock gypsum and finally worked by winds into hills or dunes. (The dunes of silica sand around the south end of Lake Michigan have been built in a similar manner.) In 1908 the utilization of these gypsum sands was begun in Otero County, N. Mex. The raw gypsum is a loose white subangular sand; all of it passes a 20-mesh sieve and about 8 per cent passes a 100-mesh sieve. The deposit lies on a flat, level plain and occurs in hills and dunes, some of which are more than 100 feet high. The material is capable of being calcined at a temperature of 250° to a plaster which is reported to be very tough and to improve with age. These deposits are reported to be about 11 miles from a railroad.

In 1907 a branch of the Atchison, Topeka and Santa Fe Railway was built to Belvidere, Kans., cutting through the gypsum beds about 25 miles northwest of the town of Medicine Lodge. The gypsum at this point was found to be even better adapted to the manufacture of Keenes cement than the material that has been successfully quarried from the same horizon at a point 7 miles southwest of Medicine Lodge and hauled by wagon to the mill at that place. During 1908 the exploitation of the newly opened deposit gave a fresh impetus to the Keenes cement industry in southern Kansas.

In southwest Virginia prospecting and development of gypsum lands on a large scale have been carried on during the last three years. As a result of core drilling there was located in Smyth County, Va., a high-grade gypsum deposit of sufficient extent and value to warrant the construction of a railroad 4 miles long and the erection of a modern mill. A new town, North Holston, has also been built. The gypsum is mined from a shaft 105 feet deep, and carried by an aerial tramway, 1,400 feet long, from the mine tipple to the mill. Gypsum for Portland cement making and in the form of land plaster and hard wall plaster is now being produced here on an important scale.

CALIFORNIA GYPSUM DEPOSITS.

In 1906 Frank L. Hess, of the United States Geological Survey, made a reconnaissance of the gypsum and gypsite deposits of California. His report on the subject is now in preparation, and from the manuscript the following summary has been taken:

> The gypsum deposits of the State may be divided into four classes: (1) Efflorescent deposits, (2) periodic-lake deposits, (3) interbedded deposits, (4)

[a] See also Herrick, C. L. Geology of the white sands of New Mexico: Bull. Hadley Laboratory, Univ. New Mexico.

selenite or crystallized gypsum veins. Of these all, except the fourth class—the veins—may be of value.

The efflorescent deposits are widely spread over the Coast Range and the Tehachapi Mountains from San Benito to Los Angeles counties. They overlie a variety of Tertiary sediments, fine and coarse sandstones, and siliceous shales. In general they are of little value, but locally, where the transportation problem is not too difficult, the deposits may be of value, as at Palmdale. In most cases the only value the deposits have is as a basis for holding claims on oil lands to which sufficient title can not otherwise be obtained to enable the locator to hold them against "jumpers" until prospecting may be done. Efflorescent deposits are formed by the evaporation of the water contained in porous gypsiferous rocks, which leaves its load of gypsum at the point of vaporization, or when vaporization has proceeded to a point where gypsum is precipitated through concentration.

The periodic-lake deposits are found in the San Joaquin Valley, the Mohave Desert, and probably in the Colorado Desert. The large deposit at Amboy is being exploited, and prospecting may show others to be of value also. In this and other desert-lake beds the waters are briny, but at Kern and Buena Vista lakes gypsum has been deposited from comparatively fresh waters. In the desert lakes gypsum is probably precipitated through supersaturation brought about by evaporation, while in the fresh-water lakes the gypsum is deposited just outside the normal shore line through evaporation of water from the soil, as in the case of the efflorescent deposits upon rocks, the soil drawing its supply of water from the somewhat concentrated solution along the shore of the lake.

Practically all of the efflorescent and lake deposits, except in the briny lakes, are covered by soil. Where they are not thus covered the soil seems to have been removed by wind or other agencies. The soil is thought to be not necessarily of later deposition, but to be older than, or contemporary with, the gypsite deposits. The summer heat is very great in all of the localities and it is probable that the moisture, drawn from the rocks and soil by the sun, is vaporized at a depth of several inches below the surface, varying with the locality, or at least sufficiently vaporized so that the gypsum is precipitated before the surface is reached.

Interbedded deposits are found in Miocene clayey sediments at many places from the middle of Los Angeles County southward along the Colorado Desert, and at a few places northward. Locally, these deposits may be workable, but they are generally poor. Interbedded deposits in the Palen Mountains are of unknown age. Veins of selenite are not known to be of importance at any place in the State.

With regard to the development of gypsum and oil lands in California a special correspondent of the Engineering and Mining Journal in the issue of May 22, 1909, says:

Recently large areas of land in the known oil belts have been located for gypsum, though it has been an open secret that oil was what was wanted. An agent of the Land Office has been looking into this matter, and where patents were about to issue to gypsum locators they have been notified that receipts have been issued under misapprehension of facts. They are also informed that the gypsum to be mined must have a commercial value, and in this value accessibility must be considered. If at a point remote from a railroad, where the cost of mining and hauling would preclude the possibility of selling at a profit, its commercial value would be nullified.

PRODUCTION AND DISPOSITION.

The quantity of gypsum mined in the United States in 1908 was 1,721,829 short tons, as compared with 1,751,748 short tons mined in 1907, a decrease of 29,919 short tons, or 1.7 per cent of the 1907 production. The total value of the gypsum products in 1908 was $4,138,-560, as compared with $4,942,264 in 1907, a decrease of $803,704, or 16.26 per cent of the 1907 value. The decrease in quantity sold was entirely confined to crude gypsum both in the lump and the ground form. The prices of this class of material fell only 4 to 7 cents per ton. The quantity sold as calcined plaster actually showed an increase of 316 short tons over the tonnage sold as such in 1907, but the decrease in value was heavy, amounting to 67 cents per ton, or nearly 18 per cent of the 1907 price. The average price for calcined plaster in 1907 was $3.91 per ton; in 1908 it was $3.24.

The production of special gypsum plasters, such as Keenes cement, and of plaster specialties, such as plaster studding, plaster lath, and plaster board, is increasing rapidly. Keenes cement is a hard wall plaster, produced by completely dehydrating pure rock gypsum through long continued heating to a high temperature and adding to the ground product small quantities of alum, borax, and other materials, which act as binders when water is added to the mass. This product is adaptable for fine interior finish and for ornamental plastering, caps, molds, bases, and extra fine white finish. It is also used for the manufacture of artificial marble. It finds its most ready market in the large eastern cities.

The following tables show the quantity of crude gypsum mined in the United States, the marketed output by States and uses, and the disposition of the marketed product:

Crude gypsum mined in the United States, 1880–1908.

	Short tons.		Short tons.
1880	90,000	1895	265,503
1881	85,000	1896	224,254
1882	100,000	1897	288,982
1883	90,000	1898	291,638
1884	90,000	1899	486,235
1885	90,405	1900	594,462
1886	95,250	1901	633,791
1887	95,000	1902	816,478
1888	110,000	1903	1,041,704
1889	267,769	1904	940,917
1890	182,995	1905	1,043,202
1891	208,126	1906	1,540,585
1892	256,259	1907	1,751,748
1893	253,615	1908	1,721,829
1894	239,312		

Production of gypsum in the United States in 1907 and 1908, by States and uses, in short tons.

State.	No. of producers reporting.	Total mined.	Sold crude.		Sold crude, ground, as land plaster.		Sold as calcined plaster.		Total value.
			Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1907.									
Alaska, Colorado, New Mexico, South Dakota, and Utah	9	96,389	13,349	$53,961	1,221	$4,884	72,872	$343,961	$402,806
California, Nevada, and Oregon	9	80,879	20,902	38,302	6,161	28,288	49,860	227,456	294,046
Iowa	7	251,874	17,272	24,837	1,562	4,278	162,965	701,268	730,383
Kansas	7	155,980	27,211	33,572	3,395	6,364	96,347	374,330	414,266
Michigan	6	317,261	36,543	56,681	15,500	23,981	197,666	600,689	681,351
New York	17	324,507	101,721	196,426	5,716	14,687	145,132	589,112	800,225
Ohio and Virginia	6	202,253	4,473	9,399	13,296	33,359	146,565	626,779	669,537
Oklahoma and Texas	11	282,461	11,075	11,049	....	....	223,254	813,568	824,617
Wyoming	4	40,144	....	....	....	....	30,640	125,033	125,033
	76	1,751,748	232,546	424,227	46,851	115,841	1,125,301	4,402,196	4,942,264
1908.									
Alaska, Arizona, Colorado, Idaho, New Mexico, South Dakota, and Utah	14	129,440	19,863	72,205	1,573	3,890	101,274	416,254	492,349
California, Nevada, and Oregon	14	93,794	3,282	8,935	4,195	17,151	64,775	345,652	371,738
Iowa	7	240,270	19,960	26,429	1,984	3,676	158,043	535,540	565,645
Kansas	7	130,184	24,064	27,047	3,162	5,679	80,523	248,613	281,339
Michigan	7	327,810	40,324	53,673	11,414	13,381	192,403	424,874	491,928
New York	18	318,046	95,146	171,747	5,712	14,255	160,930	574,757	760,759
Ohio and Virginia	4	178,904	9,260	19,988	9,632	33,591	125,167	426,426	480,005
Oklahoma and Texas	14	272,193	[a] 14,362	16,721	....	....	216,350	583,141	599,862
Wyoming	3	31,188	....	....	....	....	26,152	94,935	94,935
	88	1,721,829	226,261	396,745	37,672	91,623	1,125,617	3,650,192	4,138,560

[a] Includes a small quantity of ground material from Texas.

Production of gypsum in the United States, 1904–1908, classified as to uses.

Year.	Sold crude.			Sold crude, ground, as land plaster.		
	Quantity in short tons.	Value.	Average price per ton.	Quantity in short tons.	Value.	Average price per ton.
1904	56,137	$61,234	$1.09	70,167	$142,490	$2.03
1905	67,105	106,041	1.58	40,196	74,280	1.85
1906	186,999	460,545	2.46	62,671	157,292	2.50
1907	232,546	424,227	1.82	46,851	115,841	2.47
1908	226,261	396,745	1.75	37,672	91,623	2.43

Year.	Sold as calcined plaster.			Total value.
	Quantity in short tons.	Value.	Average price per ton.	
1904	665,340	$2,580,601	$3.88	$2,784,325
1905	736,708	2,848,906	3.87	3,029,227
1906	899,581	3,220,138	3.58	3,837,975
1907	1,125,301	4,402,196	3.91	4,942,264
1908	1,125,617	3,650,192	3.24	4,138,560

Disposition of gypsum in the United States, 1907–8, by uses, in short tons.

	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Sold crude:				
For Portland cement	194,535	$355,750	187,680	$305,745
For paint material	(a)	(a)	1,281	1,300
For plaster material	[b]36,061	66,597	29,516	77,860
As land plaster	46,851	115,841	37,972	91,833
For other purposes	1,950	1,880	7,484	11,630
Sold calcined:				
For dental plaster	11,648	24,394	174	636
As plaster of Paris, wall plaster, etc	1,060,107	4,211,821	1,074,229	3,508,520
To glass factories	5,785	17,164	14,412	41,102
For Portland cement and other purposes	47,761	148,817	36,802	99,934
	1,404,698	4,942,264	1,389,550	4,138,560

[a] Included in "For plaster material."
[b] Including paint material.

IMPORTS.

The gypsum which is imported into the United States comes, except a few hundred tons annually from France and Great Britain, almost wholly from Nova Scotia and New Brunswick, and enters the ports of the New England and North Atlantic States, over one-half of it entering the port of New York. This imported gypsum is nearly all calcined and converted into wall plasters by plants along the seaboard as far east as Red Beach, Maine. A small quantity of the material is used crude as land plaster, and some is mixed in patent fertilizers.

The following table shows the imports for consumption into the United States from 1904 to 1908, inclusive:

Gypsum imported and entered for consumption in the United States, 1904–1908, in short tons.

Year.	Ground or calcined.		Unground.		Value of manufactured plaster of Paris.	Total value.
	Quantity.	Value.	Quantity.	Value.		
1904	3,278	$11,276	294,238	$321,306	$23,819	$356,401
1905	3,889	20,883	399,230	402,328	22,948	446,152
1906	3,587	22,821	436,999	464,725	21,183	508,729
1907	1,979	12,825	453,911	486,205	36,628	535,658
1908	1,889	12,825	300,158	314,845	26,733	354,403

WORLD'S PRODUCTION.

The following table gives the world's production of gypsum from 1903 to 1907, inclusive:

World's production of gypsum, 1903–1907, in short tons.

Year.	France.		United States.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	1,798,508	$3,134,891	1,041,704	$3,792,943	314,489	$388,459
1904	1,749,875	2,916,453	940,917	2,784,325	340,761	372,924
1905	1,414,596	2,343,943	1,043,202	3,029,227	435,789	581,543
1906	1,517,603	2,423,615	1,540,585	3,837,975	485,921	646,914
1907	1,547,560	2,544,819	1,751,748	4,942,264	340,964	575,701

Year	Great Britain.		German Empire.		Algeria.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	246,282	$337,391	34,054	$19,145	31,967	$105,040	11,591	$28,796
1904	262,086	354,138	25,095	17,307	33,951	93,287	12,449	31,721
1905	286,169	400,717	....	....	38,297	98,420	17,890	42,499
1906	252,030	362,761	....	....	30,809	85,446	23,069	55,658
1907	....	....	....	....	29,101	75,907	....	....

RECENT LITERATURE.

Owing to the necessarily brief treatment of the topics comprised in this chapter, the following references are given to reports from which may be obtained local details concerning the gypsum deposits mentioned herein:

Adams, George I., and others. Gypsum deposits of the United States: Bull. U. S. Geol. Survey No. 223, 1904.[a]

Aubury, Lewis E. The structural and industrial materials of California: Bull. California State Min. Bur. No. 38, 1906, pp. 281–288.

Bartlett, C. O. The manufacture of plaster of Paris: Eng. and Min. Jour., vol. 82, No. 23, December 8, 1906, pp. 1063–1064.

Bell, J. Macintosh. Economic resources of Moose River Basin, Ontario: Ontario Bur. Mines Rept. for 1904, pt. 1, 1904, pp. 134–197.

Bell, Robert. Gypsum deposits east of Lake Manitoba: Summary Rept. on operations of Geol. Survey Canada, for 1902, 1903, pp. 188A–190A.

Boyer, Jacques. Plaster mining and preparation in the vicinity of Paris, France: Eng. Mag., March, 1906, pp. 850–859.

Brady, Frank W. The white sands of New Mexico: Mines and Minerals, vol. 25, 1905, pp. 529–530.

Burchard, E. F. Gypsum and gypsum products: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1069–1078.

——— Gypsum and gypsum products: Mineral Resources U. S. for 1907, pt. 2, U. S. Geol. Survey, 1908, pp. 643–650.

Burns, David. The gypsum of the Eden Valley (England): Trans. Inst. Min. Eng., vol. 25, 1903, pp. 410–434.

Diehl, O. C. Gypsum: Michigan Miner, vol. 6, No. 6, 1904, pp. 21–24.

Eckel, E. C. Salt and gypsum deposits of southwestern Virginia: Bull. U. S. Geol. Survey No. 213, 1903, pp. 406–416.

——— Cements, limes, and plasters: John Wiley & Sons, 1905, pt. 1, pp. 14–87.

——— Gypsum and gypsum products: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1105–1115.[a]

[a] Out of stock, but usually accessible in the libraries of cities, technical schools, and universities, and for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

Gould, Charles N. Geology and water resources of Oklahoma: Water-Supply Paper No. 148, U. S. Geol. Survey, 1905.

——— Geology and water resources of eastern portion of Panhandle of Texas: Water-Supply Paper No. 154, U. S. Geol. Survey, 1906.[a]

——— Geology and water resources of western portion of Panhandle of Texas: Water-Supply Paper No. 191, U. S. Geol. Survey, 1907.[a]

——— Extent and importance of Oklahoma gypsum deposits: Mining Science, vol. 56, December 12, 1907, pp. 542–543, and December 19, 1907, pp. 583–584.

Grimsley, G. P. The gypsum of Michigan and the plaster industry: Michigan Geol. Survey, vol. 9, pt. 2, 1904.

Grimsley, G. P., and Bailey, E. H. S. Gypsum and gypsum cement plasters: Univ. Geol. Survey Kansas, vol. 5, 1899, 178 pp.

Herrick, C. L. The geology of the white sands of New Mexico: Bull. Hadley Laboratory, Univ. New Mexico, vol. 2, pt. 1.

——— The geology of the white sands of New Mexico: Jour. Geology, vol. 8, 1900, pp. 112–128.

Hess, Frank L. A reconnaissance of the gypsum deposits of California: Bull. U. S. Geol. Survey No. ———, 1909. (In preparation.)

Hubbard, L. D. The origin of salt, gypsum, and petroleum: Michigan Geol. Survey, pt. 2, 1895, pp. ix–xxiv.

Lotti, B. Die Gipsie des toskanischen Erzgebirges und ihr Ursprung: Zeitschr. prakt. Geologie, September, 1908, pp. 370–374.

Merrill, F. J. H. Salt and gypsum industry of New York: Bull. N. Y. State Museum No. 11, vol. 3, 1893, pp. 1–38.

Metcalfe, A. T. The gypsum deposits of Nottinghamshire and Derbyshire, England: Trans. Inst. Min. Eng., vol. 12, 1896, pp. 107–114.

Parsons, Arthur L. Notes on the gypsum deposits of New York: Fifty-seventh Ann. Rept., New York State Mus., vol. 1, 1905, pp. 89–157.

Richardson, G. B. Salt, gypsum, and petroleum in trans-Pecos Texas: Bull. U. S. Geol. Survey No. 260, 1905, pp. 573–585.[a]

Rowe, J. P. Montana gypsum deposits: Am. Geology, vol. 35, 1905, pp. 104–113.

——— Montana gypsum deposits: Mines and Minerals, September, 1907, pp. 59–60.

——— The gypsum deposits of Montana: Eng. and Min. Jour., June 20, 1908, p. 1243.

Shaler, M. K. Gypsum in northwestern New Mexico: Bull. U. S. Geol. Survey No. 315, 1907, pp. 260–266.

Siebenthal, C. E. Gypsum deposits of the Laramie district, Wyoming: Bull. U. S. Geol. Survey No. 285, 1906, pp. 401–403.[a]

——— Gypsum deposits of the Uncompahgre region, Colorado: Bull. U. S. Geol. Survey No. 285, 1906, pp. 404–405.[a]

Stone, Wm. H. Gypsum plant in southwest Virginia: Mfrs. Rec., August 20, 1908, pp. 51–52.

Trumbull, Loyal W. Cement plaster industry in Wyoming: Mining World, March 23, 1907, p. 387.

Wilder, Frank A. Geology of Webster County, Iowa (gypsum deposits): Iowa Geol. Survey, vol. 12, 1902, pp. 138–167.

——— The age and origin of the gypsum of central Iowa: Jour. Geology, vol. 11, 1903, pp. 723–748.

——— Properties and uses of mineral gypsum: Trans. Appalachian Eng. Association, Bull. No. 33, 1909.

Wright, C. W. Nonmetallic mineral resources of southeastern Alaska: Bull. U. S. Geol. Survey No. 314, pp. 79–80.

Wynne, T. Trafford. Gypsum and its occurrence in the Dove Valley (England): Trans. Inst. Min. Eng., vol. 32, 1906, pp. 171–192.

---

[a] Out of stock, but usually accessible in the libraries of cities, technical schools, and universities, and for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

PHOSPHATE ROCK.

By F. B. Van Horn.

INTRODUCTION.

The occurrence of rock phosphates in the United States has a very important bearing upon the agricultural industry, since certain classes of plant life can not exist without the presence of phosphoric acid in the soil. Growing crops deplete the soil of its phosphoric acid, and if no steps are taken to restore this substance, the soil must eventually become nonproductive.

Florida, South Carolina, and Tennessee have for several years been the main sources of phosphate in the United States. North Carolina, Alabama, and Pennsylvania have produced phosphate rock, but never on a large scale, and there is at present no production from these States. In 1900 Arkansas entered the field as a producer, and in 1906 a new field was discovered in Wyoming, Idaho, and Utah.

DEVELOPMENT OF THE PHOSPHATE INDUSTRY.

According to a letter from Dr. W. L. Rasin, of Baltimore: [a]

> The manufacture of chemical fertilizers in the United States began about 1850. In that year Dr. P. S. Chappell and Dr. William Davison, of Baltimore, made some fertilizer in an experimental way. About the same time Professor Mapes was experimenting. Later De Burg utilized the spent boneblack derived from the sugar refineries and made quite a quantity of "dissolved boneblack" (superphosphate). In 1853 or 1854 Dr. P. S. Chappell commenced the manufacture of fertilizers, as did B. M. Rhodes, both of Baltimore. In 1855 Mr. John Kettlewell, recognizing the fact that Peruvian guano (then becoming quite popular and containing at that time 18 to 21 per cent ammonia) was too stimulating and deficient in plant food (phosphates), conceived the idea of manipulating the Mexican guano, containing no ammonia, but 50 to 60 per cent of (bone) phosphate of lime, and calling his preparation "Kettlewell's manipulated guano."
>
> While in 1856 the sales of Peruvian guano had increased to 50,000 tons, and of Mexican guano to some 10,000 tons, there was not at that date 20,000 tons of artificial fertilizers manufactured in the entire country. Baltimore was not only the pioneer but the principal market for fertilizers until some time after the civil war.

Phosphate mining began in the United States in 1868 in South Carolina. The existence of the rock had been known since 1837, but the possibilities of its commercial use were not recognized until 1859. According to Otto A. Moses: [b]

> In 1859 Professor Shepard and Col. L. M. Hatch suggested the utilization of phosphatic marls in the manufacture of commercial fertilizers and started a factory at or near Charleston, which was, however, soon abandoned. Re-

[a] Twelfth Census, vol. 10, pt. 4, p. 562.
[b] Mineral Resources U. S. for 1882, U. S. Geol. Survey, 1883, p. 512.

mains of their compost heap were utilized by neighboring farmers with good effect long after the war.

At the close of the war Dr. N. A. Pratt, formerly connected with the niter bureau of the Confederacy, visited Charleston, with the object of starting sulphuric acid chambers. About this time Dr. St. Julian Ravenel, of Charleston, who had mined marl extensively at Stoneys Landing, on Cooper River, for the manufacture of cements, noticed the nodules, analyzed some of them, and found them to contain much phosphate of lime. He became engaged soon after in the manufacture of commercial fertilizers from foreign phosphate rocks. Then followed the discovery (in August, 1867) which has been of such vital importance to agriculture and the prosperity of South Carolina. Pratt and Holmes (Charleston Mining Company), Ravenel and Dukes (Wanda Company), then located territory. The value of the deposits became known; other available beds were discovered, and many persons and considerable capital were soon employed in developing the new industry by mining the crude rock and exporting or manufacturing it on the spot into superphosphates. Later on, the beds of many navigable streams were found to be largely paved with the valuable substance.

Until 1888 South Carolina enjoyed a monopoly of the phosphate industry of the United States. In that year Florida came forward as a phosphate State, with a productions of 3,000 long tons. In 1904 the production surpassed that of South Carolina, and Florida has maintained its lead up to the present time.

In 1892 phosphate was discovered in Tennessee, and two years later the production from that State was 19,188 long tons. In 1899 Tennessee went ahead of South Carolina, the production from the latter State having decreased steadily since 1893.

PRODUCTION.

The production of phosphate from South Carolina from the beginning of the industry in 1867 to the year 1888, during which period that State was the only producer, was 4,442,945 long tons, valued at $23,697,019. The following table shows the total production in the United States from 1867 to 1908:

Marketed production of phosphate rock in the United States, 1867–1908, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1867–1887	4,442,945	$23,697,019	1899	1,515,702	$5,084,076
1888	448,567	2,018,552	1900	1,491,216	5,359,248
1889	550,245	2,937,776	1901	1,483,723	5,316,403
1890	510,499	3,213,795	1902	1,490,314	4,693,444
1891	587,988	3,651,150	1903	1,581,576	5,319,294
1892	681,571	3,296,227	1904	1,874,428	6,580,875
1893	941,368	4,136,070	1905	1,947,190	6,763,403
1894	996,949	3,479,547	1906	2,080,957	8,579,437
1895	1,038,551	3,606,094	1907	2,265,343	10,653,558
1896	930,779	2,803,372	1908	2,386,138	11,399,124
1897	1,039,345	2,673,202			
1898	1,308,885	3,453,460		31,594,279	128,715,126

Of this quantity South Carolina has furnished 12,138,454 tons; Florida, 14,087,833 tons; Tennessee, 5,315,422 tons; and other States, 53,570 tons. In twenty-one years Florida has produced more phosphate than has South Carolina in thirty-two years.

The year 1908 showed a small increase in quantity as well as in value of phosphate rock over 1907. The total production was 2,386,138 tons, valued at $11,399,124, as compared with 2,265,343 tons, valued at $10,653,558, in 1907; an increase of 120,795 tons in quantity and of $745,566 in value. The average price per ton in 1908 was $4.78, only 8 cents more than in 1907.

The production of the different classes of phosphate rock, by States, in 1907 and 1908 was as follows:

Production of phosphate rock in the United States, 1907–8, based on the quantity marketed.

State.	1907.			1908.		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
Florida:						
Hard rock	646,156	$4,065,375	$6.29	595,743	$4,566,018	$7.66
Land pebble	675,024	2,376,261	3.52	1,085,199	3,885,041	3.58
River pebble	36,185	136,121	3.76	11,160	33,480	3.00
Total	1,357,365	6,577,757	4.85	1,692,102	8,484,539	5.01
South Carolina:						
Land rock	228,354	883,965	3.87	192,263	854,837	4.45
River rock	28,867	96,902	3.36	33,232	135,044	4.06
Total	257,221	980,867	3.81	225,495	989,881	4.39
Tennessee:						
Brown rock	594,594	2,880,904	4.85	374,114	1,572,525	4.20
Blue rock	38,993	142,382	3.65	79,717	299,941	3.76
White rock	5,025	24,550	4.89	1,600	4,755	2.97
Total	638,612	3,047,836	4.77	455,431	1,877,221	4.12
Other States	[a] 12,145	47,098	3.88	[a] 13,110	47,483	3.62
Grand total	2,265,343	10,653,558	4.70	2,386,138	11,399,124	4.78

[a] Includes Arkansas, Idaho, Utah, and Wyoming.

The figures in the foregoing table are based on the marketed product. The actual quantity of phosphate rock mined in Florida during 1908 was 1,941,362 long tons; in South Carolina it was 252,392 long tons; in Tennessee, 454,188 long tons; and in Arkansas, Idaho, Utah, and Wyoming, 13,517 long tons—a total of 2,661,459 long tons.

PHOSPHATE DEPOSITS OF THE UNITED STATES.

GEOLOGIC OCCURRENCE.

The phosphate deposits range in age from the Ordovician in Tennessee to the Tertiary in Florida, occurring also in the Devonian in Tennessee and Arkansas, and in the Carboniferous in the Wyoming-Idaho-Utah field.

FLORIDA DEPOSITS.

DISTRIBUTION AND CLASSIFICATION.

Phosphates occur in a general way along the west coast of Florida, principally in Polk, De Soto, Hillsboro, Pasco, Hernando, Sumter, Citrus, Marion, and Levy counties, although the rock has been found also in Alachua, Suwanee, Lafayette, Taylor, Jefferson, Wakulla, and Liberty counties. There are three classes of deposits in Florida—hard rock, land pebble, and river pebble. These deposits vary in percentage of tricalcium phosphate from 78 per cent to 80 per cent in the hard rock through 68 per cent to 70 per cent in the land pebble to about 65 per cent in the river pebble.

Hard rock.—The hard-rock phosphate belongs to the Eocene and the Miocene periods. In the former it consists entirely of a bowlder deposit in a soft matrix of phosphatic sands, clays, and other materials; in the latter it is also found at many places as a bedded deposit in situ. The bowlders vary in size from 2 inches to 10 feet, and lie embedded in all positions, surrounded by sand and clay containing more or less phosphate of lime in finer particles resulting from a general distribution of the disintegrated portions of the bowlders during deposition. The deposits themselves vary from small pockets to those several acres in extent. The phosphate content of this class of deposits is from 10 per cent to 30 per cent of the mass.

Land pebble.—The pebbles making up this deposit range from minute size to that of a walnut. They are originally white in color, but become dark colored when subjected to water action. They are imbedded in sand and are underlain by a stratum of tough, stiff, clayey material known as "bed rock." Above the deposit is an overburden from 1 to 25 feet thick, consisting of sand and limestone bowlders. The proportion of phosphate to other rock in this class of deposits varies from 1 to 10 to 1 to 4, or from 10 per cent to 25 per cent.

River pebble.—This class of deposit is very similar to the land pebble and derives its name from its manner of occurrence in the river beds. The pebbles are white to dark brown in color and of about the same size as the land pebbles. They occur in the form of bars in the rivers, and are derived from the formations through which the rivers flow.

DEVELOPMENT AND PRODUCTION.

The year 1887 marked the beginning of the phosphate industry in Florida. In 1888 the first shipment of pebble phosphate from Peace River was made to Atlanta, Ga.; in 1889 hard rock phosphate was discovered in Marion County, and in 1890 the land pebble area was opened in Polk County. The growth of the industry has been rapid and remarkable, until now Florida is the largest producer of phosphate rock in the United States.

The first production consisted of 3,000 tons in 1888, and twenty years later the output for the year was 1,692,102 tons, or more than 70 per cent of the entire production of the United States in 1908. The following table shows the marketed quantity and value of phosphate rock from Florida, by years, since the first shipment:

Output of phosphate rock in Florida, based on marketed product, 1888–1908, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1888	3,000	$21,000	1900	706,243	$2,983,312
1889	4,100	28,000	1901	751,996	3,159,473
1890	46,501	338,190	1902	785,430	2,564,197
1891	112,482	703,013	1903	860,336	2,986,824
1892	287,343	1,418,418	1904	1,072,951	3,974,304
1893	438,804	1,979,056	1905	1,194,106	4,251,845
1894	527,653	1,666,813	1906	1,304,505	5,585,578
1895	568,061	2,112,902	1907	1,357,365	6,577,757
1896	495,199	1,547,353	1908	1,692,102	8,484,539
1897	552,342	1,493,515			
1898	600,894	1,847,796		14,087,833	56,527,946
1899	726,420	2,804,061			

Almost without exception each year since the beginning of the industry the production from Florida has shown an increase over the preceding year. In 1908 the increase in quantity was 334,737 tons, or more than 14 per cent over 1907, and the increase in value was $1,906,782. The increase was entirely in the land-pebble variety, of which the tonnage was 410,175 tons more than in 1907. The outputs of both the hard rock and the river pebble showed decreases, the former being 40,413 tons and the latter 25,025 tons less than in 1907. The price per ton of hard rock was $7.66 in 1908, as against $6.29 in 1907; of land pebble $3.58 as against $3.52; and of river pebble $3.00 as against $3.76. The average price per ton of Florida phosphate for 1908 was $5.01 as compared with $4.85 in 1907, a gain of about 3 per cent. Florida furnished 70.9 per cent of the production of the United States in 1908.

The quantity and value of each grade or variety of phosphate rock produced in Florida from 1904 to 1908, inclusive, based upon reports of marketed material, are shown in the following table:

Phosphate rock marketed in Florida, 1904–1908, classified by grades, in long tons.

Year.	Hard rock.		Land pebble.		River pebble.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	531,087	$2,672,184	460,834	$1,102,993	81,030	$199,127	1,072,951	$3,974,304
1905	577,672	2,993,732	528,587	1,045,113	87,847	213,000	1,194,106	4,251,845
1906	587,598	3,440,276	675,444	2,029,202	41,463	116,100	1,304,505	5,585,578
1907	646,156	4,065,375	675,024	2,376,261	36,185	136,121	1,357,365	6,577,757
1908	595,743	4,566,018	1,085,199	3,885,041	11,160	33,480	1,692,102	8,484,539

SOUTH CAROLINA DEPOSITS.

DISTRIBUTION.

The South Carolina phosphate beds occur interruptedly in a belt, the lower limit of which extends along a meandering line from a point near the source of Wando River in Charleston County to the mouth of Broad River. The belt follows the coast, running back as far as 20 miles from the ocean.

In South Carolina the phosphate rock occurs in two forms, as land rock and as river rock, running about 58 and 55 per cent, respectively, in tricalcium phosphate.

Land rock.—The land rock is very probably of Miocene age, and consists of so-called pebble rock, which is in fact a solid mass from which the calcium carbonate has been leached out and partly replaced by phosphate; thus cavities are left which connect and penetrate through the rock, giving it the appearance of being made up of separate pebbles. The rock varies from 1 to 3 feet in thickness, and is overlain by a greensand marl.

River rock.—The river rock is so called because it is mined from the river channels. It consists essentially of water-rounded fragments of the land rock.

DEVELOPMENT AND PRODUCTION.

As already stated, phosphate rock was discovered in South Carolina in 1867, during which year 6 tons were marketed. From this time on the production increased until 1889 when it amounted to 541,645 long tons. Since 1889 the production has steadily decreased, except in 1893, and in 1899 Florida took the lead in the industry. In 1908 only 225,495 tons were marketed from South Carolina. The total quantity and value of phosphate rock from South Carolina, by years, from 1867 to 1908, are shown in the following table:

Production of marketed phosphate rock in South Carolina, 1867–1908, in long tons.

Year ending—	Quantity.	Value.	Year ending—	Quantity.	Value.
May 31—			Dec. 31—Continued.		
1867	6		1888	448,567	$2,018,552
1868	12,262		1889	541,645	2,892,276
1869	31,958		1890	463,998	2,875,605
1870	65,241		1891	475,506	2,948,138
1871	74,188		1892	394,228	1,877,709
1872	58,760		1893	502,564	2,157,014
1873	79,203		1894	450,108	1,745,576
1874	109,340	a$7,248,380	1895	431,975	1,411,032
1875	122,790		1896	402,423	1,181,649
1876	132,478		1897	358,280	986,572
1877	163,000		1898	399,884	1,107,272
1878	210,322		1899	356,650	1,078,099
1879	199,365		1900	329,173	1,041,970
1880	190,763		1901	321,181	961,840
1881	266,734	1,980,259	1902	313,365	919,725
1882	332,077	1,992,462	1903	258,540	783,803
1883	378,380	2,270,280	1904	270,806	861,317
1884	431,779	2,374,784	1905	270,225	878,169
1885	395,403	2,339,468	1906	223,675	817,068
Dec. 31—			1907	257,221	980,867
1885	277,789	1,805,629	1908	225,495	989,881
1886	430,549	1,848,939			
1887	480,558	1,836,818		12,138,454	54,211,153

a Values are estimated for the years 1867 to 1880 at $5 per ton.

South Carolina showed a decrease in quantity of phosphate rock produced in 1908 as compared with 1907, although the value was slightly greater. In 1908 the production was 225,495 tons, valued at $989,881, as compared with 257,221 tons, valued at $980,867 in 1907, a decrease of 31,726 tons, or more than 12 per cent, in quantity. The production of land rock decreased 36,091 tons, but that of river rock increased 4,365 tons. The price per ton of land rock was $4.45 in 1908 as compared with $3.87 in 1907; that of river rock was $4.06 in 1908 as compared with $3.36 in 1907. The average price per ton of South Carolina rock in 1908 was $4.39 against $3.81 in 1907, a gain of 15.2 per cent. South Carolina furnished 9.4 per cent of the production of the United States in 1908.

The following table gives the quantity and value of each variety of phosphate rock marketed in South Carolina from 1904 to 1908, inclusive:

Phosphate rock marketed in South Carolina, 1904–1908, classified by grades, in long tons.

Year.	Land rock.		River rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	258,806	$830,117	12,000	$31,200	270,806	$861,317
1905	234,676	774,447	35,549	103,722	270,225	878,169
1906	190,180	711,447	33,495	105,621	223,675	817,068
1907	228,354	883,965	28,867	96,902	257,221	980,867
1908	192,263	854,837	33,232	135,044	225,495	989,881

TENNESSEE DEPOSITS.

DISTRIBUTION.

The deposits of phosphate in Tennessee lie mainly in Maury, Hickman, Perry, and Lewis counties, with some deposits in Giles, Williamson, Davidson, Sumner, and Decatur counties.

There are three commercially important classes of phosphate rock in Tennessee—the brown residual phosphate, the blue or black bedded phosphate, and the white phosphate. These range in phosphatic content from 70 per cent to 80 per cent lime phosphate in the brown rock to from 75 to 85 per cent lime phosphate in the white rock, although in all three classes are to be found portions which run as high as 90 per cent.

Brown residual phosphate.—This variety of phosphate occurs mainly in Maury County. It is of Ordovician age, and is the result of the leaching process to which the phosphatic limestones have been subjected. Surface waters bearing carbonic and other organic acids have dissolved and carried away a large part of the calcium carbonate forming the limestone, leaving the calcium phosphate as a residual deposit. The brown phosphate is from 2 to 8 feet in thickness at various points.

Blue or black bedded phosphate.—These deposits are of Devonian age, and show variations from oolitic through compact and conglomeratic to shaly forms. There is also a nodular variety which occurs in a greensand formation immediately overlying the black shale. The bedded deposit occurs in seams varying from a thin film to 50 inches in thickness, but where carrying high-grade rock the bed is seldom more than 20 inches thick. The phosphatic content ranges from 30 to 85 per cent. The nodular variety, which is embedded in a greensand matrix, carries about 60 per cent lime phosphate, but it is not practicable to work it except at points where the bedded rock is mined by stripping off the overburden.

White phosphate.—This rock is of post-Tertiary age, and occurs in three different forms—stony, brecciated, and lamellar. The stony phase contains usually only about 50 per cent of lime phosphate, and is not worked at the present time. The lamellar forms were deposits in caves, and are thus of irregular shape and extent. The breccia consists of fragments of Carboniferous chert cemented by lime phosphate. The chert fragments vary from a fraction of an inch to 3 or 4 inches in diameter. The lamellar variety consists of thin, parallel layers or plates about 1 inch thick, but several inches long and broad.

The white phosphate has thus far been found only in Perry and Decatur counties. It runs sometimes as high as 85 per cent in phosphate of lime.

DEVELOPMENT AND PRODUCTION.

The blue bedded phosphate of Tennessee was discovered in 1893, and was mined until 1896, when the brown rock was found to be valuable. The favorable location of this brown rock led to the cessation of blue-rock mining for the time. The white rock has not as yet been extensively mined.

The total production of phosphate rock from Tennessee from the first operations in 1894 to the end of 1908 is as follows:

Production of marketed phosphate rock in Tennessee, 1894–1908, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1894	19,188	$67,158	1903	460,530	$1,543,567
1895	38,515	82,160	1904	530,571	1,745,054
1896	26,157	57,370	1905	482,859	1,633,389
1897	128,723	193,115	1906	547,677	2,147,991
1898	308,107	498,392	1907	638,612	3,047,836
1899	424,109	1,177,160	1908	455,431	1,877,221
1900	454,491	1,328,707			
1901	409,653	1,192,090		5,315,422	17,797,857
1902	390,799	1,206,647			

The production from Tennessee in 1908 was 455,431 tons, valued at $1,877,221, as compared with 638,612 tons, valued at $3,047,836, in 1907. This represents a decrease in quantity of 183,181 tons, or 28 per cent. The production of brown rock decreased 220,480 tons, that of white rock decreased 3,425 tons, while that of blue rock increased 40,724 tons. The price per ton of brown rock was $4.20 in 1908, as compared with $4.80 in 1907; that of blue rock was $3.76 in 1908, as compared with $3.65 in 1907; and that of white rock was $2.97 in 1908, as compared with $4.89 in 1907. The average price per ton of all phosphate rock decreased from $4.77 in 1907 to $4.12 in 1908, a loss of 13.6 per cent. Tennessee furnished 19.1 per cent of the production of the United States in 1908.

The following table shows the tonnage and value of each grade of Tennessee phosphate rock marketed from 1905 to 1908, inclusive:

Phosphate rock marketed in Tennessee, 1905–1908, classified by grades, in long tons.

Year.	Brown rock.		Blue rock.		White rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	438,139	$1,509,748	44,031	$121,486	689	$2,155	482,859	$1,633,389
1906	510,705	2,027,917	35,669	114,997	1,303	5,077	547,677	2,147,991
1907	594,594	2,880,904	38,993	142,382	5,025	24,550	638,612	3,047,836
1908	374,114	1,572,525	79,717	299,941	1,600	4,755	455,431	1,877,221

ARKANSAS DEPOSITS.

The developed phosphate deposits of Arkansas are on Lafferty Creek, on the western edge of Independence County. The rock itself is light gray, homogeneous, and conglomeratic, with small pebbles more or less angular in form. The phosphate bed runs from 2 to 6 feet in thickness, and varies from 25 to 73 per cent in phosphate of lime.

DEVELOPMENT AND PRODUCTION.

The Arkansas phosphates as such were discovered in 1895, but it was not until 1900 that any attempt was made to develop them. At that time the Arkansas Phosphate Company was formed, and a mining and milling plant was erected. After only a few month's operation this plant was destroyed by fire, and it has only been within the last two years that any production has been marketed, and that has been a small one. Analyses show that very little of this rock is high grade, and the field will probably not be extensively operated until 30 to 50 per cent rock can be utilized.

WYOMING-IDAHO-UTAH DEPOSITS.

DISTRIBUTION.

Within the last few years a large area of phosphate-bearing rock has been discovered in the western United States. This discovery is of much importance since it opens a new field in an area which is tributary to the great agricultural region of the Middle West. The phosphate occurs over a considerable area in southeastern Idaho, southwestern Wyoming, and northeastern Utah. It is found in rocks of "Upper Carboniferous" age in a series of shales and limestones, 100 feet thick, within which are several beds of phosphate rock ranging in thickness from a few inches to 10 feet. At the base of the series is a limestone, and 6 to 8 inches of soft brown shale separates this from the principal phosphate bed, which is 5 to 6 feet thick. This phosphate bed is oolitic in character and high in phosphoric acid. There are in the series several other beds ranging from a few inches to 10 feet in thickness, and separated by thin beds of limestone or shale. Usually one and sometimes two of these beds at a given section are workable, and probably some of the others will eventually be mined. The lime phosphate content in the workable beds varies from 65 to 80 per cent, with an average of 72 per cent.

DEVELOPMENT AND PRODUCTION.

The newness of the field, the lack of transportation facilities, and the high freight rates have prevented the development of this phosphate territory to any great extent, although there has been some shipment from Montpelier, Idaho, in the last three years. According to F. B. Weeks,[a] who recently prepared a report upon these phosphates:

> This field embraces the largest area of known phosphate beds in the world, and at some future time it will doubtless furnish a large part of the world's production of commercial fertilizer. The development of intensive farming as a result of the reclamation of arid lands in the West will afford an increasing home market.

EXPORTS.

The following table shows the production and exportation of phosphate rock since 1899:

Production and exportation of phosphate rock in the United States, 1899–1908, in long tons.

Calendar year.	Production.	Exportation.	Calendar year.	Production.	Exportation.
1899	1,515,702	867,790	1905	1,947,190	934,940
1900	1,491,216	619,995	1906	2,080,957	904,214
1901	1,483,723	729,539	1907	2,265,343	1,018,212
1902	1,490,314	802,086	1908	2,386,138	1,188,411
1903	1,581,576	785,259			
1904	1,874,428	842,484		18,116,587	8,692,930

[a] Contributions to economic geology, 1907, pt. 1; Bull. U. S. Geol. Survey No. 340, 1908, pp. 441–449.

Auchincloss Brothers have kindly furnished a statement of their shipments of phosphate rock from Florida and Tennessee. The quantities of rock and the countries to which shipped are shown in the two following tables:

Exports of Florida phosphate rock, 1904–1908, by countries, in long tons.

Country.	1904.	1905.	1906.	1907.	1908.
Austria	14,866	28,070	41,252	28,906	38,620
Belgium	32,703	32,209	46,414	21,258	....
Denmark	8,450	5,202	13,803	8,653	22,953
England	37,620	49,061	56,964	45,632	41,517
France	3,000	11,014	10,468	11,565	4,427
Germany	205,703	263,731	239,380	262,221	293,416
Holland [a]	100,603	92,975	71,563	87,434	120,022
Ireland	10,218	16,250	20,654	19,450	14,623
Italy and Sicily	25,125	26,951	9,781	16,260	1,685
Norway and Sweden	28,215	33,644	37,408	59,657	50,109
Russia	2,200	....	....	....	....
Scotland	12,957	13,858	6,810	11,392	19,710
Spain	5,584	8,325	9,000	20,022	20,253
	487,244	581,290	563,497	592,450	627,335

[a] A large part of the shipments to Holland are forwarded to the interior of Germany.

Exports of Tennessee phosphate rock, 1904–1908, by countries, in long tons.

Country.	1904.	1905.	1906.	1907.	1908.
Austria	....	....	....	....	1,100
Belgium	7,776	9,984	11,216	7,959	9,665
England	7,571	10,514	19,667	11,445	12,189
France	36,449	26,917	28,050	37,090	29,021
Holland	....	....	....	....	50
Italy and Sicily	68,118	45,679	32,309	29,562	15,945
Spain	....	....	2,153	9,533	10,320
	119,914	93,094	93,395	95,589	78,290

IMPORTS.

The following table shows the imports of fertilizers of all kinds into the United States for the years 1904 to 1908, inclusive:

Fertilizers imported and entered for consumption in the United States, 1904–1908, in long tons.

Year.	Guano.		Kieserite and kainite.		Apatite, bone dust, crude phosphates, and other substances used only for manure.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1904	37,127	$498,702	218,957	$1,050,082	243,130	$2,455,618	$4,004,402
1905	27,104	379,667	351,053	1,850,622	197,115	2,450,835	4,681,124
1906	23,222	322,766	334,843	1,790,969	211,274	2,598,451	4,712,186
1907	30,287	400,054	346,266	2,526,584	194,121	2,579,843	5,506,481
1908	5,728	92,659	129,063	730,934	96,091	1,153,002	1,976,595

WORLD'S PRODUCTION.

The world's production of phosphate rock for the years 1905 to 1907, inclusive, is given in the following table:

World's production of phosphate rock, 1905–1907, by countries, in metric tons.

Country.	1905.		1906.		1907.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Algeria	334,784	$1,225,126	333,531	$965,600	373,763	$2,142,352
Aruba (Dutch West Indies)	23,307	42,188	26,138	(a)	(b)	....
Belgium	193,305	332,292	152,140	282,612	(b)	....
Canada	1,338	8,876	521	4,024	748	6,018
Christmas Island (Straits Settlements)	99,519	(a)	92,010	(a)	(b)	....
France	476,720	2,093,118	469,408	1,872,000	431,237	1,876,736
Norway	2,522	33,768	3,482	46,524	(b)	....
Spain	1,370	7,295	1,300	7,592	....	....
Tunis	521,731	1,812,493	796,000	2,304,400	1,069,000	(a)
United Kingdom	....	....	....	....	43	224
United States	1,978,345	6,763,403	2,114,252	8,579,437	2,301,588	10,653,558

[a] Value not reported. [b] Statistics not yet available.

AVAILABLE PHOSPHATE DEPOSITS.

The known phosphate deposits of the United States are distributed principally among four localities: (1) Along the west coast of Florida, running back 20 to 25 miles inland; (2) along the coast of South Carolina, extending 6 to 20 miles inland; (3) in central Tennessee; and (4) in an area comprising southeastern Idaho, southwestern Wyoming, and northeastern Utah. In addition to these areas, some deposits occur in north-central Arkansas, along the Georgia-Florida state line, and in North Carolina, Alabama, Mississippi, and Nevada, but these are mainly of low grade and not utilized at the present time. The three important deposits first mentioned have been worked from ten to thirty years; the fourth is a new field which has as yet had but a small output.

ESTIMATED LIFE OF UNITED STATES PHOSPHATE DEPOSITS.

The rate of increase in production for the last twenty years has been 117 per cent for each decade. Assuming that this rate of increase will continue, it will require but a comparatively short time to exhaust the available supply of phosphate rock in the United States. The annual production, at the stated rate of increase, will be approximately 17,000,000 tons in 1932.

It is hardly probable that the rate of increase in production will be so great as for the last decade, since the agricultural lands of the Middle West do not at present need artificial assistance. But increasing population, with its accompanying intensive farming, will eventually force these States to the use of fertilizing materials. The reclamation of arid lands in the West will probably postpone the day, but even those lands will early need some assistance to grow the large crops which will be required of them.

Of course the vast amount of low-grade rock which is not now available will be in reserve, and some time before the exhaustion of the high-grade phosphates we shall doubtless have begun to use this rock. The increasing price of the 60 to 80 per cent phosphate will have a hastening effect on the utilization of the present low-grade material. The deposits of Arkansas, Georgia, North Carolina, Alabama, Tennessee, and the West, which run from 30 to 50 per cent in lime phosphate, will be available to draw upon after the high-grade rock is exhausted. This class of deposits, especially in Tennessee and the Western States, will afford an enormous tonnage, but, based upon present available deposits, the life of the phosphates must at best be a short one.

FOREIGN DEPOSITS.

Deposits of phosphate rock exist in Algeria, France, New Zealand, Canada, Russia, Spain, Tunis, Belgium, French Guiana, and some of the South Sea Islands. The deposits of France and Belgium are practically exhausted, only those of low grade remaining. Concerning the other countries no information as to reserve tonnage is at hand except for the three South Sea Islands, Ocean, Pleasant, and Makatea. These three islands have deposits which are estimated to aggregate 60,000,000 tons of high-grade phosphate rock.

UTILIZATION OF THE PHOSPHATES.

From the foregoing pages it will be seen that the utilization of our phosphate deposits to the best possible advantage is imperative. Our farm lands must be preserved for future generations. The phosphate rock of South Carolina is nearly exhausted; the Florida deposits have probably reached their maximum production; the output of the Tennessee deposits is on the increase, but this field alone would, at the present rate of increase in production, last only a few years; there is some phosphate in Arkansas, but it is of low grade; therefore the large deposits of the public land States must be depended on for the greater part of our phosphate in the future. The proper conservation of our phosphate deposits can be best accomplished in the following ways:

1. *Correction of wasteful mining methods.*—The waste involved in mining phosphates, especially in Tennessee, should have some attention. In order to get the largest quantity of high-grade rock necessary for the export trade, 50 per cent rock in large quantities is thrown on the dump and wasted. The time is sure to come when 50 per cent rock, and even 25 per cent rock, will be utilized in fertilizer manufacture. Steps should be taken now to prevent this waste in order to avoid a similar mistake when the phosphates of the Western States are mined. Much of the western rock runs from 25 to 50 per cent lime phosphate, and such material should be saved toward the time when the term "high-grade rock" shall have come to mean a lime phosphate content of 40 to 50 per cent instead of 70 to 80 per cent, as at present.

2. *Utilization of sewage.*—One of the important sources of phosphoric acid to which we must look in the future is the human excrement that is now being wasted through the present system of sewage. Van Hise says: "Whitson estimates that the loss in the cities due

to man alone is the equivalent of 2 or 3 pounds of phosphoric acid per acre for the entire cropped region of the United States. Supposing this loss to be 2 pounds, this is one one-thousandth of a ton, which amounts for the 400,000,000 acres to 400,000 tons of phosphoric acid, equivalent to 1,200,000 tons of phosphate rock." The significance of these figures appears at once when it is recalled that the total production of phosphate rock in the United States for the year 1908 was 2,386,138 tons.

3. *Leasing of the phosphate deposits.*—Only by preventing, or materially curtailing, exportation, can we be assured of the use of our phosphate deposits for our own lands in the future. Of the 18,116,587 tons of phosphate rock produced in the United States from 1899 to 1908, inclusive, 8,692,930 tons, or nearly 48 per cent, have gone to foreign countries. In 1908 there were 2,386,138 tons of phosphate rock produced in the United States. Of this amount, 1,188,411 tons, or nearly 50 per cent, were exported. It is not difficult to see that with our steadily increasing population the time is not very far distant when the farm lands of the Middle West will be burdened to their fullest capacity. It has been shown, as the result of agricultural experiment station work in Wisconsin, Ohio, and Illinois, that in fifty-four years soils of those States in the cropped areas have been depleted of one-third of their original phosphoric acid. This is equivalent to 20 pounds per acre annually. If the loss be assumed to be only 10 pounds per acre, there would be required for the 400,000,000 acres of cropped land in the United States about 6,000,000 tons of phosphate rock annually, or nearly three times our 1907 production, to offset this loss, without considering the question of increasing the productivity. With the reclamation of the arid lands of Wyoming and other Western States there will come, as Mr. Weeks points out, a period of intensive farming, and in order to produce the large crops which will be required of them these lands must soon have the assistance of artificial fertilizer.

In this connection the American Fertilizer for November, 1908, gives an account of the organization of the Franco-American Consolidated Phosphate Company, with a capitalization of $7,500,000. The capital stock is fully paid up and is divided as follows: $5,250,000 for the purchase of phosphate lands in Tennessee, and $2,250,000 for the purchase of fertilizer plants in Europe and for working capital. The company is headed by a powerful syndicate of leading fertilizer manufacturers and bankers of France, Spain, Italy, and Belgium, who will control the stock of the company; and by this organization the fertilizer industry of Europe is expected to be completely under its control. The company has purchased 16,375 acres of phosphate lands, and has 10,000 acres more under option. As a part of its plans it as stated: "The company has contracted for all of the export rock it can produce for the next ten years, and has concluded arrangements for the immediate introduction, on a large scale, of the blue rock, both in Europe and in this country."

From this it would appear certain that the phosphate deposits of the United States are to be drained for the benefit of the worn-out farm lands of foreign countries. So far as the deposits of Florida, Tennessee, and South Carolina are concerned, this can not be easily prevented, but it has been suggested that "the production of the newly opened western fields may be preserved for the United States by retaining in the Government title to all the phosphate rock in the lands now belonging to the United States, and by leasing these deposits under appropriate terms. In the lease could be included a clause providing that the lessee shall agree to mine phosphate rock only for domestic consumption.

"If all the lands containing phosphate were reserved pending leasing, it would remove from entry certain lands which might otherwise be occupied by homeseekers, and it is therefore necessary to provide for the disposal of surface rights alone. Such a separation of surface rights and mineral rights would obviate the necessity of creating large phosphate reserves in which the surface lands would be withdrawn from settlement; it would permit the fullest utilization of the land in all particulars. A separation of surface and mineral rights would furthermore insure the proper utilization of all phosphate deposits which may hereafter be found in lands now belonging to the United States."

SALT AND BROMINE.

By W. C. Phalen.

SALT.

PRODUCTION.

Common salt occurs in nature as rock salt and in solution as brine. In the latter form, it is found in the waters of the ocean, in various inland seas and lakes, and also stored in various beds in the crust of the earth. It is obtained from all these sources in the United States.

In 1908 the quantity of salt produced in this country amounted to 28,822,062 barrels of 280 pounds, valued at $7,553,632; in 1907 the production reported was 29,704,128 barrels, valued at $7,608,323, a decrease in the output for 1908 of 882,066 barrels in quantity and of $54,691 in value. Expressed on a tonnage basis these quantities represent an output of 4,158,578 short tons in 1907 and of 4,035,089 short tons in 1908, a decrease in the latter year of 123,489 tons.

In 1907 the average net value was 25.614 cents per barrel, or $1.83 per short ton; in 1908 the average net value was 26.208 cents per barrel, or $1.87 per short ton, an increase in 1908 of 0.594 cent per barrel, or 4 cents per ton.

The following table shows the quantity and value of salt reported as produced in the United States from 1893 to 1908:

Production and value of salt in the United States, 1893–1908.

1893..barrels..	11, 897, 208	$4, 154, 668	1901..barrels..	20, 566, 661	$6, 617, 449
1894....do....	12, 968, 417	4, 739, 285	1902....do....	23, 849, 231	5, 668, 636
1895....do....	13, 669, 649	4, 423, 084	1903....do....	18, 968, 089	5, 286, 988
1896....do....	13, 850, 726	4, 040, 839	1904....do....	22, 030, 002	6, 021, 222
1897....do....	15, 973, 202	4, 920, 020	1905....do....	25, 966, 122	6, 095, 922
1898....do....	17, 612, 634	6, 212, 554	1906....do....	28, 172, 380	6, 658, 350
1899....do....	19, 708, 614	6, 867, 467	1907....do....	29, 704, 128	7, 608, 323
1900....do....	20, 869, 342	6, 944, 603	1908....do....	28, 822, 062	7, 553, 632

PRODUCTION OF SALT BY GRADES AND STATES.

Production by grades.—Salt is largely used for culinary purposes, and also in the meat-packing, fish-curing, dairying, and various other industries, to preserve the products from deterioration. The chlorination of gold also consumes large quantities of salt. In the form of brine it is largely used in the chemical industries in the preparation of soda ash (sodium carbonate), caustic soda, and various other chemicals containing a sodium base.

For convenience salt is classified according to the grades by which it is sold by the producer, the grades being determined by the amount of refining, the methods employed in refining, and the purposes for which the salt is used. These grades are "table and dairy," "common fine," "common coarse," "packers," "solar," "rock," "milling," "brine," and "other grades." The "table and dairy" salt includes extra fine and fancy grades prepared for family use, and all grades artificially dried, used for butter and cheese making, and such special brands. Under "common fine" salt are included all other grades of fine salt of first quality, not artificially dried, such as those known to the trade as "C. F.," "No. 1 F," "anthracite," etc. "Common coarse" salt includes all grades coarser than "common fine," made by artificial heat, such as "steam coarse," "No. 1 coarse," "pan solar," "G. A.," "Liverpool ground," "C. C.," etc. By "packers" salt is meant those grades prepared for the purpose of curing fish, meats, etc. "Coarse solar" includes all coarse salt made by solar evaporation. "Rock" salt includes all salt mined and shipped without special preparation. "Mill" salt is that used in gold and silver mills, and "other grades" includes all low-grade or No. 2 salt, used in salting cattle and for fertilizers, track purposes, etc. "Brine" includes all salt liquor used in the manufacture of soda ash, sodium bicarbonate, sodium hydrate (caustic soda), and other sodium salts or brine sold without being evaporated to dryness.

The following table shows the salt production of the United States, by grades, during the last five years:

Production of salt, by grades, in the United States, 1903–1908, in barrels.

Year.	Table and dairy.	Common fine.	Common coarse.	Packers.	Solar.
1904	2,508,408	6,819,109	2,604,981	96,130	1,189,393
1905	2,380,808	6,818,690	2,724,769	327,192	903,143
1906	2,923,044	6,483,937	2,550,209	452,490	1,080,591
1907	3,537,157	7,684,638	2,055,054	422,324	862,929
1908	3,202,016	7,388,903	2,550,333	373,284	1,156,034

Year.	Rock.	Milling.	Other grades.	Brine.	Total production.	Total value.
1904	4,369,141	349,421	86,469	4,006,950	22,030,002	$6,021,222
1905	4,733,765	....	207,824	7,869,931	25,966,122	6,095,922
1906	4,873,526	....	234,903	9,573,680	28,172,380	6,658,350
1907	5,809,328	....	110,227	9,222,471	29,704,128	7,608,323
1908	5,161,211	....	121,065	8,869,216	28,822,062	7,553,632

Production by States.—The following table gives the production and value of the salt produced in the United States from 1905 to 1908, inclusive, by States:

Production and value of salt, 1905–1908, by States, in barrels.

State.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York	8,359,121	$2,167,931	8,978,630	$2,098,686	9,642,178	$2,335,150	9,076,743	$2,136,738
Michigan	9,492,173	1,851,332	9,936,802	2,018,760	10,786,630	2,231,129	10,194,279	2,458,303
Ohio	2,526,558	565,946	3,236,785	789,237	3,851,243	979,078	3,427,478	864,710
Kansas	2,098,585	576,139	2,198,837	681,022	2,667,459	962,334	2,588,814	882,984
Louisiana	1,055,186	303,507	1,179,528	268,005	1,157,621	226,892	947,129	249,733
California	664,099	188,330	806,788	291,528	626,693	302,940	899,028	374,828
West Virginia	202,151	74,063	200,055	57,584	156,147	76,527	145,157	70,481
Texas	444,832	142,993	360,733	170,559	356,086	226,540	442,571	255,652
Utah	177,342	135,465	262,212	169,635	345,557	199,779	242,678	169,833
Idaho	(a)	(a)	1,574	1,867	1,600	2,040	1,114	1,413
Nevada	(a)	(a)	11,249	6,420	6,457	3,654	9,714	4,785
Oklahoma	(a)	(a)	9,893	4,965	800	910	(a)	(a)
Other States	[b] 946,075	90,216	[c] 989,294	100,082	[d] 105,657	61,350	[e] 847,357	84,172
Total	25,966,122	6,095,922	28,172,380	6,658,350	29,704,128	7,608,323	28,822,062	7,553,632

[a] Included in other States.
[b] Virginia, Pennsylvania, Oklahoma, Nevada, New Mexico, Massachusetts, and Idaho.
[c] Includes Virginia, Pennsylvania, New Mexico, and Massachusetts.
[d] Includes Pennsylvania, New Mexico, and Massachusetts.
[e] Includes New Mexico, Oklahoma, Pennsylvania, and Virginia.

During the year 1908 Michigan outranked New York as a producer of salt in both quantity and value of output. During and since 1905 Michigan has produced a larger quantity of salt than New York, but until 1908 the average net price per barrel has been so much less in the former than in the latter State that the difference in production has not compensated for the difference in the value per barrel. These two States together produced about two-thirds of the total output of the country in 1908. So far as the quantity produced is concerned, the leading salt-producing States maintained the same order of rank in 1908 as in 1907. Several changes, however, have taken place in the order of rank based on the value of the output. The fact that Michigan outranked New York has been referred to above. Kansas surpassed Ohio in the value of output, and Texas surpassed Louisiana. For the first time since 1903, there was a decrease in the total quantity of salt produced as compared with the production of the preceding year.

Production by States and grades.—The following table shows the grades of salt produced in the different States. Brine and "Other grades" are combined in order to conceal individual production of dry salt obtained from the brine.

Production of salt in the United States in 1908, by States and grades, in barrels.

State.	Table and dairy.		Common fine.		Common coarse.		Packers.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	278,864	$171,973			8,214	$2,100	96,886	$37,008
Idaho	114	243	86	$120	107	150		
Kansas	126,190	118,079	1,490,599	569,346	4,066	1,287		
Louisiana								
Michigan	584,452	620,647	3,454,062	968,617	2,029,956	610,286	134,726	53,669
Nevada	178	375			6,429	1,800		
New York	1,188,643	631,988	972,036	355,234	212,250	81,486	59,529	22,708
Ohio	867,122	413,911	937,036	274,776	235,013	73,584	82,143	33,840
Texas	69,143	51,675	331,750	180,662	30,000	16,800		
Utah	55,957	84,410	22,307	18,899	71	90		
West Virginia	31,353	16,484	90,006	42,802	23,798	11,195		
Other States [a]			91,021	45,524	429	360		
Total	3,202,016	2,109,785	7,388,903	2,455,980	2,550,333	799,138	373,284	147,225

State.	Solar.		Rock.		Other, and brine.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	490,064	$148,997	25,000	$14,750			899,028	$374,828
Idaho			536	525	271	$375	1,114	1,413
Kansas			963,860	191,676	4,099	2,596	2,588,814	882,984
Louisiana			947,129	249,733			947,129	249,733
Michigan					3,991,083	205,084	10,194,279	2,458,303
Nevada	3,107	2,610					9,714	4,785
New York	520,607	117,136	3,198,657	774,344	2,925,021	153,842	9,076,743	2,136,738
Ohio					1,306,164	68,599	3,427,478	864,710
Texas	11,678	6,515					442,571	255,652
Utah	130,578	43,927	26,029	10,940	7,736	11,567	242,678	169,833
West Virginia							145,157	70,481
Other States [a]					755,907	38,288	847,357	84,172
Total	1,156,034	319,185	5,161,211	1,241,968	8,990,281	480,351	28,822,062	7,553,632

[a] Includes New Mexico, Oklahoma, Pennsylvania, and Virginia.

THE SALT INDUSTRY BY STATES.

Salt was produced on a commercial scale in 1908 in 14 States and 1 Territory, viz, California, Idaho, Kansas, Louisiana, Michigan, Nevada, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Virginia, and West Virginia. Brief descriptions of the salt industry in some of these States follow:

California.—In the quantity of salt produced California ranked sixth among the States in 1908, maintaining the same relative rank that it did in 1907. In the value of output it ranked fifth in both years. Unlike some of the larger producing States of the East and the Middle West, the output of the State increased decidedly in both quantity and value, in spite of the fact that the average value per barrel or ton was somewhat less in 1908 than in 1907. The output of the State in 1908 was 899,028 barrels, or 125,864 short tons, valued at $374,828, an average of 42 cents per barrel, as compared with 48 cents per barrel in 1907, or $2.98 per ton, as compared with $3.45 per ton in 1907.

Practically all of the salt produced in California comes from Alameda, San Mateo, San Bernardino, San Diego, and Los Angeles counties. By far the greater part of this salt is obtained by solar evaporation, but steam is also used as an accessory at some of the plants. The crop of salt in 1908 was obtained under far more favorable conditions than was the case in 1907, and not so much loss was sustained on account of floods. This accounts in part for the somewhat lower price of the product as compared with the prices of 1907. Instead of a shortage, accompanied by the necessity of putting new salt on the market, as happened in 1907, it is estimated that the quantity of salt produced in California in 1908 is about 20 per cent in excess of current requirements.

Idaho.—There were produced in Idaho, in 1908, 1,114 barrels of salt, valued at $1,413, as compared with 1,600 barrels, valued at $2,040 in 1907. The salt was produced in Bear Lake and Bannock counties in the extreme southeast corner of the State, near the Wyoming line. The headquarters of most of the operators are in Auburn, Wyo. The salt is produced by the open-pan process, in which the heat is applied directly.

Kansas.—Kansas ranked fourth in the quantity of salt produced in 1908, maintaining the same relative rank which it held in 1907; in value of output, however, it ranked third, replacing Ohio, which held this position in 1907. The production for 1908 was 2,588,814 barrels, or 362,434 short tons, valued at $882,984. Compared with the output of 1907 of 2,667,459 barrels, or 373,444 short tons, valued at $962,334, this was a decrease for the year 1908 of 78,645 barrels, or 11,010 short tons, valued at $79,350. The average price per barrel in 1908 was 34 cents, or $2.44 per ton, a slight decrease from the values of 1907, which were, respectively, 36 cents per barrel and $2.58 per ton.

The localities where salt is produced on a commercial scale in Kansas are Hutchinson, Reno County; Lyons and Sterling, Rice County; Ellsworth and Kanopolis, Ellsworth County; Anthony, Harper County; and Kingman, Kingman County. Most of the manufacturers use the grainer process, in which steam is employed in the evaporation. The open-pan process is also used, in which the heat is applied directly. During the latter part of the year the plant of the Kingman Salt Mining Company, located at Kingman, was destroyed by fire. So far as known, it is not the present intention of the company to rebuild.

Louisiana.—The salt mined in Louisiana comes from Weeks and Avery islands, so called, in Iberia Parish. The production in 1908 amounted to 947,129 barrels, valued at $249,733, as compared with 1,157,621 barrels, valued at $226,892, in 1907. The output fell off by 210,492 barrels, but the value was $22,841 greater than in 1907. Louisiana still ranks fifth among the States in the quantity of salt produced, but seventh in the value of the output, being exceeded in this respect by Texas, California, Ohio, Kansas, New York, and Michigan.

Of the producing localities, Weeks Island, so called, is located on the east shore of Weeks Bay, an eastern lobe of Vermilion Bay. It is sometimes called Grande Côte, on account of its size, though it is scarcely 2 miles in diameter. Prospecting for salt began here in 1897, and in 1898 the Myles Salt Company, which works the deposits at present, was organized. After considerable prospecting with the drill, the location of a shaft was determined on in 1898, and in March, 1902, the 600-foot level was reached, and tunnels to the east and west were driven. The extreme depth of the shaft is now 645 feet.[a] To

[a] Harris, G. D., Rock salt in the State of Louisiana: Bull. Louisiana Geol. Survey No. 7, 1908, p. 5.

the north of the shaft the salt is impure; to the west there is danger of the tunnel running out of the salt and into the overlying sand, hence of ruining the mine; to the east the salt is excellent and there seems to be no danger ahead.

The following descriptions of the mine operations are abstracted from those of Harris:[a] Mining is carried on by first undercutting or blasting out triangular chunks of salt on the level with the floor of the mine, then blasting down layer after layer, so to speak, already undermined. The drills are worked by compressed air furnished by the compressors in the power house at the surface. The salt is conveyed to the vicinity of the shaft in small dump cars drawn by mules over narrow-gage steel tracks. At the shaft the salt is passed through the crusher and falls into a huge bin below. From this it is drawn off into a 5-ton self-dumping cage that is capable of making a round trip—that is, from the bottom of the shaft to the top of the mill at the surface and back to the bottom of the shaft—in four minutes. The capacity of the mine, then, is about 75 tons per hour, or 750 tons per ten-hour day.

The mine is lighted by electricity. Ventilation is usually fair, but much less satisfactory than it would be if there were provided an entrance and an exit shaft for the air in distant parts of the mine. Fire damp or inflammable gases are practically unknown in this mine. In the engine room a pair of 20 by 30 foot engines, geared back 3½ to 1, turn an 8-foot drum that winds up the cable lifting the cage. As usual with such machinery there is a device so actuated by the motion of the engines that the engineer knows at every instant just where in the shaft the cage is, just when to stop the engines to bring the cage to the main floor or to the bottom of the mine, or just when he must gradually bring the engines to a standstill while the cage is automatically dumping its cargo into the bins at the top of the mill.

Besides these engines for hoisting there are two air compressors for working the drills in the mine, and one small engine for working the ventilating fans. The power used to run the crusher at the bottom of the shaft, as well as the screens and the general mill work above, is transmitted by insulated wire cables from a dynamo in the engine room. The various boilers use fuel oil.

Salt of various coarseness is produced at the mill by grinding the crushed material as it is dumped from the cage, as already described, on the uppermost floor of the building through screens of varying mesh, the coarser grades being first screened out and the finer ones later on and lower down. Shipment is made via the Salt Mine branch of the Southern Pacific Railroad, sometimes in bulk, sometimes in carload lots, and sometimes in sacks. The highest priced salt is that shipped in huge chunks, used by cattlemen for salting their stock. In a moderately dry climate these chunks last a year or more, or until consumed by the cattle. The Myles Salt Company has kindly furnished the following data regarding the uses to which these various grades of salt are put:

"The crushed salt, grades Nos. 1, 2, and 3, is used in refrigerating, curing hides, curing fish, making salt pickles, glazing in enameling and pipe works, and No. 3 is especially adapted for capping all sorts of meats put up in pickle in barrels. The C (coarse) and F (fine)

---

[a] Idem, p. 12.

salt is used for dry-salting meats, clearing oleomargarine, and in all sorts of chemical works. The A grade is a special one made to suit the customer who regards No. 1 as too large and the C as too small for his purposes, such as making ice cream and pickles. The D grade is also a special one, consisting of powdered salt which results from the grinding of any of the crushed grades in the mill, and which is used for any purpose where rapid solution of the salt is desired."

Salt is also mined on "Avery Island," so called, located in Iberia Parish, 10 miles southwest of New Iberia. The workings on this island also have been described by Harris.[a] Rock salt was discovered here in 1862, and an 8 by 8 foot shaft, 83 feet deep, was sunk in 1867, whose depth was afterwards increased to 90 feet. Mining was carried on by driving long, narrow chambers in an east-west and finally in a north-south direction as well. The mine was afterwards flooded. In 1885 the shaft was deepened to 168 feet. It was subsequently flooded a second time. A new shaft was begun in 1899.

The details connected with the new mine are as follows: The shaft is 21 by 10 feet, is 518 feet deep, and is divided into two hoists and one air shaft. The galleries, about a mile of which were driven in 1904, are 30 feet wide, and run in two directions at right angles with each other, leaving square pillars 30 feet on a side as supports.

Here, as well as at Weeks Island, the salt is conveyed from the place of mining to the foot of the shaft by means of small cars drawn on a narrow-gage steel track by horse or mule power. Here, however, the cars are drawn upon the platform of the cage and hoisted and dumped by hand at the top floor of the mill. The heavy crushing is therefore done in the mill instead of at the foot of the shaft, as at Weeks Island. The various grades of salt produced are used for practically the same purposes as similar grades from Weeks Island. The purity of the salt is such that no purification processes are required. The salt is simply crushed, screened, ground, and winnowed to drive off the fine salt-dust particles. The elimination of the finest, dustlike particles is necessary owing to their tendency to deliquesce and cement together the larger salt grains.

Michigan.—In the last few years Michigan has produced a greater quantity of salt than any other State in the Union, but the value of the output has been less than that of the somewhat smaller production of New York, until 1908, when both production and value of the salt in Michigan have exceeded those of New York. In 1908 the quantity of salt produced in Michigan was 10,194,279 barrels, valued at \$2,458,303. There is included in these figures the salt contained in the brine that is worked up into soda and other chemicals. Though the salt contained in this brine does not appear on the market as such, obviously it is a part of the salt wealth of the State, and must be so considered.

According to the state geologist of Michigan, Dr. A. C. Lane, from whose article in Mineral Industry[b] the following notes are in part abstracted and in part quoted: The State is divided into six districts, which differ materially in the quality of salt occurring in them, the methods by which it is prepared for market, and the geologic conditions of its occurrence. In districts 1 and 2, which include Saginaw and Bay counties, the salt industry centers at Carrollton, Saginaw,

[a] Op. cit., p. 14.
[b] Mineral Industry, vol. 16, 1907, pp. 822–825.

St. Charles, and Bay City. Midland and Isabella counties, where bromine is made, are also included in these two districts. The geologic conditions in the counties enumerated above are similar. Their brine is obtained mainly from the sandstone of the Marshall group, a subcarboniferous sandstone whose base varies from 750 to 1,000 feet below the surface along Saginaw River. The salt plants are mainly grainers, but there is still one solar evaporation plant run in connection with some other industry.

The brine has the following composition: Sodium chloride, 228 grams per kilogram; calcium chloride, 45; magnesium chloride, 17; magnesium bromide, 0.3 to 0.1; calcium sulphate, 0.8; ferrous carbonate, 0.15; ammonium chloride, 0.05; silica, 0.02; alumina, 0.02. A brine like this, even when evaporated to a bittern and much of the salt expelled, has not enough gypsum in it for saturation; whence arises the fact that Saginaw salt does not contain gypsum, is not hard or harsh, and does not cake. Unless it is thoroughly drained, however, it will deliquesce, owing to the presence of calcium and magnesium chlorides.

The brine is treated with quicklime, which combines with the carbon dioxide and throws out the iron and possibly a little magnesia. The ammonia is left in such a condition that it is liberated during the subsequent aeration of the brine. In the settling, greenish salts of iron crystallize out. From the settling tanks and brush tower the brine passes to the grainers, built of concrete or steel. From there it is raked out automatically and allowed to drain in piles before being barreled. The bittern which runs off from the grainers and stock piles contains a notable amount of bromine, which is saved at some places.

The soda ash works are located at Delray and Wyandotte. The necessary limestone is found in outcrops of the Dundee ("Corniferous") limestone at the Sibley quarries. Around Alpena, where probably salt and limestone may be obtained, and where shipping facilities are good, the deposits have not been developed.

In Detroit and Wayne counties the salt comes from rock-salt beds of about the same age as the New York salt beds, viz, the Salina shale, near the top of the Silurian. These beds aggregate several hundred feet in thickness. With the salt occurs anhydrite, which, unless removed, makes the product feel harsh. The salt is recovered in solution by means of river water pumped down upon the beds.

In Manistee and Mason counties the salt industry centers about Manistee, Filer City, East Lake, and Ludington. The salt is obtained from a single salt bed 20 feet or more in thickness. Underground waters dissolve the salt in many places, instead of water let down from the surface, and either the ordinary hand pump or air lift is used. The vacuum-pan process is employed. A recent improvement, as practiced at the Peters plant, is the placing of the vacuum pans in tandem, somewhat as in a compound condensing engine. It is now proposed to run three pans in this manner. Coal is being introduced to supplant sawmill waste as fuel.

Nevada.—Nevada salt is produced in Churchill and Washoe counties only, and is produced entirely by solar evaporation. The production is small, amounting to only 9,714 barrels, valued at $4,785, in 1908. This, however, is an increase over the production of 1907, which was 6,457 barrels, valued at $3,654.

New Mexico.—Torrance County furnishes the only commercial salt reported from this territory.

New York.[a]—New York ranked second in both quantity and value of salt produced in 1908, being exceeded by the State of Michigan. The quantity of salt produced in New York in 1908 was 9,076,743 barrels, or 1,270,744 short tons, valued at $2,136,738, as compared with a production of 9,642,178 barrels, or 1,349,905 short tons, valued at $2,335,150, in 1907, a falling off of 565,435 barrels, or 79,161 short tons in quantity, and of $198,412 in value. In addition to the salt used as such, these figures include the brine that is converted into various chemicals, as, for instance, by the Solvay Process Company, at Solvay, near Syracuse.

Salt in New York occurs in the form of brine and also as rock salt. Brine is found at Syracuse in glacial drift, and in some places wells more than 300 feet deep have been sunk to the salt water. The brine from the shallow wells becomes weaker after continuous pumping, but the deeper wells apparently are not thus affected. From the Syracuse brine the salt is manufactured either by artificial or solar evaporation. The solar salt is made almost entirely in Onondaga County, and Syracuse has long been the center of the industry, which dates back more than one hundred years. In 1797 the Syracuse district was made a state Indian reservation, and most of the salt wells are now located on the reservation. The brine, which contains 17 to 20 per cent of sodium chloride, is furnished to operators at a fixed charge. Owing to the depression in the salt trade generally during 1908, there was a slight shrinkage in the price per bushel of the solar salt.

The rock-salt beds of New York occur in the red shales of the Salina formation in the Silurian. So far as known, they outcrop nowhere at the surface, but the area which they underlie and their mode of occurrence have been fairly well defined by numerous drill holes driven to them. They have been found from the Oatka Valley, in Wyoming County, east to Morrisville, Madison County, and south of this wherever wells have been driven down to their horizon, but they are not known to extend north of the forty-third parallel. Rock salt has been found also in Erie County, south of Buffalo. The manufacturers of salt from these beds obtain their supplies from wells driven to the rock salt. Water is introduced into the wells and then pumped up after nearly complete saturation. In this way a brine carrying nearly 25 per cent sodium chloride is obtained.

The salt produced in the State in 1908 included rock salt and the various varieties of brine salt. The localities producing were the Onondaga district, in Onondaga County, near Syracuse; Ithaca, Tompkins County; Watkins and Ludlowville, Schuyler County; Perry, Rock Glen, and Silver Springs, Wyoming County; Le Roy, Genesee County; and Retsof, Cuylerville, and Piffard, Livingston County. The plant of the International Salt Company, located at Warsaw, was shut down during the year and dismantled.

Ohio.—Ohio ranked third among the States in the quantity of salt produced in 1908. In value of production, however, it ranked fourth, being exceeded by Michigan, New York, and Kansas, in the order named. The production in 1908 amounted to 3,427,478 barrels, or

[a] The cooperation of the state geologist in the collection of the statistics of this State is hereby acknowledged.

479,847 short tons, valued at $864,710, as compared with an output of 3,851,243 barrels, or 539,174 short tons, valued at $979,078, in 1907, a falling off during the past year of 423,765 barrels, or 59,327 short tons, in quantity and $114,368 in value. A very complete description of the salt deposits of Ohio, together with their historical development and present mode of working, has been given in a recent bulletion of the Ohio Geological Survey by J. A. Bownocker,[a] and in this report, for the year 1907, a brief description of the salt industry of Ohio was given, which was compiled from that source.

Oklahoma.—The small production of salt from Oklahoma comes from near Ferguson, Blaine County. The salt resources of this State have recently been described briefly by Charles N. Gould, director of the Geological Survey of Oklahoma.[b]

According to Gould:

Wells and springs containing salt water are found not only throughout the Red Beds area in western Oklahoma, but also in the eastern part of the State, and in certain regions the water from the springs is so salty as to warrant the popular phrase "salt springs" or "salt plains."

There are two salt plains along the Cimarron River between Woods, Woodward, and Harper counties, two in northwestern Greer County, and one each in Alfalfa, Blaine, and Beckham counties. These plains are widely separated and vary greatly both in size and in the amount of water which flows from them. While all the salt springs come from the rocks of the "Red Beds," they do not all issue from the same geological horizon. The Alfalfa County plain is located 30 miles or more from the Gypsum Hills, but all the other plains are in these hills. The Cimarron River plains and the Blaine County plain are supplied by springs that issue from not far below heavy gypsum members, and the Beckham and Greer County plains are found near the base of gypsum ledges.

Salt has been manufactured at various times on all of the salt plains of Oklahoma, except the large plain in Alfalfa County, which, as stated above, contains no springs of any size. With the exception of the plant at Ferguson, primitive methods only have been employed, and no considerable amount of capital has been invested. It goes without saying that salt springs of this character will ultimately develop into properties of much value. It is estimated that there is enough salt water going to waste in Oklahoma to make 100 carloads of salt daily.

Pennsylvania.—The salt output of Pennsylvania is reported from Allegheny County.

Texas.—The quantity of salt produced in Texas in 1908 was 442,571 barrels, equivalent to 61,960 tons of 2,000 pounds each, valued at $255,652. In 1907 the corresponding figures were 356,086 barrels, or 49,852 short tons, valued at $226,540. Texas was one of the few States whose output and value of salt both increased in 1908, the increase amounting to 86,485 barrels, or 12,108 tons, in quantity and $29,112 in value.

Salt occurs in lagoons along the Gulf coast of Texas and in many salines or lakes throughout the State, from which it is taken annually. The regions of greatest importance are Van Zandt and Anderson counties in the northwestern part of the State and Crane and Mitchell counties in the western part.

Utah.—There was a decrease in both quantity and value of the salt produced in Utah in 1908. The output in 1907 was 345,557 barrels, or 48,378 short tons, valued at $199,779; and in 1908, 242,678 barrels, or 33,975 tons, valued at $169,833, a decrease of 102,879 barrels, or 14,400 tons in quantity, and of $29,946 in value.

---

[a] Bull. Geol. Survey, Ohio, No. 8, 1906.
[b] Bull. Geol. Survey, Oklahoma, No. 1, 1908, pp. 35–40.

The salt is obtained from brine by solar evaporation, chiefly in the neighborhood of Great Salt Lake, Salt Lake County. The brine is also produced at Nephi City, Juab County. Other salt-producing localities are near Gunnison, Sanpete County, in Sevier County, in Millard County, and at Withee Junction, Weber County. An enormous deposit of pure salt is reported to have been found on the west side of the Utah desert, not far from the Nevada state line.

Virginia.—Although salt is produced in Virginia, it is not marketed as such, but is worked up into chemicals by the Mathieson Alkali Works, located at Saltville. Since this is the only company producing salt in this State, the statistics of production are combined with those of other States.

West Virginia.—The output from this State in 1908 amounted to 145,157 barrels, valued at $70,481, as compared with 156,147 barrels, valued at $76,527, in 1907. The salt was reported from Mason City and Hartford, Mason County.

DOMESTIC CONSUMPTION.

The following table shows the proportion of salt produced in the United States entering into domestic consumption. Of the total consumption of salt during 1908, the quantity of domestic production used amounted to 96.2 per cent, as compared with 63.5 per cent in 1880. The country, therefore, is producing very nearly all the salt that it uses. The consumption of salt imported has decreased from 36.5 per cent of the total in 1880 to 3.8 per cent in 1908. In 1907 this figure was 3.4 per cent. The actual consumption in the last three decades is shown in the following table. The domestic consumption has increased enormously since 1880, and the increase during the present decade bids fair to equal that of the decade ending in 1900. During the year 1908 the salt consumed in the United States amounted to 29,772,176 barrels, a decrease of 774,791 barrels from the figures of 1907. The imports for consumption increased from 1,062,851 barrels in 1907 to 1,140,306 barrels in 1908.

Supply of salt for domestic consumption, 1880–1907, in barrels.

Source.	1880.	1890.	1900.	1907.	1908.
Domestic production	5,961,060	8,876,991	20,869,342	29,704,128	28,822,062
Imports	3,427,639	1,838,024	1,427,921	1,062,851	1,140,306
Total	9,388,699	10,715,015	22,297,263	30,766,979	29,962,368
Exports	4,436	17,597	53,650	220,012	190,192
Domestic consumption	9,384,263	10,697,418	22,243,613	30,546,967	29,772,176
Comparison with preceding year		+877,610	+1,274,634	+1,369,994	−774,791
Percentage of imports to total consumption	36.5	17.2	6.4	3.4	3.8

IMPORTS.

The table given below shows that the imports of salt into the United States increased during 1908, as compared with 1907, but they were considerably less than in 1906. The value of the imports in 1908 was less than in 1907 or 1906. There is no question now as to the ability of this country to meet its own requirements in salt. The chief increase is noted in the salt imported in bulk. The salt of high grade, imported in packages, showed a considerable falling off and was less than it ever has been. The salt imported for the fisheries industry also showed a shrinkage. The imports come from the United Kingdom, Italy, West Indies, and Spain, in the order of importance named. From these four sources over 90 per cent of both quantity and value of the imports was derived in 1908.

According to figures obtained from the Bureau of Statistics of the Department of Commerce and Labor the quantity and value of the salt imported and entered for consumption in the United States in the last five years is as follows:

Salt imported and entered for consumption in the United States, 1903–1908, in pounds.

Year.	In bags, barrels, and other packages.		In bulk.		For the purpose of curing fish.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1903	72,838,011	$259,029	147,635,246	$134,714	107,487,450	$102,205	327,960,707	$495,948
1904	69,657,850	209,509	143,903,175	135,408	118,718,456	122,837	332,279,481	467,754
1905	73,252,959	247,853	155,091,301	153,914	93,972,951	90,422	322,317,211	492,189
1906	74,228,878	257,592	159,674,675	149,944	115,359,107	101,326	349,262,660	508,862
1907	74,762,435	242,377	115,826,979	108,166	107,008,980	100,739	297,598,394	451,282
1908	66,409,270	219,272	153,031,808	120,979	99,844,560	104,439	319,285,638	444,690

EXPORTS.

The exports of salt of domestic production from the United States from 1904 to 1908 is shown as follows:

Salt of domestic production exported from the United States, 1904–1908.

1904	pounds	27,928,090	$113,625
1905	do	68,475,356	239,223
1906	do	67,976,581	274,627
1907	pounds	61,603,422	$232,895
1908	do	53,253,739	202,338

WORLD'S PRODUCTION.

In the following table the statistics of salt production in the principal salt-producing countries of the world from 1901 to 1907 are shown, as far as statistics are available. The production of Turkey is not included. The industry in that country, as in Austria-Hungary, is a government monopoly, with no statistics of production published. No statistics are available from Russia since 1903.

The world's salt production, 1902–1907, in short tons.

Year.	United States.		United Kingdom.		France.[a]		German Empire.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	3,339,891	$5,668,636	2,121,147	$2,805,838	982,479	$2,605,800	1,745,226	$4,992,600
1903	2,655,533	5,286,988	2,113,431	2,967,676	1,096,017	3,036,930	1,867,296	4,587,767
1904	3,084,200	6,021,222	2,118,629	2,900,375	1,292,557	3,660,052	1,875,733	4,693,122
1905	3,635,257	6,095,922	2,116,699	2,707,622	1,275,361	3,594,818	1,959,401	4,829,496
1906	3,944,133	6,658,350	2,201,293	2,900,983	1,496,923	4,198,329	2,059,096	5,000,823
1907	4,158,578	7,608,323	2,222,236	3,157,094	1,373,906	3,823,523	2,150,587	5,319.273

[a] Includes product of Algeria.

The world's salt production, 1902–1907, in short tons—Continued.

Year.	Japan.		Italy.		Austria-Hungary.[a]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	684,330	$4,415,145	505,401	$711,400	575,936	$16,071,930
1903	724,750	4,692,539	538,480	717,466	630,076	16,180,748
1904	773,776	4,852,049	511,827	713,595	595,335	16,024,783
1905	(b)	(b)	482,475	714,859	609,572	17,115,539
1906	(b)	(b)	586,424	1,119,786	[c]414,465	[c]9,717,164
1907	....	....	5,566,615	1,075,203	435,409	9,764,835

Year.	Russia.		Spain.		India.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	2,035,969	$3,984,162	470,057	$707,424	1,231,058	$2,481,357
1903	1,828,646	3,652,074	471,116	670,247	1,002,221	2,420,260
1904	(d)	(d)	599,292	738,348	1,236,702	2,008,930
1905	(d)	(d)	543,931	736,074	1,336,682	1,981,293
1906	(d)	(d)	597,422	782,407	1,296,674	1,916,092
1907	....	....	667,878	744,815	1,235,117	1,936,118

Year.	Canada.		Other countries.[e]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	63,056	$288,581	125,467	$970,522	13,880,017	$45,613,395
1903	62,452	297,517	477,000	1,106,000	13,674,341	45,858,300
1904	68,777	318,628	584,000	1,543,000	14,569,464	47,537,508
1905	67,340	320,858	442,086	1,841,926	15,071,226	48,442,530
1906	76,387	327,150	[f]69,004	45,548	15,340,553	41,185,910
1907	72,697	342,315	[f]85,979	57,900	....	....

[a] Government monopoly.
[b] Production and value in 1904 used in making up the total for the world's production in 1905 and 1906.
[c] Hungary not included.
[d] Production and value in 1903 used in making up total for world's production in 1904, 1905, and 1906.
[e] Probably 500,000 tons should be added annually for countries not furnishing statistics.
[f] Tunis.

BROMINE.

The following table gives the production and value of the bromine produced in the United States since 1880:

Production and value of bromine, 1880–1908.

1880	pounds	404,690	....	1896	pounds	546,580	$144,501
1883	do	301,000	....	1897	do	487,149	129,094
1884	do	281,100	$67,464	1898	do	486,979	126,614
1885	do	310,000	89,900	1899	do	433,004	108,251
1886	do	428,334	141,350	1900	do	521,444	140,790
1887	do	199,087	61,717	1901	do	552,043	154,572
1888	do	307,386	95,290	1902	do	513,893	128,472
1889	do	418,891	125,667	1903	do	598,500	167,580
1890	do	387,847	104,719	1904	do	897,100	269,130
1891	do	343,000	54,880	1905	do	1,192,758	178,914
1892	do	379,480	64,502	1906	do	1,283,250	165,204
1893	do	348,399	104,520	1907	do	1,379,496	195,281
1894	do	379,444	102,450	1908	do	1,055,636	102,344
1895	do	517,421	134,343				

The bromine industry in the United States is centered in Michigan, Ohio, Pennsylvania, and West Virginia. In 1908 these States produced 1,055,636 pounds of bromine, valued at $102,344, the average price per pound being less than 10 cents. From this price it is apparent that the conditions in the trade were notably worse than in either 1906 or 1907. The low price at the end of 1907 and at the beginning of 1908, when bromine was sold as low as 10 cents per pound in carload lots, f. o. b. at the works, is believed to be below the cost of production to the bulk of the manufacturers. The trade has been exceedingly poor, and much of the bromine made remains unsold on the hands of the producers.

The low price of bromine enables the bromides to be made very cheaply. The manufacturing cost of bromides is said to be from 5 to 9 cents per pound, exclusive of the bromine. The manufacture of bromide of potassium requires about 0.7 pound of bromine, while bromide of sodium requires 0.8 pound of bromine. For several years the bromine market has been an open one, and prices have fluctuated during the last five years, reaching their lowest point in 1908.

According to A. C. Lane: [a]

> The continued low price of bromine took away all stimulus to further increase in production in Michigan, where the industry remains confined to the Dow Chemical Company, at Midland and Mount Pleasant, and to the production of small quantities at St. Charles, St. Louis, etc. New wells were put down at Midland during 1907. A brine about equally strong was struck by Salling, Hansen & Co. at Grayling, where it could be handled in connection with extensive sawmills, but, so far as known to me, no one has been found to take up the business. The analysis of the brine is as follows: $CaCl_2$, 72.627 grams per kilogram; NaCl, 134.684; NH_4Cl, 3.07; $MgCl_2$, 20.128; KCl, 0.873; $MgBr_2$, 2.116; K_2SO_4, 0.248; total 233.746.

This is about as strong as the Midland water. Just about the same amount of bromine—that is, 2,000 milligrams per liter—has been found by Fernekes in the deep water of the copper mines described by Fernekes and Lane. But those waters occur in very limited quantity and soon drain away. The ordinary Marshall sandstone brine along the Saginaw River will run from 0.35 to 0.97 gram of bromine per kilogram.

BIBLIOGRAPHY.

The following list contains the titles of the more important recent papers relating to the technology, distribution, and origin of salt:

PAPERS OF GENERAL NATURE.

CHATARD, T. M. The salt-making processes in the United States: Seventh Ann. Rept. U. S. Geol. Survey, 1888, pp. 491–535.

OCHSENIUS, C. Bildung von Steinsalzlagern: Chem. Zeitung, vol. 11, 1887, pp. 848, 935, 962, and 1549.

DISTRIBUTION.

California.

BAILEY, GILBERT. The saline deposits of California: Bull. California State Mining Bureau No. 24, 1902, pp. 105–138.

ECKEL, E. C. The salt industry in Utah and California: Bull. U. S. Geol. Survey No. 225, 1904, pp. 488–495.

Iowa.

WILDER, F. A. The age and origin of the gypsum of central Iowa: Jour. Geol., vol. 11, 1903, pp. 723–748.

---

[a] Mineral Industry, vol. 16, 1907, p. 125.

Kansas.

KIRK, M. Z. Kansas salt: Mineral Resources of Kansas, 1898, pp. 68–97.
——— Technology of salt: Mineral Resources of Kansas, 1898, pp. 98–123.

Louisiana.

HARRIS, G. D. Rock salt: Its origin, geological occurrences, and economic importance in the State of Louisiana: Bull. Geol. Survey Louisiana No. 7, 1908, pp. 259.

——— The geological occurrence of rock salt in Louisiana and east Texas: Economic Geology, vol 4, No. 1, 1909, pp. 12–34.

HILGARD, E. W. The salines of Louisiana: Mineral Resources U. S. for 1882, 1883, pp. 554–565.

LUCAS, A. F. Rock salt in Louisiana: Trans. Amer. Inst. Min. Engrs., vol. 29, 1899, pp 462–474.

——— The Avery Island Salt Mines and the Joseph Jefferson Salt Deposit: Eng. and Min. Journal, November 14, 1896.

VEATCH A. C. The Five Islands: Rept. Geol. Survey Louisiana for 1899; special report No. 3, pp. 213–262.

——— The salines of North Louisiana: Rept. Geol. Survey Louisiana for 1902, pp. 47–100.

Michigan.

HUBBARD, L. L. The origin of salt, gypsum, and petroleum: Geol. Survey Michigan, pt. 2, 1895, pp. ix–xxiv.

LANE, A. C. Salt: Rept. of the State Board of the Geol. Survey of Michigan for 1901, 1902, pp. 241–242.

New Mexico.

DARTON, N. H. Zuñi salt deposits, New Mexico: Bull. U. S. Geol. Survey No. 260, 1905, pp. 565–566.

New York.

ENGLEHARDT, F. E. The manufacture of salt in the State of New York: Bull. N. Y. State Museum No. 11, 1893, pp. 38–69.

KINDLE, E. M. Salt resources of the Watkins Glen district, N. Y.: Bull. U. S. Geol. Survey No. 260, 1905, pp. 567–572.

MERRILL, F. J. H. Salt and gypsum industry of New York: Bull. N. Y. State Museum No. 11, vol. 3, 1893, pp. 1–38.

Ohio.

BOWNOCKER, J. A. Salt deposits and the salt industry in Ohio: Economic Geology, Bull. Geol. Survey Ohio No. 8, vol. 9, 1906.

ROOT, W. J. The manufacture of salt and bromine: Economic Geology, Rept. Geol. Survey Ohio, vol. 6, 1888, pp. 653–670.

Oklahoma.

GOULD, C. N. The Oklahoma salt plains: Trans. Kansas Academy of Sciences, vol. 17, 1899–1900, pp. 181–184.

Texas.

CUMMINS, W. F. Salt in northwestern Texas: Second Ann. Rept. Geol. Survey Texas, 1891, pp. 444–449.

RICHARDSON, G. B. Salt, gypsum, and petroleum in Trans-Pecos, Texas: Bull. U. S. Geol. Survey No. 260, 1905, pp. 573–585.

Utah.

ECKEL, E. C. The salt industry in Utah and California: Bull. U. S. Geol. Survey No. 225, 1904, pp. 488–495.

Virginia.

ECKEL, E. C. Salt and gypsum deposits of southwestern Virginia: Bull. U. S. Geol. Survey No. 213, 1903, pp. 406–416.

SULPHUR AND PYRITE.

By W. C. Phalen.

SULPHUR.

PRODUCTION.

In 1908 sulphur was produced in the United States in Louisiana, Nevada, Utah, and Wyoming. The Colorado Sulphur Company, which was active in Colorado in 1907, was idle during 1908, thus excluding this State from the category of sulphur-producing States during that year. As heretofore, the bulk of the output of sulphur came from Louisiana. The production of Nevada fell off considerably, and the production of Utah and Wyoming decreased also, though to a less extent. In Wyoming the Big Horn Sulphur Company was idle, but the Wyoming Sulphur Company, though a new producer, was actively engaged in working the deposit near Thermopolis, Fremont County. A brief account of this deposit appears elsewhere in this article.

The value of most of the output for 1908 was compiled from current market prices in New York, from which prices the value at the mine was then computed. The total value thus obtained was $6,668,215, an advance of $1,525,365 over the value for 1907.

The production of the country since 1880 is shown in the following table:

Production of sulphur in the United States, 1880–1908.

1880..long tons..	536	$21,000	1895..long tons..	1,607	$42,000
1881......do....	536	21,000	1896......do....	4,696	87,200
1882......do....	536	21,000	1897......do....	2,031	45,590
1883......do....	893	27,000	1898......do....	1,071	32,960
1884......do....	446	12,000	1899......do....	4,313	107,500
1885......do....	638	17,875	1900......do....	3,147	88,100
1886......do....	2,232	75,000	1901......do....	[a] 241,691	1,257,879
1887......do....	2,679	100,000	1902......do....	[a] 207,874	947,089
1888......do....			1903......do....	[a] 233,127	1,109,818
1889......do....	402	7,850	1904......do....	127,292	2,663,760
1890......do....			1905......do....	181,677	3,706,560
1891......do....	1,071	39,600	1906......do....	294,153	5,096,678
1892......do....	2,400	80,640	1907......do....	293,106	5,142,850
1893......do....	1,071	42,000	1908......do....	369,444	6,668,215
1894......do....	446	20,000			

[a] Includes the production of pyrite.

OCCURRENCE.

LOUISIANA.

In the report on sulphur for 1907[a] the details of sulphur mining by the Union Sulphur Company in Calcasieu Parish, La., were described, and they will not again be outlined in the present report. The process has also been frequently described in the current scientific journals, among the more important recent articles bearing on the subject being the following: (1) "An improved method of mining sulphur," by Herman Frasch, president of the Union Sulphur Company and the inventor of the so-called "Frasch" process,[b] who notes the difficulties to be overcome in mining Louisiana sulphur and gives a description of a recent invention secured by him for this purpose. (2) "The sulphur mines of Louisiana," by D. A. Willey.[c] In this article Mr. Willey describes briefly the method of obtaining the sulphur and its subsequent treatment at the surface. (3) "Louisiana's domination of the world's sulphur trade," by Albert Phenis.[d] This article contains a brief history of the Union Sulphur Company, a brief description of the Frasch process, and a sketch of the commercial outlook of the sulphur industry, especially with reference to competition with Sicilian sulphur.

WYOMING.

Sulphur was mined in 1907 near Cody, Wyo., by the Big Horn Sulphur Company. This property was idle in 1908, but sulphur was produced in the State near Thermopolis by the Wyoming Sulphur Company. In the report on sulphur for 1907, a brief account of the Cody deposits was given, and, for the details connected with the deposits and the mode of obtaining the sulphur from them, the reader is referred to the publications cited below.[e] In a recent publication of the Survey[f] the Thermopolis deposits are described by E. G. Woodruff, from whose account the following description is taken:

Location and extent.—The sulphur deposits are located 3½ miles northwest of Thermopolis, Wyo., on the gentle northeast slope of a small eroded anticline adjacent to the valley of Owl Creek, in sec. 21, T. 43 N., R. 95 W. A large number of drill holes put down in this area by the Wyoming Sulphur Company have found the deposits of sulphur in a zone about one-eighth of a mile in width and one-fourth of a mile in length, along the base of the anticline. * * * It is believed that the sulphur-bearing zone extends for a considerable distance * * * beyond the limits of the proved ground. One condition that is considered to point to the presence of sulphur within the area outlined above is the occurrence of deposits of travertine upon beds of altered limestone. This association of travertine and limestone seems to be necessary to the deposition of sulphur. * * *

The minable sulphur deposits occur in the altered Embar limestone which lies immediately below the travertine and through which the sulphur-bearing waters passed in their course to the surface. The sulphur seems to be present in very irregular deposits or pockets about the sites of extinct springs, where the sulphur-bearing waters came into contact with the limestone. * * * There is no uniformity in the shape, size, or arrangement of these ore-bearing pockets. * * *

Native sulphur in this district occurs in two forms—in small yellow crystals filling veins or cavities in the rocks, and in a massive form where the original structure of the

---

[a] Mineral Resources U. S. for 1907, U. S. Geol. Survey, pt. 2, 1908, p. 674.
[b] Min. World, December 4, 1907, pp. 1049 et seq.
[c] Eng. and Min. Jour., December 14, 1907, pp. 107 et seq.
[d] Mfrs. Rec., January 2, 1908, p. 85.
[e] Bull. U. S. Geol. Survey No. 340, 1908, pp. 451-456. Mineral Resources U. S. for 1907, U. S. Geol. Survey, pt. 2, 1908, pp. 674-675.
[f] Bull. U. S. Geol. Survey No. 380, 1909. See also Woodruff, E. G., Sulphur deposits at Cody, Wyo.: Bull. U. S. Geol. Survey No. 340, 1908.

limestone is retained, but where the calcium carbonate is replaced by the sulphur. * * * Laterally a deposit may be rich at one point and barren 10 feet away. The sulphur ores thus vary from a low percentage associated with barren rock to small masses of almost pure mineral, but as the deposits follow no general laws all of the area where geologic conditions are favorable must be tested to locate the sulphur beds. * * *

Mining, smelting, and marketing.—The Wyoming Sulphur Company, of Thermopolis, Wyo., the only company operating in the area at the present time, began development in the fall of 1908. Mining is carried on in open-pit quarries, in which promising places are located, small drill holes are put down to prove the ground, the surface rock is removed from favorable sites, and the rock and ore are extracted by drilling and blasting. The rock is then broken to convenient size and sorted by hand, and all ore estimated to contain sufficient sulphur for treatment is hauled by wagon to the reduction works, one-fourth of a mile distant. At the smelter the ore is placed in bins, from which it is discharged into small steel cars with perforated sides, each holding about 2 tons. A string of three cars is then run into a large cylindrical retort, the door closed, and steam admitted at 60 pounds pressure for two hours. The sulphur is melted and flows to the bottom of the retorts, from which it escapes through a trap into bins, where it is allowed to cool. When the sulphur has been melted the cars containing the gangue are removed from the retort, other cars are admitted, and the process is repeated. This process is not considered highly efficient, as only about two-thirds of the sulphur which the rock contains is melted out; the remainder is lost in the refuse. After the sulphur is cooled, it is crushed in an 8-inch Blake crusher and pulverized to an impalpable powder in a rotary grinder. It is then sacked and taken to Crosby, 8 miles distant, for shipment to various points in Wyoming and adjoining States.

Production.—The plant now installed has a capacity of 20 tons a day, but has not yet been operated to the full capacity. According to a statement of the superintendent of the company on December 15, 1908, the plant had produced up to the time 200 tons of sulphur and was then yielding 10 tons a day. The demand for ground sulphur is reported to be fairly good at $35 a ton at destination.

UTAH.

The Utah sulphur deposits are known as the "Cove Creek[a] beds" and are located near Black Rock, Beaver County. The sulphur is found in beds of soft rhyolitic tuff, which some of the miners call "gypsum." The series in which the tuffs are found are thought to overlie Paleozoic sediments. The sulphur beds are located in or near a zone of intense faulting and volcanic activity which is not yet ended, and hydrogen sulphide (H_2S) is still escaping from the line of sulphur beds.

The sulphur occurs mainly as a dark-colored impregnation or cement in the rhyolitic tuff, but it is also found in cylindrical masses 10 to 15 feet in diameter, having a rude radial structure, and as irregular veins of pure yellow sulphur often several inches thick. The sulphur ore varies greatly in richness, from material containing only a trace to ore nearly 100 per cent pure. Material having as little as 15 per cent sulphur is considered paying ore.

The cost of production is considerably more than would be the case were operations conducted on a scale justifying the installation of labor-saving machinery. Surface stripping by horses and scrapers to a depth of 10 feet is practiced, and the ore is removed by manual labor and taken to the smelter. Here it is placed in iron retorts and melted by steam forced into it at a pressure of 60 pounds and at a temperature of 144° C. The liquid sulphur is drawn off through the bottom into iron receptacles and cooled in masses weighing 200 pounds. In this form it is stored until needed, when it is ground and shipped in sacks.

---

[a] Lee, W. T., Cove Creek sulphur beds, Utah: Bull. U. S. Geol. Survey No. 315, 1907, pp. 485-489.

IMPORTS AND EXPORTS.

Imports.—For the second time in the history of the importation of sulphur into the United States, the total value of the imports in 1908 was less than $1,000,000. The great decline in 1908, as in 1907, was in the quantity and value of the crude sulphur received into the country for consumption, the falling off, as compared with 1906, amounting to 74 per cent, as against about 70 per cent in 1907. The total value of the imports into the country declined about 14 per cent as compared with 1907 and about 73 per cent as compared with 1906.

In the following table the total importation for consumption is given for the last five years:

Sulphur imported and entered for consumption in the United States, 1904–1908, in long tons.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1904	127,996	$2,462,360	1,332	$39,133	163	$4,373	41	$5,403	$2,511,269
1905	82,961	1,528,136	572	16,037	779	19,960	27	3,352	1,567,485
1906	72,404	1,282,873	1,100	29,565	709	17,918	28	3,224	1,333,580
1907	20,399	355,944	1,458	41,216	606	14,589	60	8,426	420,175
1908	19,620	318,577	793	22,562	693	17,227	30	4,013	362,379

[a] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

In the following table are given the statistics of imports by countries from which sulphur was exported into this country and by ports at which it was received for the years 1906 to 1908. The falling off in the importations from Italy in the last two years and the marked diminution in the quantity of the imports as a whole are the most noteworthy features.

Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each calendar year, 1906–1908, in long tons.

Countries whence exported and customs districts through which imported.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRY.						
Canada					26	$485
United Kingdom	3,881	$76,068	226	$4,654		13
Italy	47,629	868,453	3,393	60,152	12,950	197,203
Japan	20,848	337,323	16,699	292,361	7,055	119,457
Other countries	46	1,029			87	1,419
Total	72,404	1,282,873	20,318	357,167	20,118	318,577
CUSTOMS DISTRICT.						
Baltimore, Md			13	328		
Boston and Charlestown, Mass	7,552	150,244	200	4,136	1	18
New Orleans, La	185	4,437				
New York, N. Y	35,798	631,959	3,141	54,231	7,366	114,939
Philadelphia, Pa	5,892	86,824				
Portland, Me	7,050	139,581				
San Francisco, Cal	12,192	198,010	11,224	192,906	10,231	157,847
Willamette, Oreg	3,530	67,362	3,827	70,572	1,978	35,691
All other	205	4,456	1,913	34,994	542	10,082
Total	72,404	1,282,873	20,318	357,167	20,118	318,577

Exports.—In 1907 the United States exported 35,925 long tons of sulphur, valued at $734,749; in 1908 the exports were considerably less, being 27,894 long tons, valued at $561,534. Even with this reduced exportation the quantity of sulphur sent out of the country was nearly 7,000 tons in excess of the total importation for consumption, which amounted to only 21,136 tons of all grades. These figures indicate that the country is producing more than enough sulphur to supply its own needs, a fact which a few years ago would have been considered impossible.

FOREIGN SULPHUR.

Italy.—The production of sulphur in Italy in 1904 was 519,000 long tons; in 1905 it was 560,000 tons; in 1906 it was 492,000 tons; and in 1907 it was 420,000 tons.

The exports of sulphur from Sicily in 1904 were 476,000 long tons; in 1905 456,000 tons; in 1906 387,000 tons; in 1907 334,000 tons; and in 1908 372,000 tons.

The stock of sulphur on hand in Sicily in 1904 was 397,000 long tons; in 1905 it was 462,000 tons; in 1906 525,000 tons; and in 1907 576,000 tons.

PYRITE.

PRODUCTION BY STATES.

The production of pyrite in the United States in 1908 amounted to 222,598 long tons, valued at $857,113. As compared with the production of 1907, this was a decrease in quantity but an increase in value, the average price per ton for 1908 exceeding the 1907 price by 64 cents. The list of important producing States remained as in the past. New Jersey produced no pyrite, but a small tonnage was reported from Wisconsin.

In the following table is given the production of pyrite in the United States by States during the last three years:

Production of pyrite in the United States, 1906–1908, by States, in long tons.

State.	1906.			1907.			1908.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Alabama and Georgia	26,173	$78,817	$3.01	28,281	$85,307	$3.02	23,915	$69,635	$2.91
California	52,926	236,867	4.48	51,950	174,549	3.36	30,545	131,744	4.31
Indiana	2,579	7,179	2.78	[a] 4,929	14,713	2.98	[a] 4,905	14,157	2.89
Massachusetts and New York	46,218	162,615	3.52	30,671	126,991	4.14	[b] 40,362	186,126	4.61
Ohio	4,732	14,439	3.05	6,816	20,803	3.05	6,531	19,929	3.05
Virginia	128,794	431,388	3.35	124,740	372,586	2.99	116,340	435,522	3.74
Total	261,422	931,305	3.56	247,387	794,949	3.21	222,598	857,113	3.85

[a] Includes the production of Illinois. [b] Includes the production of Wisconsin.

OCCURRENCE BY STATES.[a]

Alabama.—The production of pyrite in Alabama in 1908 was considerably less than in 1907. The output was reported by the Alabama Sulphur Ore and Copper Company and the Planters Chemical Company. The Southern Sulphur Ore Company, which reported a considerable share of the State's production in 1907, was idle in 1908, and reported no production. The returns from the State do not include a small tonnage of pyrite mined, but not sold. The commercial mines of Alabama are confined to Clay County, and a branch of the Louisville and Nashville Railroad affords transportation facilities from Stockdale. Some of the pyrite contains copper, which appears to increase with depth and which, of course, adds to the value of the ore.

California.—There was a considerable decrease in the output of pyrite in 1908 as compared with 1907 in California. A considerable portion of the pyrite is manufactured directly into sulphuric acid.

Georgia.—There was a decided increase in the production of pyrite in 1908 in Georgia. This increase amounted to approximately 24 per cent as compared with the production of 1907. Georgia pyrite is mined at Acworth, Cobb County, and at Villa Rica, about 30 miles west of Atlanta.

Indiana and Illinois.—There was a decrease in the production of pyrite in Illinois in 1908. The fact that the figures of both Indiana and Illinois remain about as they were in 1907 is due to the increase in the production of the first-named State. The pyrite of these two States is obtained as a by-product in the mining of coal.

Massachusetts.[b]—The only pyrite-producing mine in Massachusetts is known as the Davis mine, located in the northwestern part of Franklin County, in the Berkshire Hills. The small mining village which surrounds the mine is known as Davis, and is located in Rowe Township. The nearest railroad point is Charlemont, on the Boston and Maine Railroad, about 5 miles away.

During the twenty-seven years in which the mine has been in operation the entire product has been hauled down a rough mountain road to storage sheds at Charlemont, from which point the ore is shipped as the market requires. Heavy wagons are used in the summer, and sleds during the winter. There is a fall of about 600 feet from the mines to the railroad, so that very heavy loads may be taken down. All the mine supplies must be hauled uphill to the mine.

The deposit of iron pyrites lies in crystalline schists which strike to the northeast and dip at very high angles. The deposits have been opened up along the strike for about 900 feet and down the dip to about 1,400 feet. The ore body presents many of the characteristics of a true fissure vein, thickening and thinning as it is worked along the strike. The ore body contains horses of country rock. The crystals of pyrite are large and well formed, and the walls are slickensided in places. Owing in all probability to the location of the deposits and to recent glaciation, there is only a foot or two of gossan, which forms the capping of most pyrites deposits. This condition is in decided contrast to the deposits in Virginia, where the gossan is often 50 feet thick and is mined for iron.

---

[a] The cooperation of the State geologists of Alabama, Georgia, Illinois, New York, and Virginia in the collection of pyrite statistics in their respective States is hereby acknowledged.

[b] Compiled in part from the report of J. J. Rutledge: Eng. and Min. Jour., vol. 82, 1906, No. 15, pp. 674-676; No. 16, pp. 724-727; No. 17, pp. 772-774.

The ore is hard and yields about 70 per cent of broken material. It has a brassy appearance and is not at all gray in color as is often the case with pyrite. The individual crystals of iron pyrites have been measured and are often one-eighth of an inch in diameter. They are firmly bound together so that there is only a small percentage of fines made in mining the ore. Five feet in thickness has been found to be the economic limit for the working of the ore. When the ore thins below this extent, the level is usually abandoned.

Chalcopyrite is found at the Davis mine, as are also garnets, indicative of metamorphic action. The chalcopyrite occurs in two ways—as masses in the pyrite and in veins. These veins usually carry quartz when they occur in the foot wall. When they occur on the hanging wall, they are generally free from clear glassy quartz and, together with the associated wall rock, are much contorted. Occasionally large quantities of the chalcopyrite have been found, and it has been predicted that with increased depth the ore might change to chalcopyrite. No attempt has been made to precipitate copper from the mine water as it does not seem to carry an appreciable amount of this metal.

An analysis of the concentrated pyrite shows about 47 per cent of sulphur. A complete analysis gives 47 per cent sulphur, 44 per cent iron, 3 per cent silica, 1.5 per cent copper, and a trace of zinc. The ore is free from arsenic, which makes it particularly adapted to the manufacture of pure sulphuric acid. The acid made from the Davis ore can be used for all purposes for which that made from brimstone is used.

Just opposite Charlemont station the superintendent of the Davis mine, R. H. Craig, is at present prospecting for pyrite. A vein of the mineral has been discovered and a shaft 135 feet deep has been sunk. The geologic conditions are similar to those described at the Davis mine, but the vein of pyrite opened thus far has not proved to be so thick.

New York.[a]—The production of pyrite in New York in 1908 came from St. Lawrence County, where mining has been carried on intermittently for several years. The pyrite is associated with crystalline limestones and schists, and occurs in bedded veins, impregnated zones, and fahlbands, which in places widen into lenses or chutes similar to those encountered in the magnetite deposits of the Adirondack region, New York. The pyrite is associated with a quartz and feldspar gangue. The zones strike northeast and are conformable to the wall rock. The more important zones are found in a line extending from Gouverneur, N. Y., where the American Pyrites Company operated during 1907, northeast to the High Falls mine in the town of Canton. Pyrrhotite occurs in considerable quantity at the High Falls mine.

The companies mining pyrite are the St. Lawrence Pyrite Company and the Oliver Iron Mining Company. The property of the first company mentioned is located 1 mile north of Hermon and includes the old Stella mine, the first opened in the district, but not worked at present. The ore is obtained from two new shafts near and southeast of the Stella mine. The output is concentrated to a product containing about 50 per cent sulphur. This concentration is effected by Han-

[a] Compiled in part from the report of D. H. Newland, Mineral Industry, vol. 16, 1908, p. 841.

cock jigs with retreatment of the tailings after crushing on Harz jigs. The slimes are passed over Overstrom tables.

During 1907 the Oliver Iron Mining Company acquired an option on the High Falls mine from the National Pyrites Company, and the property has been thoroughly prospected with the diamond drill.

The American Pyrites Company has suspended operations at the Cole mine near Gouverneur, and no production was reported from this company in 1908. The difficulty is said to be due to the heavy royalties demanded by the owners of the property. The ore of this mine is above the average, and part of the output is suitable for shipment in the crude state.

An account of the mining and milling practice connected with the pyrite industry in New York was published a few years ago by R. D. Brinsmade.[a]

Ohio.—The output of pyrite in Ohio in 1908 was but slightly less than in 1907. The mineral is obtained in small quantities by the various coal operators in the preparation of soft coal for market.

Virginia.—The production of pyrite from Virginia in 1908 was slightly less than in 1907. The value of the product reported, however, increased materially. The output of the State comes from Prince William, Louisa, and Pulaski counties. In Prince William County the Cabin Branch Mining Company has been active, and in Louisa County only two companies—the Arminius Chemical Company and the Sulphur Mining and Railroad Company—have engaged in operations on a large scale. The Pulaski Mining Company has been active in Pulaski County. A recent report[b] states that a deposit of pyrite has been found near Holladay, Spottsylvania County. The outlook is regarded as favorable as to both quantity and quality of ore. There is a vein on the property which has been traced a long distance. The developments contemplated include the building of a branch railroad. No ore has yet been shipped from this locality.

The worked deposits of pyrite in eastern Virginia are in Louisa and Prince William counties. They occur as lenses or in immense lenticular masses conforming to the foliation of the inclosing rocks, which are for the most part crystalline schists of various types. In the Prince William County area a wide belt of true slates lies a short distance to the east of the ore-bearing schist series. At the Cabin Branch mine in Prince William County the schists, according to Watson,[c] dip to the northwest at angles ranging from 25° to 64°. The rocks here are highly jointed, and in the Cabin Branch mine cross faulting is observed. The general strike of the schist belt and of the contained lenses of pyrite in Louisa County does not vary much from N. 20° E., and the dips are approximately 60° to the southeast.

The pyrite consists of massive and granular ore, varying in texture from fine to moderately coarse grained. Some of it is hard and nonfriable, but much of it is quite friable. It is usually associated with varying quantities of quartz and calcite. It occurs as lenses, as stated above, which vary greatly in size. In Louisa County a lens 700 feet long is known; in thickness the lenses run as high as 60 to 80

[a] Eng. and Min. Jour., October 28, 1905; Min. Industry, vol. 14, 1905, pp. 525-527.
[b] Paint, Oil, and Drug Reporter, September 8, 1908.
[c] Mineral Resources, Virginia, 1907, p. 193.

feet; and, according to Watson,[a] the ore-bearing zone is said to be from 800 to 1,000 feet wide. At the Cabin Branch mine in Prince William County the lenses are much thinner, not more than 10 feet, but one lens is approximately 1,000 feet long.

The Louisa County ore runs from approximately 40 to more than 50 per cent sulphur. The former figure represents the sulphur contained in a sample of unwashed ore, which after washing ran 46.5 per cent. The ore contains some copper, and at the property of the Sulphur Mining and Railroad Company this metal is partly recovered by allowing the mine waters to run through tanks filled with scrap iron. The iron is gradually replaced by copper and a new supply of scrap is added from time to time, as may be necessary. Every year the tanks are cleaned out for their copper content. Gold and silver are associated with the ore in small quantities, as also are arsenic, lead, and zinc.

The mineral associations at the Cabin Branch mine in Prince William County are similar to those in Louisa County. They consist of chalcopyrite, pyrrhotite, some galenite and sphalerite, and a trace of gold.

The methods of mining pyrite at the different mines differ only in minor details. The general practice is to sink shafts in the direction of the dip and to run levels from both sides of the shaft in the direction of the strike at convenient intervals from each other. In the Louisa County mine these levels are connected by raises and the ore is broken down by overhand stoping. The walls are strong and little timbering is necessary, except in the main shaft. Owing to different conditions encountered at the Cabin Branch mine, the methods employed are slightly different. The ore is raised by inclined cables and cars.

The ore is marketed in three sizes—lump, spall, and fine. The lump ore is broken in the mine and is freed from all slate and lean material. Spall ore is clean lump which will pass a 2½-inch ring; it is freed from finer material by screening. Fine ore is sized to pass a ⅝-inch screen, and is either washed or jigged to bring it up to grade. The details of the milling of pyrite ore were referred to in the report for 1907. They have been described by Painter.[b]

The following table shows the development of the pyrite industry in the United States since 1882:

Production of pyrite in the United States, 1882–1908.

1882..long tons..	12,000	$72,000	1896..long tons..	115,483	$320,163
1883......do....	25,000	137,500	1897......do....	143,201	391,541
1884......do....	35,000	175,000	1898......do....	193,364	593,801
1885......do....	49,000	220,500	1899......do....	174,734	543,249
1886......do....	55,000	220,000	1900......do....	204,615	749,991
1887......do....	52,000	210,000	1901......do....	[c]241,691	1,257,879
1888......do....	54,331	167,658	1902......do....	[c]207,874	947,089
1889......do....	93,705	202,119	1903......do....	[c]233,127	1,109,818
1890......do....	99,854	273,745	1904......do....	207,081	814,808
1891......do....	106,536	338,880	1905......do....	253,000	938,492
1892......do....	109,788	305,191	1906......do....	261,422	931,305
1893......do....	75,777	256,552	1907......do....	247,387	794,949
1894......do....	105,940	363,134	1908......do....	222,598	857,113
1895......do....	99,549	322,845			

[a] Mineral Resources, Virginia, 1907, p. 202.
[b] Mineral Industry, vol. 14, 1905, pp. 525-527; Eng. and Min. Jour., July, 1905.
[c] Includes production of natural sulphur.

IMPORTS.

The importation of pyrite still greatly exceeds the domestic supply, and the value of the imported material is more than three times that of the domestic production. Foreign pyrite comes chiefly from Spain, Portugal, Canada, and Newfoundland.

Imports of pyrite containing not more than 3.5 per cent of copper, 1904–1908.

1904	long tons	422,720	$1,533,997
1905	do	511,946	1,774,379
1906	do	598,078	2,148,558
1907	long tons	627,985	$2,581,787
1908	do	668,117	2,624,339

WORLD'S PRODUCTION OF PYRITE.

In the following table is given the world's production of pyrite, together with the quantity of pure sulphur which it is supposed to replace in the market. The latter figure is calculated on the assumption that the pyrite averages 45 per cent sulphur.

World's production of iron pyrite and quantity of sulphur displaced, 1903–1907, in long tons.

Country.	1903.	1904.	1905.	1906.	1907.
Spain	153,543	159,292	176,258	186,262	186,023
France [b]	[a] 324,212	267,268	262,907	261,084	278,543
Portugal	370,253	377,540	346,928	345,222	136,016
United States	233,137	207,081	253,000	261,422	247,387
Germany	168,307	172,030	182,448	193,869	192,913
Norway	127,887	131,499	159,461	194,770	260,185
Hungary	95,560	95,618	105,165	110,849	109,682
Italy	99,857	110,240	115,814	120,437	125,000
Canada	33,039	29,499	29,236	35,365	41,288
Newfoundland	42,000	60,200	50,720	28,132	22,310
Russia	22,420	(b)	(b)	30,019	(b)
United Kingdom	9,639	10,287	12,186	11,140	10,137
Bosnia and Herzegovina	6,484	10,256	18,745	13,262	7,969
Belgium	709	1,058	961	894	390
Sweden	7,670	15,705	20,435	21,483	26,583
Total	1,694,717	1,693,492	1,742,686	1,814,210	....
Sulphur displaced [c]	762,623	762,071	784,209	816,395	....

[a] Includes Algeria.
[b] Statistics not available.
[c] Based on estimated 45 per cent of sulphur content.

CONSUMPTION OF SULPHUR IN THE UNITED STATES.

The consumption of sulphur in the United States is taken as the sum of the domestic production and of the quantity imported together with the sulphur content of the domestic and imported pyrite. The figures for the sulphur consumed in the United States during the last three years are as follows:

Consumption of sulphur in the United States, 1906–1908, in long tons.

Source.	1906.	1907.	1908.
Domestic sulphur and sulphur content of pyrite	411,793	404,430	469,613
Imported sulphur	74,441	22,523	21,136
Sulphur content of imported pyrite [a]	269,135	282,593	300,653
Total domestic consumption	755,369	709,546	791,402

[a] Based on average sulphur content of 45 per cent.

BARYTES AND STRONTIUM.

By Ernest F. Burchard.

BARYTES.[a]

PRODUCTION.

In 1908 the quantity of crude barytes reported as mined in the United States was 38,527 short tons, valued at $120,442. This value is intended to represent that of the crude barytes at the mines, hand cobbed, sorted, and ready for shipment to the mills. In reality it probably represents, especially for Kentucky, the value of some of the material at railroad shipping points and includes the cost of haulage by wagon.

The production for 1908 showed a decrease in quantity of 41,094 short tons and in value of $171,333 from that of 1907, and amounted in fact to only about 43 per cent of the output of 1907. This great decrease was not surprising, since a curtailment of production in 1908 had been foreseen by many persons interested in the barytes industry. The year 1907 proved to be a record year in the barytes business, the production surpassing that of 1906 by more than 78 per cent, and resulting in a large overproduction. After the panic in the latter part of 1907 the trade in barytes products came practically to a standstill, and mills that operated at all during 1908 had nearly sufficient material on hand to last throughout that year; consequently the production of the mines was greatly curtailed.

The average price of crude barytes per short ton ($3.13) in 1908 was only 13 cents less than in 1907, and it was higher than in any year except 1907. Prices per short ton quoted by dealers toward the close of 1908 were as follows: "American ground," $14 to $17.50, and "floated," $18 to $21; in May, 1909, these prices were, respectively, $12 to $17, and $17 to $20.

The total quantity of barytes reported as refined by mills in Kentucky, Missouri, North Carolina, Tennessee, and Virginia was 28,415 short tons, valued at $318,096, an average price per ton at the mills of $11.19, a decrease of 23.3 per cent, as compared with $14.59 per ton in 1907.

At the close of 1908 there were 16,471 short tons of crude barytes unsold, according to reports from all the producing districts. Most of this stock was produced in 1907.

[a] Discussions of the character, occurrence, and production of barytes in the United States and Canada will be found in the volumes Mineral Resources of the United States for 1906 and 1907.

Production of crude barytes in the United States, 1906–1908, by States, in short tons.

State.	1906.			1907.			1908.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Kentucky	(a)	(a)	....	(a)	(a)	....	5,233	$21,504	$4.11
Missouri	28,869	$93,479	$3.24	44,039	$162,459	$3.69	16,319	56,768	3.48
North Carolina	(a)	(a)	....	5,785	18,855	3.26	(a)	(a)	....
Tennessee	5,247	8,782	1.67	20,861	37,138	1.78	8,618	12,313	1.43
Virginia	11,775	45,336	3.85	9,254	32,833	3.55	(a)	(a)	....
Other States	[b] 4,340	12,770	2.94	[b] 9,682	40,492	4.18	[b] 8,357	29,857	3.51
	50,231	160,367	3.19	89,621	291,777	3.26	38,527	120,442	3.13

[a] Included in other States.
[b] Includes, 1906, Alabama, Kentucky, and North Carolina; 1907, Georgia and Kentucky; 1908, Georgia, North Carolina, and Virginia.

Production of crude barytes, 1882–1908.

Year	Short tons.
1882	22,400
1883	30,240
1884	28,000
1885	16,800
1886	11,200
1887	16,800
1888	22,400
1889	21,460
1890	21,911
1891	31,069
1892	32,108
1893	28,970
1894	23,335
1895	21,529
1896	17,068
1897	26,042
1898	31,306
1899	41,894
1900	67,680
1901	49,070
1902	61,668
1903	50,397
1904	65,727
1905	48,235
1906	50,231
1907	89,621
1908	38,527

TRADE CONDITIONS BY STATES.

Reports from practically all the districts producing barytes in the various States showed a decidedly discouraging condition in 1908, especially as to mining. At the close of 1907 barytes mills were fairly well supplied with crude material, so that some of them were able to run throughout 1908 without making any purchases; consequently there was little demand, and as a rule prices were so low that few mines were able to operate at all.

Georgia.—The deposits near Cartersville, Bartow County, Ga., were worked to a limited extent in the year 1908, but the output was less than in 1907.

Kentucky.[a]—"In 1908 the barytes industry was confined to the central Kentucky district and work was done in thirteen counties: Anderson, Bourbon, Boyle, Clark, Fayette, Franklin, Garrard, Harrison, Jessamine, Lincoln, Owen, Scott, and Woodford. Good deposits occur also in Henry, Mercer, and Russell, especially in the first two. Boyle, Fayette, and Garrard were the largest producers of barytes in the order named. Deposits in Caldwell, Crittenden, and Livingston counties

[a] Extract from advance sheets of report of J. C. Norwood, inspector of mines and state geologist of Kentucky.

of western Kentucky were not worked in 1908, although efforts are being made to open them and to erect a grinding mill at Mexico.

"There were 11,051 tons of barytes mined in Kentucky in 1908; 5,233 tons of crude barytes, valued at $21,504, and 3,300 tons of ground, valued at $39,600, were shipped. At the close of 1908, 5,904 tons of barytes were reported in stock. The average value of crude barytes per ton was $4.11 and of ground $12. That progress was made in the barytes industry in Kentucky in 1908 is indicated by a tonnage mined, marketed, and in stock in excess of that for 1907. The average prices received for crude and ground barytes were under those for 1907, and the indications are that the prices in 1909 will be still less."

Missouri.—Missouri, as usual, took the lead in production of barytes in 1908, although the production was only about 37 per cent of that in 1907. The demand for manufactured barytes in the paint and chemical industries was comparatively small, and mills which had accumulated large stocks of raw material at the close of 1907 had to purchase little additional material during 1908, and what was purchased was bought at prices that were not at all attractive to miners. In some localities the shallow barytes seems to be nearly all mined out. The increased cost of going deeper was not justified by the low prices that prevailed during the year, and this condition caused idleness among many heretofore steadily producing tracts of land. It is reported that as a consequence many miners suffered from want.

New York.—New York refines but does not produce crude barytes. One noteworthy addition to the list of barytes manufacturers is a mill recently built by the Barium Production Company, of New York City, which treats barytes mined near Strathlohm, Nova Scotia.

North Carolina.—Extreme dullness characterized the barytes industry in North Carolina. No new mines were opened, and one important firm is reported to have retired from the business.

Tennessee.—Tennessee ranked second in the production of barytes in 1908, having an output of 8,618 short tons. The average price was $1.43 per ton, the lowest reported by the various producing States. It may be accounted for in part by the character of mining, which is largely of the open-cut type, and it is understood that the values as reported to the Survey represent strictly the value at the mines, before hauling to railroad or mill. Business was in general dull, although the depression was not felt by all the firms operating in the State.

Virginia.—The production of barytes in Virginia was only about one-third of that for 1907. One firm formerly operating in this State and in North Carolina is reported to have retired from the business, several were reported as idle, while certain of those that operated reported a decided falling off in business.

IMPORTS.

The imports of barytes for consumption during the last five years and the imports of barium compounds during the last three years have been as follows:

Barytes imported and entered for consumption in the United States, 1904–1908, in short tons.

Year.	Manufactured.		Unmanufactured.	
	Quantity.	Value.	Quantity.	Value.
1904	6,630	$48,658	7,492	$27,363
1905	4,803	39,803	14,256	62,459
1906	4,807	37,296	9,190	27,584
1907	11,207	96,542	20,544	76,883
1908	3,401	29,168	13,661	58,822

Value of the imports of barium compounds, 1906–1908.

Barium compound.	1906.	1907.	1908.
Witherite, barium carbonate	$55,405	$24,552	$22,159
Barium binoxide	152,403	167,519	181,533
Barium chloride	65,242	79,333	42,291
Blanc fixe, or artificial barium sulphate	61,961	85,713	73,131
	335,011	357,117	319,114

PRODUCTION OF BARYTES IN CANADA.

According to the preliminary report on the mineral production of Canada in 1908, there were produced in that year 4,091 short tons of barytes, valued at $18,265. This is a large increase from the production of 1907, which was reported as 2,016 short tons, valued at $4,500.

BIBLIOGRAPHY.

The following papers represent the important articles of recent date pertaining to the occurrence and technology of barytes:

ANDRU, K. Ueber ein bemerkenswertes Vorkommen von Schwerspat auf dem Rosenhofe bei Clausthal: Zeitschr. prakt. Geologie, July, 1908.

BURCHARD, E. F. Production of barytes in 1906: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1109–1114.

——— Production of barytes in 1907: Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908.

CATLETT, CHAS. Barite associated with iron ore in Pinar del Rio Province, Cuba: Bull. Am. Inst. Min. Eng. No. 16, July, 1907, pp. 623–624.

FAY, A. H. Barytes in Tennessee: Eng. and Min. Jour., January, 1909, p. 137.

HAYES, C. W., and PHALEN, W. C. A commercial occurrence of barite near Cartersville, Ga.: Bull. U. S. Geol. Survey No. 340, 1908.

HIGGINS, EDWIN. Barytes and its preparation for the market: Eng. News, vol. 53, February 23, 1905, pp. 196–198.

HUTCHINSON, W. SPENCER. Barytes deposits at Five Islands, N. S.: Eng. and Min. Jour., November 2, 1907, pp. 825–826.

JUDD, EDWARD K. The barytes industry in the South: Eng. and Min. Jour., April 20, 1907, pp. 751–753.

——— A barytes grinding plant: Eng. and Min. Jour., May 25, 1907, pp. 996–997.

LAKES, ARTHUR. A new and large deposit of barytes in Idaho: Min. Reporter, August 16, 1906.

Miller, A. M. The lead and zinc rocks of central Kentucky, with notes on the mineral veins: Bull. Kentucky Geol. Survey No. 2, 1905, pp. 24–35.

Poole, Henry S. The barytes deposits of Lake Ainslee and North Cheticamp, N. S., with notes on the production, manufacture, and uses of barytes in Canada: Bull. Geol. Survey Canada No. 953, 1907, 43 pp.

Pratt, Joseph Hyde. Production of barytes in 1904: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1095–1101.

Stose, George W. Barite in southern Pennsylvania: Bull. U. S. Geol. Survey No. 225, 1904, pp. 515–516.

Watson, Thos. L. Geology of the Virginia barite deposits: Bull. Am. Inst. Min. Eng. No. 18, November, 1907, pp. 953–976.

——— Fluorite and barite in Tennessee: Bull. Am. Inst. Min. Eng. No. 13, January, 1907, p. 13.

STRONTIUM.

No strontium ore is reported to have been produced in the United States in 1908. The only importation of strontium salts reported by the Bureau of Statistics in 1908 was strontium monoxide or strontia, valued at $11.

MINERAL PAINTS.

By Ernest F. Burchard.

INTRODUCTION.

GROUPS OF MINERAL PAINTS.

The mineral paints considered in this chapter are arranged in three groups: (1) Natural mineral products which after mechanical treatment, such as cleaning and grinding, are either used directly as pigments or are first roasted to give certain desired colors; (2) chemical products made directly from ores of valuable metals; and (3) chemical products that pass through several metallurgical and chemical processes in their preparation from the original ores.

Group 1 comprises ocher, umber, sienna, hematite, siderite, and limonite (metallic paints and mortar colors), ground slate and shale. Many other minerals or mineral products are used in the paint trade, such as asbestos and its derivatives, asphalt, barytes, clay, graphite, gypsum, magnesite, pyrite, shells, silica, talc, and whiting (ground chalk), but they are not considered here, since most of them are reported elsewhere in this volume.

Group 2 comprises zinc oxide, leaded zinc oxide, zinc-lead, sublimed white lead, and sublimed blue lead.

Group 3 comprises the chemical products basic carbonate white lead, litharge, red lead, orange mineral, lithopone, and Venetian red. Collection of the statistics of production of the pigments and colors made by treating a mineral base with organic dyes does not come within the scope of this work. The quantity and value of the original minerals entering into their composition has, in most cases, been included elsewhere, so that the publication of the statistics of the manufactured products, including the value of the organic colors, would not only result in duplication of original quantities but would give greater than proportionate values to the minerals concerned.

This grouping has reference particularly to the origin of the materials, and it is not intended to be a commercial classification. The total value of the lead and zinc-white pigments is enormously greater than that for the natural pigments. Lead and zinc-white pigments form the bases for the greater part of all the paint manufactured at present, and on account of this fact the following commercial classification has been proposed by R. S. Perry, formerly director of the scientific section of the Paint Manufacturers' Association of the United States, for use in publications of that association, and is published herewith at Mr. Perry's request:

COMMERCIAL GROUPING OF MOST IMPORTANT PIGMENTS USED IN THE PAINT INDUSTRY.

First group.—Pigments made from valuable metals or ores by sublimation, corrosion, or other chemical treatment, including the following: Basic carbonate white lead, basic sulphate white lead, zinc oxide, zinc-lead white, leaded zinc, red lead, litharge.

Second group.—(A) Pigments made by precipitation and other chemical treatment from the earthy minerals and metallic salts; (B) pigments found naturally in the earth.

This group should be called "Dry chemical and earth pigments." Under subdivision A, which should be called "Dry chemical pigments," are included lithopone, blanc fixe, precipitated barium carbonate, precipitated calcium carbonate. Under subdivision B, which should be called "Dry earth pigments," are included barytes or barium sulphate, aluminum silicate, magnesium silicate (both asbestine and talcose varieties), whiting, gypsum, silica, shale, slate, natural iron oxides, roasted iron carbonate (mineral brown), etc., ocher, umber, sienna, natural blacks (natural graphite and mineral black).

Third group.—Sundry dry colors (inorganic and organic), including the various lakes, etc.

NATURAL MINERAL PAINTS.

NATURAL PIGMENTS.

Production.—In 1908 the total production of the natural pigments—ocher, umber, sienna, metallic paints, mortar colors, slate, and shale—reported to the Survey amounted to 49,853 short tons, valued at $536,544, as compared with 48,546 short tons, valued at $530,486 in 1907, an increase of 1,307 short tons in quantity and of $6,058 in value. This increase, although not great, indicates that the natural mineral paint industry survived the effects of the panic of 1907 better than did many other industries whose gross product showed a falling off during 1908. The following table shows the production of these several natural mineral pigments from 1905 to 1908, inclusive:

Production of natural mineral pigments, 1905–1908, in short tons.

Kind.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ocher	13,402	$126,351	15,482	$148,049	16,971	$164,742	17,019	$156,360
Umber Sienna	689	17,004	657	17,394	730	19,309	2,756	70,996
Metallic paint	[a]16,489	176,722	17,992	204,026	16,225	195,176	16,224	182,007
Mortar colors	10,494	120,430	10,309	111,720	10,490	110,719	9,026	86,961
Slate and shale ground	5,181	44,108	5,481	40,540	4,130	40,540	4,828	40,220
	46,255	484,615	49,921	521,729	48,546	530,486	49,853	536,544

[a] Includes a small quantity of unground material.

OCHER, UMBER, AND SIENNA.

PRODUCTION.

Ocher.—The quantity of ocher reported to the Survey as having been mined in the United States in 1908 was 17,019 short tons, valued at $156,360; in 1907 there were reported as produced 16,971 short tons, valued at $164,742—an increase in 1908 of 48 short tons in quantity and a decrease of $8,382 in value. The relative rank of the States as producers remains practically the same as in 1907. Had it not been for the general business depression of 1908, following the financial stringency in the autumn of 1907, the year's production would probably have shown a larger increase. Aside from the demand for ocher in the paint trade, there is generally a good market for it in the manufacture of oilcloths and linoleums, a large proportion of the production of this mineral from Georgia, Pennsylvania, and Vermont now being taken by makers of these fabrics.

Umber and sienna.—The combined production of umber and sienna in 1908 amounted to 2,756 short tons, valued at $70,996, as compared with 730 short tons, valued at $19,309, in 1907. The production of these substances, therefore, shows a very large increase for the year, 2,026 tons in quantity and $51,687 in value.

The production of ocher by States for the last four years is shown in the following table:

Production of ocher, 1905–1908, by States, in short tons.

State.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	780	$5,900	500	$4,470	450	$3,970	335	$2,250
Georgia	4,209	43,481	5,550	58,350	5,600	57,100	6,035	63,851
Pennsylvania	7,789	72,360	8,597	79,244	8,047	76,816	9,286	78,956
Vermont	(a)	(a)	(a)	(a)	682	6,638	188	2,050
Other States	[b] 624	4,610	[b] 835	5,985	[b] 2,192	20,218	1,175	9,253
	13,402	126,351	15,482	148,049	16,971	164,742	17,019	156,360

[a] Included in "Other States."
[b] Includes, 1905, Iowa, Vermont, and Virginia; 1906, Alabama, Iowa, Kentucky, Vermont, and Virginia; 1907 and 1908, Iowa, Kentucky, and Virginia.

The total production of ocher and of umber and sienna in the United States from 1904 to 1908, inclusive, is as follows:

Production of ocher and of umber and sienna, 1904–1908, in short tons.

Year.	Ocher.		Umber and sienna.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	16,826	$110,602	522	$12,960	17,348	$123,562
1905	13,402	126,351	689	17,004	14,091	143,355
1906	15,482	148,049	657	17,394	16,139	165,443
1907	16,971	164,742	730	19,309	17,701	184,051
1908	17,019	156,360	2,756	70,996	19,775	227,356

IMPORTS.

The imports of ocher, umber, and sienna for the last five years are shown in the following tables:

Imports of ocher, 1904–1908, in pounds.

Year.	Crude.		Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	....	....	9,430,916	$93,137	12,756	$583	9,443,672	$93,720
1905	....	....	10,616,496	91,673	15,985	880	10,632,481	92,553
1906	....	....	11,316,868	97,830	113,049	2,233	11,429,917	100,063
1907	127,117	$1,312	11,850,372	102,194	14,482	1,079	11,991,971	104,585
1908	584,129	4,954	8,663,537	69,815	6,094	307	9,253,760	75,076

Imports of umber, 1904–1908, in pounds.

Year.	Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	2,261,793	$19,727	13,133	$784	2,274,926	$20,511
1905	2,580,501	20,763	6,783	461	2,587,284	21,224
1906	2,948,539	23,732	6,028	418	2,954,567	24,150
1907	3,395,690	26,502	2,569	211	3,398,259	26,713
1908	2,391,153	19,461	15,556	803	2,406,709	20,264

Imports of sienna, 1904–1908, in pounds.

Year.	Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	1,286,301	$22,118	5,770	$396	1,292,071	$22,514
1905	1,737,909	26,097	2,886	227	1,740,795	26,324
1906	1,941,664	32,673	....	....	1,941,664	32,673
1907	2,176,566	34,752	14,629	864	2,191,195	35,616
1908	1,756,273	28,407	7,621	458	1,763,894	28,865

WORLD'S PRODUCTION OF OCHER.

The following table gives the output of ocher in the principal producing countries for the years 1903 to 1907, inclusive, as far as statistics are available:

World's production of ocher, 1903–1907, in short tons.

Year.	United States.		United Kingdom.		France.		German Empire.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	12,524	$111,625	15,848	$82,839	37,524	$652,811	21,479	$53,291
1904	16,826	110,602	17,976	88,656	38,520	639,192	21,062	26,280
1905	13,402	126,351	18,185	75,238	41,667	655,003	20,175	40,369
1906	15,482	148,049	15,915	71,358	39,187	275,266	24,586	72,920
1907	16,971	164,742	16,455	70,117	36,217	423,830	1,679	5,290

World's production of ocher, 1903–1907, in short tons—Continued.

Year.	Canada.		Belgium.		Japan.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	6,226	$32,440	220	$772	....	....	[a] 3,506	$7,499
1904	3,925	24,995	496	1,592	192	$764	[a] 2,540	5,531
1905	5,105	34,675	683	2,084	23	243	[a] 3,092	6,817
1906	6,837	36,955	276	243	32	297	[a] 2,526	6,258
1907	5,828	35,569	220	876	331	2,531	[a] 7,301	20,279

[a] Umber exports.

PAINT ORE DEPOSITS OF EASTERN PENNSYLVANIA.

Recent geologic work by Messrs. Agathe, Callen, Dynan, and Stoddard has demonstrated that the paint ore deposits of eastern Pennsylvania may be classified according to their composition and occurrence as follows:

1. Ocher deposits:
   a. Residual ocher deposits of the Reading-Allentown district.
   b. Bedded ocher deposits of the Moosehead district.
2. "Metallic paint" rock or bedded siderite of the Lehigh Gap district.

OCHER DEPOSITS.[a]

READING-ALLENTOWN DISTRICT.

Geography.—The principal ocher belt in Pennsylvania is a comparatively narrow strip extending from Reading to Allentown, approximately along the line of the east Philadelphia branch of the Philadelphia and Reading Railway. The district lies in Berks and Lehigh counties, and is comprised in the Reading, Slatington, and Allentown quadrangles, as mapped topographically by the United States Geological Survey.

Physiographically the ocher belt lies at the northern base of the Durham and Reading hills. From the base of these hills the region passes into a low-lying level limestone valley well drained by numerous streams tributary to Schuylkill and Lehigh rivers. Mining operations are impracticable between November and April, owing to snow and heavy rain. The timber used in the mines is obtained from the local growth of chestnut and oak.

Geologic relations, character, and origin of the ocher.—The rocks in this district, beginning at the lowest, are the pre-Cambrian gneiss; the Chickies quartzite (called by Stoddard and Callen the Hardyston quartzite), of Cambrian age; and the Shenandoah limestone (called by Stoddard and Callen the Kittatinny limestone), of Cambro-Ordovician age. The pre-Cambrian gneiss forms the main mass of the Reading and Durham hills, and its outcrops vary from 1 to 5 miles in width. Above the gneiss the Chickies quartzite rests unconformably. The latter formation outcrops in a narrow belt, usually less than a mile in width, extending along the base of the hills and in a few isolated places between strips of limestone. The limestone forms the floors of the valleys and is very widely distributed throughout the region. It lies conformably on the Chickies quartzite.

[a] Abstract from unpublished thesis by J. C. Stoddard and A. C. Callen, Lehigh University, June, 1909.

The ocher deposits in this district occur in irregular masses in clay that is residual from the Shenandoah limestone. The clays in most places are very thick. A well boring at Fleetwood passed through 250 feet of clay and stopped in unconsolidated gravel. In some of the ocher-bearing clay deposits there is evidence of stratification. Pebbles of quartzite are sometimes found imbedded in the clay. Folding of the original limestone was complex, so that there is not a definite dip and stratification to the beds, and it is not possible to establish a definite alignment of the ocher deposits. In general, it appears that the ocher deposits may be found at any horizon in the Shenandoah limestone, although they are most common near its base.

The term ocher is ordinarily applied to the rough and pulverulent forms of the minerals hematite and limonite. It is always rendered more or less impure by the presence of other metallic oxides and of argillaceous or clayey material. Limonite ochers are the only ones referred to in this report. Natural ochers show a variety of colors, which depend for the most part upon chemical composition. Hematites give red ochers, and limonites give yellow, buff, or brown colors. The amount and kind of impurities also influence the color. In brief, the natural color of ocher depends upon the degree of hydration and oxidation and the kind and amount of impurities. Since the color of ocher depends upon the degree of hydration, a red ocher can be made by calcining the common yellow ocher.

The only ore minerals present here are ocher and nodules and geodes of limonite. The gangue material is chiefly clay, in which the ocher occurs in irregular masses. The clay is moist and plastic, and varies in color from white to brown, some even being reddish and purplish. These clays are the result of weathering of intercalated hydromica slates, which occur in association with the Cambro-Ordovician limestone and with the Cambrian quartzite. Besides the ore minerals there are present also smaller quantities of turgite, ilmenite, siderite, and pyrite.

The product after washing, drying, and grinding carries from 12 to 30 per cent of Fe_2O_3.

The ocher has been derived from iron minerals in the rocks of the region. Possible sources of iron in the district are: (1) The Lower Cambrian slate, which contains iron sulphide and silicate; (2) Cambro-Ordovician limestone, which contains disseminated iron carbonate, silicate, and sulphide; (3) Ordovician shale and slate, which contain iron carbonate, sulphide, and hydroxide. Probably all these sources have contributed to the iron content of the ocher deposits, but it is believed that the Shenandoah limestone was the main source of the iron. The quantity of iron furnished was not necessarily proportional to the iron contained in the strata, but the manner of disintegration of the rocks was probably the controlling feature. Sandstone and shale are largely eroded by mechanical means, so that any iron minerals would be mostly washed away with the quartz grains and other sedimentary material. Limestones, however, are removed mainly by solution, and the insoluble iron minerals, silica and alumina, are left as a residue. The close association of the ocher deposits with the Shenandoah limestone and its residual clay and chert, in connection with the fact that the disintegrated beds of this limestone originally contained sufficient iron if concentrated to account for the formation of the iron ore, furnishes the chief reasons for believing that the limestone is the main source of the ocher.

The age of the ocher deposits is probably much later than that of the Shenandoah limestone. The deposits themselves are in residual material, which has been formed since the uplift of these beds in Permian or post-Permian time, and the process of formation is probably still in progress at present.

Productive deposits.—The principal deposits of ocher in this district are at the Reading mine of the Keystone Ocher Company, 1 mile northwest of Reading; E. B. Wade's property, one-half mile south of Blandon; the properties of the Keystone Ocher Company and of the C. K. Williams Company, both 1¼ miles east of Fleetwood; Henry Erwin & Sons' property at Topton; Dr. W. P. Long's property, one-fourth mile south of Hancock; the Prince Metallic Paint Company mine, 1½ miles northwest of Alburtis; and Bear Brothers' mine, 1½ miles northwest of Breinigsville. Several of these deposits were not worked during 1908. In addition, there is a deposit of umber at Camels Hump, about 3½ miles northeast of Bethlehem, worked by C. K. Williams, of Easton.

Mining methods.—The general method of mining the ocher in the deeper deposits, as at Reading and Fleetwood, consists of sinking shafts 30 to 70 feet deep into the ocher-bearing clay. Underground work is carried on by drifts which follow the pockets and stringers of ocher. The ocher is mined from stopes or breasts, and drifts are driven indefinitely until other deposits are found. Hoisting is done by hand windlass or by engine. Shafts and drifts must be timbered, and the clay frequently squeezes and crushes the timbers, especially when the mine has been inactive for several months during the wet season. Certain of the deposits, such as at Blandon and Topton, are mined as open cuts.

Milling methods.—For preparing the ocher for market, the general equipment consists of log washers, floating troughs with baffle boards and settling boxes, settling tanks and ponds, drying sheds, buhr mills, roasting furnaces, and packing devices. The raw material is usually passed first through log washers, in which the rough particles of limonite and chert and other foreign material are washed out. Next the fine material is passed into floating troughs in which are baffle boards and settling boxes. Here the smaller particles of foreign material settle out, and finally the suspended ocher passes into large settling tanks or ponds. By means of tap holes at different levels ochers of different degrees of fineness can be drawn out as desired. When the water in these tanks has evaporated so that the ocher reaches the consistency of a stiff mush, a process requiring usually three weeks or more, the ocher is shoveled up and put into drying sheds, where it lies exposed to the air for a month or more, until it is in condition to be ground. The product is then ground in French buhr mills. Most of the ocher and sienna are of the desired shade without being roasted, but if desired the material can be burned or roasted in kilns.

MOOSEHEAD DISTRICT.

The Moosehead district is about 5 miles north of Whitehaven, and 1 mile east of the Lehigh Valley Railroad, in Luzerne County. The ocher deposits have been worked here since 1885. The Luzerne Ocher Company now operates the mine.

Geologic relations and character of the ocher.—The rocks in the vicinity of Moosehead are of Mississippian age, and consist in the eastern part of Luzerne County of the Pocono sandstone, overlain to the west and south by Mauch Chunk shale. The Pocono formation is composed of gray sandstone, shale, and fine siliceous conglomerate, and varies in thickness from 800 to more than 1,300 feet. The Mauch Chunk shale consists of red, green, and yellow shale, gray and greenish-gray sandstone, and conglomerate. The rocks dip at low angles (2° to 5°) to the north. The ocher mined is in a low anticline. The ocher deposit is at the base of the Mauch Chunk shale and is underlain by hard Pocono sandstone. The ocher itself is simply a bed of soft, buff-colored shale, containing more ferric oxide than is usually found in a shale. The bed is 12 to 15 feet thick and is overlain by 12 feet of red shale. This cover is stripped by blasting, and the ocher is mined from an open cut. The ocher is of comparatively low grade, but the quantity of it is very great. The Luzerne Company is reported to own a tract of 3,000 acres under which the ocher is practically continuous.

Preparation of the ocher.—When stripped of its cover, the ocher is blasted out by dynamite and black powder, broken up by hand, and trammed to the mill, where it is crushed, ground, and bolted through silk screens of 156 mesh. The product is light yellow, and is used chiefly as a base for oilcloth. The finished ocher contains 6 to 7 per cent Fe_2O_3.

METALLIC PAINT AND MORTAR COLORS.

PRODUCTION.

Metallic paint and mortar colors are red and brown iron oxides, produced either by grinding the impure mineral found in the natural state, or by roasting impure iron carbonate. The production of metallic paint and mortar colors in 1908, as reported to the Survey, amounted to 25,250 short tons, valued at $268,968, a slight decrease in quantity from the 1907 production of 26,715 short tons, but a large decrease in value as compared with $305,895, the total value for 1907. Pennsylvania still continues to produce the largest quantity of metallic paint. New York is the next largest producer, and the other States maintain practically the same rank as in 1907. The following table gives the production of metallic paint and mortar colors from 1905 to 1908, inclusive:

Production of metallic paint and mortar colors, 1905–1908, by States, in short tons.

State.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Maryland and Tennessee.	6,209	$40,192	5,625	$51,800	6,038	$64,020	4,919	$47,403
New York	[a]7,159	76,990	7,106	79,060	6,394	70,771	7,048	65,482
Ohio	1,589	20,360	[b]1,929	19,360	[b]1,341	15,471	[b]1,171	10,546
Pennsylvania	8,596	123,570	11,021	136,086	10,327	127,973	9,197	113,112
Other States	[c]3,430	36,040	[c]2,620	29,440	[c]2,615	27,660	[c]2,915	32,425
	26,983	297,152	28,301	315,746	26,715	305,895	25,250	268,968

[a] Includes a small quantity of unground material.
[b] Includes 1906 and 1908, Connecticut and Vermont; 1907, Connecticut.
[c] Includes 1905, California, New Jersey, Virginia, and Wisconsin; 1906 and 1907, California, Illinois, and Wisconsin; 1908, California, Virginia, and Wisconsin.

SLATE AND SHALE.

PRODUCTION.

Slate and shale were ground for use as pigments in 1908 in Pennsylvania, New Jersey, New York, Iowa, and Tennessee, the first two States being the principal producers. In 1908 there were reported to the Survey 4,828 short tons, valued at $40,220. This is an increase in quantity of 698 short tons, but a decrease in value of $320.

The following table gives the production of slate and shale ground for pigment from 1905 to 1908, inclusive:

Quantity and value of slate and shale ground for pigment, 1905–1908.

1905	short tons	5,181	44,108
1906	do	5,481	40,540
1907	short tons	4,130	40,540
1908	do	4,828	40,220

PAINT-ORE DEPOSITS NEAR LEHIGH GAP, PA.

These deposits have been briefly mentioned in two publications of the United States Geological Survey.[a] Further studies have been made recently by Agthe and Dynan, and a few notes from their report with reference to the stratigraphic and structural relations, methods of mining and preparation of material, and estimates of the ore reserves are given here.[b]

Location and geologic relations.—The paint-ore deposits are situated in the southern part of Carbon County, Pa., 7 miles below Mauch Chunk, and extend in a general east-west direction for about 20 miles. The paint bed is a sedimentary formation of Devonian age lying between the Oriskany and Hamilton formations. It has been traced west to Germans, 5 miles west of Lehigh River, and eastward to Little Gap. The area in which the deposit lies is a narrow strip with the above-mentioned east and west limits, and from one-half mile to 2 miles wide, comprising the outcrops of the Helderberg, Oriskany, Marcellus, and Hamilton (lower part) formations. The region is part of the Appalachian province, and is made up of a series of hills and valleys extending east and west. Most prominent of these on the extreme south is the Blue Ridge, formed by the resistant Medina formation of Silurian age. This stands as a high, steep, knife-like ridge 1,100 feet above Lehigh River, which cuts through the ridge at Lehigh Gap. The Oriskany sandstone forms the most peculiar topographic feature of the region. With only a few interruptions it stands out as a long, continuous hill. West of Lehigh River this hill is very narrow and precipitous, at places being a vertical cliff. It resembles a huge artificial wall in several places.

The rocks immediately associated with the paint-ore deposits are sandstones, clays, shales, and limestones of Devonian age. A section in one of the paint mine tunnels shows, in succession from south to north, lower Hamilton shale, paint ore, and Oriskany sandstone. These strata occur in narrow bands striking east and west. At most places the structure is that of a number of monoclinal, conformable, sedimentary beds. At the outcrop the beds usually show overturned

[a] Eckel, E. C., Mineral paint ores of Lehigh Gap, Pa.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 435–437; also
Eckel, E. C., Metallic paints of the Lehigh Gap district, Pa.: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1120–1122.

[b] Agthe, F. T., and Dynan, J. L., The paint-ore deposits near Lehigh Gap, Pa.: Unpublished thesis, Lehigh University, June, 1909.

steep dips to the south. Below the surface there is probably another flexure restoring the normal dip. The country thus consists of truncated ends of a slightly overturned anticline, which has been entirely eroded away to the south of the present exposures. The structure is complicated between Bowmanstown and Hazard by the presence of a syncline of Oriskany sandstone to the south of the main outcrop.

The following is a section of the strata in which the paint ore occurs:

	Feet.
Cement rock	25
Paint ore	2
Clay	8
	35

The upper 5 feet of the cement rock consists of cherty limestone, the chert occurring in black nodules. The lower 20 feet is made up of hard, compact, blue, siliceous limestone, in appearance much resembling paint ore. The rock is very fine grained and contains small veins of quartz and calcite. The cement rock was formerly burned for cement in a number of places. It is said to have produced a very good cement, and the material was used in building the locks of the Lehigh Canal and several reservoirs in the vicinity. The clay beneath the paint ore varies greatly in its characteristics. Its color may be either blue, white, yellow, or red. Its thickness ranges from 2 to 9 feet.

Character of the paint ore.—The paint ore in this vicinity consists principally of carbonate of iron. The bed varies in thickness, being in some places 1½ to 2 feet thick; rarely it is found as thick as 4 feet; in many places it pinches out to a thickness of but a few inches; and in others it can not be found. No outcrops were observed anywhere within the area above outlined. Even though the bed is approximately vertical in many places, the débris from the Oriskany, which projects prominently above the other formations, has entirely covered the outcrop. The presence of test pits, air shafts, and in places the outcrop of the Oriskany sandstone alone mark the general position of the bed. There is no sharp line between the ore measures and the Hamilton shale above. Descending waters have carried the mineral material into the lower portions of the underlying clay, so that the cement rock is usually low in mineral value and shows up poorly after burning. The miners distinguish the iron-bearing strata chiefly by the specific gravity of the material. The lithologic characteristics of the paint rock and the cement rock are very similar; they both resemble a compact limestone, rather dark blue and crystalline. Upon close examination, however, the ore shows a rather compact structure and the presence of pyrites in most places; it is not so crystalline as the cement rock. The ore where exposed to sun and rain becomes oxidized to a reddish color. Near the surface the ore has been changed to limonite in places. The ore has been found to grow leaner as the distance below the water level increases. These facts and many others support the most generally accepted theory of origin, viz, replacement of calcium in the cement rock by iron through the agency of descending waters. The following analysis of the crude ore has been averaged from several analyses published in the annual report of the Pennsylvania Geological Survey for 1886, together with analyses furnished by the Prince Metallic Paint Company of Allentown:

Average partial analysis of crude paint ore at Lehigh Gap district.

Metallic iron (Fe)	33.00
Manganese (Mn)	.01
Silica (SiO_2)	25.00
Carbon dioxide (CO_2)	25.00

There are in addition small quantities of magnesia, sulphur, and phosphorus present. The specific gravity of the ore varies from 3.2 to nearly 4.

Mining.—The ore bed is a compact mass, is almost entirely mineralized, and contains few waste materials. For this reason the only separation necessary is the hand sorting, which is carried on in the mine. The ore lying between the cement rock above and the clay beneath requires only that some care be exercised in stoping. The clay is easily removed, being soft and unctuous. The cement rock is rather more difficult to separate, but with some experience the miner may become very adept in judging the ore. So easily is the ore separated underground that the material of the ore pile is nearly all pure paint rock.

The paint ore has been in the past very extensively worked. Most of the old workings have been abandoned and there are at present no working mines west of Lehigh River. Within a mile of Germans are five old shaft mines and two which were worked through tunnels. There are also a number of abandoned mines east of the river. The mines now operated are the two tunnels and the shaft of the Prince Manufacturing Company, at Hazard, and the tunnel and shaft of the Prince Metallic Paint Company, east of Millport. The deposits are worked through tunnels and by shafts. Tunnels are used whereever practicable. In most places the Oriskany sandstone next to which the ore occurs stands out as a prominent hill, and the favorite method of working the bed has been to drive a tunnel from the hillside through the Oriskany, striking the ore at a depth of 50 to 150 feet below the top of the hill. This gives the tunnel a length of 500 to 1,500 feet. In many places, particularly in the old workings, it appears that a great part of this length could be more economically carried on as an open cut, since much of the overburden is but a few feet thick. Where a tunnel is driven to the ore bed, drifts are driven along the strike of the bed, which is east and west, and the ore is stoped out by the overhead method with filling. Where a tunnel goes through a great thickness of shale and clay, close timbering and lagging are necessary. Tunnels are about 6 feet high and of about the same width. The sets consist of two posts and a cap of 8 inches diameter, placed 3 to 6 feet apart. They are lagged with rough poles 15 feet long; the tracks usually have a gage of $2\frac{1}{2}$ feet. No timbering is necessary in passing through the Helderberg limestone or the Oriskany formation.

At a typical mine worked through a shaft, the shaft was put down in the hanging wall and struck the ore bed at a depth of 159 feet. The shaft is 5 feet square and is timbered with 6-inch cribbing, on the inside of which are nailed 1-inch boards forming a complete lining. The drifts along the strike of the ore bed are 7 feet high, $5\frac{1}{2}$ feet wide at the bottom, and 5 feet at the top. They are driven along the ore, which is here 2 feet thick, and are timbered their entire length. Only one post is used in the sets, as the cement rock hanging wall is sufficiently firm to permit supporting one end of the cap in a hitch cut in it. Nine-inch timber is used. The sets are placed 3 feet apart and are closely lagged. A pillar is left to protect the shaft, and beyond this the stoping commences. The drift is driven 30 to 40 feet at a time, and a section of its length, extending up to the surface or to the overburden of earth and clay, is made ready for stoping. Overhead stoping with filling is the method used. The stope is kept inclined in advancing so that the top corner away from the shaft is kept about 20 feet ahead of the face of the drift. The ore can then be rolled down from the working face to the drift. Six-inch props are placed at intervals to support the roof while the ore is being removed. The stopes are 4 to 6 feet wide, 2 feet of which is ore and the rest clay and cement rock. The ore is carefully sorted out and rolled down. The clay and cement rock are used as filling. The ore is blasted down with dynamite, the holes being drilled by hand. After being sorted and rolled down to the drift, the ore is loaded into boxes holding about half a ton. These are mounted on trucks, trammed to the shaft, and hoisted by horse power to the surface.

The mining problems so far have been very simple, since only slight depths have been attained, and natural drainage is in most cases relied on to drain the workings. None of the mines have yet opened a second level because of the great horizontal extent of the ore.

Reserves of ore.—The entire production to date of the whole region is estimated to be about 100,000 tons. Of this amount 25,000 tons have come from the mines now operating at Millport. Approximately an equal quantity has been mined from the present workings at Hazard, and the remainder is from mines now abandoned. There is still available above ground-water level about 200,000 tons of ore, or enough to last for twenty-five years longer at the present rate of production. This estimate was made on the assumption that the ore averages $1\frac{1}{2}$ feet thick and that there are 65 feet of ore above ground-water level.

Preparation of paint.—The treatment of the ore in this region consists of calcining and grinding to a fine powder, in which state it is sold dry to be mixed with oil. At the mills the ore is broken up with sledges into 6-inch pieces and is ready for calcination. This was formerly carried on in stone kilns, but these are being replaced by more modern steel-jacketed shaft kilns. Certain typical kilns are of brick construction with sheet-steel sheathing 25 feet high and 10 feet in diameter. There are two fireplaces, one on each side, making the width of the kiln at the bottom 18 feet. Cord wood is used as fuel and the average temperature obtained is 500° F. The run lasts twenty-four hours and every twelve hours 10 tons of calcined ore is drawn off at the bottom, a corresponding quantity of raw ore being charged at the top. The calcined material is very compact and of a dark reddish-brown color. It is of the same composition as the finished product, the rest of the process consisting simply of grinding. The loss during calcination is from 20 to 25 per cent. The product is ground to buckwheat size by gyratory crushers, after which it is ground very fine by three 36-inch horizontal buhr mills and three vertical mills. The ground paint ready for market has the following composition according to analyses of the Prince Metallic Paint Company:

Percentage composition of ground paint from Lehigh Gap district ready for market.

Fe_2O_3	41 –47
SiO_2	32 –37
Al_2O_3	9 –11
CaO	.1 – 3
MgO	1.7 – 3.5
MnO	.35– 1.8
P_2O_5	.14– .17
S	.5 – 1
CO_2	1.5 – 2.5
H_2O	.6 – .9

Uses.—More of this metallic paint is used for freight cars than for any other purpose. It is recommended that 7 pounds of paint be mixed with 1 gallon of boiled linseed oil and the mixture will be sufficient for one coat over an area of 500 square feet. It is used also for painting structural steel, tin roofing, tanks, boats, and as a filling in oilcloth and linoleum.

PIGMENTS MADE DIRECTLY FROM ORES.

The important pigments made directly from ores or valuable metals are zinc oxide, leaded zinc oxide, zinc lead, sublimed white lead, and sublimed blue lead. The ores utilized in making these pigments are the franklinite ores of New Jersey, the sphalerite and galena ores of the Mississippi Valley (mined in the Plattville district of Wisconsin and the Joplin district of Missouri, Kansas, and Oklahoma), and the sulphide, carbonate, and silicate ores of zinc and lead produced in Colorado and New Mexico.

PRODUCTION.

Zinc oxide.—The production of zinc oxide in 1908 as reported to the Survey was 56,292[a] short tons, valued at $5,072,460, as compared with 71,784 short tons, valued at $6,490,660, in 1907. This represents a decrease of 15,492 short tons in quantity and of $1,418,200 in value. The reported average value in 1907 was $90.47 per short ton; that of 1908 was $90.09, a decrease of only 38 cents per ton.

Zinc-lead.—The production of zinc-lead, including leaded zinc oxide, in 1908 was 8,430 short tons, valued at $778,200, as compared with 13,516 short tons, valued at $1,286,440, in 1907—a decrease of 5,086 short tons in quantity and of $508,240 in value. In 1907 the average value was $95.18 per short ton; in 1908 it was $92.31, a decrease of only $2.18 per ton.

Sublimed white lead.—In 1908 there were produced in the United States 9,100 short tons of sublimed white lead, valued at $973,700, an average value of $107 per ton; in 1907 the production amounted to 8,700 short tons, valued at $1,026,600, an average value of $118 per ton. There was, therefore, an increase in quantity in 1908, as compared with 1907, of 400 short tons and a decrease in value of $52,900. The decrease per ton in 1908 as compared with 1907 was $11, or 9.3 per cent of the average value for 1907.

Sublimed blue lead.—There were 1,311 short tons of sublimed blue lead produced in 1908, valued at $121,923, as compared with 1,211 short tons, valued at $135,632, in 1907—an increase of 100 tons in quantity, but a decrease of $13,709 in value. The average value per ton in 1907 was $112; in 1908 it was $93, a decrease of $19 per ton,

[a] Exclusive of 945 tons from foreign ores.

or nearly 17 per cent of the 1907 value. The following table shows the production of pigments made directly from ores from 1905 to 1908, inclusive:

Production of pigments made directly from ores, in short tons.

Pigment.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Sublimed blue lead	....	....	....	....	1,211	$135,632	1,311	$121,923
Sublimed white lead	6,977	$732,585	7,988	$958,440	8,700	1,026,600	9,100	973,700
Zinc-lead	6,779	474,530	8,124	681,292	13,516	1,286,440	[a] 8,430	778,200
Zinc oxide	68,603	5,520,240	74,680	5,999,375	71,784	6,490,660	[b] 56,292	5,072,460
	82,359	6,737,355	90,792	7,639,107	95,211	8,939,332	75,133	6,946,283

[a] Includes leaded zinc oxide. [b] Exclusive of 945 tons from foreign ores.

IMPORTS.

The following table shows the imports of zinc oxide into the United States in the last five years:

Imports for consumption of zinc oxide, 1904–1908, in pounds.

Year.	Dry.		In oil.		Total.	
	Quantity.	Value.	Value.	Value.	Quantity.	Quantity.
1904	2,585,661	$138,674	$224,244	$26,436	2,809,905	$165,110
1905	3,436,367	196,220	342,944	40,542	3,779,311	236,762
1906	4,191,476	251,609	292,538	36,457	4,484,014	288,066
1907	5,311,318	323,551	362,814	33,679	5,674,132	357,230
1908	4,635,101	262,876	210,166	16,798	4,845,267	279,674

CHEMICALLY MANUFACTURED PIGMENTS.

Under this heading are grouped the important lead pigments made from pig lead and lead compounds, and such minor pigments as lithopone and Venetian red, both of which are chemically precipitated from mineral salts. Much of the material now sold as Venetian red, however, instead of being precipitated from ferrous sulphate and calcium hydroxide, is made by calcining a mixture of ferrous sulphate and terra alba and also by grinding natural red iron oxide with a white base, such as ground oyster shells.

PRODUCTION.

Basic carbonate white lead.—The production of basic carbonate (corroded) white lead, as reported to the Survey, in 1908 was 132,588 short tons, valued at $15,891,601. Of this total 101,109 short tons were sold in oil, valued at $12,552,771, and 31,479 short tons were reported sold dry, valued at $3,338,830. The sales for 1908 represented a net gain over those for 1907 of 5,337 short tons in quantity, but a net decrease of $556,723 in value, showing a general decrease from the average value, $129.25 per ton, in 1907 to $119.85 per ton in 1908, or $9.40 per ton, or more than 7 per cent of the 1907 value.

Red lead.—The production of red lead fell from 20,078 short tons, valued at $2,802,454, in 1907, to 16,720 short tons, valued at

$2,065,202, in 1908, a decrease of 3,358 short tons in quantity and of $737,252 in value. The average value per ton decreased from $139.57 in 1907 to $123.52 in 1908, a drop of $16.05 per ton, or 11.5 per cent of the 1907 value.

Litharge.—In 1908 15,542 short tons of litharge were produced, valued at $1,887,506, as compared with 20,838 short tons, valued at $2,854,987, in 1907, a decrease of 5,296 short tons in quantity and of $967,481 in value. This represents a fall from the average value per ton, $137, in 1907 to $121.45 in 1908, a decrease of $15.55, or 11.3 per cent of the 1907 value.

Orange mineral.—Orange mineral likewise showed a reduction in output, there being 397 short tons produced in 1908, valued at $65,498, as compared with 669 short tons, valued at $129,410, in 1907, a decrease of 272 short tons in quantity and of $63,912 in value. The apparent average value in 1907 was $193.44, and in 1908 it was $194.35, or an increase of 91 cents per short ton in 1908.

It is very evident from these figures that nearly the whole line of lead pigments suffered very material reductions in price as well as in output during 1908. The principal factor causing this depression in the industry was of course the financial stringency of 1907, which resulted in a reduction of building operations. Aside from this, however, the quantity of paint bought for renewals was very much reduced, since under depressed financial conditions paint was regarded rather as a luxury than as a necessity.

Lithopone.—The production of lithopone in 1908 was reported as 8,292 short tons, valued at $639,483, as compared with 10,275 short tons, valued at $750,350, in 1907. This represents a decrease of 1,983 short tons in quantity and of $110,867 in value. In the case of lithopone the value per ton apparently increased from $73.03 in 1907 to $77.12 in 1908, or $4.09.

Venetian red.—The production of Venetian red in 1908 amounted to 8,825 short tons, valued at $159,650, as compared with 7,566 short tons, valued at $134,167, in 1907. This represents an increase of 1,259 short tons in quantity and of $25,483 in value. The average value per ton apparently increased from $17.73 in 1907 to $18.09 in 1908, or 36 cents.

The following table gives the production of these various chemical pigments and colors for the years 1905 to 1908, inclusive:

Production of chemically manufactured pigments, 1905–1908, in short tons.

	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Basic carbonate white lead:								
In oil	62,767	$7,577,437	93,763	$12,357,632	92,216	$12,138,932	101,109	$12,552,771
Dry	73,909	8,261,212	38,318	4,571,618	35,035	4,309,392	31,479	3,338,830
Red lead	16,378	2,049,888	13,808	1,924,288	20,078	2,802,454	16,720	2,065,202
Litharge Orange mineral	19,878	2,307,233	18,910	2,551,346	20,838 669	2,854,987 129,410	15,542 397	1,887,506 65,498
Lithopone	....	....	4,300	311,500	10,275	750,350	8,292	639,483
Venetian red	6,879	137,541	13,526	198,394	7,566	134,167	8,825	159,650
	179,811	20,333,311	182,625	21,914,778	186,677	23,119,692	182,364	20,708,940

IMPORTS.

The following table gives the quantity and value of the imports of corroded white lead, red lead, litharge, orange mineral, and Venetian red from 1904 to 1908, inclusive:

Basic carbonate white lead, red lead, litharge, orange mineral, and Venetian red imported, 1904–1908, in pounds.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.		Venetian red.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	587,338	$33,788	836,077	$30,115	44,541	$1,500	766,469	$37,178	4,937,397	$40,270
1905	597,510	34,722	704,402	26,553	117,757	4,139	628,003	31,106	4,558,998	39,585
1906	647,636	41,233	1,093,639	50,741	87,230	3,737	770,342	42,519	5,432,732	43,091
1907	584,310	37,482	679,171	35,959	90,475	4,386	615,015	37,793	4,738,148	37,869
1908	540,311	30,452	645,073	28,155	96,184	3,327	485,407	26,645	3,113,858	25,745

PAINT TESTS.

During the year 1908 and the first half of 1909 the subject of paints or, to speak broadly, of protective coatings for structural materials has received more serious study than at any time in the past. Foremost among the active investigators has been the scientific section of the Paint Manufacturers' Association of the United States, both in practical field tests and in laboratory investigations. Not less interested has been the United States Government from the standpoint of a consumer, and the Pennsylvania Railroad and other corporations have also taken a hand in the work. Research investigations have been carried on at some educational institutions, notably at the Massachusetts Institute of Technology, at certain state experiment stations, and at the laboratories of certain manufacturers of pigments. The American Society for Testing Materials has cooperated in these investigations, and the spirit of that society has guided the work, for the foremost of the investigators are nearly all members of the society. Representatives of the Master Painters Association of Pennsylvania have also been actively concerned in the application of many of the practical tests. Thus all three classes most vitally interested in impartial administration and interpretation of the tests—manufacturers, painters, and purchasers—have been represented. The field is a broad one and, while the possibilities for further work are still very great, results of great value have already been obtained, the more important of which will be reviewed here.

One of the fundamental principles regarding the structure of paint films that appears to have been confirmed by recent study is that a paint coating consisting of three sizes of particles is superior to a film containing only one or two sizes of particles. In many respects the problems connected with the preparation of paint are similar to those involved in the preparation of concrete. As the problem with concrete is to produce strength with a minimum of voids by using a mixture of particles of three or more determinate or characteristic sizes, just so in the coating of paint a minimum of voids and a maximum of imperviousness can be obtained by a wise selection of three pigments which supply these three different determinate or characteristic sizes of particles.

The average paint coating is only 0.003 inch thick, yet it is required to withstand expansion and contraction of the underlying surface, abrasion or wear from storms of dust, sand, rain, sleet, and hail. It must have both hardness enough to withstand to a reasonable extent this surface wear and elasticity enough to meet internal strain and to conform to changes in the underlying surface, and it must penetrate and cling to the surface upon which it is applied. It must also retard or prevent free access to the underlying surface of both moisture and atmospheric gases, which cause decay. Very evidently, then, not only the physical and chemical character of the pigment particles themselves must be studied in this connection, but also the paint vehicle and the lumber or metal to which the paint is to be applied are important factors to be considered.

Lack of space forbids here a detailed review of the published results of the laboratory and field investigations of the scientific section of the Paint Manufacturers' Association; consequently, interested persons are referred to the bibliography of publications of this association given at the end of this chapter. As stated in Mineral Resources for 1907, test fences were painted early in 1908 at Pittsburg and at Atlantic City. The results of the exposures for one year in moist sea air to sudden and considerable changes in temperature and to the abrasive action of wind-blown sand at Atlantic City of some 560 panels painted with paints made under 47 different formulas are now available as Bulletin No. 16 of the scientific section. Information regarding the results of experiments of similar character at Pittsburg will soon be published as Bulletin No. 17 of the same series.

ATLANTIC CITY PAINT TESTS.

The general conclusions that have been drawn from the Atlantic City tests are as follows:[a]

Combination paints.—A mixture containing more than one prime white pigment, either with or without a small percentage of inert pigments, makes a paint that is far superior to one manufactured from one pigment alone. (This confirms the theory that a paint coat should consist of particles of more than one size, and, since each individual pigment possesses particles of a characteristic size, the best way to effect a combination of three sizes in order to reduce the voids to a minimum is to select three pigments whose particles are known to average the desired sizes.) The prime white pigments used in mixtures or singly were basic carbonate white lead, basic sulphate white lead, zinc oxide, and zinc-lead white. The inert pigments are gypsum (calcium sulphate), whiting (calcium carbonate), barytes and blanc fixe (barium sulphate), asbestine (magnesium silicate), and silica (silicon dioxide).

White lead.—All the basic carbonates or "straight white lead" panels chalked, checked, and weathered badly, but the color and

[a] Perry, R. S., and Gardner, H. A., First annual report on the wearing of paints applied to Atlantic City test fences: Bull. Sci. Sec. Paint Mfrs. Assoc. No. 16, 1909, pp. 20–24.

hiding power remained generally good. The use of this pigment alone does not appear to have been successful. A large percentage of basic carbonate white lead in a paint, however, even when somewhat in preponderance, shows thus far excellent results when the pigments combined therewith were selected with regard to a proper balance of good qualities and a proper compensation for defects.

Sublimed white lead.—This pigment, where used alone, showed good general condition, good hiding power, eggshell gloss, good color, was somewhat checked, showed considerable chalking, and a hardness of 2 in a scale of 10.

Zinc oxide.—This pigment, where used alone, was in fair condition, had fair to good hiding power, good color, good to high gloss, checking was evident, and hardness was 9 to 10. On one panel indications of scaling were noticed.

Zinc-lead white.—A panel painted with this pigment alone was found in good condition, the hiding power was fair, the color good, the gloss good, there was some chalking, and the hardness was rated at 6.

Inert pigments.—This class of paint materials, called also "inert extenders," and "reinforcing pigments," has been the cause of much controversy and even of legislative action. The tests seemed to show what was generally anticipated beforehand by all persons informed on paint matters, that these materials have no especial value as pigments when used alone, but that their intelligent use within certain limits is necessary for the production of a satisfactory mixed paint for such conditions of exposure as prevail at Atlantic City. Some of the particular points noted are as follows: Gypsum apparently must be used with discretion in the paint coating because of its solubility and liability to leach through the coating of linoxyn (dried film of linseed oil). Whiting or calcium carbonate has apparently demonstrated that it is efficient in moderate percentages in the manufacture of paints, but an excess of this material must be avoided. Barytes and blanc fixe seem to be useful when the percentage is well subordinate to the percentages of prime white pigments; the use of a mixture of these two reinforcing pigments, which are physically different but chemically the same, permits advantage to be taken of the different sized particles exhibited by the two materials. Asbestine, judged from the results shown by formulas containing this pigment, appears to be useful when used in moderate proportions, and the same may be said of silica.

Lithopone.—The formulas containing large percentages of lithopone failed completely, and the panels were removed from the fences. The formulas containing this pigment, which wore the best, were those containing zinc oxide and calcium carbonate. It is believed that a large percentage of the latter pigments, together with a more conservative percentage of lithopone, will give a combination of value for outdoor use. (It should be understood that this was an unusually severe outdoor test, and that it in no wise has any bearing on the value of lithopone for indoor work.) The softness of this pigment seems to require for outdoor use the addition of a hardening agent, such as zinc oxide, and in tests outlined for the future such combinations will be tried.

Tinted paints.—The yellow and gray panels all showed slower wear, less checking, and less chalking than the white panels of corresponding composition. The tints were produced by the use of ocher, umber, bone black, lamp black, and Venetian red.

Special colors.—Of the four bases on which Para red was tried, viz, basic carbonate white lead, sublimed white lead, zinc oxide, and lithopone, those which proved the best were lithopone and basic carbonate white lead, the red on the latter being much brighter than on any of the others. Of the blues, those which gave the greater permanence and the least degree of fading were applied to panels with sublimed white lead and zinc oxide. The basic carbonate white leads which were tinted with blues showed marked failure and, in some cases, the original blue panels could not be distinguished from panels of untinted white lead, because of the complete fading that had occurred. On the other hand, the sublimed white lead and zinc oxide, which were tinted with blues, stood up remarkably well. The chrome green, subjected to tests, was found to be in excellent condition; it did not fade or mildew. The bronze green, however, lightened somewhat and mildewed in spots, possibly because of segregation of carbon. Tests on the Atlantic City fences are still in progress, 35 formulas in all being painted on a new batch of panels, including all the original white leads used in the previous tests. Each formula is painted out in white, yellow, and gray on panels of white pine.

PAINTS FOR PROTECTION OF IRON AND STEEL.

According to Cushman[a] the corrosion of iron, like that of other metals, is an electrochemical phenomenon. The application of paint coating constitutes the most general method for the preservation of iron and steel, and, along this line, the electrochemical theory finds important application. A large amount of research work has already been done on this subject by Cushman and others in determining the effect which all well-known pigments have on steel, and it has been concluded that certain pigments were unsafe in a paint designed for the protection of steel. Such pigments have been classified as "stimulators" of corrosion. Other pigments have indicated possible properties of protecting steel from corrosion and are termed "inhibitors." Still other pigments were found neither to stimulate nor to inhibit corrosion to any marked degree, and these were classified as "indeterminates." The effect of certain impurities in pigments often determines in what class the pigments shall be placed. The effect of certain impurities in steel likewise may influence its tendency to corrode, and the position of these impurities in steel may localize the corrosion. Two years ago Cushman[b] suggested that, owing to their inhibitive action against rusting, the slightly soluble chromates should be theoretically the best protectors to be used in the first coat to be applied to iron and steel surfaces. A long series of tests followed, under taken by five separate investigators,[c] and "from these results a

[a] Cushman, Allerton S., The preservation of iron and steel: Bull. U. S. Dept. Agr., Office of Public Roads, No. 35, May 21, 1909, p. 8.

[b] Cushman, Allerton S., The corrosion of iron: Proc. Am. Soc. Testing Materials, vol. 7, 1907, pp. 211–228:

[c] Cushman, Allerton S. The inhibitive power of certain pigments on the corrosion of iron and steel. Proc. Am. Soc. Testing Materials, vol. 8, 1908, pp. 605–610.

tentative classification of the pigments was made under the headings: (1) Inhibitors, (2) indeterminates, and (3) stimulators. No one of the 50 pigments tested was, however, admitted to any class except in the cases in which a majority of the investigators reached the same result." For details of the investigation and the consequent classification the reader is referred to the pamphlet by Dr. Cushman: "The Preservation of Iron and Steel."[a]

These laboratory results, however, have been considered only as a step to further and more practical studies and, accordingly, 600 large plates,[b] representing three different kinds of steel were mounted in wooden frames facing the seashore near Atlantic City, N. J. These plates were painted under the strictest test conditions with single paints, as well as with formulas made up from the three tentative classes of pigments. The following organizations cooperated to a greater or less extent in this work: United States Department of Agriculture, American Society for Testing Materials, Paint Manufacturers' Association of the United States, Master Painters' Association of Pennsylvania, Carnegie Steel Company, and American Rolling Mill Company. The test plates were completed and exposed in September, 1908, and they are being inspected from time to time, and at the inspection incident to the meeting of the American Society for Testing Materials on June 30, 1909, certain results were already evident. It is believed that the ultimate results will be of much value to the metallurgist, to the engineer, and to all persons interested in paint technology.

Simultaneously in Pittsburg there was erected on the ground of the Carnegie Technical School a test fence, consisting of various grades of galvanized steel wire and woven wire panels. These wire fences have been painted in part with special inhibitive paints and have in part been left unprotected. The comparative tests should in time yield results of great value.

Experimental tests on various types of roofing and sheathing metals was undertaken in the spring of 1909 by the United States Geological Survey at its structural materials laboratory on Youngs Pier, at Atlantic City, N. J. Here a number of plates representing three grades of material, Bessemer steel, basic open hearth steel, and pure iron, including flat and corrugated siding and flat and corrugated roofing, each as plain black metal, as galvanized metal, and as tinned metal. The galvanizing was done by several processes, including the Sherardizing process. These plates have been mounted in an exposed position, and the black metal plates have been coated with red and green paints containing rust inhibitors in the pigment and in the vehicle.

Another well-known service test of pigments for the protection of structural steel has been in progress for the last two and one-half years on the Pennsylvania Railroad bridge over Susquehanna River at Havre de Grace, Md. The application of the paint and the subsequent observations have been under the auspices of the American Society for Testing Materials, and reports have been published by that society in its proceedings for 1908 and 1909.

---

[a] Cushman, Allerton S., The preservation of iron and steel: Bull. U. S. Dept. Agr., Office of Public Roads, No. 35, May 21, 1909, pp. 23–34.

[b] For details on the construction of these steel test fences, see Bulletin No. 7 of the scientific section of the Paint Manufacturers' Association of the United States.

Although it is too early to give conclusive data as to the results of these various actual practical tests, yet if the autoelectrolytic theory of the cause of corrosion be applied to the subject of protection by paint films, it would, in general, appear that pigments that are good conductors of electricity should not be applied directly to the surface of iron and steel. Specific reasons for this appear in Cushman's bulletin,[a] and also descriptions of other experiments which indicate that some pigments which have been supposed to be excellent for protecting steel should not, in reality, be used for the prime coat, and that some pigments which, theoretically, should inhibit corrosion act apparently as a stimulus. This fact seems to depend on the technology of their manufacture and whether or not impurities are present. Cushman, therfore, advances the following conclusions: (1) The name of the type of pigment does not necessarily guarantee its inhibitive value; (2) pigments that are good conductors should not be applied as the prime or contact coating to iron and steel; and (3) if pigments contain material which is, even in the slightest degree, soluble in water, they should not be used unless their inhibitive effect on corrosion has first been established by tests.

BIBLIOGRAPHY.

The following list represents a few of the papers of recent date dealing with the geology and statistics of mineral paints and pigments:

Ball, S. Mays. The mining and treatment of ocher in Georgia: Min. World, March 6, 1909, pp. 441–442.

Burchard, Ernest F. Southern red hematite as an ingredient of metallic paint: Bull. U. S. Geol. Survey No. 315, pt. 1, 1907, pp. 430–434.

——— The production of mineral paints in 1907: Mineral Resources U. S. for 1907, pt. 2, U. S. Geol. Survey, 1908, pp. 697–709.

Eckel, Edwin C. The production of mineral paints in 1906: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1115–1122.

——— Mineral paint ores of Lehigh Gap, Pa.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 435–437.

Hayes, C. W. Geological relations of the iron ores in the Cartersville district, Ga.: Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 403–419.

Watson, Thomas L. The ocher deposits of Georgia: Bull. No. 13, Georgia Geol. Survey, 1906, 81 pp.

——— The yellow ocher deposits of the Cartersville district, Bartow County, Ga.: Trans. Am. Inst. Min. Eng., vol. 66, 1903, pp. 643–666.

Willimott, C. W. The mineral pigments of Canada: Bull. No. 913, Geol. Survey Canada, 1906, 39 pp.

The following list comprises a number of the most important papers and texts dealing with the technology and use of paints and pigments that have appeared within recent years:

Buskett, Evans W. Manufacture of zinc pigments: Mines and Minerals, November, 1907, pp. 193–194.

Cushman, Allerton H. The preservation of iron and steel: U. S. Department of Agriculture, Office of Public Roads, Bull. No. 35, May 21, 1909.

Gordon, Wm. F. Zinc oxide and zinc-lead pigment manufacture: Eng. and Min. Jour., vol. 83, No. 22, June 1, 1907, pp. 1033–1036.

Hall, Clare H. The chemistry of paint and paint vehicles: D. Van Nostrand Company, New York, 1906, 134 pp.

Heckel, G. B. A paint catechism for paint men: Drugs, Oils, and Paints, Philadelphia, 1907, 43 pp.

Holley, C. D., and Ladd, E. F. Analysis of mixed paints, color pigments, and varnishes: Wiley & Sons, New York, 1908, xiii, 235 pp.

[a] Op. cit., pp. 31–32.

Hughes, L. S. Notes on the structure of paint films: Pamphlet published by Picher Lead Company, Chicago, Ill.

——— Fire process pigments and paints: Pamphlet published by Picher Lead Company, Chicago, Ill., also published as An Address on Paint, in Lead and Zinc News, May 20, 1907, pp. 5–8.

——— Sublimed white lead: Eng. and Min. Jour., August 24, 1907, p. 356.

——— Sublimed white lead: Jour. Soc. Chem. Industry, April 30, 1909, pp. 405–406.

Lenoble, E. Supériorité du pouvoir courant de la ceruse sur celui du blanc de zinc dans la peinture à l'huile: Bull. Soc. Ind. Nord France, 35me année, No. 138, 1907.

Macnichol, Chas. Painting concrete and cement structures: Drugs, Oils, and Paints, March, 1909, pp. 391–392.

Mining World. Making zinc-lead white at Canyon City: Min. World, August 1, 1908, pp. 167–170.

Rickard, T. A. The story of the manufacture of white lead paint: Min. and Sci. Press, May 9, 1908, pp. 622–636.

Scott, W. G. The two white leads: Modern Painter, Chicago, January, 1908, pp. 862–866.

——— Zinc oxide, its properties and uses: Min. World, November 9, 1907, pp. 853–854; November 16, 1907, pp. 887–888, and December 7, 1907, pp. 1007–1008.

——— Oxide of zinc: Prize essay published in pamphlet form by New Jersey Zinc Company, 1907.

Tassin, Wirt. Suggestions for the microscopic study of paint films: Drugs, Oils, and Paints, vol. 20, June, 1909, pp. 10–11.

Thompson, Gustave. White lead, its advantages as a paint pigment: Lead and Zinc News, April 29, 1907, pp. 5–9.

Toch, Maximilian. The chemistry and technology of mixed paints: D. Van Nostrand Company, New York, 1907, 166 pp.

United States Refining and Reduction Company. Standard zinc-lead white: Pamphlet published by United States Reduction and Refining Company, Colorado Springs, Colo.

Walker, Percy H. Some methods of testing miscellaneous supplies: U. S. Department of Agriculture, Bureau of Chemistry, Bull. No. 109, April 22, 1908.

Walker, P. H., and McIlhenny, P. C. Havre de Grace bridge test, report of committee "E" on preservative coatings for iron and steel: Proc. Am. Soc. for Testing Materials, vol. 8, 1908.

The following list comprises the publications to July, 1909, of the scientific section, Paint Manufacturers' Association of the United States, Henry A. Gardner, director, 3500 Grays Ferry road, Philadelphia, Pa.:

Preliminary booklet—Addresses on paint, delivered before the Michigan chapter, American Institute of Architects, 1907.

1. Tables of white pigments and vehicle, standard nomenclature.
2. Standard can sizes recommended to paint manufacturers.
3. First report on the test fences erected by the scientific section. (Out of print.)
4. Methods for the analysis of the vehicle constituents of paint.
5. Tests upon the corrosion of iron to be conducted by the scientific section. (Out of print.)
6. First annual report of the scientific section.
7. Preliminary report on steel test fences.
8. Report of committee "E" on preservative coatings for iron and steel.
9. Recent technical developments in paint manufacture.
10. Protective coatings for conservation of structural material.
11. The corrosion of iron and steel. By Alfred Sang. (Out of print.) (See also Proceedings Engineering Society Western Pennsylvania, vol. 24, No. 10, January, 1909.)
12. The function of oxygen in the corrosion of metals. By William H. Walker.
13. Protective coatings for steel and iron. By Robert S. Perry. (Out of print.)
14. Coatings for the conservation of structural material. (Out of print.)
15. Protective coatings for structural material. By R. S. Perry.
16. Atlantic City test fence: report on first annual inspection. By R. S. Perry and Henry A. Gardner.
17. Pittsburg test fence: report on first annual inspection. (In press.)

ASBESTOS.

By J. S. Diller.

INTRODUCTION.

The United States leads all other countries of the world in the conversion of raw asbestos into manufactured products, although a very small percentage of the material used, much less than 1 per cent, is mined in the United States. By far the larger part of it comes from Canada. It is gratifying, however, to note that the production of asbestos in the United States is on the increase and that most of the increase is in grades that are better than those previously produced. The bulk of the asbestos mined in the United States has ever been of the amphibole type, but in 1908 the production of chrysotile advanced decidedly and thus affords a more promising outlook for the future.

VARIETIES AND CHARACTERISTICS.

The most general characteristics of asbestos and the ones on which its utility depend are its fibrous structure and its incombustibility, but all the varieties are not equally resistant to heat, nor do they possess equal flexibility and strength of fiber. The asbestos of commerce includes fibrous minerals of different species, most of which belong to the amphibole type, but the most important mineral is chrysotile, a variety of serpentine.

Amphibole asbestos is generally dull, varies in color from greenish to gray and white, and, though flexible for the most part, has a considerable degree of brittleness. It occurs in ancient crystalline rocks that have been crushed and sheared under great pressure in the process of mountain building, and it appears in three forms. Two of these forms, slip fiber and cross fiber, are veins, and the third is found in large fibrous masses, generally made up of small bunches of asbestos which are more or less divergent and sometimes distinctly radial. For convenience in distinguishing the latter form from the vein fiber (slip fiber and cross fiber), the designation "mass fiber" has been proposed for it.

In veins of slip-fiber asbestos the fiber lies parallel to the vein walls and marks a plane of fracture along which the two sides have slipped upon each other and given direction to the development of the fiber. Cross-fiber asbestos extends directly across the vein which it forms. The mass fiber is not in veins, but forms the whole mass of the rock, in which veins of slip or cross fiber may occur. As a matter of fact, however, where mass fiber is best developed veins of slip fiber and cross fiber are rare or entirely absent.

Chrysotile asbestos is for the most part green, rarely yellowish, and the fiber of good quality has a silky luster and sufficient toughness to give it considerable tensile strength, so that it can be spun and woven. It is generally, if not always, associated with massive serpentine, in which its most important form is small cross-fiber veins varying from a mere film to a few inches in thickness, though in some localities there is much slip-fiber chrysotile scattered in thin sheets throughout the rock. The fibers of chrysotile in their original position extend directly across the vein, but subsequent rock movements may make them appear to pass into slip fiber, as at East Broughton, Canada.

USES.

The fundamental property of asbestos, upon which its use depends, is its flexible, fibrous structure, but coupled with this are the scarcely less important qualities of incombustibility and slow conduction of heat and electricity when the mass is fiberized and porous, which makes it valuable not only for fireproofing, but for insulating against heat and electricity.

It was first used only for spinning and weaving, to make incombustible thread, yarn, rope, and cloth, and this use has continued to be the most important application ever since the days of the Greeks and Romans. Only the highest grades of asbestos—Nos. 1 and 2 crude, with best grade from the mills—can be used for this purpose. Thread can now be spun so fine that it will run about 32,000 feet to the pound. The cloth is extensively employed for making theater curtains and for other fireproof and insulating uses.

Asbestos has been widely used of late in the electrical arts as a basis of insulation which must withstand somewhat elevated temperatures, and also as a fibrous binder for a great number of insulating compositions. It has a fiber, practically the only one, talc excepted, which is of a refractory nature and is at the same time an electrical insulator of high order. Further, asbestos is not affected chemically by many of the active chemical agents likely to attack most insulations. It is extensively used for boiler and pipe coverings to prevent heat radiation, and its efficiency is greatly increased by developing the cellular structure of the covering. It may be rendered more efficient, too, by a composition in which the asbestos acts as a binder for some good nonconductor. There are many patents concerning mixtures of asbestos with various compounds to produce light incombustible and insulating pastes and moldable or solid material suited to many different purposes. They play an important part in many fireproof constructions where electricity and heat are used. Such materials are asbestos building lumber, century shingles, asbestos wood, asbestos slate, asbestic for stucco and plaster, and asbestolith.

A mass of asbestos broken into fibers and then again compressed is highly porous; but it may be rendered not only waterproof, but an especially effective insulator, under conditions of varying moisture, by being saturated with certain varieties of asphalt.

As a nonconductor of heat it is used not only in the preparation of fireproof safes and vaults, but also for cold-storage and cooling structures. Houses made of asbestos materials or coated with asbestos throughout are not only warmer in winter, but cooler in summer.

One of the notable applications of asbestos in recent years is as a pigment under the name "asbestine," and the investigations of the scientific section of the Paint Manufacturers' Association[a] of the United States shows that asbestine is a most valuable pigment. On account of its fibrous structure it has the property of holding up other heavier pigments in the paint. It possesses "tooth" or "feel under the brush," is very stable, may retard chalking, and apparently gives increased strength to the paint coating; when used with paint containing lead and zinc it adds certain properties which no other pigment can give. It has a use to-day in high-grade paints. However, the proportion which should be used should be moderate. If used in excess it cheapens and adulterates the paint.

PRODUCTION AND IMPORTS.

All of the asbestos mined and sold in the United States in 1908 was mined in Georgia and Vermont, and the total output of the various grades, including a few tons of high-grade fiber from the Grand Canyon (not sold), was 936 short tons, an increase from 1907 of over 42 per cent. The total value of the output of refined produced in 1908 was $19,624, as compared with $11,889 in 1907, which represents an increase of 64 per cent in the value of the output, and shows that the increase in production has been mainly in the better grades. This is undoubtedly due to the fact that while the production of the amphibole variety remained nearly as in 1907 the increase of 1908 was almost wholly in chrysotile. More chrysotile asbestos was produced in 1908 in the United States than ever before, apparently. This affords an encouraging outlook, especially when we consider that the actively producing area in Canada is being extended farther and farther southwest toward the Lowell locality of Vermont.

In the following table are given the quantity and value of the asbestos produced in the United States annually since 1890. The table includes also the value of the imported asbestos, both unmanufactured and manufactured:

Annual production and annual value of imports of asbestos into the United States, 1890–1908.

Year.	Production.		Value of imports.		
	Quantity (short tons).	Value.	Unmanufactured.	Manufactured.	Total.
1890	71	$4,560	$252,557	$5,342	$257,899
1891	66	3,960	353,589	4,872	358,461
1892	104	6,416	262,433	7,209	269,642
1893	50	2,500	175,602	9,403	185,005
1894	325	4,463	240,029	15,989	256,018
1895	795	13,525	225,147	19,731	244,878
1896	504	6,100	229,084	5,773	234,857
1897	580	6,450	263,640	4,634	268,264
1898	605	10,300	287,636	12,897	300,533
1899	681	11,740	303,119	8,949	312,068
1900	1,054	16,310	331,796	24,155	355,951
1901	747	13,498	667,087	24,741	691,828
1902	1,005	16,200	729,421	33,011	762,432
1903	887	16,760	657,269	32,058	689,327
1904	1,480	25,740	700,572	51,290	751,862
1905	3,109	42,975	776,362	70,117	846,479
1906	1,695	28,565	1,010,454	65,716	1,076,170
1907	653	11,899	1,104,109	200,371	1,316,379
1908	936	19,624	1,068,322	127,548	1,195,870

[a] Private letter from its director, Robert S. Perry, June 4, 1909.

The total production in the United States for 1908 is but little more than 1.4 per cent of that of Canada for 1908, and its insignificance as a factor in the asbestos industry becomes even more pronounced when the quality of the material is taken into consideration. The asbestos mined in the United States is still, for the most part, of the amphibole type, and much of it is exported. Very little chrysotile is produced in this country that will spin, and none has been produced that is of as good quality as the best of the spinning grades of Canada, but with further exploitation it is hoped that better grades may be found that are workable.

Canada still continues to be the greatest source of the raw asbestos used in the manufactories of the United States. Raw asbestos is imported duty free, but on the manufactured asbestos there is a duty of 25 per cent.

The total value of the unmanufactured asbestos exported from Canada during the calendar year 1908 was $1,842,763. The total value of that imported by the United States for the same time was $1,068,322, from which it appears that much over half of all the asbestos exported by Canada came to the United States. The total value of the unmanufactured asbestos imported by the United States in 1907 from other parts of the world, excepting Canada, was only $1,646. About half of it came from Germany and the remainder equally from Italy and the United Kingdom. It is evident that as yet Russia plays no appreciable part in the asbestos industry of the United States.

PRICES AND CONDITIONS OF TRADE.

Although the trade conditions of the Middle West and the South have been reported much below the normal, the demand in the Eastern States is said, by most of those familiar with the industry, to have remained reasonably steady throughout the year, with no changes of any moment as regards prices, unless it be a slight sagging in the prices of some of the lower grades. The outlook for the coming year is for lower prices on the lower grades of material, but high-grade crudes and fibers will probably remain at the present prices.

The distressed trade conditions which existed in the United States and Canada during 1908 extended to the countries of Europe, resulting in a moderate falling off of exports in 1908 from Canada, as compared with 1907, when the supply was not equal to the demand.

The whole asbestos industry, however, is better established now than ever before and, with stable trade conditions, must greatly increase in volume.

The range of prices for the various grades is about as follows:

No. 1 crude asbestos	per short ton	$275–$350
No. 2 crude asbestos	do	150– 250
Asbestos fiber (according to grading)	do	25– 150
Fines (according to grading)	do	10– 25
Asbestic (a by-product), averaging in 1907	do	Less than $1

CANADIAN PRODUCTION AND CONDITIONS.

From the fact that the Canadian asbestos is the chief factor in the control of the asbestos industry of the United States and to a marked degree of the world and that the development of the industry is coeval with that of the Canadian mines, the following table is introduced:

Production of asbestos and asbestic in Canada for the calendar years 1895–1908, in short tons.[a]

Year.	Asbestos.		Asbestic.	
	Quantity.	Value.	Quantity.	Value.
1895	8,756	$368,175	....	....
1896	10,892	423,066	1,358	$6,790
1897	13,202	399,528	17,240	45,840
1898	16,124	475,131	7,661	16,066
1899	17,700	468,635	7,746	17,214
1900	21,621	729,886	7,520	18,545
1901	32,892	1,248,645	7,325	11,114
1902	30,219	1,126,688	10,197	21,631
1903	31,129	915,888	10,548	16,869
1904	35,611	1,213,502	12,854	12,850
1905	50,669	1,486,359	17,594	16,900
1906	60,761	2,036,428	21,424	23,715
1907	62,130	2,484,768	28,296	20,275
1908	65,534	2,547,507	25,239	25,829

[a] Obtained from the report of the director of mines on the mines and metallurgical industries of Canada for 1907–8, pp. 448, 936. The table published in the report by the United States Geological Survey on asbestos for 1907 was based on preliminary reports of the director of mines and subject to correction.

The output noted for Canada in 1908 is only a preliminary statement, but it is sufficiently close to indicate clearly a decided increase in the value of the production since 1907. Although there was an increase of 3,404 tons in the output of asbestos in 1908 over 1907, there was in the same year a decrease of 3,057 tons in the output of asbestic. Nevertheless, there was a total increase of $68,293 in the value of the production, showing that the increase was in the high grades. Twelve operating companies reported their output and employed 2,643 men.

In the mining plants there were great improvements, especially in the East Broughton district, where two mills were completed in 1908, and a large one, the 500-ton mill of the Frontenac Company, is still under construction.

The greatest producing mines of Canada still center in Asbestos Hill, at Thetford, where the King Brothers, the Bell, the Johnson, and the Beaver mines are located, and where electric power has been so successfully used.

The greatest extension of the asbestos mining field in 1908 has been in the East Broughton district, and it is of interest to note that there is much actinolite reported in that region. The rocks are much more crushed and altered than at Thetford and Black Lake.

Of greater significance to the United States is the extension of the asbestos mining region of Canada southwest to Eastman, which is near the international boundary, and only about 40 miles from the asbestos locality near Lowell, Vt.

United States Consul Paul Lang, of Sherbrooke, reports, January 20, 1909, that several companies have organized to develop the new mines at Eastman, and states that "The Orford Mountain Railroad is near these properties, and a spur will be built from the main line to the mills, which are already in course of construction."

Actinolite was mined in Canada up to 1903, when the greatest output amounted to 550 tons, valued at $3,108. None has been reported by the department of mines since. Practically all of the asbestos reported in the table passes in the trade as chrysotile, although some of it contains a considerable admixture of slip fiber, which is mostly actinolite. Although more expensive, chrysotile is more uniform and of so much better quality than actinolite that it drives the latter out of the market. Small quantities of slip fiber, which appear to be chiefly actinolite, occur in nearly all the Canadian mines, and unless it is removed before milling, as it is in the best mines, it lowers the grade of the fiber.

On account of the irregularity in the distribution of the asbestos-rich serpentine there has been more or less doubt concerning the greatest depth at which asbestos mining might be expected to pay. But with the increase in the depth of the large paying mines at Thetford, and especially with the discovery of good asbestos in one of the mines at Black Lake at a depth of 400 feet, great confidence prevails.

RUSSIAN PRODUCTION AND OUTLOOK.

Of late years Russia has become an important producer of asbestos. The mines are as yet of only local development, but the abundance of the asbestos, its relations to market, and the cheapness of labor indicate that Russia will appear in the not distant future a much larger producer than to-day.

In general, it should be said, however, of the Russian asbestos that it is much harsher to the touch than that of Canada and less suitable for spinning. This may be due, at least in part, to the fact that the mines are in shallow open cuts and the rocks decidedly affected by weathering. The region is flat and not well drained, so that the open, shallow mining pits encounter an abundance of water, which is greatly to their disadvantage. Furthermore, much of the region is covered with glacial drift and forest and the working season is short and interrupted. The working season lasts from May to October, but as most of the workmen are farmers, who must attend to their farms in July and August, the mine work is interrupted for two months. The mines are said to employ 15,000 men, chiefly peasants.

According to Consul-General Hunter Sharp's report from Moscow, February 12, 1909, there was in 1905 a total output of 7,894 tons of asbestos from the Russian mines, which varied in price f. o. b. at the mines from $25 to $117 per ton. The greater part, 6,495 tons, came from the 25 mines in the Perm district of the Urals; the remainder, 1,490 tons, came from the Minusinsk mining district on Yenisei River, not far from the Trans-Siberian Railroad.

Asbestos was discovered in the Ural Mountains nearly two hundred years ago, but it was not until about 1885, when Baron Girard took hold of the matter, that systematic development began. The methods employed at first were primitive, but they have steadily advanced until at the present time some of the mines have modern equipment with electric power.

The mines are broad, shallow, open cuts, and the serpentine is generally so soft as to be easily mined with a pick. In the deepest workings, 70 feet, the rocks are becoming more solid, and explosives have to be used.

The growth of the Russian asbestos mines is indicated by comparing the total output of 1,167 tons in 1893 with 10,308 tons, the output in 1907, a relative advance which approaches that of Canada for the same period.

The principal mines in Russia, as described by Krijanousky,[a] are located about 57 miles north of Ekaterinburg in the Ural Mountains. According to Krijanousky's map, the mining district has a length of about 18 miles north and south and a width of from 2 to 3 miles. The mines are limited to a mass of serpentine which is bounded by schist or slate on the west and by granite on the east. In the northern and southern parts of this mining region the mines are not as productive as those in the middle portion of the field, where the mines of Baron Girard and Korff are situated.

The genesis of the serpentine is suggested by the associated diallage. The serpentine is cut by dikes of diabase as well as porphyry, and by a few veins of quartz. The asbestos is not found everywhere in the serpentine, but is confined to ellipsoidal portions which invariably have their longer axis north and south, these portions sometimes attaining a length of 3,500 feet and a width of 1,000 feet. Generally within each ellipsoid the eastern and western borders are less rich in asbestos than the central portion running north and south. The veins of cross-fiber asbestos run generally north and south with vertical dips, although some of the veins are nearly horizontal. Masses of slip fiber are present, but not abundant. The richest ellipsoidal masses bearing asbestos occur in the middle part of the field. Where richest, the yield is from 42 to 55 pounds of asbestos per cubic yard; while in the other mines to the north and south the yield is from 28 to 33 pounds per cubic yard.

Krijanousky describes in detail the Russian method of milling asbestos and grading it in preparation for the market. The fiber is separated into five grades according to length, ranging from 4 centimeters down to about one-half centimeter. His paper is the most important the writer has found concerning Russian asbestos.

The actively producing mines of the Ural, as already stated, are north of Ekaterinburg. Although actively mined for only about 20 miles, asbestos has been reported at many localities to the south for a distance of 200 miles from Ekaterinburg to Orenburg, where active prospecting is now going on.

In Siberia, although an output is reported from only one mining region—that of the Minusinsk, on Yenisei River—asbestos is reported from many localities in the Altai mountain region and to the southward, but of the real value of these deposits little knowledge is yet available.

NOTES ON THE ASBESTOS DEPOSITS OF THE UNITED STATES.

GENERAL STATEMENT.

It is a matter of surprise that a country so large as the United States and so rich in varied mineral resources should yield so little asbestos, notwithstanding the fact that the belt of ancient crystalline rocks in which the asbestos mines of Canada occur extends from the vicinity of Quebec southwestward through all the States to Alabama. The successful mining in this belt is confined almost wholly to Canada, where the asbestos is chrysotile. In the same belt within the

[a] Krijanousky, V. J., Occurrences of serpentine and asbestos on the Beresovski, Kamenski, and Monoten estates in the Ural Mountains. (Published in Russian.) Work of the Geological Museum of Peter the Great, Imp. Acad. Sci., vol. 1, No. 3, 1907.

United States there are only two active mines at present and both are small, one in Vermont producing chrysotile asbestos and the other in Georgia producing amphibole asbestos. There are many prospects between Vermont and Georgia, and practically all of them show amphibole asbestos. This difference in the specific character of the asbestos is related in large measure to the mineralogical composition of the country rock from which the asbestos is derived. Before the Canadian mines supplied a better grade of material (chrysotile), there were a number of small mines of amphibole asbestos in Massachusetts, Connecticut, Virginia, North Carolina, and South Carolina, as well as in Georgia. The best grade of asbestos (chrysotile) is associated with serpentine derived from peridotite, a rock of which olivine was originally the chief constituent; amphibole asbestos, frequently referred to as actinolite, is generally derived from the alteration of pyroxene.

DEPOSITS BY STATES.

VERMONT.

The Lowell Lumber and Asbestos Company, of which William G. Gallagher is president, erected an asbestos mill on what was once known as the Tucker property, near Mount Belvidere,[a] in the vicinity of Lowell, Vt. The mill began operations in the spring of 1908 and continued running for a considerable portion of the year. Thus Vermont enters again the list of producing States under what seem to be promising general conditions. The total output of the United States has thus not only been increased in quantity but bettered in quality.

The mill is nearly 160 feet in length, about 40 feet in width, and 2 stories in height. Its machinery embraces jaw crushers, screens, rotary driers, Raymond pulverizers, double-cone separators connected with fans, and numerous ingeniously arranged air currents in flues and chambers devised by E. B. Craven for separating the various grades of fiber from one another, as well as from the nonfibrous rock particles of sand and dust. The cyclone, so frequently employed in Canadian mines, is not used at Lowell, nor is any of the fiber picked up from the open screens by suction. The mill appears to be very efficient and the output clean and satisfactory. Preparation is being made to install a water-power electric plant that will greatly increase the possibilities of the mill. The mill is near the mine, which is on a low bluff, and gravity carries the rock by a large bucket tramway only about 300 feet to the storage bin of the crusher at the top of the mill.

By the milling process several grades of asbestos are produced. The first grade can be spun, the second and third grades are adapted to the manufacture of asbestos coverings, and the fourth and fifth grades are best suited for paper stock.

[a] Perkins, G. H., Rept. State Geologist of Vermont for 1907–8, pp. 53–55; Marsters, V. F., Rept. State Geologist of Vermont for 1903–4, pp. 86–102; also Bull. Geol. Soc. America, vol. 16, pp. 419–446.

ARIZONA.

The best asbestos yet found anywhere in the United States occurs in a "national monument" near the bottom of the Grand Canyon of Arizona. The quality of the asbestos is exceptional, as are also the grandeur of the scenery in its locality and the peculiarity of its mode of occurrence.

It is cross-fiber chrysotile, and locally the fiber is 4 inches in length. This locality has been described in Mineral Resources for 1904 and 1907. The asbestos outcrop being 1,000 feet above the bottom of the canyon on the north side, the asbestos must be packed on donkeys about a dozen miles down one side of the canyon and up the other 4,000 feet to the brink upon the south side, from which point it must be hauled 20 miles to the railroad for shipment.

The asbestos is associated with a belt of limestone where affected by an intrusion of diabase. The serpentine including the chrysotile is supposed to have been derived from pyroxene contained in the limestone, and forms a narrow belt in the limestone wherever influenced by the diabase.

These rocks have recently been studied in detail by L. F. Noble,[a] who has traced the asbestos for a number of miles west from Asbestos Creek, and has shown that it probably occurs on the west side of Powell's Butte. This asbestos outcrop, though narrow and not continuous, occurs at intervals in the same horizon for many miles in the depth of the Grand Canyon. The inaccessibility of its locality and the difficulty of mining so thin a mass will limit the operations to open cuts along the outcrop, permitting shipment of only the hand-cobbed, best grade of material. A small quantity of such material, less than a carload, has been brought up to the brink of the canyon from the prospects near Bass's Ferry, but none has yet been sold.

GEORGIA.

The returns from Georgia show a slightly increased output at Sall Mountain, the only place in the State where asbestos is mined at present. The peculiar fiberized amphibolite which has been mined and milled at Sall Mountain for over a dozen years is described in the report on asbestos in 1907[b] and need not be repeated here. The whole mass of the rock is fibrous and has been successfully mined only where it has softened by weathering. Other masses of essentially the same rock have been found in that vicinity only.

OTHER STATES.

Wyoming.—In Wyoming, the Caspar region continues to attract attention. Some development work has been done on the property of the North American Asbestos Company of Caspar Mountain and on the claims of the Wyoming Consolidated Asbestos Company of Smith Creek, but their operations have been limited and mill construction was not reached in 1908, although it is reported from

---

[a] Private letter; data not yet published.
[b] Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, pp. 716–718.

various sources that mills have been contracted for. A small production is reported, but the material was not in marketable form and there were no sales.

Asbestos has been reported from the mountain west of Sheridan, Wyo., but, as far as may be judged from the sample submitted, the deposit is of no economic importance.

California.—In Placer County, Cal., on the north slope of the canyon of American River, near Dutch Flat, a company, of which T. E. Morgan is president, continues prospecting by deep tunnels to determine whether the deposit will justify the erection of a mill, but as far as can be learned no richer ground has been found than that at the surface. It is generally understood that asbestos can be mined successfully only in open cuts. Prospecting by deep tunnels is not generally recommended.

ASPHALT, RELATED BITUMENS, AND BITUMINOUS ROCK.

By Joseph A. Taff.

INTRODUCTION.

The term "asphalt," as commonly used in the industrial sense, denotes the various forms of solid and semisolid bitumen or mineral pitch found in nature or produced by refining processes. An essential property of asphalt so defined is that it melts at temperatures near that of boiling water and may thus be used in various industries to which it is applicable. An asphalt thus defined consists of two mixtures of hydrocarbons, one of which, a very viscous substance, when separated from the other is to a large extent soluble in petroleum naphtha. The hydrocarbon mixtures of this nature have been aptly named malthenes. The remaining parts of the asphalts after the separation of the malthenes compose a brittle solid not so soluble and have been designated asphalines or carbines.[a]

Asphalts are found natural in many parts of the world and disseminated in rocks of various kinds. It is recovered, also, in large quantity as a residuum from asphaltic petroleum, the same source from which the natural asphalts are held to have originated. In an additional sense, the term "asphalt" is employed broadly to include a series of solid hydrocarbons, related metamorphosed bitumens, known as gilsonite, wurtzelite (elaterite), grahamite, "tabbyite," and other kindred hard asphaltic substances. Ozokerite, a mineral wax, is a natural paraffin and has been classed statistically with asphalts.

Semiliquid or viscous bitumens that contain a very large percentage of the malthenes and smaller percentages of the carbines are known in the trade as maltha or mineral tar. Maltha is found in nature issuing from bituminous rock and from vents in the earth; it is also extracted from bituminous rock, and is a by-product from asphaltic oils. A similar liquid hydrocarbon mixture is known industrially as asphalt flux, which is a form of maltha.

It appears that there are various gradations through the asphaltic series of hydrocarbons that depend upon the composition and the relative quantity of the more volatile constituents. At one end of the series the percentage of volatile oil is so large that the asphalt is essentially fluid; at the other end, the volatile matter is so small that the mineral is a brittle solid, not convertible by the use of solvents into a commercial product. Such is the state of a species of grahamite or albertite in eastern Oklahoma.

[a] For full descriptions of the properties of solid native asphalts and related bitumens, see "The modern asphalt pavement," by Clifford Richardson, John Wiley & Sons, 1908.

The term "bituminous rock" is used to designate all kinds of rock, whether in a friable or solid state, that contain an appreciable quantity of bitumen or asphalt intermingled with its particles. Bituminous rock, therefore, includes asphaltic earth, sand, sandstone, shale, limestone, etc. The volume, richness, and adaptability of the various deposits of bituminous rock are not subjects for consideration in a report on the statistics of production. It is pertinent to remark, however, that an asphalt rock, though rich in bitumen, may not be applicable in the paving or other industries. It is necessary to know that the bitumen content of the rock is in sufficient quantity and has the composition and consistency of a true asphalt, and that it is not a maltha or an oil bitumen which can not be utilized successfully for certain industrial purposes without distillation, if at all. It is equally essential to know that the sand, limestone, or other rock material that contains the bitumen is of the proper nature as a filler in the utilization of the bituminous rock for paving or other purposes. A lack of the proper knowledge of the quantity, quality, and uses of bituminous rock on the part of many who have attempted to develop this material has resulted in a greater loss than gain many times over. Large investments have been made even before ascertaining facts in regard to the quantity of bituminous rock available, not to mention the quality as a whole.

OCCURRENCE.

The asphaltic hydrocarbons occur naturally in three principal forms: (1) In a viscous, semiliquid state filling interstices and cavities in rocks of almost every class, but most abundantly in sand, as asphaltic sand, and in sandstone and limestone strata; (2) as viscous and semisolid, tenacious exudations from the earth, either from the exposed bituminous rock or from subterranean passages; (3) as a solid, filling fissures, or cavities cutting across or extending between beds of rock. The asphalts and other forms of bitumen are found in commercial quantity in or associated with sedimentary rocks of all kinds and of all ages from the Ordovician to the Pleistocene. They are found in smaller quantities impregnating certain schists, and occasionally in igneous rocks.

Bituminous rock.—Extensive deposits of asphaltic shale and sandstone are found in California in and contiguous to the oil fields from the vicinity of Santa Cruz southwestward, generally parallel with the coast. Bitumen permeates porous sandy strata and exudes at the surface from highly bituminous oil-bearing deposits, and is found in smaller quantities in veins cutting the same class of rocks. The asphalt in this region appears for the most part to be a residue by natural distillation at or near the surface of the earth from the same crude oil that yields the oil asphalt.

Utah contains large deposits of both asphaltic limestone and sandstone. Those probably of greatest purity and highest quality are the asphaltic limestones in the vicinity of Indian and Lake canyons in Strawberry Creek Valley, Wasatch County; on Tie Fork of Soldier Creek northwest of Tucker, on the Rio Grande Western Railroad, Utah County; and between Soldier and Diamond creeks a few miles northeast of Thistle Junction, in the same county. Bituminous-rock deposits are also reported from the same vicinities south of

Thistle Junction. Similar deposits of bituminous limestone are known near the head of Whittemore Canyon north of Sunnyside, in Carbon County. In the Strawberry Creek valley especially the bituminous rock seems to be associated with veins of wurtzelite, and it is probable that the asphalt contained in the limestone partakes of the nature of wurtzelite or gilsonite. The natural asphalt that exudes from the bituminous rock of certain localities in Wasatch and Carbon counties is noticeably tenacious and elastic. Bituminous sandstone is reported in Uinta County east and northwest of Jensen, and in the Book Cliffs toward the source of Willow and Whittemore creeks in Carbon County. These bituminous-rock deposits are flat lying and are usually accessible from the sides of the canyon and valleys. All the bituminous-rock deposits of Utah at present known are contained in formations of Tertiary or later age, and occur in or near the boundaries of the Uinta Basin.

Extensive deposits of bituminous rock of variable richness are found in Oklahoma. Flat-lying strata of bituminous sand occur in eastern Stephens, in Jefferson, in Comanche, and in Carter counties in late Carboniferous strata. Notable deposits also occur near Loco and Asphaltum, and asphaltic sandstones, more or less steeply inclined, are found in Carboniferous rocks near Woodford, Ardmore, Overbrook, Buckhorn, and Fitzhugh. Bituminous sandstone and limestone in large quantity and of considerable richness, impregnating rocks of Ordovician age, are found at Gilsonite and near Sulphur and Dougherty, in Murray County.

Bituminous rock is found in Texas as asphaltic sand and limestone, occurring in the basal Comanche rocks in Burnett County, near the town of Burnett, and in Montague County, near St. Joe; as asphaltic limestone of Cretaceous age in Nueces County; and as asphaltic limestone in Uvalde County—which appears to be of better quality and of more interest at the present time than the bituminous sandstone found elsewhere in Texas. This limestone is very porous, and the interstices and cavities contain a semisolid asphalt.

The asphalts of Kentucky occur as bituminous impregnations of flat-lying Carboniferous sandstones, chiefly in the western part of the State, in Breckenridge, Grayson, Edmonson, Warren, and Logan counties, and in Carter and Floyd counties in the northeastern part.

Asphaltic sandstone of possible commercial value is found in southwestern Wyoming in sec. 15, T. 15 N., R. 118 W. This bed is 6 feet thick, and its areal extent is not known. Another asphaltic sandstone of similar quality and of the same thickness occurs in the Bighorn Basin, in northern Wyoming, secs. 28, 29, 32, and 33, T. 52 N., R. 89 W.

Asphaltic sands of Comanche (Lower Cretaceous) age occur in Arkansas near Wolf Creek, Pike County. Bituminous sandstones of Carboniferous age have been developed locally in Missouri in the vicinity of Higgins Valley, Lafayette County, and in northern Alabama, but their commercial values are not known. Bituminous rock in Georgia has been reported from Fulton County. Presumably for trade reasons, bituminous deposits are not exploited in these States at the present time.

Natural asphalt.—Natural asphalt is not known in the United States in sufficient quantity to warrant profitable exploitation at the present time. It is widely distributed in California oil fields, where it is formed at the surface of the earth by evaporation of the volatile oils from seepage of the bitumen. It is also known to occur in the form of veins in oil-bearing or related rocks in Santa Barbara and Kern counties, but these deposits have not been found in volume sufficient for extended exploitation. In Oklahoma it exudes at a number of places from bituminous-rock deposits, but in small quantities.

Oil asphalt.—Certain crude petroleums in the California and Texas coast regions, and in the Kansas and Oklahoma oil fields, contain quantities of asphalt in solution. Some of these crude oils are said to contain over 35 per cent of oil asphalt, the asphalt being so abundant as to be a profitable commodity in their commercial treatment. A large output is obtained at the present time in the process of distillation of these asphaltic oils.

Gilsonite.—Gilsonite, a naturally hard bitumen, is the most abundant of all the hard natural asphaltic substances in the United States. It is found in northeastern Utah, in Uinta and Wasatch counties, where it occurs in vertical gash veins or fissures cutting across nearly flat Tertiary rocks. The gilsonite veins bear generally northeast-southwest directions, and vary in width from thin stringers to several feet. At one locality a vein 18 feet thick has been reported. The same vein extends for several miles with thicknesses varying from 4 to 12 feet. The horizontal length of some of these veins is known to be many miles, but their vertical depth as a rule is not known. The best known and the thickest deposits of gilsonite in Utah are in the central part of the Uinta Basin, on both sides of the White River valley. Notable localities are near Dragon and on the north side of White River near the Colorado state line. Very important deposits are at Pariette, near Fort Duchesne, and northwest of Fort Duchesne. Some of the gilsonite veins in Utah in the White River valley extend into Colorado. Veins of similar species of asphalt occur also in Colorado in Willow Creek valley, near the north side of Middle Park, in Grand County.

Grahamite.—Grahamite and other solid brittle bitumens that are closely related to grahamite occur at several localities in Oklahoma. One of these localities is in western Pushmataha and eastern Atoka counties, northwest of Antlers, between the St. Louis and San Francisco and the Missouri, Kansas and Texas railroads. Another locality is 10 miles west of Tuskahoma, where recent active developments of grahamite have been carried on. Grahamite occurs in vertically or steeply pitched veins in highly folded sandstone and shale of Carboniferous age. The veins vary in width from stringers to bodies several feet thick. A solid brittle bitumen of similar nature is found in Stephens County, Okla., near Loco, where it fills vertical fissures through flat-lying shale and sandstone of late Carboniferous age. Similar but harder and more highly metamorphosed bitumen substances are found as fissure fillings in the district east of Page in Le Flore County, Okla., and in western Arkansas. It is reported that these substances are too highly metamorphosed to be converted into products of commercial use. These grahamite and kindred deposits in Oklahoma are characterized by perfect blackness, high luster, brittleness, and a high grade of purity.[a] A small deposit of grahamite has been reported from Middle Park,

---

[a] For detailed descriptions see Grahamite deposits of southeastern Oklahoma: Bull. U. S. Geol. Survey No. 380, 1909.

Colorado. This locality is far removed from transportation and little is known of the extent of the grahamite. Another locality for grahamite in the United States, the original locality, is in West Virginia, in Richmond County, 25 miles east of Parkersburg, where it occurs filling a vertical fissure across Carboniferous strata, but the available supply has been exhausted.

Wurtzilite (elaterite) and "tabbyite."—Wurtzilite and "tabbyite," elastic hard bitumens, are found in the western part of the Uinta Basin, Utah. They occur as veins or fissures cutting across flat beds of limey shales in certain gulches tributary to the Strawberry Creek valley in south-central Wasatch County. The processes for utilizing these resistant rubbery bitumens are now to a certain extent in the experimental stage, and the production is not large. Claims are made that an excellent and durable substitute for certain rubber products may be produced from these substances. The elaterite veins are similar in form to those of gilsonite, but their known horizontal extent and vertical range are more limited. "Tabbyite" is related probably to both gilsonite and wurtzilite, and possibly to ozokerite. It is expected that various gradations from one to the other of these solid bitumens may be found in the Uinta Basin country.

Ozokerite.—Ozokerite [a] is one of the rarest of the commercially valuable hydrocarbons. It occurs in Utah in vertical fissures and zones of crushed rock, in Tertiary strata, near Midway, Soldiers' Summit, and Colters station on the Rio Grande Western Railway. It is a mineral wax or variety of natural paraffin. No product of this class was put upon the market in 1908.

Albertite.—Albertite, also a rare hard and densely black bitumen, occurs in small quantity in eastern Oklahoma and in Utah near Calton Station. There was no production in 1908.

USES.

Bituminous rock, a natural mixture usually consisting of sandstone and limestone and included bitumen, is used chiefly for paving and in the manufacture of mastics. For these purposes it must be crushed and the bitumen or asphaltic content brought to a proper consistency and quantity with respect to the stone matrix. The extracts from most bituminous-rock deposits are usually found to be a maltha or viscous asphalt, similar to the malthas or asphalts found exuding from bituminous strata. The natural asphalt imported from Trinidad and from Bermudez, Venezuela, supplies a large part of the paving material in the United States. The oil asphalt, when properly made in the process of distillation of the Mid-Continent, Texas, and California asphaltic oils, seems to meet all the requirements of an asphalt. In the refined state it is practically pure, being free from earthy substances commonly carried by the natural product, and although hampered in its use by freight charges, large quantities are brought to the eastern markets and used for the various purposes to which asphalt is applied. Natural asphalt and oil asphalts are converted into similar commercial products and employed in the trades. The most extensive uses to which these products are applied are paving, road dressing, waterproofing metals,

[a] For further information see Ozokerite deposits in Utah: Bull. U. S. Geol. Survey No. 285, 1906, pp. 369-372.

papers, and fabrics, roofing, electrical insulations, adulteration of hard rubber, wood preservation, brick and wood block filling, macadam binding, concrete construction, reservoir and foundation linings, and briquetting coals; and in the more refined states they are used for acid-fume proofing, insulations, etc.

Mastic, a manufactured product consisting of a mixture of asphalt and maltha with sand and lime-dust filler, is used for paving, floor construction for breweries, vats, reservoir linings, etc.

Gilsonite and grahamite in converted and refined condition fulfil all the uses to which asphalts are applied, besides having special adaptability for the manufacture of japans, paints, varnishes, electric insulations, marine cables, acid-fume proofing, and for coating high-grade metal surfaces. Gilsonite has been used to a certain extent for street paving, and is said to be an excellent material for this purpose. The chief advantages possessed by these substances are the perfectly smooth, solid, and more or less elastic coating they produce, and the resistance offered to the action of heat, moisture, and acids. It is probable that the refined products of certain natural and oil asphalts have many of the essential qualities of the refined gilsonite and grahamite.

The natural ozokerite that occurs in Utah contains a small but variable percentage of bitumen, which gives it shades of dark brown to black and a hardness ranging between that of beeswax and of a brittle solid having nearly the consistency of elaterite. It is used as a leather polish, in sealing wax, pencils, etc., and when refined it is a light yellow to white. It is manufactured into candles for special purposes, and may also be used as an insulator, and is said to make a good acid-proof coating.

PRODUCTION.

The following table presents the output of natural asphalt, related bitumens, and bituminous rock that entered the market from quarries and mines in the United States, together with refined asphalt that has been converted by producers from the crude material. The production in 1908 was 185,382 short tons, valued at $1,888,881, as against 223,603 short tons, valued at $2,826,481, in 1907. The marked decrease in the output and the still greater decline in the value of bituminous products were apparently due to depressed trade conditions, especially in the early part of 1908.

Production of asphalt and bituminous rock, 1882–1908, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	3,000	$10,500	1896	80,503	$577,563
1883	3,000	10,500	1897	75,945	664,632
1884	3,000	10,500	1898	76,337	675,649
1885	3,000	10,500	1899	75,085	553,904
1886	3,500	14,000	1900	54,389	415,958
1887	4,000	16,000	1901	63,134	555,335
1888	50,450	187,500	1902	105,458	765,048
1889	51,735	171,537	1903	101,255	1,005,446
1890	40,841	190,416	1904	108,572	879,836
1891	45,054	242,264	1905	115,267	758,153
1892	87,680	445,375	1906	138,059	1,290,340
1893	47,779	372,232	1907	223,861	2,826,489
1894	60,570	353,400	1908	185,382	1,888,881
1895	68,163	348,281			

PRODUCTION OF ASPHALT BY VARIETIES AND STATES.

The total production of asphalt by varieties for the last four years is given in the following table, and the production in 1908, by States as well as by varieties, is given in the succeeding table. The reports from producers for 1908 did not distinguish between bituminous sandstone and bituminous limestone. The localities from which the reports of production come induce the belief that almost the entire output of this class is bituminous sandstone. The decrease in the production of this commodity was due to the falling off in California, where there was a continued increase in the production of oil asphalt. Kentucky advanced in the production of bituminous rock in 1908 over 1907 by more than 50 per cent; and California superseded Kentucky in the output of mastic in 1908, whereas in 1907 Kentucky was the only producer. There was a slight decline in the production of gilsonite in 1908 from that of 1907 and an apparently greater decrease in the price. The apparent decrease in price, however, as shown by the figures, does not, it is believed, show an actual decline in value per ton, but instead indicates a change in conditions of transportation to trunk lines of railroads from the mines. The prices seem to be based on estimates of value at the mines which are, in some cases, at a distance from railroad transportation. That the value of gilsonite should be below that of California or Texas oil asphalt is unexpected, and that it should be below that of bituminous rock is unreasonable. The production of grahamite showed a slight increase, with a smaller advance in price. The output of "tabbyite" was small, and its utilization is yet to a certain degree in the experimental stage. Its output being small and from a single State, its production is combined with wurtzilite—a related hydrocarbon.

Production of asphalt, 1905–1908, by varieties, in short tons.

Variety.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	45,302	$136,972	24,085	$70,686	45,526	$129,040	37,371	$146,821
Refined bitumen	2,200	22,000	2,543	24,158	1,744	16,568	4,536	48,780
Gum	3,036	41,438	24,178	341,106	5,195	78,400	7,000	88,000
Maltha	3,139	34,292	9,900	86,750	13,507	143,758	12,875	162,000
Wurtzilite (elaterite)	500	44,000	} 12,947	159,960	{ 422	35,327	450	36,000
Gilsonite	10,916	47,040			20,285	531,965	18,533	61,824
Grahamite	....	....	1,952	16,432	966	7,743	2,286	20,340
Ozokerite and tabbyite	5	1,500	....	....	12	2,148	50	2,500
Oil asphalt	50,169	430,911	62,454	591,248	136,204	1,881,540	102,281	1,322,616
	115,267	758,153	138,059	1,290,340	223,861	2,826,489	185,382	1,888,881

Production of asphalt in 1908, by varieties and by States, in short tons.

Variety.	California.		Utah.		Oklahoma.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	27,118	$91,998				
Mastic	3,250	36,563				
Refined bitumen	7,000	88,000				
Maltha	12,759	158,520			116	$3,480
Uintaite (gilsonite)			18,533	$61,824		
Wurtzilite (elaterite) and tabbyite			500	38,500		
Grahamite					2,286	20,340
Oil asphalt	85,114	972,176				
	135,241	1,347,257	19,033	100,324	2,402	23,820

Variety.	Kentucky.		Texas.	
	Quantity.	Value.	Quantity.	Value.
Bituminous rock	10,253	$54,823		
Mastic	1,286	12,217		
Oil asphalt			17,167	$350,440
	11,539	67,040	17,167	350,440

IMPORTS.

The following table shows the imports of asphalt by calendar years from 1904 to 1908, inclusive:

Asphalt imported for consumption into the United States, 1904–1908, in short tons.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	117,184	$490,809	16,766	$100,081	6,496	$20,236	140,446	$611,126
1905	85,014	381,474	9,688	78,639	5,895	19,183	100,597	479,296
1906	100,818	355,493	14,178	114,076	5,086	15,110	120,082	484,679
1907	142,494	502,811	13,535	127,024	4,925	15,629	160,954	[a] 648,564
1908	137,808	532,297	7,642	67,364	6,224	20,758	151,674	[a] 624,979

[a] Imports for 1907 include $3,100 of manufactures; 1908, $4,560.

The greater part of the asphalt which is imported into the United States from foreign countries comes from the island of Trinidad off the coast of Venezuela. Other important sources of the mineral are Venezuela (Bermudez), Cuba, Germany, Italy, and Mexico. Smaller quantities are imported from Switzerland, France, the United Kingdom, and Turkey in Asia, with insignificant quantities from Colombia and the Netherlands.

The ozokerite imported for consumption in 1907 amounted to 1,451,231 pounds, valued at $149,507; in 1908 it amounted to 3,595,393 pounds, valued at $374,953.

EXPORTS.

During the fiscal year ending June 30, 1908, domestic asphalt and manufactured asphaltic material to the value of $451,968 were exported from the United States to other countries, as against similar exports valued at $374,476 during the fiscal year ending June 30, 1907.

EXPORTS FROM TRINIDAD.

The asphalt of Trinidad is described as occuring in two forms, as land pitch and as lake pitch, although there seems to be no fundamental difference between the two varieties. The land pitch occurs in sheets or layers—supposed overflows from the lake—and as exudations at the surface of the land from the same source. The land pitch seems to have been slightly metamorphosed at the surface by evaporation of the lighter oils and local hardening by surface fires. The pitch lake is the original source of all the asphalt which is exploited in the vicinity of the village of La Brea, and between the village and the lake. The surface of the lake is about 138 feet above the sea; its area is about 100 acres; and it is nearly circular in outline. Borings in the central part and near the sides of the lake show that the bitumen fills a bowl-like depression or crater that has steep sides and a depth of more than 135 feet. The minimum available tonnage of asphalt in the crater was estimated at over 9,000,000 tons. Excavations in the lake pitch fill again with asphalt in a short time.

The exports of asphalt from the island of Trinidad decreased slightly during 1908 as compared with 1907, according to the report of the New Trinidad Lake Asphalt Company (Limited), through whose courtesy this statistical information regarding the asphalt of Trinidad has been received. The total quantity of asphalt exported from the island during the fiscal year ending January 31, 1909, was 150,557 short tons, as against 162,096 short tons exported in the year ending January 31, 1908; 145,932 short tons in the year ending January 31, 1907; and 128,685 short tons in the year ending January 31, 1906. More than 2,191,055 short tons of asphalt have been removed from the pitch lake and exported to foreign countries since records have been kept.

Total exports of asphalt from Trinidad, 1905–1908, in short tons.

Year.	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1905 [a]	53,701	13,581	67,282	54,640	577	55,217	5,900	286	6,186	128,685
1906 [b]	71,902	5,292	77,194	68,284	454	68,738	....	....	....	145,932
1907 [c]	97,243	4,642	101,885	59,987	224	60,211	....	230	230	162,096
1908 [d]	92,212	5,886	98,098	51,183	1,276	52,459	....	....	....	150,557

[a] Year ending January 31, 1906.
[b] Year ending January 31, 1907.
[c] Year ending January 31, 1908.
[d] Year ending January 31, 1909.

GRAPHITE.

By Edson S. Bastin.

PHYSICAL AND CHEMICAL PROPERTIES.

Chemically the purest graphite is carbon with a fraction of 1 per cent of ash and volatile matter. In the trade graphite is frequently referred to as plumbago, or black lead. The graphites of commerce contain various impurities, sometimes in large quantities. Graphites showing 90 to 95 per cent graphitic carbon are pure enough for the requirements of the general trade, and for many purposes, such as paint making, graphites with as low as 30 to 35 per cent of graphitic carbon are employed. The mineral possesses certain physical characteristics which enable it to be easily recognized. These are its steel-gray to blue-black color, extreme softness (1 to 2 in the scale of hardness), a greasy feel, and the property of making a black metallic mark on paper. It is opaque in even the thinnest flakes, and the latter, though flexible, are inelastic. The specific gravity in most cases lies between 2.20 and 2.27. The only mineral with which graphite might be confused is molybdenite, from which it differs slightly in color, the molybdenite having a somewhat bluish or greenish tinge; the two minerals may be distinguished by simple blowpipe tests. Graphite is in general a better conductor of electricity than are most of the amorphous forms of carbon. Tests by F. M. Lincoln, of the Niagara Falls Power Company, showed a resistance of 0.00032 ohm in a graphite electrode, while an amorphous carbon electrode of the same size showed a resistance of 0.00124 ohm. In the utilization of graphite the physical characteristics are frequently of the utmost importance. In the manufacture of graphite crucibles, for instance, a graphite of more or less fibrous character is desired. In the manufacture of pencils, on the other hand, a fine, unctuous, amorphous graphite is required.

In the trade two varieties of graphite are generally recognized. The graphite that possesses a lamellar, scaly, flaky, or fibrous structure and that is composed of almost pure carbon is classed as crystalline. The other forms of graphite, of whatever occurrence or appearance, are classed as amorphous. The two varieties are not sharply differentiated, and the distinction appears to be largely in the size of the graphite particles. In compiling the statistics of production for the present report, all the domestic graphite is classed as amorphous except that of New York, New Jersey, and Pennsylvania, which is termed "flake."

ORIGIN.

Graphite unquestionably originates in nature in a number of different ways. The disseminated graphite ores of the Adirondack region are graphitic schists, which were originally sedimentary rocks, but have been converted to their present foliated form by the heat and pressure of dynamic or contact metamorphism. Carbon, presumably of plant or animal origin, probably occurred as a constituent of the original sediments and became graphite in the metamorphism. The graphite of Sonora, Mexico, and of Colfax County, N. Mex., described elsewhere in this report, has been formed through the contact metamorphism of coal beds by intruding masses of igneous rock.

The origin of other types of deposits is less well understood. It seems probable that some of the deposits of graphite in fissure veins, such as certain of the Ticonderoga deposits, are of pneumatolytic origin and were formed by the condensation of carbon vapors penetrating fractures in the rocks during a period of dynamic or contact metamorphism. Neighboring carbonaceous sedimentary rocks appear in most cases to have been the ultimate source of the graphite in such cases. Graphite is also known to occur as an original constituent of granitic rocks, but such occurrences are seldom of any commercial importance.

A graphite-bearing granite-pegmatite in Maine, as recently described, contains graphite to the extent of 9 per cent, it being present mostly in evenly distributed flakes with a few nests of pure graphite an inch in diameter. The graphite is disseminated in the larger masses of quartz and throughout the finer-grained matrix, although not within the larger crystals of feldspar. It appears, therefore, that the graphite crystallized possibly later than the feldspar, but plainly earlier than the quartz, and that, like both of these minerals, it is an original constituent of magmatic origin.

USES.

The characteristics possessed by graphite and already mentioned make it a mineral of great and increasing industrial importance.

The fact that graphite is nearly pure carbon, is relatively inert chemically, and volatilizes only at high temperatures makes it of exceptional value in the manufacture of crucibles for the steel, brass, and bronze industries, etc. Most of the graphite used in the United States for these purposes is imported from Ceylon, the fibrous structure of the Ceylon product, not developed to a like degree in graphite from any other locality known, being of especial value in this utilization, since with clay it forms a stiffer mix than other varieties of graphite. Muffles, stirring rods, and other refractory products are made from material similar to that used in crucibles. The experiments which have thus far been made in the use of American crystalline graphite for refractory products have not yielded results equal to those obtained with the Ceylon graphite. The poorer the binding quality of graphite used in crucibles, the greater the quantity of other binding material which must be added to hold the mass together, thus increasing the more readily fusible constituents of the crucible at the expense of the more refractory, and materially decreasing its life. The so-called amorphous types of graphite have not yet been successfully used in the manufacture of refractory products.

One of the most important utilizations of graphite is for lubricating. The addition of graphite to oil results in a lower frictional resistance than would be obtained by the use of oil alone. The quantity of oil required for a given service is also reduced and a lighter grade of oil or one of inferior quality may be employed without decreasing the quality of the lubrication. A small quantity of graphite only is required, and the benefits derived from its use persist long after the application has ceased. In light bearings of machinery where oil can not be used on account of the danger of soiling delicate textures, graphite can be used alone as a lubricant. Both the amorphous and the crystalline varieties of natural graphite are extensively employed for lubrication. The artificial graphite manufactured at Niagara Falls is also largely utilized in this way, and the Acheson Company has secured a product, termed "deflocculated graphite," which shows little or no tendency to sink when mixed in with oil or water, and when suspended in water will pass through the finest filter paper made. The suspension is obtained by adding small quantities of gallotanic acid and other substances to the medium carrying the graphite. The statement has frequently been made that graphite mixed only with water would form a safe and satisfactory lubricant, since it was believed that the graphite had a tendency to counteract the rust-producing effects of the water. Recent experiments have shown, however, that graphite when mixed with water accelerates rather than retards rusting in iron and steel, and its use as a lubricant with water alone is therefore not practicable.

The use of graphite in the manufacture of pencils is probably both its oldest and its best-known application. This industry in Germany and England is several centuries old, and many of the modern factories manufacture hundreds of varieties of pencils; yet the percentage of graphite used for this purpose is not large, being undoubtedly less than 10 per cent of the world's production, and one authority estimates it as low as 4 per cent. Not all graphite is adapted for use in the manufacture of pencils. Here again the physical condition of the material is all important; the flake graphite, however pure, would yield a "lead" that would slip over the paper without leaving more than a faint streak. Furthermore, it is almost impossible to grind the easily-cleavable flake graphite into a powder of the fineness and evenness of grain requisite for the better grades of pencils. Therefore either a high grade of amorphous graphite or very fine crystalline graphite is regarded as furnishing the best material for pencils. The graphite when used for pencils is mixed with carefully refined clay, usually imported from Germany. The resulting mix is worked and reworked until it is so pliable that it can be looped in coils and even tied in knots. The more graphite and the less clay the softer the pencil; the less graphite and the more clay the harder the pencil. The cores of softer pencils are usually made larger than those of the harder ones, in order to give them equal tensile strength.

Up to a few years ago every American pencil manufacturer had to import his graphite from Bohemia or Bavaria. About ten years ago a large deposit of amorphous graphite was discovered in Sonora, Mexico. This proved to be of excellent quality for pencil making and many other purposes, and the American pencil trade now derives its supply mainly from this source. Some is also exported to European pencil manufacturers.

A utilization which has increased rapidly in importance within the last few years is the manufacture of paint used especially as a rust preventive for structural iron and steel works. Much of the graphite used for this purpose is rather impure, the specifications frequently requiring not more than 35 or 40 per cent of graphite in the paint pigment, the remainder being generally siliceous, aluminous, or ferruginous material. Six graphite paints used in tests on the Pennsylvania Railroad bridge at Havre de Grace, Md., showed from 19.16 to 97.80 per cent of graphite in the pigment. Recent tests made in cooperation between the Office of Public Roads of the Department of Agriculture and the Paint Manufacturers' Association, for the purpose of determining the relative merits of various paint pigments as preservative coatings for iron and steel, have yielded results of great importance, with which makers and users of graphite paint should be familiar. Reference to this report is given in the bibliography.

Large quantities of amorphous graphite and of finely-ground crystalline graphite are used for coating foundry facings. A high degree of purity, though essential for the finest castings, is not necessary in all graphites used for this purpose; in fact, the presence of siliceous material may sometimes be of positive benefit by causing the graphite to cling or spread better on the face of the mold. The high electric conductivity of graphite renders it superior to amorphous carbon for certain electric purposes, such as the manufacture of electrodes for use in electro-chemical industries. Considerable amounts both of amorphous graphite and of finely-ground crystalline graphite are used in the manufacture of stove-polishing powders and pastes. Another use of crystalline graphite is as a protective polish for gun powder and as a packing material for the delicate electric lamp filaments; it is also used in electrotyping and as a filler for dry batteries. An impure and cheap graphite mined in Georgia is used as an adulterant in fertilizers, to which it imparts a dark color and greasy feel; but a still more unusual application has been its use to color and glaze both tea leaves and coffee beans, the pure graphite being a harmless material which protects these articles against moisture and adds to their attractive appearance.

ARTIFICIAL GRAPHITE.

The manufacture of artificial graphite on a commercial scale is conducted by the International Acheson Graphite Company of Niagara Falls, which utilizes electric power generated at the Falls. Mr. Acheson patented the process for the manufacture of graphite by the electric furnace in 1896, and its commercial development has been so rapid that at present the output of artificial graphite is greater than the whole production of natural crystalline graphite in the United States. Pure amorphous carbon appears to be converted into graphite only very slowly in the electric furnace at atmospheric pressures. Pure petroleum coke, for example, yields practically no graphite when so heated, and the carbon cores of the furnace are converted into graphite only when impure. The conversion appears to take place on a commercial scale only when certain amounts of impurities, usually siliceous, aluminous, or ferruginous, are present. These need not form more than 3 per cent of the total mass, but to obtain the best results should be evenly disseminated through the mass. The explanation of the conversion which has been most generally accepted supposes that the amorphous carbon first unites with the siliceous, ferruginous, or other impurities present, to form carbides which are later decomposed with the formation of graphite and the volatilization of the other constituents. The small amount of impurity required to affect the change is explained by supposing that the transfer becomes progressive, vapors of iron or silicon traversing the entire charge, combining with molecules of amorphous carbon and then abandoning them in a graphitic state. This explanation is not, however, accepted by all investigators. Anthracite coal, with a small amount of finely distributed ash, is the material which has yielded the best results commercially. An anthracite with 5.78 per cent of ash has yielded a graphite with only 0.03 per cent of ash. The earlier productions of artificial graphite were not as soft and unctuous as much of the natural graphite, but in 1906 Mr. Acheson devised a process of manufacturing graphite of this type which has since been used in increasing quantities for lubricating purposes. The so-called "deflocculated graphite" is said to be produced by adding small quantities of gallotannic acid and ammonia to oil or water mixed with very fine graphite. The latter, it is claimed, will then remain in suspension almost indefinitely and can thus be fed through ordinary oil cups.

In spite of the development of the manufactured or artificial graphite by the electric furnace, the demand for the natural product has increased very largely in recent years because of the growth of the iron and steel industry, the largely increased use of copper and its alloys, the increased need for lubricants, and the development of electric machinery which calls for graphitized products.

GRAPHITE INDUSTRY BY STATES.

NEW YORK.

Mainly because of the large production of the American Graphite Company, controlled by the Joseph Dixon Crucible Company, New York heads the list of graphite producers. There was a decrease in this State of over a million pounds from 1907 to 1908, but the reported value of the product was somewhat greater in 1908 than in 1907. All of the graphite mines are located in the Adirondack region in Essex, Warren, Washington, and Saratoga counties. The writer visited a number of these properties in April, 1909, and will probably examine other localities during the year. Descriptions of the properties visited in April are given below. The Glens Falls Graphite Company and the Crown Point Graphite Company, which were not operating in 1907, reported production during 1908.

Empire Graphite Company.—A graphite mine worked by the Empire Graphite Company, of Bedford, N. Y., is located about 2¼ miles west of Porter Corners in the town of Greenfield, Saratoga County. The excavations cover about 2 acres along a small ravine on an eastern hill slope, but are only about 25 feet in maximum depth. One tunnel 100 feet long and another about 50 feet long have been driven. The rocks are schists which strike about N. 80° W. and dip about 25° S. They were observed to be graphitic for a thickness of at least 25 feet. It is planned to work the property for the present by open-pit methods, the excavations thus far having been largely of an experimental character.

In general appearance the ore is similar to that of the American Graphite Company, though the graphite flakes seem to be somewhat smaller. The schist is pure silver gray in color when fresh, but weathers to rusty brown and yellow. Certain layers interbedded with the highly graphitic portions are coarser grained and contain only occasional graphite plates, and under the microscope were seen to be composed largely of quartz, altered feldspar, and some biotite.

A sample of the best ore when examined under the microscope showed quartz in interlocking grains as its principal mineral, many of the grains showing undulatory distinction. Feldspar, in part plagioclase and in part orthoclase, is nearly as abundant as quartz, but most of the grains are clouded with alteration products. Brown biotite is present only in small quantities. There are occasional small apatite prisms. Graphite occurs in plates about 0.8 millimeter in average length and 0.09 millimeter in average thickness, though few attain a length of over a millimeter. A considerable quantity of pyrite is also present, the grains usually being in contact with or closely adjacent to the graphite plates. A feature of interest is the fact that the layers of minute fluid inclusions in the quartz grains are all nearly parallel to each other and lie in the planes of schistosity of the rock.

Outcrops are scarce in the immediate vicinity of the mine, but the graphitic schists have been traced by test pits for over 1,000 feet along their strike. At a locality about half a mile north of this mine on the Nathan Towne place graphitic schists similar to those at the Empire mine are interbedded with granite gneiss like that associated with the ore at Graphite, and with thick beds of quartzite bearing occasional mica plates from one-eighth to one-quarter of an inch in diameter. These quartzite beds grade gradually into layers of graphitic schist. They furnish good evidence of the sedimentary origin of the rocks of this vicinity, the original beds being in all probability an alternation of beds of sandstone and shale. These have been brought to their present form of quartzites and graphite schists and garnet schists through regional metamorphism.

The mine was opened in 1906. A large mill has been erected at the mine and was described by F. C. Nicholas.[a] From the mine the rock goes to a gyratory crusher and thence to two sets of crushing rolls. From there it goes to a storage bin and is delivered as fast as needed to buddles, of which there are two sets, the concentrates from the first being treated again in the second. From the buddles the material goes successively to settling tanks, rotary sills, wet screens, rotary drier, and sizing screens. The mill is located on a steep hill slope and all the materials are made to descend by gravity with very little handling. The process appears to be successful in separating the quartz, feldspar, and other granular constituents, but does not effect a separation of the foliated minerals, biotite (brown mica), chlorite, etc. Fortunately, in much of the ore these foliated minerals are rare. Thus far only experimental runs have been made, but the company expects soon to begin producing on a commercial scale. Some of the ore is said to analyze as high as 12 per cent graphitic carbon, though the average would probably not exceed 7 per cent. The actual percentage saved in milling would probably

[a] The Mining World, January 4, 1908.

be considerably lower. The output will have to be hauled 4 miles to the Delaware and Hudson Railroad at Kings station.

American Graphite Company's mine.—This mine is located in the northeastern part of Warren County, about 3 miles west of Lake George in the town of Hague, at a small settlement known as Graphite. The mine is owned by the Joseph Dixon Crucible Company and has been operated by that company for over thirty years. It is by far the largest producing graphite mine in the United States. The ore is a medium-grained quartz-graphite schist, dark silver gray when fresh, but becoming stained yellow and brown upon weathering. This rusty weathering is of assistance in tracing the outcrops of the ore bed. An analysis of a composite sample of ore taken from the bins at the mill and selected so as to be somewhat representative of the run of the mine was analyzed in the laboratory of the United States Geological Survey and showed 6.25 per cent of graphitic carbon.

A sample of this ore when examined under the microscope showed quartz as its dominant mineral. This occurs in irregularly interlocking grains, many of which show undulatory distinction. Muscovite occurs as aggregates of small shreds forming irregular bands and patches. Some of these probably represent decomposed and altered feldspar grains. Apatite is abundant in small prisms with more or less rounded outlines. There is an occasional small plate of biotite. The graphite forms flakes of an average length of about 0.9 millimeter and an average thickness of about 0.09 millimeter. The longest flake in the section was 2.8 millimeters, and a few were as much as 0.2 millimeter in thickness. Cross sections of the plates show them to possess very ragged and irregular borders.

The texture of the rock is decidedly schistose, due to a tendency for the quartz grains to be more or less elongate in the same direction and for many of the graphite plates to be oriented parallel.

The rock overlying the ore bed is in most cases a gneiss with pink garnets up to half an inch in diameter in a matrix composed of interlocking grains of brown biotite, feldspar, and quartz, with a few scattered plates of graphite. Another dark-gray schistose rock which is locally interbedded with the ore, but which is discarded in the mining, is shown under the microscope to consist wholly of quartz, plagioclase feldspar, and greenish-brown biotite, with no graphite. Evidence of sedimentary origin of the rocks of this locality is found in (1) the highly quartzose, nonfeldspathic character of much of the ore; (2) the highly and evenly garnetiferous character of much of the wall rock; (3) the even dissemination of the graphite in the schist which forms the ore; (4) the persistence of ore beds and garnetiferous gneisses with fairly uniform trend, width, and character for considerable distances, and (5) the presence locally of interbanded masses of crystalline limestone. They probably represent carbonaceous quartzites alternating with beds which were less carbonaceous and with thin masses of crystalline limestone, all of which have been wholly recrystallized with the development of a schistose structure and the conversion of the original carbonaceous material into graphite through the heat and pressure of dynamic metamorphism.

The general strike of the schist at this locality is nearly N. 45° E. and the dips are from 20° to 25° SE. Ore has been mined from two distinct beds several hundred yards apart. The southeastern of these pits is not now worked, but was excavated several years ago at what is known as the "summer pit," the workings being shallow and operated only during the summer season. The ore bed here strikes about N. 50° E. and dips 20° SE. The thickness at the mouth of the pit is from 6 to 10 feet. The workings extend at least 600 feet along the strike, but were not carried to any great depth along the dip. This pit was opened about 1890 and operated for two or three summers after that. The ore is similar to that of the bed now being worked, and a very large supply is probably still not touched.

The main or northwestern bed (which is the one now being worked) is parallel to that at the "summer pit" in strike and dip. Its outcrop is visible at a number of old workings near the mine. All of the present work is underground, and excavations have extended for about 2,000 feet along the dip of the ore bed, the deepest parts of the mine being about 200 or 250 feet below the surface. The thickness of the productive bed varies from 3 to 20 feet, the average being much nearer the larger limit than the smaller. Occasional lens-shaped enlargements of the productive bed are made, and one of these is being mined at the present time in what is known as the "sink." At one of the outcrops a strike of nearly N. 60° E. and a dip of 25° SE. was observed; at another the dip was slight, but the strike nearly N. 45° E., and the thickness about 10 feet. Because of the gentle inclination of the ore bed no tunnels or shafts need be driven through barren rock, and practically all of the excavation is within the ore bed itself, the wall being supported by timbering and by occasional pillars of ore. The excavating is accomplished by compressed-air drills and blasting, and the ore is broken with sledges into pieces under 8 or 10 inches in diameter, loaded upon cars, and hauled by electric locomotives to the mill. The latter is located at the mine, but was not visited by the writer, the processes of treatment being kept secret. The concentrates obtained at this mill are said to average about 3 per cent by weight of the ore mined. From this mill the concentrates are hauled by teams 11 miles to Ticonderoga, where they receive final treatment in the finishing mill of this company.

What was known as the Lake Shore mine, worked by this company at Hague several years ago, has been abandoned and the mill at Hague demolished.

Faxon's mine.—The property adjoining the American Graphite Company's land on the southwest is owned by William H. Faxon, of Chester, N. Y. Some excavating and prospecting have been done, but no ore has been shipped. The principal workings are located about a mile southwest of the mill of the American Graphite Company. Here the ore bed shows in a natural exposure on the side of a small creek valley, and a tunnel about 40 feet long has been driven horizontally along the strike of the ore bed. The ore and associated rocks here strike N. 50° E. and dip about 20° SE. In general appearance the ore is practically identical with that at the Dixon mine. The microscopic appearance of the sample is as follows:

Under the microscope quartz in irregular interlocking grains is seen to be the most abundant mineral. Feldspar, in part plagioclase and in part microcline, also occurs, but has suffered considerable alteration. Brown biotite is present in small quantities, as are also small rounded prisms of apatite. Graphite occurs in plates averaging about 0.45 millimeter in length and about 0.075 millimeter in thickness though a few are 0.75 millimeter long. The schistose structure, which is quite marked in this rock, is due to the parallel elongation of many of the graphite and biotite plates and a slight tendency for the quartz grains to be elongate in the same direction.

The ore bed here has a thickness of about 25 feet, though the percentage of graphite varies somewhat from layer to layer. The rock overlying the ore bed is in part a gneiss studded with pink garnets similar in every way to that overlying the ore at the American Graphite Company's workings. This gneiss contains a few graphite flakes. Interbedded with the gneiss occurs crystalline limestone, light gray in color and fine-grained, which under the microscope shows scattered pyroxene grains and a few quartz grains and graphite plates. There is evidence of shearing movement in the beds overlying the ore, lenses of quartz schist surrounded by crystalline limestone having been broken in several instances and the fragments dragged apart, though still preserving their angular outlines. There is also some crumpling in the more quartzose layers.

It is probable that the ore bed at the Faxon mine is the continuation of one or the other of the beds worked by the American Graphite Company, though their continuity has not been certainly traced. The ore is similar in quality, and there seems to be no reason why this property should not in the future be worked as successfully as the adjoining one.

Glens Falls Graphite Company.—This company, with office at Glens Falls, has a mine in the town of Day, Saratoga County. The property is located about $1\frac{1}{4}$ miles due west of Conklingville in the Sacandaga Valley, and may be reached by an 8-mile drive from Hadley, on the Adirondack branch of the Delaware and Hudson Railroad. The mine was opened in the spring of 1906. It consists of a single open pit on a southwest hill slope at an altitude of about 1,000 feet. The excavations have extended only to a depth of about 20 feet and cover an area of about one acre. The rocks are gneisses whose strike varies from about N. 70° W. to east and west, with average dips of about 30° N. The schists are coarsely banded and show notable variation in composition from layer to layer. Some bands are light gray and even grained, and under the microscope are seen to be composed of a granular aggregate of interlocking quartz and feldspar grains, with small lenses of more coarsely crystalline quartz and bands of small garnets. Other layers are highly garnetiferous, the garnets averaging about one-fourth of an inch in diameter, though some are three-fourths. These barren portions of the schist alternate with bands which are graphitic.

Much of the graphitic gneiss at this locality is dark silvery gray in color and shows an alternation of thin layers which are highly micaceous and graphitic with other layers from one-eighth to one-fourth of an inch across, which are largely composed of feldspar or quartz. Occasional single crystals of feldspar one-fourth of an inch across are developed and are evidently secondary, since they replace rather than displace the banding. Under the microscope finer-grained bands are seen to consist of a granular aggregate of quartz, orthoclase, and biotite, with some graphite flakes. Other layers are rich in epidote, which is colorless in a thin section. The graphite plates are not so evenly distributed as in the schist at the American Graphite Company's mine, but usually occur in very irregular aggregates, and some of the plates have a length of 3 or 4 millimeters.

Only the more highly graphitic portions of the schist are now being saved in the mining. These usually form more or less lens-shaped masses from a few inches to a foot or more in length, inclosed by the less graphitic rock. Since the workings are at present shallow, much of the ore is partly decomposed and rather soft. Although the percentage of graphite is locally much higher than in deposits like those at Greenfield and Graphite, where the flakes are more evenly disseminated, the ore is much less regular in its distribution, and it is difficult to predict anything in regard to its probable extent laterally beyond the present exposures, or in depth. The origin of the graphite-bearing gneiss is not entirely clear. It probably represents, in part at least, sediments which have been severely metamorphosed, but there is some indication in their highly feldspathic character that they may, previous to the metamorphism, have been more or less injected by granitic material. The mill of this company is located about 1,700 feet southwest of the mine and is operated by the water power of a small creek. Only test runs have been made with the graphite from this mine, but the power is being partially utilized for very fine grinding of Ceylon graphite for electrotyping.

Jumbo graphite mine.—This mine is located on Bear Pond Mountain, in the town of Ticonderoga, and is reached by an 11-mile drive from Crown Point. Only prospecting work has been done at this locality, but it has been extended over a large area, so that a very good idea can be obtained as to the extent of the ore. At the test pit dug across the trend of the schist on the northeast slope of Bear Pond Mountain the schists strike about N. 65° W., and are nearly vertical. Farther west strikes of N. 80° E. and N. 85° W. were observed; and at the upper pit high up on the northwestern slope of the mountain the strike was nearly 70° E. and the dip vertical. This latter hillside pit is 15 feet in maximum depth and 15 feet wide, and exposes 20 feet of graphitic schist at right angles to the strike. Strippings above the pit raise the known thickness of graphitic rock to about 100 feet. At another small pit about 10 by 12 feet and only 5 feet in depth, at the extreme western part of the summit of the mountain, the schists are vertical and strike about east and west. They are also more quartzose and more contorted than at the other pits. The first pit which was opened is on the south side of the summit and is about 20 by 20 feet and 15 feet in depth. Exposures in the pit and strippings above the pit show about 40 feet of graphitic schist measured at right angles to the trend. The pits on the south side of the mountain are plainly in a separate graphite bed from those on the north side of the mountain.

Exposures in these pits and the natural outcrops show that almost the whole mountain is composed of quartz-mica schists, locally becoming very highly quartzose, which have a fairly regular strike of about east and west and are about vertical in dip. Within these masses occur at least two broad bands of graphitic schist, one on the north side of the mountain which locally attains a width of at least 100 feet, and another on the south side of the mountain locally at least 40 feet wide. Both of these, and especially the northern one, have been traced for considerable distances parallel to the trend of the schist. The supply of graphitic rock is unquestionably large, probably larger than at any other locality thus far prospected in the State. The ore is typically a dark gray, rather coarse and even-grained schist, containing locally small lenses of quartz and feldspar which are much coarser and are pegmatitic in their texture. These may represent small intrusions of granite-pegmatite, but the apparent lack of connection between them and any larger masses of granite favors the idea that they are portions of the schists which crystallized more coarsely in the metamorphism that has affected all the rocks in the mountain. At some of the shallow openings on the northeast slope of the mountain the rock is much decomposed, and the graphite instead of being evenly distributed is most abundant in small lens-shaped masses which constitute what is called by the owner of this property the "soft ore." Careful examination shows this to be graphitic schist similar to the hard ore but much more decomposed.

The geology of this region has been mapped by Miss Ida H. Ogilvie,[a] who regards the schists of Bear Pond Mountain as of sedimentary origin and pre-Cambrian age. Miss Ogilvie's view, in regard to the origin of the disseminated graphite ores, with which the present writer is in full accord, is as follows:[b]

> The widespread dissemination of graphite scales in sedimentary limestone and quartzite can best be explained on the organic hypothesis. There seems no possibility of any origin but that of a metamorphic product from some original constituent of the rock, and regional metamorphism is the only process by which it can reasonably be supposed to have been formed. It seems most probable that the original limestone and sandstone were heavily charged with organic material which in the pre-Potsdam period of metamorphism was completely reduced and in some part volatilized.

Three samples of ore from different prospect pits on this property were examined under the microscope and were found to be composed of interlocking grains of quartz and feldspar in nearly equal abundance, with much biotite (brown mica) and an occasional grain of epidote. The feldspar is in part orthoclase and in part andesine, and many of the grains are clouded with alteration products. The biotite is in part altered to chlorite. Nearly all of the graphite present is either intergrown with the biotite or closely associated with it. Most of the graphite plates are bordered on both sides by biotite and lie between the biotite laminæ as between leaves of a book. Thus biotite crystals 0.15 to 0.45 millimeter thick may inclose graphite flakes of about one-tenth this thickness. The fairly well-developed schistose structure is due to the fact that most of the biotite and graphite plates are oriented in a common direction.

The parallel intergrowth of much of the graphite with brown mica in this ore would unquestionably increase the difficulty of the separation of these two minerals in the milling processes. Fine grinding of some of the ore by the writer shows, however, that a partial separation can be effected in this manner, and portions of the deposit may be found which are sufficiently free from biotite so that this difficulty need not be reckoned with.

Analyses of four samples of ore from various pits at this property made for the owners are reported to run 6.4, 6.6, 6.2, and 8.8 per

[a] Geology of the Paradox Lake quadrangle: Bull. 96, New York State Mus., 1905 (30 cents).
[b] Op. cit., p. 505.

cent of graphitic carbon. An analysis of a composite sample selected in 1904 to represent as nearly as might be the general run of the mine showed about 5 per cent of graphitic carbon.

The plans for developing the property include erection of a mill at the mine for rough concentrating and the erection of a finishing mill at Crown Point village. Both of these mills can be run by water power, and electric power can be generated for the cheap operating of the mine machinery. Since the graphitic schists are vertical, open-pit methods of mining will be the most economic.

Crown Point Graphite Company.—This company operates a graphite mine about 7½ miles southwest of Crown Point Center, 11 miles from Crown Point station, and about 10 miles from the railroad at Ticonderoga. A concentrating mill is located at the mine and a finishing mill at Crown Point Center.

The mine is located on the northern slope of the low ridge north of Chilson Lake. The ore is a graphite-bearing crystalline limestone, and the single bed now being worked strikes about N. 65° to 70° E. and dips 55° to 60° S. The width of the limestone bed varies from 3 to 7 feet, and it is traceable along its strike for over 1,000 feet, east-northeast from the shaft. A second bed of graphitic limestone occurs about 375 feet south of the main bed, but is apparently narrower and not traceable far along its trend. Other bands and lenses of graphitic limestone thus far discovered in the vicinity appear to be small and probably are not of much commercial importance.

The best ore from this mine is light gray in color and is made up almost entirely of calcite grains and plates of graphite, with a few scattered grains of pyroxene. Much of the ore, however, is a darker gray in color, due to the presence of more pyroxene. Under the microscope this type of ore is found to consist of interlocking grains of calcite averaging about 2 millimeters in diameter, of pyroxene largely altered to chlorite, and of graphite plates. Most of the latter range from 0.9 to 3 millimeters in length and from 0.15 to 0.3 millimeter in thickness. The rock shows very little tendency toward a schistose structure and the graphite plates are oriented in every direction. A faint banding is due to the greater abundance of pyroxene (green to the naked eye) in certain layers than in others. Little or no mica is present.

A composite sample of the ore selected by the writer so as to represent approximately the run of the mine was analyzed in the laboratory of the United States Geological Survey and showed 2.97 per cent of graphitic carbon.

Granite occurs near the ore body in dikes which are mainly parallel to the limestone in trend, but which here and there cut across the trend of the limestone and the associated schists and are therefore distinctly intrusive in them. At several points typical granite occurs within a few feet of the ore bed. A light gray rock, which is locally interbanded with the graphitic limestone, is seen under the microscope to be a fine granitic aggregate of quartz, microcline, and some garnet, and this may be an aplitic offshoot from the more typical granite. Rocks, in which gray bands alternate with bands which are dark-green to brownish-black ore, are interbanded with the ore. Under the microscope the dark bands are found to consist largely of pyroxene with some biotite, while the lighter bands are quartz and feldspar with occasionally some calcite and pyroxene grains. Certain phases of the schist associated with the ore are coarsely crystalline, showing dark-brown pyroxene crystals over 1 inch in length, crystals of calcite one-half inch to 1 inch across, pyrite grains one-half inch or so in diameter, and graphite plates up to one-half inch across.

This locality lies near the border of a large area of granite of pre-Cambrian age. The even distribution of the graphite through the crystalline limestone renders it probable that the carbon formed an original constituent of the limestone. Its conversion to the graphitic state, the recrystallization of the limestone, and the development in it of the mineral pyroxene are the result of metamorphism, possibly in part dynamic but due to some extent to the contact effect of the neighboring masses of granite rock, as shown by the development of pyroxene schists and coarse crystalline aggregates of pyroxene, calcite, pyrite, and graphite. As already stated, the ore bed persists laterally with fairly uniform width and values for over 1,000 feet. There is no evidence that it may not also persist to a considerable depth, although the proximity of intrusive granite renders it liable to be cut off at any point by that rock.

The development work, aside from shallow surface pits, consists of an inclined shaft about 72 feet in depth, from which the miners have drifted eastward along the ore bed removing a considerable amount of ore by stoping and finally reaching the surface again about 150 feet east-northeast of the shaft. From the shaft the ore is hoisted direct to storage floors at the mill and after preliminary crushing and drying is concentrated by dry processes which are not made public. The mill is said to have a capacity of 30 to 50 tons per ten-hour day. From this mill the concentrates are hauled by teams 7½ miles to a finishing mill at Crown Point Center. The finished product is bagged and hauled 2½ miles to the railroad at Crown Point. The plant to date has been in more or less of an experimental stage, but the product, though small in quantity, appears to be of good quality. The ore, being calcareous, is soft and easy milling.

Ticonderoga graphite mine.—This mine is located on the eastern slope of Chilson, or Lead Hill, about 3 miles northwest of Ticonderoga, and was worked for many years by Dixon's American Graphite Company. It has now been idle for a number of years, but the supply of graphite ore is not exhausted, and it appears probable that the property will be worked again in the future.

The workings consist of a large number of small open pits and several of larger size scattered over an area of several acres in extent. One of the largest of the open pits is about 20 by 40 feet and 20 feet deep, and two short tunnels have been driven from it. The workings first reached in approaching this property along the wagon road are underground and are said to be quite extensive. At the time of the writer's visit they were partly filled with water and could not be entered for any great distance.

Geologically this is one of the most interesting localities with which the writer is familiar. The rocks are granite gneisses, pegmatitic granites, and coarse granite-pegmatite, which are associated with schists and crystalline limestones, into which they are plainly intrusive and which appear to have produced marked contact-metamorphic effects, with the development of certain unusual rocks characterized by a typical assemblage of contact-metamorphic minerals.

Where the granite gneisses are exposed they strike about east and west, nearly parallel to the trend of the associated schists. The gneissic phases of the granite grade into others which are somewhat pegmatitic, with feldspar crystals seldom more than 2 inches in diameter. The only mass of coarse pegmatite exposed at this locality is a highly quartzose one exposed at one of the larger pits. The quartz is white to dark gray. Feldspar is absent throughout most of this mass, but is present with pyroxene and an occasional black tourmaline in some of the apophyses which branch from the main mass. The quartz pegmatite is largely barren of graphite, though carrying an occasional isolated plate near its border. In the finer-grained pegmatites and the granite gneiss practically no graphite occurs, except close to the contact. The schists intruded by the pegmatite trend at one place east and west, with a dip of about 55° S. Crystalline limestone at one place shows a trend of about N. 70° W., and a dip of 30° S. Much of the schist is highly quartzose and was probably originally an impure sandstone. The beds of crystalline limestone pinch and swell and are sometimes cut off by the granitic rocks. None were observed which were over 3 to 4 feet in thickness. Occasional schist fragments are inclosed in the pegmatitic granite, and, although more or less recrystallized, still preserve their angular outlines and foliated structure.

The graphite occurs in veins, and is also irregularly distributed throughout what appears to be a contact metamorphic zone between pegmatite and pegmatitic granite and the schists and limestone which they intrude. In the latter occurrence it forms plates usually less than one-half inch across, but locally over 1½ inches, oriented in every direction, with the interspaces occupied sometimes by scapolite, which superficially resembles light-gray feldspar, sometimes by pinkish to green pyroxene, and sometimes by an association of both these minerals. Some aggregates, several inches across, are composed almost wholly of graphite plates, and constitute one of the principal types of rich ore. Masses several feet across associated with the graphite consist of a granular aggregate of dark-green or pinkish pyroxene grains averaging about 2 millimeters in diameter, with only on occasional crystal of calcite, scapolite, or graphite. Between this and the rich graphite ore there is every possible gradation. Aggregates of coarsely crystalline graphite and scapolite sometimes traverse the fine-grained granular pyroxene aggregates in a more or less veinlike, though irregular manner. Near the contact between the pegmatitic granite and the crystalline limestone, as exposed at the most extensive of the underground workings, the graphite is associated with large crystals of dark-green pyroxene 6 inches across, crystals of calcite of equal size, and large crystals of quartz, scapolite, and biotite. Weathering away of the calcite in some cases shows the pyroxene with very perfect crystal forms. Vesuvianite was observed in crystals about one-half inch in diameter, associated with the pyroxene at this working.

The second mode of occurrence of the graphite at this locality is in narrow veins from 1 to 2 inches wide, most of which are vertical and trend nearly north and south. They cut indiscriminately across the schists and pegmatitic granite, but in a number of cases apparently disappear when crystalline limestone is reached. In them graphite is usually the only mineral recognizable and forms aggregates of nearly parallel blades arranged about at right angles to the walls of the vein and closely resembling certain of the Ceylon occurrences. In most places the walls of the veins are sharp, and the pegmatitic granite shows no change of texture next to the vein. In a few places, however, the pegmatite becomes pyroxenic, finer grained, and somewhat graphitic next to the vein.

In conclusion, the field evidence seems to indicate a contact metamorphic origin for the graphite of this locality and its associated pyroxene, scapolite, vesuvianite, coarsely crystalline calcite, quartz, etc. In less technical language, these minerals appear to have been formed through the alterations produced in masses of limestone of varying purity by masses of pegmatite and pegmatitic granite which were forced into them in a hot and somewhat fluid condition. Since graphite is not observed in these granitic rocks at a distance of more than a few feet from the sedimentary rocks, it was probably not derived from these igneous rocks, but, on the contrary, was an original carbonaceous constituent of the sedimentary rocks, and has been recrystallized in the contact metamorphism. The vein occurrences of graphite appear to have been formed in the later stages of this metamorphism, and may represent sublimations from carbon vapors.

RHODE ISLAND.

Graphitic shales have been worked in Rhode Island for many years, though only small quantities of this material are at present produced. The deposits occur in the vicinity of Providence and near Tiverton, in Newport County, and have been studied by Prof. C. W. Brown, of Brown University, who furnishes the following descriptions of their mode of occurrence and development:

Graphite has been known in the State for more than twenty years, and during the excavation of the sandstone on the east side of Rocky Hill, in Cranston, about 1,000 tons of graphitic "waste" were dumped on the site of the present Narragansett brewery. No successful attempts at development were made, however, until about 1888. All of the graphite of the Narragansett basin règion is similar in character and in mode of occurrence. The largest workings are located at Cranston, near Providence. Smaller deposits occur at Saunderstown, and at Pawtucket and Valley Falls. All the deposits thus far enumerated occur in the Kingstown series of Carboniferous rocks near the western border of the Narragansett basin. Graphite is found also at one locality on the eastern border of the Narragansett basin between Tiverton and Little Compton, and at two localities nearer the center of the basin at Portsmouth, and in the College Hill tunnel in Providence. At these localities it occurs in carbonaceous beds of the Aquidneck series.

PROVIDENCE COUNTY.

Cranston mines.—The largest of the Rhode Island mines is at Fenner Ledge, in Cranston, a suburb of Providence, and is typical of the mode of occurrence in the western portion of the Narragansett basin. This locality has in the past been worked by a number of companies, among others the Rhode Island Graphite Company. A stock company, capitalized at $50,000, was formed in 1898 by J. Mason Gross. The venture, however, was not a success, and for the last two years the property has been worked on a small scale by Mr. Fenner.

The section at Fenner Ledge, as exposed from west to east on a quarried face, is as follows:

Section at Fenner Ledge, Cranston, R. I.

	Feet.
Slightly sheared coarse sandy shale, with occasional pebbly beds	60
Darker, more carbonaceous shale, speckled with glistening plates of ottrelite	75
Graphitic shale, much crumpled and possibly faulty	20
Sandy shale	25
Highly contorted graphitic shales showing lustrous graphite on the sheared surfaces, with more clayey material between; some small quartz and pyrite veins (this is the principal portion which has been worked for graphite)	30
Somewhat carbonaceous shales, with a small bed which is quite graphitic	100+

Just south of the cliff section described above, at the openings formerly worked by the Rhode Island Graphite Company, the most graphitic portions show close folding with westerly overturning and a gentle northerly pitch. The worked bed is 12 to 14 feet wide, and pinches out upward. The strike is north-northeast, with an easterly dip of 50°. A drift some 30 feet high has been carried along this bed for about 100 feet. As much as 15 tons was taken from this property per diem with a working force of 12 men. In all, about 30,000 tons must have been taken out during the intermittent operations of this property for the last ten years. The plant, which is now abandoned, consisted of a 50-horsepower hoisting engine, sheds for crushing, pulverizing, drying, bolting through silk or brass mesh (from 160 to 220 to the inch), and barreling. The product was shipped to eastern and western firms for foundry facings.

The present operations are confined to the open quarry face, whose detailed section is given above, and about 300 tons of crude material have been shipped in the last two years, at an average selling price of $6 per ton. The material is excavated cheaply by hand drilling and blasting, and shipments are made to the Springfield Facing Company, Springfield, Mass.; to Cincinnati; Detroit; Hamilton, Ontario; New York City, and to New Jersey firms.

NEWPORT COUNTY.

Tiverton quarry.—The graphitic schist worked between Tiverton and Little Compton is exposed in an open cut on the beach. It is exposed for a length of 70 feet and a width of 25 feet. Since it is located at tidewater, any downward development will have to take this factor into consideration. Henry Sisson has worked this occurrence on a lease for the last ten years, and in that period has extracted at a low cost per ton about 200 tons. After grinding by the Springfield Facing Company, it is sold for paint at about $100 per ton. Recently some contracts for painting bridges and gasometers with this paint have been made. The graphite at this locality appears to be more unctuous to the touch than that at other places. There has been more shearing and faulting, but less contortion, than to the westward. Underneath there are also some occurrences of crude hematite and larger quartz veins than at Cranston.

Other localities with shafts were filled with water, and no data could be secured.

All the evidence shows that the graphite represents an original carbonaceous constituent of these rocks, which has been converted into its present form by heat and pressure. The most highly graphitic portions of the graphite-bearing formations are the softest and the most crumpled.

In the following table analysis No. 1 shows the composition of an average specimen of the graphitic shale from the Cranston property, and analysis No. 2 shows the composition of a selected specimen:

Analysis of graphitic shale from Cranston mines, Rhode Island.

	1.	2.
Volatile	5.92	7.86
Graphitic carbon	40.76	25.27
Ash	53.32	66.87
	100.00	100.00

PENNSYLVANIA.

Pennsylvania ranks third in the list of crystalline graphite producing States, and three firms reported production in 1908. The production was 356,000 pounds, valued at $16,740, or 1,318,000 pounds less in quantity and $35,220 less in value than in 1907. Two firms, active in 1907, ceased operations in 1908, while two other firms, not operating in 1907, were producing in 1908. Most of the mines were operated only part of the year. The Federal Graphite Company, which has been idle since 1906, is remodeling its mill and expects to resume operations in 1909 under the name of the Ferro Carbon Mining Company. All the mines are located near Chester Springs and Kimberton, in Chester County. References to the only published descriptions are given in the bibliography.

NEW MEXICO.

Small quantities of graphite are mined near Raton, in Colfax County, and are ground for use in the manufacture of paint. The following description of these deposits has been furnished by Willis T. Lee, of the United States Geological Survey:

A large body of amorphous graphite occurs in the canyon of the Canadian River about 7 miles southwest of Raton, in Colfax County, N. Mex. The bed lies practically horizontal and has been prospected for a distance of several miles along the outcrop in the Canadian and its tributary canyons and traced laterally into the principal coal bed of the Raton field, which contains bituminous coking coal. Igneous rock was forced into the coal-bearing sedimentaries in many places in this field and usually formed coke where it came into contact with the coal, but in the Canadian Canyon many sills were formed both above, below, and in the coal, and apparently the sedimentary rocks were heated through a considerable thickness. The coal has been most completely graphitized where the bed was fractured and diabase forced into it. Graphite occurs in "pockets" or irregular masses in the diabase and is more or less columnar normal to the faces of the igneous rock.

Several years ago a prospect opening was run in on the coal bed 160 feet, and about 250 tons of graphite were mined for the manufacture of paint. The ore contains 77.12 per cent of carbon, 16.73 per cent of ash, 0.17 per cent of sulphur, and 6.15 per cent of volatile matter consisting principally of water. It was crushed and the graphite separated from some of the impurities by means of air blasts, the refined product containing 80 per cent of carbon which was considered sufficiently pure for the manufacture of paints.

OTHER STATES.

In Alabama several firms active in 1907 suspended operations in 1908, and the production was reduced almost one-half. In Georgia two concerns, which in 1907 mined large quantities of graphite for use in fertilizers, suspended operations during 1908. One of them, the American Graphite Company, reports the sale of their property in August, 1908, to C. M. Jones. The Detroit Graphite Company continued operations at their mine in Baraga County, Mich., on the western extension of the Marquette range. The ore is a graphitic slate which is shipped to Detroit and there ground for use as pigment. In Missouri graphite was mined by two concerns near Junction in Portage County; it is ground for pigment. In Colorado the Federal Graphite Company, with a mine 3 miles east of Turret, in Chaffee County, reported an increased production in 1908. The product is shipped to Warren, Ohio, for refining. In Idaho a graphite mine is reported to have been opened near Ketchum. In Alaska development and proving work was continued at the Alaska Graphite Company's property near Teller.

MEXICO.

The following description of the graphite mines of Sonora, Mexico, has been furnished by Frank L. Hess, of the Survey, who visited these properties early in 1909:

The Santa Maria graphite mines, which are owned by the United States Graphite Company, of Saginaw, Mich., are situated about 20 miles south and a little east of La Colorada, in central Sonora. They are the largest amorphous-graphite mines on the Western Hemisphere and probably in the world. The country rock is composed of metamorphosed sandstone, ranging in fineness from shaly material to conglomerate containing pebbles of 1½ inches diameter. Considerable andalusite in small crystals is developed in the sandstone. The rocks are probably of Upper Triassic age. They are intruded by granite, which has been the metamorphosing agent. Intercalated with the sandstone are at least seven beds of graphite, ranging in thickness up to 24 feet and standing at high angles. The rocks are considerably folded, and the graphite beds show the effect of movement more than the inclosing sandstone; in places they are almost cut off through squeezing, while in other places they show thickening. The graphite beds are also intruded by granite dikes, and in places the walls are of granite. The graphite was undoubtedly formed through the metamorphism of coal beds, which in other parts of the State are to be found in the form of coke, anthracite, and bituminous coal. The graphite of the Santa Maria deposits is entirely amorphous, and from the main vein worked averages about 86 per cent graphitic carbon. Specimens may be picked which carry 95 per cent graphitic carbon. The company is steadily mining graphite and has accumulated a considerable quantity at the mine, as no shipments have been made for some time. However, it expects to begin shipping again shortly. It is working about 30 men in one shift. The graphite is shipped to Saginaw, Mich., for refining. A large part of the best pencils, both of European and American manufacture, are made from this graphite. It is also used as a lubricant, for powder coating, and for foundry facings. A few miles north of Torres, and 3 miles west of the railroad, Pettinos Brothers, of Bethlehem, Pa., own graphite deposits, for which a good price was paid a few years ago. A small amount of graphite was shipped, but the property is now lying idle. Prospecting is being carried on for graphite on the east side of Yaqui River, a few miles above Onavas. The geology is similar to that of the deposits at Santa Maria, about 75 miles west. At San Marcial, between Santa Maria and Onavas, coal is found partly graphitized; and at points on Yaqui River above Onavas unaltered coal beds are reported, which, it is said, the Southern Pacific controls and will use for fuel on its Mexican lines.

PRODUCTION AND CONSUMPTION.

NATURAL GRAPHITE.

Production.—In 1908 domestic graphite was produced by only sixteen firms operating in nine different States. The financial stringency had a disastrous effect on this industry, the total number of tons of natural graphite produced in 1908 being less than one-tenth of the production of 1907. This great decrease is due principally to the fact that the Georgia firms which in 1907 produced a large number of tons of graphite for use in fertilizers, suspended operations during 1908. As, however, the value of this material is only about $1.25 per ton, the falling off in the value of the total graphite production of the United States from $296,970 in 1907 to $208,090 in 1908, is not commensurate with the decrease in the tonnage.

In 1908, as in 1907, New York ranked first, Alabama second, and Pennsylvania third in both quantity and value of the natural graphite produced.

In the following table are given the statistics of production of natural graphite in the United States, by States, in 1908:

Production and value of natural graphite in the United States, 1908, by States.

State.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
Alabama	453	$33,750			453	$33,750
New York			1,932,000	$116,100	966	116,100
Pennsylvania			356,000	16,740	178	16,740
Other States [a]	990	41,500			990	41,500
	1,443	75,250	2,288,000	132,840	2,587	208,090

[a] Includes Alaska, Colorado, Michigan, Nevada, New Mexico, and Wisconsin.

The following table gives the production and value of both crystalline and amorphous graphite in the United States for the last five years:

Production of natural graphite, 1904–1908.

Year.	Crystalline.		Amorphous.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Short tons.*		*Short tons.*	
1904	5,681,177	$238,447	16,927	$82,925	19,768	$321,372
1905	6,036,567	237,572	21,953	80,639	24,971	318,211
1906	5,887,982	238,064	16,853	102,175	19,797	340,239
1907	4,947,840	171,149	26,803	125,821	29,277	296,970
1908	2,288,000	132,840	1,443	75,250	2,587	208,090

Imports.—The following table gives the imports of graphite into this country since 1903:

Imports of graphite into the United States, 1903–1908, in short tons.

Year.	Quantity.	Value.
1903	17,928	$1,207,700
1904	14,195	905,581
1905	17,457	983,034
1906	25,487	1,554,212
1907	22,939	1,777,389
1908	11,456	762,367

ARTIFICIAL GRAPHITE.

As shown in the following table, artificial graphite increased in both quantity and value in 1908 over the production of 1907, but the average value of the product fell from $0.073 per pound in 1907 to $0.068 per pound in 1908:

Production and value of artificial graphite, 1904–1908.

Year.	Quantity.	Value.	Price per pound.
	Pounds.		*Cents.*
1904	3,248,000	$217,790	6.70
1905	4,591,550	313,980	6.83
1906	5,074,757	337,204	6.64
1907	6,590,000	481,239	7.30
1908	7,385,511	502,667	6.80

WORLD'S PRODUCTION.

The world's production of graphite for the years 1905, 1906, and 1907, as gathered from various government publications, is as follows:

World's production of graphite, 1905, 1906, and 1907, in short tons.

Country.	1905.		1906.		1907.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	24,971	$318,211	19,797	$340,239	29,277	$296,970
Austria	37,937	274,154	42,016	293,615	53,013	387,930
Canada	541	17,033	446	18,780	579	16,000
Ceylon	[a] 34,319	2,307,042	40,320	3,406,550	36,406	2,889,596
France	110	1,351	276	2,433	138	1,206
Germany	5,424	49,742	4,470	47,122	4,409	47,671
India	2,603	82,085	2,912	48,709	2,725	35,949
Italy	11,654	52,104	11,910	61,162	12,125	61,374
Japan	230	18,201	155	12,191	115	5,222
Mexico	1,069	42,916	4,315	77,110	3,530	54,339
Norway	....	....	2,101	5,884	1,543	14,974
Sweden	44	1,276	41	1,197	36	946
Queensland	36	1,324	34	973	34	965
	118,938	3,165,439	128,793	4,315,965	143,930	3,797,142

[a] Exports.

SELECT BIBLIOGRAPHY.

The literature dealing with graphite is voluminous and contains many repetitions and quotations. The following list is selected so far as possible to avoid duplication and yet convey all the important information relative to the use and production of the mineral in the United States. Under such references the general scope of each paper is described, and attention is directed to its most important features. The list is incomplete, but will be added to from time to time.

GENERAL TREATISES.

Mineral Resources of the United States, 1899–1907. Brief summaries by various writers of the progress of the industry in the United States to date of writing. The most important are the following:

- 1903. Pratt, J. H., pp. 1121–1129, includes description of processes of manufacturing artificial graphite; quotes Young on assaying graphite ores.
- 1904. Pratt, J. H., pp. 1157–1167, good brief summary of occurrences and uses.
- 1905. Smith, G. O., pp. 1266–1269, calls attention to occurrence of graphite as original constituent of certain igneous rocks; discusses types of graphite best suited for manufacture of crucibles and of lead pencils.
- 1906. Smith, G. O., pp. 1139–1143; gives summary of characters, occurrence, and uses of graphite.

Mineral Industry for 1893 to 1908, inclusive, vols. 2 to 18. Annual statements of the progress of the graphite industry. The most important numbers are the following:

- 1893. Vol. 2, pp. 335–342, describes foreign and domestic occurrences and uses, with numerous references to foreign literature.
- 1897. Vol. 6, pp. 387–390, discusses particularly the use of graphite paint for metallic structure.
- 1898. Vol. 7, pp. 382–387, contains short description by T. C. Hopkins of Chester County (Pa.) deposits; quotes Weinschenk on mode of occurrence of graphite in Bavarian and Bohemian deposits.
- 1899. Vol. 8, pp. 348–352, description by T. C. Hopkins, of Berks County (Pa.) deposits; discussion of artificial graphite by E. G. Acheson.
- 1900. Vol. 9, pp. 378–383, discussion of assay of graphite by blast and fusion, by F. S. Hyde.
- 1901. Vol. 10, pp. 367–373, two pages devoted to artificial graphite.

1902. Vol. 11, pp. 343-353, W. E. H. Carter, on the graphite industry in Canada during 1902; two pages on artificial graphite.

1907. Vol. 17, pp. 567-575, F. S. Hyde, on some characteristics of natural graphite; describes occurrence of graphite in Alabama, New Jersey, and Wyoming.

1907. CIRKEL, FRITZ. Graphite; its properties, occurrence, refining, and uses: Department of Mines, Ontario, Canada, 307 pages. The best general treatise on this mineral; includes bibliography and description of foreign occurrences.

NEW YORK.

1897. KEMP, J. F., and NEWLAND, D. H. Preliminary report on the geology of Washington, Warren, and parts of Essex and Hamilton counties, N. Y.; 51st Ann. Rept. N. Y. State Inst., vol. 2, p. 539; describes character and mode of occurrence of graphite in town of Hague, Essex County, and method of ore dressing.

1899. WALCOTT, C. D. Pre-Cambrian fossiliferous formations: Geol. Soc. Am. Bull., vol. 10, p. 227; devotes paragraph to mode of occurrence and origin of graphite in town of Hague, Essex County, with illustration of mine.

1903. KEMP, J. F. Graphite in the eastern Adirondacks, New York: Bull. U. S. Geol. Survey No. 225, pp. 512-514; describes four modes of occurrence; believes workable disseminated deposits to have originated through dynamic metamorphism of bituminous clay shale.

1905. OGILVIE, I. H. Geology of the Paradox Lake quadrangle, New York: Bull. N. Y. State Inst. No. 96; describes occurrence of graphite at Rock Pond, Essex County; discusses origin of Adirondack graphite deposits.

MAINE.

1906. SMITH, G. O. Graphite in Maine: Bull. U. S. Geol. Survey No. 285, pp. 480-483; describes origin and mode of occurrence and possible utilization of graphite at Madrid, Franklin County, and at Yarmouth, Cumberland County.

PENNSYLVANIA

1881. FRAZER, PERSIFOR. Relations of the graphite deposits of Chester County, Pa., to the geology of the rocks containing them: Trans. Am. Inst. Min. Eng., vol. 9, pp. 730-733; describes graphite mine in town of Windsor, Chester County, and describes method of mining and milling.

1898. HOPKINS, T. C. Mineral Industry, vol. 7, p. 383; describes graphite mines near Chester Springs, Chester County (half page).

1899. HOPKINS, T. C. Mineral Industry, vol. 8, p. 350; describes occurrences of graphite in Berks County.

VIRGINIA.

1905. Mineral Industry, vol. 14, pp. 311-312; a short description (one-third of a page) of the graphite deposits near Charlottesville.

ALABAMA.

1907. SMITH, E. A. Mineral Industry, vol 16, pp. 567-568.

GEORGIA.

1907. HAYES, C. W., and PHALEN, W. C. Graphite deposits near Cartersville, Ga.: Bull. U. S. Geol. Survey No. 340, pp. 463-465; discusses character, origin, and uses of graphitic talcose slates of Cartersville region.

NORTH CAROLINA.

1901. PRATT, J. H. North Carolina Geol. Survey Econ. Paper No. 6, pp. 69-72; describes occurrence of graphite in gneiss in McDowell, Wake, and Catawba counties, and in pegmatite in Alexander County.

1905. KEITH, A. Mount Mitchell folio (No. 124), Geol. Atlas of the United States, U. S. Geol. Survey; describes character and utilization of graphitic schists near Graphiteville.

WYOMING.

1906. Ball, S. H. Graphite in the Haystack Hills, Laramie County, Wyo.: Bull. U. S. Geol. Survey No. 315, pp. 426–428; describes character, origin, and economic value of undeveloped graphite deposits of this region.

1907. Mineral Industry, vol. 16, p. 570; mentions occurrence of graphite in Albany and Carbon counties. (6 lines.)

ORIGIN OF GRAPHITE.

1904. See New York (1).

1905. See New York (2).

ASSAYING AND TESTING OF GRAPHITE.

1907. Sadler, S. S. Determining ash in graphite: Australian Mining Standard, December 11, 1907; small quantities of magnesia are added to the samples to prevent the residue from fusing to the crucible. The ash can then be readily removed and analyzed.

1908. Hyde, F. S. Some characteristics of natural graphite: Eng. and Min. Jour., February 1, 1908, pp. 255–256; describes chemical and physical tests for distinguishing different kinds of natural graphite.

GRAPHITE ORE DRESSING.

1903. Richardson, R. H. Ore dressing: pp. 1074–1075; describes briefly foreign and domestic processes of dressing graphite.

LUBRICANT.

1907. Acheson graphite lubricant: The Iron Age, May 23, 1907; discusses the lubricating value of "deflocculated" graphite.

GRAPHITE PAINTS.

1908. Preliminary report on steel test fences: Scientific Section Paint Manufacturers' Association of the United States, Philadelphia, Pa.; describes methods of testing protective qualities of graphite and other pigments. Results not reported.

1909. Cushman, A. S. The preservation of iron and steel: Bull. No. 35, Office of Public Roads, Dept. of Agriculture; describes tests on the rust-preventing qualities of graphite and other paint pigments, when applied to iron and steel. Experiments appear to show that graphite is a rust stimulator, and not a rust inhibitor, and hence that it should not be applied as a first coating to iron or steel.

PENCILS.

1906. Walker, John A. The manufacture and use of lead pencils: Graphite Trades man (published by Joseph Dixon Crucible Co.), August 15, 1906; gives the history and method of lead-pencil manufacture.

ARTIFICIAL GRAPHITE.

1901. Townsend, C. P. The artificial production of graphite: Elec. World and Engineer, vol. 37, April 6, 1901, pp. 546–550; is an excellent review of the various methods of the artificial production of graphite, and a discussion of the chemical changes involved.

1902. Fitzgerald, F. J. The conversion of amorphous carbon to graphite: (chemist of the International Acheson Graphite Co.), Jour. Franklin Inst., vol. 154; pp. 321–348; similar in scope to the preceding, but devotes more space to the Acheson processes.

1908. Standish, Alfred. The electric furnace: pp. 142–149; gives good summary of processes and principles of the commercial production of artificial graphite and diagrams of electric furnaces used.

MAGNESITE.

By Charles G. Yale.

PRODUCTION.

The only magnesite deposits in the United States which are being commercially utilized are those in the State of California. The output of these mines in 1908 was 6,587 short tons crude, valued at $19,761, as compared with 7,651 short tons in 1907, valued at $22,683. The sale of the product of the California mines is limited to localities on the Pacific coast, since the freight rates are prohibitive to points of greatest consumption in States east of the Rocky Mountains. The California magnesite can not be shipped to eastern points and compete in price with that imported from Greece and Hungary, where there is cheap mining labor and where shipments may be made by sea. For this reason many known deposits in California continue to lie unworked. The larger mines near railroad lines can alone be profitably worked, and even in such cases production is restricted to the local demand. Only a limited number of tons of magnesite annually can be disposed of on the Pacific coast, and as the commercial demand is already fully met by mines having advantage of good transportation facilities and equipped with furnaces for calcining no new properties of note are being opened. Were there any opportunities for shipment by sea from San Francisco to eastern ports of the United States some of the California calcined magnesite might be sent there, but the margin of difference in prices from foreign material is quite small, and there have been no regular shipping lines by sea from California around the Horn in many years until late in 1909.

Very large quantities of magnesite, both crude and calcined, are imported into the United States annually. In 1908 the quantity of crude imported was 39,526,865 pounds, valued at $81,578, or $4.13 per short ton, and of calcined, but not purified, 129,462,109 pounds, valued at $655,245, or $10.12 per ton. These prices are the wholesale prices or market values in the foreign countries of the material when ready for shipment, and, if cases, crates, etc., are used, the cost of said cases, crates, etc., is included in the value given; the values do not include freight or any other charges incurred after shipment. The New York prices for crude in 1908 were from $6.30 to $7.10 per short ton and for calcined from $16.75 to $25 per short ton, the latter for small lots free from lime and well roasted.

At the points of largest production, in Tulare County, Cal., the crude magnesite has a value of about $3 per ton, and this is increased by freight charges to $6 to $6.50 in San Francisco. The calcined magnesite, according to quality, is sold in San Francisco at from $14 to $20 per ton. The calcined magnesite used for making brick and building material must receive a "dead" roast to get rid of as much carbonic-acid gas as possible, but that used in the process of manufacture of paper from wood pulp need not be so well calcined and can be sold for lower prices. Most of that burned in California is used by the paper manufacturers. The California magnesite is ordinarily of better quality than that imported from Greece or Hungary, but scarcely any of it is used at points of greatest consumption in the United States for the reason stated.

There are no marked changes to be recorded in the condition of the magnesite industry in California in 1908. No new mines of importance have been opened, though small quantities of mineral have been taken from a few deposits not heretofore opened, the material from which has been used mainly in the manufacture of building material, for covering pipes, and for artificial stone. By far the largest quantity of magnesite in California is derived from the deposits near Porterville and South Tule, in Tulare County. These deposits are owned by the Willamette Pulp and Paper Company. On both of them calcining furnaces have been erected, and calcined magnesite is manufactured for use in making paper from wood pulp. Some ore was also mined at Porterville and at Exeter and shipped crude to the works of the Western Carbonic Acid Gas Company, at Shell Mound, Alameda County, for calcination to obtain the carbonic-acid gas. The calcined residue is sold to paper manufacturers and makers of artificial stone or building material. In Fresno County a new deposit has been opened and a furnace erected. Some little magnesite was also obtained from the deposit near Winchester, Riverside County. Since the close of the year the Magnesite Corporation of California has opened deposits both in Alameda and Santa Clara counties, but there was no output from these sources in 1908. Nominal quantities of magnesite were mined in Alameda and Santa Clara counties in 1908 from old properties. The old deposits in Sonoma and Napa counties are no longer productive, the wagon haul to railroad preventing them from competing with the San Joaquin Valley deposits, which are larger and nearer transportation facilities.

It is to be noted that there is some increase in the use of magnesite in California for tiling, flooring, steam-pipe covering, wainscoting, artificial stone, etc. For these purposes the calcined magnesite is used, but not in any great quantities as yet. In the manufacture of paper from wood pulp, for which purpose most of the domestic material is utilized, there is no special increase in consumption.

The numerous deposits of magnesite in the counties of California have been fully described by Frank L. Hess,[a] and it is not necessary therefore to give them special consideration in this chapter. Hess mentions also other domestic deposits and the principal foreign deposits as well.

The following table shows the quantity and value of the domestic output from 1891 to 1908, inclusive:

Quantity and value of crude magnesite produced in the United States, 1891–1908.

1891	short tons..	439	$4,390	1900 ....short tons..	2,252	$19,333
1892	do....	1,004	10,040	1901 ....do....	3,500	10,500

Year	Unit	Quantity	Value	Year	Unit	Quantity	Value
1891	short tons	439	$4,390	1900	short tons	2,252	$19,333
1892	do	1,004	10,040	1901	do	3,500	10,500
1893	do	704	7,040	1902	do	2,830	8,490
1894	do	1,440	10,240	1903	do	3,744	10,595
1895	do	2,220	17,000	1904	do	2,850	9,298
1896	do	1,500	11,000	1905	do	3,933	15,221
1897	do	1,143	13,671	1906	do	7,805	23,415
1898	do	1,263	19,075	1907	do	7,561	22,683
1899	do	1,280	18,480	1908	do	6,587	19,761

[a] Hess Frank L., The magnesite deposits of California; Bull. U. S. Geol. Survey No. 355, 1908.

It requires 2.4 tons of crude magnesite ($MgCO_3$) to make 1 ton of calcined (MgO). The calcined magnesite is worth from $14 to $20 per ton according to the roasting given it. This calcined magnesite is used in the process of making paper from wood pulp, in the manufacture of fireproof brick, and for tiling, wainscoting, building material, and artificial stone.

IMPORTS.

The imports of magnesite into the United States in 1907 and 1908 were as follows:

Imports of magnesite into the United States in 1907 and 1908, in pounds.

	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Magnesia:				
Calcined, medical	49,489	$9,005	46,823	$7,451
Carbonate of, medical	85,467	3,994	62,514	3,475
Sulphate of, or Epsom salts	4,532,713	16,256	4,990,875	15,543
Magnesite:				
Calcined, not purified	151,137,661	688,371	129,462,109	655,245
Crude	46,878,740	186,988	39,526,865	81,518

In addition, magnesium not made up into articles was imported to the value of $12,410 in 1908, against $14,332 in 1907. The total value of the imports of magnesia and magnesite in 1908 was $775,642.

It is to be noted that there is a decrease in both quantity and value of the imports of crude and calcined magnesite in 1908 as compared with 1907. These imports are mainly from Greece and Hungary, where there are large deposits of magnesite mined by very cheap labor, wages in Hungary, for example, being 40 cents for a 10-hour day at the mines.

An attempt was made by domestic producers of magnesite to have Congress place a duty on both crude and calcined material, but this was not accomplished. The new tariff law does, however, place a duty of 25 per cent ad valorem on importations of magnesite brick if not decorated, glazed, enameled, or ornamented. If decorated, glazed, etc., the ad valorem duty is 35 per cent. The basis of value is the value when packed ready for shipment at the foreign port and does not include freight or other charges after being made ready for shipment.

The various uses to which magnesite may be put were given in full in the report for 1907, and are also published in Bulletin No. 355, heretofore referred to.

MICA.

By Douglas B. Sterrett.

INTRODUCTION.

Among the several varieties of mica only two are of economic value for their physical properties. These are muscovite, or " white " mica of the trade, and phlogopite, or " amber " mica. Of these two varieties only muscovite is found in quantities of importance in the United States. Muscovite is a silicate of aluminum and potash, with a small per cent of water. It is attacked with difficulty by reagents and successfully resists decomposition in nature for long periods. The common properties of mica, as perfect cleavage with marked flexibility, elasticity, toughness, transparency, and nonconductivity to heat and electricity, are possessed by muscovite in a high degree. It is due to these properties that mica occupies an important place in the industrial world. The physical properties of mica vary not only in the different varieties, but to a certain extent, also, as in quality of cleavage, color, clearness, firmness, etc., in different occurrences of the same variety. Muscovite and phlogopite with their various qualities are found to be adapted to special uses mentioned later.

OCCURRENCE.

Muscovite is found in many kinds of rocks, though deposits of commercial value are limited to pegmatite. Pegmatite is a coarse-grained rock, composed of quartz and feldspar, with or without mica and accessory minerals. The composition of some pegmatites is closely allied to that of granite; in others the component minerals are the same as in granite, though the proportion of each is variable. Pegmatite occurs in sheets, lenses, veinlets, balls, and irregular masses. These are in some places evidently formed by the intrusion of magmas into the inclosing rock formations, and in other places by deposition from solutions. Such pegmatites commonly occur in regions of metamorphic gneisses and schists. The pegmatites either follow the bedding planes of the inclosing rock through part or all of their extent, or cut across the formations at various angles. Pegmatite deposits carrying mica of commercial value range from 1 foot to more than 50 feet in thickness. The length depends on the nature of the deposit, whether a lens or a sheet, and varies from a few feet to several hundred yards. The pinching out of a lens-shaped deposit of pegmatite does not necessarily mean the exhaustion of a mica deposit, as another lens may be found along the strike of the first one or to the side slightly overlapping it. Deposits of mica have been found in about twenty States of the United States, and have been worked profitably in a number of them. Among the States where mica has been actively mined are North Carolina, South Dakota, New Hampshire, Colorado, Virginia, Alabama, South Carolina, and New Mexico.

NORTH CAROLINA.

The mica mines of North Carolina are located in the mountain region northwest of the Blue Ridge, along the Blue Ridge, and in the Piedmont Plateau southeast of the Blue Ridge. Most of the deposits that have been worked in recent years are in three sections of the mountain region. These are Ashe County, Mitchell and Yancey counties, and Haywood, Jackson, Transylvania, and Macon counties. During 1908 mining was most active in the Mitchell-Yancey county and the Haywood-Jackson-Macon county regions.

The better grades of North Carolina mica are of excellent quality and well suited to the glazing industry. A large quantity of less perfect sheet mica is supplied to the electrical industry, where it is satisfactory for all uses except for certain commutator insulation. The greater portion of mica produced in North Carolina is clear and has a light " rum " color. A small part, however, is dark brownish or greenish, and is sometimes " specked."

The mica of North Carolina is derived from numerous mines of various sizes. Part comes from mere prospects and part from a number of regularly worked deposits. The operations at most of these deposits are small as compared with most metal mining or even with the best mica mining in South Dakota and Canada. A few of the mines, however, are equipped with steam pumps and hoists, air drills, etc., and work compares more favorably with that in other mica regions. The following is a description of a mica mine of North Carolina that was formerly of importance:

The Gibbs mica mine is on the west side of South Toe River, 2 miles west of south of Newdale, Yancey County. It was operated on a large scale until 1906 by the J. E. Burleson Mica Company, and was then abandoned for mines where mica could be obtained with less difficulty. The mine entrance is about 75 feet above the river and on a hillside. The work consisted of an incline on the dip of the " vein " carried down over 500 feet. The incline has a grade of about 35° for the first 150 feet from the surface and about 25° below this. For about two-thirds of the length of the incline the " vein " has been removed for a width of 40 feet. Pillars were left, and a few stulls were placed as supports. The workings off to the sides of the incline were irregular in nature and consist of short tunnels, rooms, or stopes, where rich " leads " of mica were found. The " vein " was first removed for a thickness of 7 to 10 feet in the upper part of the mine, and then for the full thickness of 15 feet or more in the lower part. Hoisting was done by a steam engine with a track and skip. The skip was used as a pump also and satisfactorily handled the mine water.

The pegmatite formation is large and more continuous than is found at many other mica mines in North Carolina. It is conformable with the bedding of the inclosing mica gneiss, and strikes about N. 50° W., with a dip of 35° SW. at the surface and less with depth. The feldspar of the pegmatite is a plagioclase carrying soda and some calcium and is probably oligoclase. Most of it is pure white, though part is transparent and has a pale aquamarine-green color. Other minerals of the pegmatite are quartz, muscovite, biotite, and a little garnet and apatite. The texture of the pegmatite is granitic and fairly coarse. Masses of feldspar crystals of 200 pounds weight were seen on the dump, and mica blocks of similar weight are sometimes obtained. The quality of mica from the Gibbs mine is the finest, and the color of thick sheets a rich "rum." The general run of sizes is in crystals of 3 to 12 inches in diameter. Still larger sheets are obtained sometimes. At the time of examination in 1905 the production amounted to about 1,000 pounds of good block mica per week, though at times larger quantities were obtained.

SOUTH DAKOTA.

South Dakota mica is, as a rule, softer than that from the southern Appalachian States. The color is much the same as that from the latter region, ranging from "wine" to "rum" in sheets one-sixteenth inch or more in thickness. The quality is highly satisfactory for all electrical purposes, except for certain commutator insulation. The proportion of mica obtained suitable for glazing purposes is small, since much of it is clouded with minute inclusions or numerous small blisters between the laminæ.

The best mica deposits of South Dakota, so far located, are in the Black Hills in Custer County, within a radius of 8 miles from Custer. The possibilities of the mines of this region have been demonstrated by the operations of the Westinghouse Electric and Manufacturing Company during the last two years. This company has taken up four mines and is operating two of them on a large scale. The equipment for mining at these mines is probably the best ever used in mica mining in the United States. The following description of one of the Westinghouse mines[a] and of the treatment of mica after mining is given through the courtesy of Mr. W. J. Longmore, who has complete charge of the mica mining and manufacturing for the company:

Description of No. 1 mine.—The No. 1 mine of the Westinghouse Company, formerly called the "New York mine," is 5¼ miles southwest of Custer, between Hay Creek and Fourmile Creek. The mine is in a small, prominent hogback knob some 700 feet long and about one-third as wide. This knob is nearly 200 feet higher than the level of Hay Creek on the southeast, and about 100 feet higher than the gentle slopes from its base to the valley of Hay Creek.

The earlier work at the New York mine consisted of open cuts, inclines, and stopes from the surface nearly to the present 100-foot level in one place. The operations of the present company have been very systematic, and consist of a vertical shaft to the 200-foot level with a 16-foot sump at the bottom and drifts with stopes on the 50-foot, 100-foot, and 200-foot levels. The mine is equipped with a 400-horsepower boiler and engine of Westinghouse make. Power is

[a] Other mines described in Mica deposits of South Dakota; Contributions to economic geology, 1908, part 1; Bull. U. S. Geol. Survey No. 380 [in press].

transmitted electrically from a 150-kilowatt generator. The mine is lighted with incandescent electric lights, and the camp with arc lamps. The hoist, the grinding plant, and the shop are also operated by electric motors. Air drills are used throughout the mine. From 65 to 75 men are employed around the mine.

The country rock is biotite gneiss and schist striking northwest and southeast with a dip of about 50° SW. The pegmatite is approximately conformable with the inclosing gneiss. The contact of the two is sharp, with gentle rolls along the strike. The pegmatite has a thickness across the dip of about 30 feet at the surface, 25 feet on the 100-foot level, and 28 feet on the 200-foot level. The mica occurs in the pegmatite in two streaks or " veins " from 1 to 8 feet thick along each wall. The interior of the pegmatite is nearly barren of mica or too poor to pay for working. Although the mica streaks vary in thickness and richness they are unusually regular for mica " veins." Through the greater part of the mine opened up to August, 1908, the veins were found sufficiently rich to pay for working, while in places the mica was abundant. The mica crystals have a tendency to occur in flattened or tabular blocks lying perpendicular to the walls of the pegmatite, though without other definite orientation. The more common sizes of crystals range from 2 to 8 inches in diameter and from 1 to 5 inches in thickness. Crystals a foot in diameter are not rare, and some measuring a yard across are found.

The earlier operations at this mine were influenced largely by the position of the outcrop of the pegmatite. The latter forms the top and southwest side of the knob in which the mine is located. The hanging wall lies near the surface of this side of the knob and was readily worked by open cuts. The foot wall of the pegmatite outcrops along the top of the knob. Besides numerous smaller openings on the outcrops, drifts have been run to the northwest on each " vein " on the 50-foot level. The entrance to the 50-foot level is from an open cut on the outcrop of the vein about 50 feet below the top of the hill. The drift on the hanging-wall " vein " was run about 130 feet, and a small amount of stoping done. The " vein " was rich in mica to within 15 feet of the end of the drift, at which point the mica content was low. A crosscut connects with the foot-wall " vein." The drift on the latter was carried some 250 feet to the northwest. For 100 feet of this drift the vein has been stoped out to the top of the knob 50 feet above, while beyond this point good vein matter is held ready for stoping. At the southeast limit of the surface workings, about 200 feet from the shaft, the pegmatite contains a large quantity of black tourmaline in crystals ranging from 1 inch to several inches in diameter and as many feet long. The mica content of the pegmatite is very low at this point.

The shaft is located to the southwest of the pegmatite, through which it cuts between the 100-foot and the 200-foot levels. Only the hanging wall has been worked on the 100-foot level. The latter is connected with the shaft to the southwest by a short crosscut. Drifts have been run from the crosscut about 300 feet to the northwest and 250 feet to the southeast. The vein was stoped out to the 50-foot level for a distance of 200 feet to the northwest and was being carried farther. The pegmatite at the end of this drift was found to be very poor in mica and was composed of large feldspar crystals, massive quartz, black tourmaline, and feldspar rosettes 8 to 12 inches in diameter and composed of radiating feldspar columns. The drift was to be carried farther in search of richer " vein " matter. In the southeast drift much of the vein has been stoped out to the surface for a distance of about 240 feet from the crosscut. At this point the " vein " becomes poor in mica and has the same abundant black tourmaline as seen in the surface workings. Some of these tourmaline crystals measure 10 inches in diameter. They do not appear to have any definite position relative to the wall of the pegmatite. The " vein " was found to be rich nearly to the end of each drift and in the large stopes. The strike of the contact of the " vein " is nearly straight throughout the length of the drifts, except at one point a few feet southeast of the crosscut. Here the mica schist wall elbows out into the pegmatite several feet across the strike of the " vein."

A room has been made on the southeast of the shaft on the 200-foot level for the placing of an electric pump, loading cars on the cage, etc. A crosscut of 10 feet from this room to the southwest cuts the foot wall of the pegmatite, which is about 28 feet thick. Though mica is found in the foot-wall " vein " here, it had not been developed at the time of visit. Drifts had been started on the hanging-wall " vein " in each direction, and were each in about 20 feet when seen. These drifts have since been carried 175 feet to the northwest and 125 feet to the southeast. At the latter point an irregularity in the " vein," or a fault, has been encountered, and this is being investigated by the company. The vein matter seen in the 40 feet of drift on the 200-foot level was very rich, and contained considerable mica of large size. Several blocks over a foot across were seen in the walls, along with a large number of small ones.

Mention has already been made of the richness in mica of various parts of the " vein." Data for estimating the percentage of mica in the " veins " are given by Mr. Joseph Pyne, superintendent. Records of the quantity of mica obtained and the quantity of rock moved show an average of 600 pounds of rough mica to 10 square feet of vein removed. The " veins " average from 5 to 6 feet in thickness, say $5\frac{1}{2}$ feet. On estimating the weight of a cubic foot of pegmatite at 163 pounds, it is found that the rough mica obtained averages about 6.6 per cent of the vein matter. The production of the No. 1 mine is stated to amount to approximately 150,000 pounds of rough mica mined per month with the ordinary force of men.

Treatment of the mica.—The Westinghouse Company consumes all of the sheet mica produced by its mines in its own manufacturing establishments. The rough mica is hand cobbed and thumb trimmed at the mines. The roughly trimmed mica is then shipped to a better-equipped plant at Lincoln, Nebr., formerly at Denver, Colo., where it is further split, trimmed, and carefully graded for use at the main works at East Pittsburg, Pa. The plant at Lincoln is equipped with seven power presses for punching washers at one stroke, and ten sheet-trimming machines. These machines are all operated by electric power. Working space is supplied for 150 people to " thin split " the mica for use at the main works. The thin splitting is done by piecework by girls, who become very skillful in the operation.

Part of the scrap mica produced at the mines is ground at a mill located at the No. 1 mine. The grinding is done by a dry pulverizer. This machine has a reported capacity of 3,000 pounds of ground mica a day. The surplus waste mica at the trimming plants is sold for grinding for the manufacture of lubricants and for molded mica insulation.

The "thin split," trimmed, and punched mica received at East Pittsburg is adapted to different uses. The punched and trimmed sheets are in some cases ready for use without further treatment, though a portion of the sheets require additional trimming to adapt them to particular uses. A large part of the mica is used in the form of "thin splittings," and is built up into mica board, flexible mica sheets, and various forms for insulation. Much of the mica board is constructed by placing a layer of "thin split" mica over a sheet of tissue paper freshly varnished with shellac. This is covered by another sheet of tissue paper with a coating of shellac and another layer of "thin splittings," etc., until the desired thickness is reached. Some of the sheets of mica board are also built up without the tissue paper. The mica board is generally made in rectangular sheets, measuring 20 by 36 inches. The large sheets thus built up are pressed, many sheets at a time separated by iron plates, in hydraulic presses. The sheets are subjected to a low heat during the pressing, and the shellac is dried by baking after pressing.

Dried sheets are reduced to the required thickness by sanding and milling machines and are then cut into strips or punched to pattern as required.

COLORADO.

Certain of the mica deposits of Colorado are of interest because their product is peculiarly adapted to grinding purposes, although not of value as sheet mica. Of this type are the Mica Hill Mine, of the Canyon City Mica Mining and Mills Company, 4 miles northwest of Canon City, and the Wild Rose claim of J. D. Endicott, 6 miles north of Texas Creek.

At Mica Hill the mica occurs in a large pegmatite mass over 100 feet thick and several hundred feet long. The outcrop of this pegmatite forms a small prominent oval-shaped hill, with its extension roughly parallel to the strike of the country rock. The latter is crumpled biotite gneiss, which has a strike north of east and a high northerly dip. There are granite and diorite masses in the vicinity. About 200 yards east of Mica Hill is a similar hill formed by the outcrop of a mass of pegmatite, in which lithia mica (lepidolite) and pink and green tourmaline crystals have been found. The pegmatite of Mica Hill is composed of large masses of feldspar and quartz, graphically intergrown in places, and of irregular masses and streaks of solid mica. The masses and streaks of mica occur in massive feldspar, and vary from 2 to 10 feet in thickness. The mica is in the form of wedge-shaped blocks, with fish-bone structure, and in twisted plates bunched together at all angles. In places there is a little biotite or black mica mixed through the white mica, so that it is necessary to hand cob part of the material after crushing before grinding. The solid mica is plentiful in the better exposures, and 200 tons are reported as having been obtained from a small opening in the south face of the hill near the summit. In small openings lower down rough beryl crystals from 1 inch to 1 foot in diameter and columbite in masses of two or three pounds weight were found.

At the Wild Rose claim the occurrence is very similar to that at Mica Hill. The mica occurs in irregular streaks of solid masses of twisted and wedge-shaped crystals. These streaks vary from 1 foot to more than 6 feet in thickness, and occur in both quartz and feldspar. The quartz at this mine has a rose color and some is of quality suitable for gem purposes. The solid mica at this mine does not appear to have any associated biotite, and is therefore well adapted to grinding without other preparation than mining, shipping, and crushing. This claim has not yet been worked commercially. The mining of the deposits of solid mica should not be difficult as long as the streaks or masses hold out. At the two deposits visited, the quantity of mica exposed was large and could supply the demand of an ordinary mica-grinding mill for a considerable time.

The transportation of the mica from these deposits to the railroad and mills is an item of importance. The Mica Hill locality is reached by a 10-mile wagon road from Canyon City. The Wild Rose claim has at present only a trail connecting it with the railroad at Texas Creek, about 6 miles distant, though a wagon road could be constructed without very great expense.

GEORGIA.

A number of mica deposits are known to occur in northwestern Georgia, both in the mountain regions and in the Piedmont Plateau. The associations of these deposits are very similar to those of North Carolina, in both type of country rock and nature of pegmatite. Mica mining has never become an established industry in this region, and the amount of development work at the majority of the mines and prospects has not been extensive.

During 1907 and 1908 the Pitner Mica Company was engaged in developing a group of mica mines in Lumpkin and Fannin counties, from 6 to 10 miles northwest of Dahlonega. These mines are situated in the Piedmont Plateau at the foot of the Blue Ridge, on the Blue Ridge, and in the mountain country to the north of the Blue Ridge. So far the work has been more in the nature of prospecting, though some mica has been obtained at the same time. With one exception, the mica in this group of mines is light colored, and portions are of good quality. Some of the mica is subject to conditions common to the product of most mica mines, as "ruling," "wedge," and "A" structure, clay stains, etc.

Among the mines and prospects owned by the Pitner Mica Company are the Ward, Eph Lee, Masters, Graham, and William Gooch, yielding "rum" colored mica; the Green Vein, F. G. Williams, and Sain, yielding light-green colored mica; and the Matt Gooch, yielding dark and partly "specked" mica. The company owns other deposits which were not visited. The Eph Lee, William Gooch, and Green Vein mines are old mines and have not been opened recently. The other deposits mentioned were prospected by the Pitner Mica Company. The Masters, Sain, Williams, and Graham mines are within a mile northwest of the old Two Run post-office. The Eph Lee, Ward, and Green Vein mines are on the top of the Blue Ridge, near Ward Gap. The William Gooch mine is about a mile north of Ward Gap, and the Matt Goch mine is near Gaddistown.

At the Ward mine the mica occurs in pegmatite, which has small quartz lenses and masses segregated out. The pegmatite cuts the mica-gneiss country rock unconformably.

At the Eph Lee mine the granitic mica-gneiss country rock has been contorted by small folds and is cut by the pegmatite near the axis of one of these folds. The pegmatite is not large, and ranges from a few inches to $2\frac{1}{2}$ feet in thickness. It has yielded sheets of mica several inches across, however.

The country rock at the Masters mine is cyanite mica gneiss, with a variable strike and dip. The pegmatite occurs in lenses more or less connected, and varies in thickness from a few inches to several feet. The main lead of lenses has been traced in a northeast direction for about 75 yards. Branch "veins" or lenses of pegmatite occur on the northwest side of the main lead and yield good mica in places. Some fair-sized sheet mica has been obtained at this mine along with a large amount of "ruled" and "A" varieties.

The pegmatite at the Graham mine has a strike of N. 60° E. and a vertical to southeast dip. It contains a quartz streak or lens 30 feet long and from a fraction of an inch to 2 feet in thickness parallel to its strike. The pegmatite is 10 feet thick where exposed in one opening. A branch streak of pegmatite to the northwest is exposed at this point.

The old workings at the William Gooch mine have fallen in badly. They cover an area about 50 feet wide and over 100 feet long in a northeast direction. Several pits, shafts, and tunnels have been made and considerable massive quartz was encountered.

The Green Vein mine was opened by a cut 20 feet deep and 40 feet back into the side of a hill. The mica-gneiss country rock has a northerly strike, with a dip of 30° E. The pegmatite cuts across it with the same strike and a nearly vertical dip. It varies from 1 to 5 feet in thickness.

The pegmatite at the Sain mine is very irregular in shape and includes horses of the mica gneiss and diorite. The "vein" has a northeast strike with a vertical dip. Several tons of mica were found in pockets within a few feet of the surface. Some of the crystals seen were 15 to 18 inches across, though cut into smaller plates by "ruling."

At the F. G. Williams mine the pegmatite has an irregular northwest strike and a dip of 20° NE. It cuts across the mica-gneiss country rock, which has a northeast strike with a southwest dip. Mica crystals have been found 18 inches across, though somewhat "ruled" and "A" shaped.

At the Matt Gooch mine a trench and open cut in a hillside exposed a pegmatite body at least 6 feet thick with a northerly strike and a low westerly dip. The pegmatite contains irregular quartz masses and segregations with which the mica is associated.

Mica also occurs in other counties in northwest Georgia. In Union County, near Tower, B. E. Dyer prospected a mica deposit during 1908. Some promising looking mica crystals of several inches diameter were obtained. J. A. Hinson, of Hinson, Fla., has reported the discovery of mica near Marietta, Cobb County, and has furnished a portion of a crystal 4 by 6 inches across.

USES.

The principal use for mica during recent years has been and still is in the manufacture of electrical apparatus; formerly its application in stove manufacture consumed the bulk of the production. The glazing industry still consumes much of the finest grades of sheet mica in the manufacture of windows for coal, gas, and oil stoves, gas-lamp chimneys, and in many minor uses, as lamp shades, fronts for fancy boxes, etc. The use of mica as an insulating material in electrical apparatus and machinery is extensive. Many forms of dynamos, motors, induction apparatus using high voltage, switchboards, lamp sockets, etc., have sheet mica in their construction. For practically every purpose of electrical insulation, with the exception of commutators of dynamos and motors, the domestic mica is as satisfactory as any other. For insulation between the copper bars of commutator segments, however, no mica produced in the United States is as satisfactory as the "amber" or phlogopite mined in Canada and Ceylon. This is due to the fact that the "amber" mica wears down evenly with the copper segments, while the ordinary white or muscovite mica, through its greater hardness, does not wear down so rapidly and is left in ridges above the copper, causing the motor to spark. Much of the sheet mica used in electrical apparatus is first made up into large sheets of mica board or micanite. In this form it is available for use in most of the purposes for which ordinary sheet mica can be used. It can be bent, rolled, cut, punched, etc. Bending is accomplished during baking, or by heating to soften the shellac used in the manufacture of the mica board. Insulation for commutators is generally cut from "amber" mica board.

Scrap mica, or mica too small to cut into sheets, and the waste from the manufacture of sheet mica are used in large quantities commercially. The greater part is ground for the manufacture of wall papers, lubricants, fancy paints, molded mica for electrical insulation, etc. Ground mica applied to wall papers gives them a silvery luster. When mixed with grease or oils mica forms an excellent lubricant for axles and bearings. Mixed with shellac or special compositions, ground mica can be molded into desired forms, and is used in insulators for wires carrying high potential currents. Ground mica for use in molded mica for insulation purposes should be free of metallic minerals. For lubrication purposes it is necessary that gritty matter be eliminated, either after grinding or by using only pure mica for grinding. For wall papers and brocade paints a ground mica with a high luster is required. This is best obtained by using a clean light-colored mica and grinding under water.

Coarsely ground or bran mica is used to coat the surface of composition roofing material, especially that manufactured by the Western Elaterite Roofing Company, of Denver, Colo. The mica serves the purpose of keeping the material from sticking when rolled for shipping or storage.

GROUND MICA.

In the Western States the dry process is the common practice in grinding mica, but in the mica regions of the Eastern States the greater part of the mica is ground under water. In dry-grinding machines the mica is pulverized by the beating action of teeth or bars on cylinders revolving at a high rate of speed. In wet-grinding machines the mica is beaten and torn under water by teeth of spikes mounted in wheels or cylinders revolving at a comparatively slow rate of speed. The capacity of the dry-grinding machines or pulverizers is considerably greater than that of the wet-grinding machines. The dust of fine mica scales from the pulverizers is often a cause of annoyance to workmen around the mills, as it is very irritating to the throat and lungs when breathed. It is claimed that mica ground under water is better than that ground dry. Some consumers demand the wet-ground mica, claiming a greater purity and more brilliant luster. It is possible that the same effect could be obtained by thoroughly washing dry-ground mica and floating the product.

PRODUCTION BY STATES.

The total value of the mica produced in the United States in 1908 amounted to $267,925. This production came from 10 States—North Carolina, South Dakota, Colorado, Alabama, Virginia, South Carolina, New Hampshire, Georgia, New Mexico, and Maine—named in the order of the value of their output. Idaho was credited with no production during 1908 as against a small one in 1907. The value of the production of mica in 1908 was less by $124,186 than in 1907.

The production of sheet mica amounted to 972,964 pounds, valued at $234,021, a decrease of 87,218 pounds in quantity and of $115,290 in value as compared with 1907.

The production of scrap mica amounted to 2,417 short tons, valued at $33,904, a decrease of 708 tons in quantity and of $8,896 in value from 1907.

North Carolina.—The value of the mica produced in North Carolina in 1908 was $127,870 as compared with $225,206 in 1907, a decrease of $97,336. The production in 1908 consisted of 599,234 pounds of sheet mica, valued at $114,540, and 1,308 short tons of scrap mica, valued at $13,330. The output came principally from Mitchell, Yancey, Jackson, Macon, Haywood, and Transylvania counties.

South Dakota.—The production of mica in South Dakota was large and places that State second on the list of mica-producing States.

Colorado.—The output of mica in Colorado during 1908 was all reported as scrap and amounted to 533 short tons, valued at $13,330.

Alabama.—The production of sheet mica in Alabama amounted to 39,803 pounds, valued at $9,451, and of scrap mica to 34 tons, valued at $359. Considerable interest is being shown in the mica deposits of this State, and a number of new deposits were opened during the latter part of 1908 or the first part of 1909.

Virginia.—The production of mica in Virginia during 1908 amounted to 13,427 pounds of sheet, valued at $5,941, and 46 tons of scrap, valued at $1,405. It is probable that some of the mica reported as scrap was of sufficient size and quality to yield punch or small sheet mica, and that it should not properly have been classed as scrap; hence the high value given for scrap mica.

Other States.—Of the production of mica in the other States only in South Carolina and New Hampshire was it of any importance.

The production in Georgia, Maine, and New Mexico combined amounted to only $320.

The production of mica in the United States since 1880 is given in the following table:

Production of mica in the United States, 1880–1908.

Year.	Sheet mica.		Scrap mica.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Short tons.*		
1880	81,669	$127,825			$127,825
1881	100,000	250,000			250,000
1882	100,000	250,000			250,000
1883	114,000	285,000			285,000
1884	147,410	368,525			368,525
1885	92,000	161,000			161,000
1886	40,000	70,000			70,000
1887	70,000	142,250			142,250
1888	48,000	70,000			70,000
1889	49,500	50,000			50,000
1890	60,000	75,000			75,000
1891	75,000	100,000			100,000
1892	75,000	100,000			100,000
1893	51,111		156		88,929
1894	35,943		191		52,388
1895	44,325		148		55,831
1896	49,156	65,441	222	$1,750	67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	50,878	121,465
1900	456,283	92,758	5,497	55,202	147,960
1901	360,060	98,859	2,171	19,719	118,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,854	120,316
1905	924,875	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111
1908	972,964	234,021	2,417	33,904	267,925

PRICES.

The average price of sheet mica in the United States during 1908, as deduced from the total production, was 24.1 cents per pound, as compared with 33 cents per pound in 1907 and with 17.7 cents in 1906. The average prices per pound of sheet mica as reported in the production from several States were as follows: Virginia, 44.2 cents; South Carolina, 35.7 cents; South Dakota, 33.3 cents; Alabama, 24 cents; North Carolina, 19.1 cents. These average values vary greatly from year to year, a result caused in part by variation between the proportion of rough and trimmed sheet mica sold by the producers and in part by variation in the size of sheet produced.

The prices of several sizes of selected mica quoted in the price list of a large mica company of New York during 1908 were as follows:

Prices per pound of selected sizes of sheet mica at New York in 1908.

2 by 2 inches	$0.87	3 by 4 inches	$3.25
2 by 3 inches	1.10	4 by 6 inches	4.75
2 by 5 inches	1.70	6 by 8 inches	6.75
3 by 3 inches	2.75		

IMPORTS AND EXPORTS.

The imports of unmanufactured and trimmed sheet mica into the United States during 1908, as reported by the Bureau of Statistics of the Department of Commerce and Labor, were less than in 1907 by 1,790,317 pounds in quantity and by $659,201 in value. The quantity of mica imported in 1908 was smaller than in any previous year recorded since 1897, though the value was slightly greater than in 1897, 1898, and 1904.

The quantity and value of mica imported into the United States annually from 1903 to 1908, inclusive, are shown in the following table:

Mica imported and entered for consumption in the United States, 1903–1908, in pounds.

Year.	Unmanufactured.		Cut or trimmed.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	1,355,375	$288,783	67,680	$29,186	1,423,055	$317,969
1904	1,085,343	241,051	61,986	22,663	1,147,329	263,714
1905	1,506,382	352,475	88,188	51,281	1,594,570	403,756
1906	2,984,719	983,981	82,019	58,627	3,066,738	1,042,608
1907	2,226,460	848,098	112,230	77,161	2,338,690	925,259
1908	497,332	224,456	51,041	41,602	548,373	266,058

A small quantity of mica is exported each year, for which figures have not been obtained for calendar years.

FOREIGN PRODUCTION.

INDIA.

The exports of mica from India[a] in 1907 amounted to 39,055 hundredweight, valued at £226,382, as compared with 54,262 hundredweight, valued at £259,543, in 1906. The exports were considerably less in 1907 than in 1906, though the value per hundredweight was much greater.

CANADA.

The production of mica in Canada[b] during 1908 was valued at $191,602, a large decrease from that of 1907, which was 774 tons, valued at $312,599. The exports during 1908 were 580,195 pounds, valued at $198,839, or about half as large as those of 1907.

CEYLON.

James Parsons,[c] principal mineral surveyor of Ceylon, reports a production in 1907 of 42,600 pounds of mica, valued at $4,935, an increase of 32,700 pounds and of $2,455 over 1906. This mica is all phlogopite and comes from veins associated with crystalline limestone. The mines are not worked extensively.

[a] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.
[b] Preliminary report on the mineral production of Canada in 1908, Dept. Mines, Canada.
[c] Ceylon Administration Repts., pt. 4, 1907.

MINERAL WATERS.

By Samuel Sanford.

DEFINITION OF MINERAL WATERS.

A mineral water is here defined as any spring or well water sold as water for table or for medicinal use, whether still or carbonated, in bulk or in packages. The outputs of the wells and springs listed by States in this report vary greatly in mineralization, are marketed in widely different ways, and are purchased for a variety of purposes. These points were not considered in determining the inclusion in the tables of the output of a particular spring, nor was consideration given to the statement of a spring owner that the water he sells is not mineral.

SCOPE OF STATISTICS.

According to this definition the statistics cover the output of famous medicinal springs and of other springs yielding supplies that differ in no way from ordinary good drinking water. The kind and quantity of the salts and gases in solution have not determined the inclusion of a specified output; neither has the manner of marketing, whether in half-pint bottles or in barrels.

The statistics include both natural waters—those bottled as they flow from spring or well without the addition or subtraction of any substance whatever—and those that may be classed as semiartificial—natural waters that have been treated to prevent the deposition of iron, have been strengthened by evaporation, or have been carbonated by the addition of carbon dioxide collected from the spring itself or from gas made artificially.

The waters excluded comprise those distributed by public supply systems, the water furnished free to guests at hotels and sanitariums, the artificial medicinal and table waters, and the sweetened beverages or soft drinks. Where a spring or well is part of a public supply system only such water is included in state totals as is sold separately. The artificial medicinal waters comprise various proprietary remedies, some of which are widely advertised and have a large sale. The artificial table waters comprise the seltzer, vichy, etc., frequently made from public supplies and sold in siphons and in comparison but little advertised. The sweetened beverages, ginger ale, pop, sarsaparilla, and others variously named, are sold in small packages.

MAGNITUDE OF MINERAL-WATER TRADE.

That the totals given in the tabulated statement of production by States do not represent the real importance of the mineral-water industry in the United States, using the term mineral water in its broadest sense, is apparent. At many resorts the quantity of water furnished free to guests far exceeds the quantity sold, and this without taking into account water used for bathing. No figures are available to show the quantity of strictly artificial table and medicinal water sold nor the value of the product. Neither are there returns from producers of sweetened beverages, but an idea of the extent of the industry may be had from the figures reported by spring owners and well owners.

TRADE IN SOFT DRINKS.

The total quantity of water sold by commercial springs reporting sales in 1908 was 56,108,820 gallons. The water reported used in the manufacture of soft drinks amounted to 6,020,912 gallons. The value of this water is difficult to estimate; but the retail value of the beverages made from it was not less than $3,000,000.

Returns from several States are given below. They show how important an industry is the production of soft drinks at springs in certain States:

Quantity of water used in the manufacture of soft drinks in 1908, in gallons.

Michigan	1,279,953	South Carolina	262,795
Wisconsin	1,051,325	New Hampshire	241,331
Massachusetts	628,798	Other States	1,927,890
Iowa	317,500		
Maine	311,320		6,020,912

MINERALIZATION OF WELL AND SPRING WATERS.

The quantity and kind of the solids and gases carried by the water from a given spring or well are determined chiefly by the texture and composition of the material through which it has passed in its underground journey and the depth from which it comes. Hence waters that have circulated through beds that contain little readily soluble matter and have traveled but a short way underground may be remarkably pure, and those that have passed through soluble beds or come from great depths may be highly mineralized. It frequently happens that the springs or wells in a certain district draw on the same beds or series of beds and that the waters have a certain resemblance, yet springs within a short distance of each other may differ notably in mineral content, particularly if the rocks of the region are much folded or fissured, because of decided differences in underground circulation.

In general the low mineralized waters, and these include most of the waters sold chiefly for table use, come from springs of shallow source. Many of these springs flow from beds of sand. Other springs yielding table waters, and these include some of the most noted, flow from crevices in granite or related rocks. Limestone springs usually yield waters containing relatively high quantities of lime and magnesia; and springs from pyritiferous shales and schists usually contain salts of iron and aluminum.

The springs that rise from some depth and deep wells yield waters that as a rule are more highly mineralized, and the mineralization shows less relation to the character of the bed in which the water is found. Deeply buried sands and sandstones yield waters of widely varying content, and waters from deep wells in granite may have a composition that baffles explanation.

TABLE AND MEDICINAL WATERS.

A medicinal water may be defined as one containing a sufficient proportion of one or two constituents to have a therapeutic value when drunk in reasonable quantities; a table water, as one without a sufficient proportion of such constituents. But as the physiologic effects of two constituents may bear little relation to the quantities present, one being potent in small quantities, the other relatively inert, and as the sensitiveness of different individuals to the same mineral salts varies decidedly, it is practically impossible to separate all waters into two classes. Some are on the border line and are purchased for both medicinal and table use. At the same time, it is evident that a water can scarcely be classed as medicinal because it contains a trace of some element thought to have especial value in the treatment of certain diseases.

In general the medicinal waters sell at a higher price than the table waters. Yet certain waters that are sold largely for table use bring a higher price than many waters so strongly mineralized that they should be drunk only under the advice of a physician. Particularly is this true of the medicinal waters in those sections where many deep wells have been drilled.

On account of the difficulty of sharply separating medicinal water from table water, either by chemical analysis and assumed physiologic effect or by market price, the statements of producers have been taken as a basis for the values of these waters sold in 1908.

SPRINGS AS RESORTS.

The development of springs as resorts promises to be an important feature of the growth of the mineral-water industry in the United States. That there is abundant room for development in this direction, and that the returns will amply justify the necessary investment of capital is shown by the number of those who visit the different European baths and by the attendance at the more notable domestic resorts.

The two great needs at most of the resorts in this country are, first, a rational system of use, a prescribed plan of treatment, the mode of life, the diet, and the use of the waters to be under competent medical direction; second, an endeavor to make the springs attractive, to provide pleasant and even beautiful surroundings and means of healthful diversion, and thus to make the taking of the water something else than a monotonous routine.

Of the springs reporting sales in 1908 but 158 are said to be resorts, and it is safe to say that at the great majority of these the proprietors paid little regard to instructing guests in a rational use of the waters, and at even fewer were other attractions provided than could be found at most summer-resort hotels.

VALUATION OF MINERAL WATERS.

In estimating the value of the mineral water produced in 1908 the same basis was used as in estimating the value of the 1907 output, that is, the retail price of the water at the spring. This includes the cost of preparing the water for market, but does not include freight charges, salaries of agents, and other costs of distribution.

REVIEW OF MINERAL-WATER TRADE IN 1908.

PRODUCTION AND VALUE.

The depressed condition of many industries consequent upon the financial disturbance of 1907 is not reflected by the totals in the statistics of the mineral-water trade here presented. The quantity sold was 56,108,820 gallons, compared with 52,060,520 gallons in 1907, a gain of 4,048,300 gallons, or 7.78 per cent. The value of the output was $7,287,269, compared with $7,331,503 in 1907, a decrease of $44,234, or less than 1 per cent. These figures show that the mineral-water trade did not suffer as severely as might have been expected, in view of the fact that some of the high-priced and widely advertised carbonated table waters are to most consumers luxuries rather than necessaries.

The following table shows the number of springs listed and the quantity and value of the output from 1883, the year the Survey began to collect statistics of production, to 1908, inclusive:

Estimated production of mineral waters, 1883–1908.

Year.	Number of springs.	Quantity sold (gallons).	Value.	Year.	Number of springs.	Quantity sold (gallons).	Value.
1883	189	7,529,423	$1,119,603	1896	377	25,795,312	$4,136,192
1884	189	10,215,328	1,459,143	1897	441	23,255,911	4,599,106
1885	224	9,148,401	1,312,845	1898	484	28,853,464	8,051,833
1886	225	8,950,317	1,284,070	1899	541	39,562,136	6,948,030
1887	215	8,259,609	1,261,463	1900	561	45,276,995	5,791,805
1888	198	9,578,648	1,679,302	1901	659	54,733,661	7,443,904
1889	258	12,780,471	1,748,458	1902	721	63,174,552	8,634,179
1890	273	13,907,418	2,600,750	1903	a 560	40,107,147	6,788,426
1891	288	18,392,732	2,996,259	1904	a 484	41,969,145	6,218,873
1892	283	21,876,604	4,905,970	1905	a 564	46,544,361	6,491,251
1893	330	23,544,495	4,246,734	1906	a 582	48,108,580	8,028,387
1894	357	21,569,608	3,741,846	1907	a 584	52,060,520	7,331,503
1895	370	21,463,543	4,254,337	1908	a 695	56,108,820	7,287,269

a Springs reporting sales.

Details of the production in 1907 and 1908 are given in the accompanying tables.

Production and value of mineral waters in the United States, 1907, by States.

State or Territory.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Alabama	7	130,800	$0.16	$17,220	$3,500	$20,720
Arkansas	7	431,511	.20	59,861	25,375	85,236
California	28	1,680,169	.27	251,275	209,697	460,972
Colorado	12	775,100	.20	45,775	108,640	154,415
Connecticut	13	307,906	.13	4,470	36,969	41,439
Florida	7	43,430	.29	9,669	2,709	12,378
Georgia	8	246,800	.11	15,938	12,182	28,120
Illinois	15	720,400	.13	31,240	60,520	91,760
Indiana	17	514,366	.99	497,246	10,500	507,746
Iowa	6	127,200	.24	23,633	6,867	30,500
Kansas	14	362,252	.17	47,262	14,192	61,454
Kentucky	14	736,920	.10	47,918	24,455	72,373
Maine	26	1,161,832	.36	18,255	396,045	414,300
Maryland	7	1,023,562	.11	20,200	89,839	110,039
Massachusetts	51	4,661,115	.04	26,487	182,092	208,579
Michigan	19	1,472,679	.09	35,091	92,042	127,133
Minnesota	8	9,654,030	.05	7,088	517,712	524,800
Mississippi	8	425,500	.22	85,055	8,295	93,350
Missouri	18	667,232	.15	37,614	65,700	103,314

Production and value of mineral waters in the United States, 1907, by States.—Cont'd.

State or Territory.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
New Hampshire	6	343,500	$0.48	$53,015	$111,928	$164 943
New Jersey	11	982,445	.11	9,600	93,482	103,082
New Mexico	4	65,800	.14	4,170	4,950	9,120
New York	41	7,176,815	.09	259,730	426,844	686,574
North Carolina	13	193,479	.21	37,262	3,040	40,302
Ohio	24	1,536,621	.08	33,777	87,754	121,531
Oklahoma	4	69,725	.11	3,755	3,590	7,345
Oregon	5	24,225	.23	2,369	3,187	5,556
Pennsylvania	27	1,287,063	.18	75,418	160,389	235,807
Rhode Island	4	245,307	.07	0	17,108	17,108
South Carolina	13	786,754	.25	144,717	50,465	195,182
Tennessee	17	758,312	.11	57,080	28,169	85,249
Texas	23	1,146,279	.13	126,571	25,662	152,233
Vermont	7	88,550	.23	8,055	11,893	19,948
Virginia	44	2,442,075	.18	284,224	147,546	431,770
Washington	4	68,400	.16	4,800	6,020	10,820
West Virginia	10	135,809	.59	47,148	32,511	79,659
Wisconsin	29	6,839,219	.22	482,392	1,044,311	1,526,703
Other States and Territories[a]	13	2,727,338	.11	35,888	254,055	289,943
	584	52,060,520	.15	2,951,268	4,380,235	7,331,503

[a] Includes Alaska, Arizona, Delaware, District of Columbia, Idaho, Louisiana, Montana, Nebraska, South Dakota, Utah, and Wyoming.

Production and value of mineral waters in the United States, 1908, by States.

State or Territory.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Alabama	8	99,192	$0.32	$24,289	$7,294	$31,583
Arkansas	10	1,175,053	.20	193,716	35,544	229,260
California	40	1,960,770	.25	162,173	337,699	499,872
Colorado	11	761,150	.17	46,625	81,095	127,720
Connecticut	15	424,826	.09	2,758	33,646	36,404
Florida	12	123,552	.17	16,469	4,100	20,569
Georgia	14	346,198	.15	14,710	36,220	50,930
Illinois	17	685,763	.09	23,930	34,974	58,904
Indiana	15	615,429	.96	576,731	14,148	590,879
Iowa	6	493,500	.11	41,650	13,700	55,350
Kansas	16	370,943	.20	57,279	17,101	74,380
Kentucky	12	797,186	.08	31,407	34,705	66,112
Louisiana	3	400,500	.13	16,500	35,520	52,020
Maine	27	1,182,322	.33	14,461	379,885	394,346
Maryland	8	806,673	.09	2,100	73,758	75,858
Massachusetts	61	4,395,049	.05	42,511	185,396	227,907
Michigan	24	2,004,433	.04	5,995	82,915	88,910
Minnesota	11	10,985,536	.05	4,561	547,425	551,986
Mississippi	8	257,200	.21	39,730	13,050	52,780
Missouri	30	682,821	.13	57,062	28,981	86,043
Nebraska	3	48,498	.23	3,779	7,268	11,047
New Hampshire	9	835,349	.31	109,008	150,512	259,520
New Jersey	13	1,199,023	.11	10,525	116,078	126,603
New Mexico	6	152,200	.11	9,100	6,960	16,060
New York	47	8,007,092	.11	126,629	751,019	877,648
North Carolina	18	160,195	.17	24,282	2,881	27,163
Ohio	27	2,409,598	.05	26,799	98,139	124,938
Oklahoma	9	534,114	.10	42,237	10,542	52,779
Oregon	6	25,350	.35	5,670	3,160	8,830
Pennsylvania	32	1,430,489	.14	61,026	136,471	197,497
Rhode Island	9	594,208	.07	1,325	38,080	39,405
South Carolina	13	271,572	.26	47,402	23,535	70,937
Tennessee	14	712,912	.10	53,445	15,248	68,693
Texas	36	1,586,634	.10	138,863	12,169	151,032
Vermont	5	107,800	.15	6,718	9,662	16,380
Virginia	46	2,009,614	.10	97,502	109,613	207,115
Washington	5	38,900	.35	3,375	10,275	13,650
West Virginia	9	130,295	.61	48,457	31,458	79,915
Wisconsin	28	6,084,571	.23	541,522	871,585	1,413,107
Other States[a]	12	1,202,310	....	20,375	132,762	153,137
	695	56,108,820	.13	2,752,696	4,534,573	7,287,269

[a] Includes Alaska, Arizona, Delaware, District of Columbia, Idaho, Montana, North Dakota, South Dakota, Utah, and Wyoming.

The foregoing table shows that the rank of the States based on value of output differs from their rank based on quantity of water sold. The ten leading States compare as follows:

Rank of States based on springs reporting, on quantity sold, and on value of output, 1908.

	Number of springs reporting.	Quantity sold.	Value of medicinal waters.	Value of table waters.	Total value.
1	Massachusetts	Minnesota	Indiana	Wisconsin	Wisconsin.
2	New York	New York	Wisconsin	New York	New York.
3	Virginia	Wisconsin	Arkansas	Minnesota	Indiana.
4	California	Massachusetts	California	Maine	Minnesota.
5	Texas	Ohio	Texas	California	California.
6	Pennsylvania	Virginia	New York	Massachusetts	Maine.
7	Missouri	Michigan	New Hampshire	New Hampshire	New Hampshire.
8	Wisconsin	California	Virginia	Pennsylvania	Arkansas.
9	Maine Ohio	Texas	Pennsylvania	New Jersey	Massachusetts.
10	Michigan	Pennsylvania	Kansas	Virginia	Virginia.

In these groups certain States have commanding leads over those ranking next to them. Thus Minnesota, with reported sales of nearly 11,000,000 gallons, is almost 3,000,000 gallons ahead of the second State, New York; and the first four States—Minnesota, New York, Wisconsin, and Massachusetts—produced 53 per cent of the total.

Similarly, the value of the medicinal water output of Indiana and Wisconsin was over $500,000 for each State, while the next State in order, Arkansas, sold medicinal water of a value of only $193,716. In value of output of table water Wisconsin, with sales exceeding $870,000, and New York, with sales amounting to over $750,000, easily led the list, Maine springs selling less than $380,000. In total value of output Wisconsin was easily first, with sales exceeding $1,400,000, while New York, with sales amounting to more than $870,000, led the next State, Indiana, by over $275,000.

The commanding lead of Wisconsin in total value is due to sales of both medicinal and table water. The rank of Indiana is due almost wholly to medicinal water, that of New York chiefly to table water, and that of Minnesota practically altogether to table-water sales.

This table also shows that while some States, like Massachusetts, owe their rank to the combined production of many relatively small outputs, others, like Minnesota, lead by reason of the large output marketed from a few wells or springs.

CONDITION OF THE TRADE.

A comparison of the returns for 1908 with those for 1907 shows the reason for the gain in volume and the slight decline in value of sales in spite of the generally depressed condition of many industries and the consequent curtailing of expense by many thousands of consumers. The following tables show that there was a large increase in the number of springs reporting, the gain amounting to 111, or 19 per cent, more than in 1907. Of the 39 States separately named, 29 gained one or more springs, 7 had losses, and 3 showed neither gain nor loss. Of the 29 same States that showed gains in number of springs 8 showed losses in quantity of water sold. Of the 7 States reporting fewer springs in 1908, 3 sold more water and 4 sold less.

These figures demonstrate that while the increase in the number of springs accounted for much of the gain in production, it did not account for all, and that many springs sold more water in 1908 than in 1907 in spite of business depression. This conclusion is borne out by the statements accompanying the returns made by spring owners.

Number of springs and quantity and value of mineral waters sold in 1907 and 1908.

State or Territory.	1907.			1908.		
	Springs reporting.	Quantity sold (gallons).	Value.	Springs reporting.	Quantity sold (gallons).	Value.
Alabama	7	130,800	$20,720	8	99,192	$31,583
Alaska	1	....	....	1	....	....
Arizona	1	....	....	1	....	....
Arkansas	7	431,511	85,236	10	1,175,053	229,260
California	28	1,680,169	460,972	40	1,960,770	499,872
Colorado	12	775,100	154,415	11	761,150	127,720
Connecticut	13	307,906	41,439	15	424,826	36,404
Delaware	1	....	....	1	....	....
District of Columbia	1	....	....	1	....	....
Florida	7	43,430	12,378	12	123,552	20,569
Georgia	8	246,800	28,120	14	346,198	50,930
Idaho	1	....	....	1	....	....
Illinois	15	720,400	91,760	17	685,763	58,904
Indiana	17	514,366	507,746	15	615,429	590,879
Iowa	6	127,200	30,500	6	493,500	55,350
Kansas	14	362,252	61,454	16	370,943	74,380
Kentucky	14	736,920	72,373	12	797,186	66,112
Louisiana	2	....	....	3	400,500	52,020
Maine	26	1,161,832	414,300	27	1,182,322	394,346
Maryland	7	1,023,562	110,039	8	806,673	75,858
Massachusetts	51	4,661,115	208,579	61	4,395,049	227,907
Michigan	19	1,472,679	127,133	24	2,004,433	88,910
Minnesota	8	9,654,030	524,800	11	10,985,536	551,986
Mississippi	8	425,500	93,350	8	257,200	52,780
Missouri	18	667,232	103,314	30	682,821	86,043
Montana	2	....	....	1	....	....
Nebraska	1	....	....	3	48,498	11,047
New Hampshire	6	343,500	164,943	9	835,349	259,520
New Jersey	11	982,445	103,082	13	1,199,023	126,603
New Mexico	4	65,800	9,120	6	152,200	16,060
New York	41	7,176,815	686,574	47	8,007,092	877,648
North Carolina	13	193,479	40,302	18	160,195	27,163
North Dakota	0	....	....	1	....	....
Ohio	24	1,536,621	121,531	27	2,409,598	124,938
Oklahoma	4	69,725	7,345	9	534,114	52,779
Oregon	5	24,225	5,556	6	25,350	8,830
Pennsylvania	27	1,287,063	235,807	32	1,430,489	197,497
Rhode Island	4	245,307	17,108	9	594,208	39,405
South Carolina	13	786,754	195,182	13	271,572	70,937
South Dakota	1	....	....	3	....	....
Tennessee	17	758,312	85,249	14	712,912	68,693
Texas	23	1,146,279	152,233	36	1,586,634	151,032
Utah	1	....	....	1	....	....
Vermont	7	88,550	19,948	5	107,800	16,380
Virginia	44	2,442,075	431,770	46	2,009,614	207,115
Washington	4	68,400	10,820	5	38,900	13,650
West Virginia	10	135,809	79,659	9	130,295	79,915
Wisconsin	29	6,839,219	1,526,703	28	6,084,571	1,413,107
Wyoming	1	....	....	1	....	....
States or Territories of one or two springs each, including those for which figures are not given in the above list	....	2,727,338	289,943	....	1,202,310	153,137
	584	52,060,520	7,331,503	695	56,108,820	7,287,269

The 13 more important States separately named, those producing over 1,000,000 gallons in 1908, are, in order of quantity sold, Minnesota, New York, Wisconsin, Massachusetts, Ohio, Virginia, Michigan, California, Texas, Pennsylvania, New Jersey, Maine, and Arkansas. Producing springs in these States reported their total output of water sold as 44,430,184 gallons, or 79 per cent of the total production of the country. Of these States, 1, Wisconsin, had fewer reporting springs in 1908 than in 1907; 3, Massachusetts, Virginia, and Wisconsin, sold less water; and 6, Maine, Michigan, Pennsylvania, Texas, Virginia, and Wisconsin, reported a lower valuation in 1908 than in 1907. These figures indicate that the gain in production in these 13 States came largely from new springs and that the lower valuation was due to the lower selling price of the waters as compared with the prices realized by the older springs. The reports from individual producers show that the financial depression was felt most severely by springs doing a comparatively small business and presumably having insufficient capital to carry them through a period of stress, and by a few of the large springs which make a specialty of supplying carbonated water for bar and hotel trade.

Comparative production of mineral waters, 1907–8.

State or Territory.	Increase (+) or decrease (−) in number of springs reporting sales.	Increase (+) or decrease (−) in gallons sold.	Percentage of increase (+) or decrease (−) in gallons sold.	Increase (+) or decrease (−) in value of product.	Percentage of increase (+) or decrease (−) in value of product.
Alabama	+ 1	− 31,608	− 24.17	+$10,863	+ 52.43
Arkansas	+ 3	+ 743,542	+172.31	+144,024	+168.97
California	+ 12	+ 280,601	+ 16.70	+ 38,900	+ 8.44
Colorado	− 1	− 13,950	− 1.80	− 26,695	− 17.29
Connecticut	+ 2	+ 116,920	+ 37.97	− 5,035	− 12.15
Florida	+ 5	+ 80,122	+184.49	+ 8,191	+ 66.17
Georgia	+ 6	+ 99,398	+ 40.27	+ 22,810	+ 81.12
Illinois	+ 2	− 34,637	− 4.81	− 32,856	− 35.81
Indiana	− 2	+ 101,063	+ 19.65	+ 83,133	+ 16.37
Iowa	Same.	+ 366,300	+287.97	+ 24,850	+ 81.48
Kansas	+ 2	+ 8,691	+ 2.40	+ 12,926	+ 21.03
Kentucky	− 2	+ 60,266	+ 8.18	− 6,261	− 8.65
Louisiana and Nebraska	+ 1	−1,571,002	− 77.77	−112,533	− 64.08
Maine	+ 1	+ 20,490	+ 1.73	− 19,954	− 4.82
Maryland	+ 1	− 216,889	− 21.19	− 34,181	− 31.06
Massachusetts	+ 10	− 266,066	− 5.71	+ 19,328	+ 9.27
Michigan	+ 5	+ 531,754	+ 36.11	− 38,223	− 30.07
Minnesota	+ 3	+1,331,506	+ 13.79	+ 27,186	+ 5.18
Mississippi	Same.	− 168,300	− 39.55	− 40,570	− 43.46
Missouri	+ 12	+ 15,589	+ 2.34	− 17,271	− 16.72
Nebraska	+ 2	(a)	....	(a)	....
New Hampshire	+ 3	+ 491,849	+143.19	+ 94,577	+ 57.34
New Jersey	+ 2	+ 216,578	+ 22.04	+ 23,521	+ 22.82
New Mexico	+ 2	+ 86,400	+131.31	+ 6,940	+ 76.10
New York	+ 6	+ 830,277	+ 11.58	+191,074	+ 27.83
North Carolina	+ 5	− 33,284	− 17.20	− 13,139	− 32.60
Ohio	+ 3	+ 872,977	+ 56.81	+ 3,407	+ 2.80
Oklahoma	+ 5	+ 464,389	+666.03	+ 45,434	+618.57
Oregon	+ 1	+ 1,125	+ 4.64	+ 3,274	+ 58.93
Pennsylvania	+ 5	+ 143,426	+ 11.14	− 38,310	− 16.25
Rhode Island	+ 5	+ 348,901	+142.23	+ 22,297	+130.33
South Carolina	Same.	− 515,182	− 65.48	−124,245	− 63.64
Tennessee	− 3	− 45,400	− 5.99	− 16,556	− 19.42
Texas	+ 13	+ 440,355	+ 38.42	− 1,201	− 0.79
Vermont	− 2	+ 19,250	+ 21.74	− 3,568	− 17.89
Virginia	+ 2	− 432,461	− 17.71	−224,655	− 52.03
Washington	+ 1	− 29,500	− 43.13	+ 2,830	+ 26.16
West Virginia	− 1	− 5,514	− 4.06	+ 256	+ 0.32
Wisconsin	− 1	− 754,648	− 11.03	−113,596	− 7.45
Other States and Territories not included above[b]	+ 2	+ 494,972	+ 81.50	+ 38,794	+ 33.93
Net increase or decrease, 1908	+111	+4,048,300	+ 7.78	− 44,234	− 0.60

[a] Decreases included with Louisiana.
[b] Includes Alaska, Arizona, Delaware, District of Columbia, Idaho, Montana, North Dakota, South Dakota, Utah, and Wyoming.

A comparison of the values of table and medicinal waters in this report and of those in the 1907 report shows that the total valuation of the water sold in 1908 declined because of the lower valuation of the medicinal water, the springs reporting for the first time being mostly shippers of table water.

The values of the table and the medicinal waters produced in 1907 and 1908 compare thus:

Value of medicinal and table waters, 1907–8.

	Value of medicinal waters.	Value of table waters.	Total value.
1907	$2,951,268	$4,380,235	$7,331,503
1908	2,752,696	4,534,573	7,287,269
Increase (+) or decrease (−) in 1908	−198,572	+154,338	−44,234
Percentage of increase (+) or decrease (−) in 1908	− 6.73	+ 3.52	− 0.60

The figures emphasize the fact that in value of product the table waters gained, the medicinal lost, and the total loss slightly more than exceeded the gains. Due allowance being made for springs productive in 1907 but not reporting for 1908, it appears that in 1908 business depression was felt most severely by those springs that are resorts, as appears also from the statements of the proprietors. Another fact indicated by individual returns is that some of the strictly medicinal waters sold in bottles suffered from the stagnation of general trade. The large eastern resorts seem to have suffered most keenly. West of the Mississippi the resorts made a better showing, notably in Texas, but some of the bottled medicinal waters from western springs did not meet as ready a market as in 1907.

TRADE PROSPECTS.

That the financial disturbance of 1907 had less effect on the production of mineral water in the United States than on many other industries is evidence of several facts.

In the first place, the condition of the mineral-water industry during 1908 shows that the demand for pure drinking water extends across the continent and has come to stay. It is a stable demand little affected by temporary checks to industrial expansion. That 111 springs which did not report in 1907 reported in 1908 shows that there is plenty of room for competition, due allowance being made for the fact that some of these springs, though selling water, have not previously made returns. It is not probable that all the new concerns will be successful. But the growth of population, the movement toward cities, the wholesale pollution of surface waters, and the time that will elapse before even a majority of the cities of this country are provided with purification plants are factors that indicate continued growth for the table-water trade, particularly for the waters sold in bulk. The table-water springs hit hardest by financial depression, those doing a large business in carbonated natural waters, will gain new customers with the return of prosperity, and the medicinal springs, notably those situated at resorts, have every reason to be satisfied with the outlook. The rational use of water in health and in disease is still, in spite of all advances made, only imperfectly understood, and there can be no doubt of a great increase in the number of resorts and in the attendance if enterprising spring proprietors offer the public what the proprietors of European springs have offered for years.

IMPORTS AND EXPORTS.

IMPORTS.

The imports for 1908, which include natural, semiartificial, and strictly artificial waters, amounted to 2,912,398 gallons, valued at $1,033,047. These figures are reported by the Bureau of Statistics of the Department of Commerce and Labor, and represent imports entered for consumption, not total imports. The valuation is that assessed by customs officials. The decrease is chiefly due to general business depression.

The following table shows the quantity and value of mineral waters imported into the United States for the last six years:

Mineral waters imported and entered for consumption in the United States, 1903–1908, in gallons.

Year.	Mineral waters.		Year.	Mineral waters.	
	Quantity.	Value.		Quantity.	Value.
1903	2,851,964	$846,294	1906	3,157,609	$1,012,333
1904	2,901,828	868,262	1907	3,497,239	1,165,555
1905	3,150,030	926,357	1908	2,912,398	1,033,047

EXPORTS.

Considerable quantities of certain domestic waters are exported to Canada, Mexico, and the West Indies, but no account is taken of such shipments by the Department of Commerce and Labor. No exports have been reported since 1883.

TRADE BY STATES.

ALABAMA.

Depression in the important mining and manufacturing industries of Alabama was reflected by the fall in the mineral water output from 130,800 gallons sold in 1907 to 99,192 gallons in 1908, a decrease of 31,608 gallons, or 24 per cent. The value, however, increased from $20,720 in 1907 to $31,583 in 1908, a gain of $10,863, or 52 per cent, the average retail price rising from $0.16 to $0.32. This seemingly great increase in price is accounted for by the increase in output of one spring, which returned a very high price per gallon for its water. One new spring reported sales, the Luverne Mineral, the total number of springs selling water being 8. Nearly two-thirds of the output was used for medicinal purposes. There are resorts at 4 of these 8 springs, accommodating more than 600 people, and the water at 3 is used for bathing. Besides the 99,192 gallons of water reported as actually sold, there were 30,638 gallons used in the manufacture of soft drinks.

The springs reporting sales are as follows:

Bailey Springs, Florence, Lauderdale County.
Healing Springs, Healing Springs, Washington County.
Ingram Lithia Wells, near Ohatchee, Calhoun County.
Livingston Mineral Springs, Livingston, Sumter County.
Luverne Mineral Spring, Luverne, Crenshaw County.
MacGregor Spring, Spring Hill, Mobile County.
Wilkinson's Matchless Mineral Wells, east of Greenville, Butler County.
York Well, York, Sumter County.

ALASKA.

In Alaska, as for 1907, only one spring was listed. The output, however, was twenty times that reported in 1907. This water is all used for table purposes. To avoid disclosing returns, Alaska has been included with other States having less than three producers. The spring is called—

Zarembo Mineral Spring, Zarembo Island.

ARIZONA.

Arizona's mineral-water trade did not differ materially from that of 1907, only one spring reporting. This spring is a resort where there are accommodations for 125 guests. The water is also used for bathing. This spring is—

Castle Hot Springs, Hot Springs, Yavapai County.

ARKANSAS.

The mineral-water output of Arkansas exceeded the million-gallon mark for the first time in 1908, amounting to 1,175,053 gallons, against 431,511 reported in 1907, an increase of 743,542 gallons, or 172 per cent, the value also increasing at about the same ratio, from $85,236 in 1907 to $229,260 in 1908. The average retail price quoted was the same for the two years. Four new springs reported sales, the Famous, Hughes's Magnesia, Mountain Blood, and Ozark Lithia, raising the total number of springs reporting to 10. One of the new springs in the Hot Springs district reported a volume of trade exceeding any of the older springs. By far the larger proportion of the output is used for medicinal purposes. In addition to the sales reported there were 91,250 gallons used during the year in the manufacture of soft drinks. There are 5 resorts at these 10 springs, with accommodations for more than 13,000 people, and the water at 3 is used for bathing purposes.

Below is given the record for the last five years:

Production and value of mineral waters in Arkansas, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	5	534,440	$57,107	1907	7	431,511	$85,236
1905	7	474,005	50,501	1908	10	1,175,053	229,260
1906	8	727,765	105,286				

The springs reporting sales are as follows:

Arkansas Lithia Springs, near Hope, Hempstead County.
Arsenic Springs, Hot Springs, Garland County.
Famous Spring, near Hot Springs, Garland County.
Howard's Mineral Wells, Sharp, Independence County.
Hughes's Magnesia Spring, Hot Springs, Garland County.
Magnetic Spring, Eureka Springs, Carroll County.
Mountain Blood Spring, near Hot Springs, Garland County.
Mountain Valley Spring, near Hot Springs, Garland County.
Ozark Lithia Spring, near Hot Springs, Garland County.
Potash Sulphur Springs, Lawrence, Garland County.

CALIFORNIA.

The returns showed a substantial increase in the output of California for the year 1908, sales increasing nearly 17 per cent over the production reported in 1907. This gain was chiefly in water sold for medicinal purposes, though the new springs contributed also. According to returns received there were sold 1,960,770 gallons, valued at $499,872, an increase of 280,601 gallons and of $38,900 over the figures for 1907. The average price obtained per gallon declined from 27 to 25 cents. Statistics for the last five years are given in the following table:

Production and value of mineral waters in California, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	35	3,756,779	$899,763	1907	28	1,680,169	$460,972
1905	39	1,934,784	675,214	1908	40	1,960,770	499,872
1906	28	1,487,975	520,515				

No less than 11 new springs reported, as follows: Adams Springs, Bartlett, Bythnia, Corona, La Mesa, Nuvida Springs, Sausalito, Tia Juana Springs, Valley Springs, White Sulphur, and Yosemite Mineral, increasing the total number reporting to 40. About two-thirds of the output was used for table purposes. There are 17 resorts situated at these springs, with accommodations for more than 3,000 people, and the water at 10 is used for bathing. There was a comparatively small quantity said to have been used in the manufacture of soft drinks. Those springs from which reports of output are available are as follows:

Adams Springs, Middletown, Lake County.
Ætna Spring, Lidell, Napa County.
Alhambra Spring, near Martinez, Contra Costa County.
Bartlett Spring, Bartlett Springs, Lake County.
Bradley and Corona Springs, near Foster, San Diego County.
Buckman Springs, near Descanso, San Diego County.
Bythnia Springs, Santa Barbara, Santa Barbara County.
California Geysers, Sonoma County.
Castalian Spring, Inyo County.
Castle Rock Spring, Castle Rock, Shasta County.
Console Mineral Spring, Colton, San Bernardino County.
Cooks Springs, near Williams, Colusa County.
Duncan Springs, Hopland, Mendocino County.
El Granito Mineral Spring, El Cajon, San Diego County.
Iron Lithia and White Sulphur Springs, Eden Hot Springs, Riverside County.
Isham Springs, near San Diego, San Diego County.
La Mesa Spring, La Mesa, San Diego County.
Lytton Spring, Lytton, Sonoma County.
McDowell Spring, Hopland, Mendocino County.
Mount Ida Mineral Spring, Wyandotte, Butte County.
Napa Soda Springs, Napa Valley, Napa County.
Nuvida Springs, near San Diego, San Diego County.
Red Eye Spring, Fouts Springs, Colusa County.
Samuel Soda Spring, Monticello, Napa County.
San Benito Spring, near Hollister, San Benito County.
Sausalito Spring, Sausalito, Marin County.
Shasta Spring, Shasta Springs, Siskiyou County.
Tahoe Mineral Spring, near Truckee, Placer County.
Tassajara Hot Springs, near Jamesburg, Monterey County.

Tia Juana Springs, near Nestor, San Diego County.
Tolenas Spring, near Suisun City, Solano County.
Upper Soda Spring, near Dunsmuir, Siskiyou County.
Valley Springs, Valley Springs, Calaveras County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
Vichy Springs, near Napa, Napa County.
Witter Medical Spring, Witter Springs, Lake County.
Yacht Club Spring, Sausalito, Marin County.
Yosemite Mineral Spring, Mono Lake, Mono County.

COLORADO.

The mineral-water trade of Colorado felt the depression in other branches of business during 1908. The sales decreased from 775,100 gallons in 1907 to 761,150 gallons in 1908, a decline of 1.8 per cent. Were the water used in the manufacture of soft drinks included, the totals would show an increase, proprietors reporting a total of 89,490 gallons used for soft drinks. The value decreased in larger ratio, or 17.3 per cent, the average retail price declining from $0.20 in 1907 to $0.17 in 1908. No new springs reported, and the total number heard from was one less than in 1907. About two-thirds of the output was used for table purposes. Resorts are situated at 4 of these springs with accommodations for about 5,000 people, and the water at 4 of them is said to be used for bathing purposes.

The springs making returns are as follows:

Blue Ribbon Mineral Spring, Idaho Springs, Clear Creek County.
Boulder Springs, Boulder Springs, Boulder County.
Canon City Vichy Spring, Canon City, Fremont County.
Clark Magnetic Mineral Spring, Pueblo, Pueblo County.
Columbia Mineral Spring, Denver, Denver County.
Kearney's Golden Spring, near Golden, Jefferson County.
Marshall Magnetic Mineral Spring, Pueblo, Pueblo County.
Navaho, Shoshone, Manitou, and Cheyenne Springs, Manitou, El Paso County.
Ute Chief Spring, Manitou, El Paso County.
Ute Iron, Ouray, and Little Chief Springs, Manitou, El Paso County.
Yampah Spring, Glenwood Springs, Garfield County.

CONNECTICUT.

The returns from Connecticut showed an increase in the quantity of mineral water sold, in spite of a falling off in demand reported by some springs because of general business depression. The sales reached 424,826 gallons, valued at $36,404, compared with 307,906 gallons, valued at $41,439 for the previous year, a gain in quantity of 116,920 gallons, and a loss in value of $5,035. The average price declined from 13 cents in 1907 to 9 cents in 1908. Two new springs reported for the first time, the Crystal and the Glenbrook, increasing the total to 15. Practically all of the output was sold for table purposes. There are no resorts at any of these springs, though the water at one is said to be used for bathing purposes. In addition to the quantity sold as water, 107,550 gallons went into the manufacture of soft drinks.

The 15 reporting springs are as follows:

Arethusa Spring, Seymour, New Haven County.
Cherry Hill Spring, Hamden, New Haven County.
Crystal Spring, near Little River, Middlesex County.
Elco Springs, Bristol, Hartford County.
Glenbrook Spring, Glenbrook, Fairfield County.
Granite Rock Spring, Higganum, Middlesex County.
Highland Spring, near Mount Higbee, Middlesex County.
Hillside Spring, Meriden, New Haven County.

Live Oak Spring, Meriden, New Haven County.
Mohican Springs, Fairfield, Fairfield County.
Pequabuck Mountain Spring, Bristol, Hartford County.
Red Rock Spring, Meriden, New Haven County.
Rock Ledge Spring, New Haven, New Haven County.
Stafford Mineral Springs, Stafford Springs, Tolland County.
Varuna Spring, Stamford, Fairfield County.

DELAWARE.

There is but one spring credited to Delaware, and this spring increased its output 433 per cent, as compared with 1907. The water is used entirely for table purposes, principally by residents of Wilmington. This spring is—

Kiamensi Spring, near Wilmington, Newcastle County.

DISTRICT OF COLUMBIA.

There was but one spring reporting sales from the District of Columbia, its water being distributed mainly in Washington for table purposes. The figures for this spring are grouped with those of other States having less than three producers. The name of the spring follows:

Gitche Crystal Spring, Benning.

FLORIDA.

The returns from Florida showed a decided increase in the output, the sales advancing from 43,430 gallons in 1907 to 123,552 gallons in 1908, a gain of 80,122 gallons, or nearly 185 per cent in quantity, but the average price per gallon fell from $0.29 in 1907 to $0.17 in 1908. More energetic search for trade by some of the old springs and the sales of new springs account for the gain in output. There were 4 new springs added to the list, the Cedar, Lackawanna, Welaka Mineral, and Wekiwa, the total number reporting being 12. About four-fifths of the total output of Florida mineral water is said to be used for medicinal purposes. There are resorts at 7 of the 12 springs, with accommodations for about 1,500 people, and the water at 7 is used for bathing. The springs are as follows:

Cedar Spring, near Jacksonville, Duval County.
Dishong Spring, Tampa, Hillsboro County.
Espiritu Santo Spring, Tampa Bay, Hillsboro County.
Heilbronn, Nos. 1 and 2, near Starke, Bradford County.
Lackawanna Spring, near Jacksonville, Duval County.
Magnolia Spring, Magnolia Springs, Clay County.
Orange City Mineral Spring, Orange City, Volusia County.
Panacea Mineral Springs, Panacea, Wakulla County.
Quisiance Spring, Green Cove Springs, Clay County.
Suwanee Sulphur Springs, Suwanee, Suwanee County.
Wekiwa Springs, Wekiwa Springs, Orange County.
Welaka Mineral Spring, Welaka, Putnam County.

GEORGIA.

The Georgia mineral-water trade made considerable gains in 1908, partly because of new springs seeking custom. The output was 346,198 gallons, valued at $50,930, as compared with 246,800 gallons, valued at $28,120, in 1907, an increase of 40 per cent in quantity and of 81 per cent in value. The average retail price rose from

$0.11 to $0.15. Nine new springs were added to the list, the Daniel Mineral, Electric Lithia, High Rock Magnesia, Miona, Point Andrew, Powder, Utoy, White Elk, and White Oak, making the total number reporting sales 14. Nearly seven-tenths of the total output is reported used for table purposes. There are resorts at 5 of the springs, accommodating over 500 people, but at none is the water used for bathing. The names of the springs follow:

Benscot Lithia Springs, Austell, Cobb County.
Catoosa Springs, Catoosa Springs, Catoosa County.
Cox Mineral Spring, Waynesboro, Burke County.
Daniel Mineral Spring, Union Point, Greene County.
Electric Lithia Spring, Hillman, Taliaferro County.
High Rock Magnesia Spring, near Atlanta, Fulton County.
Major's Springs, Menlo, Chattooga County.
Miller's Spring, Milledgeville, Baldwin County.
Miona Spring, near Oglethorpe, Macon County.
Point Andrew Spring, Macon, Bibb County.
Powder Springs, Powder Springs, Cobb County.
Utoy Spring, near Atlanta, Fulton County.
White Elk Spring, near Macon, Bibb County.
White Oak Mineral Spring, Macon, Bibb County.

IDAHO.

Returns from the one spring credited to Idaho show no material difference either in quantity sold or in value as compared with 1907. The spring is on the site of a resort, where about 80 people are accommodated. The water is not used for bathing. The name of the spring is—

Idanha Spring, Soda Springs, Bannock County.

ILLINOIS.

There was a decline both in the quantity sold and in the value of Illinois mineral water for 1908, the sales amounting to 685,763 gallons, against 720,400 gallons in 1907, a decrease of 34,637 gallons, or 4.8 per cent. The value decreased in even greater ratio, from $91,760 to $58,904, a loss of $32,856, or 35.8 per cent. The average price fell from 13 to 9 cents. The business depression following the financial crisis of 1907 accounts for the lessened demand. About two-thirds of the output is used for table purposes. There are resorts at 2 springs, with accommodations for over 100 people; the water at 6 springs is said to be used for bathing. The list of springs was enlarged by 4, the Central Park Sulphur, Mini-Niyan, Pekin Mineral, and Ripley Mineral, the total number reporting being 17. Besides the sales reported, 133,175 gallons from these springs were used in the manufacture of soft drinks. The 17 reporting springs are as follows:

Abana Mineral Springs, Libertyville, Lake County.
Aqua Vitae Mineral Spring, Maquon, Knox County.
Central Park Sulphur, Peoria, Peoria County.
Deer Lick Mineral Spring, Deerfield, Lake County.
Depler Mineral Spring, near Lewistown, Fulton County.
Diamond Mineral Springs, near Grantfork, Madison County.
Gravel Springs, near Jacksonville, Morgan County.
Greenup Mineral Spring, Greenup, Cumberland County.
Macinac Mineral Spring, near Carlock, McLean County.
Mini-Niyan, Bristol, Kendall County.
Mokena Mineral Spring, near Mokena, Will County.

Pekin Mineral Spring, Tazewell County.
Peoria Mineral Springs, Peoria, Peoria County.
Ripley Mineral Spring, near Ripley, Brown County.
Sanicula Spring, Ottawa, Lasalle County.
White Diamond Spring, South Elgin, Kane County.
White Eagle Spring, Edgemont, St. Clair County.

INDIANA.

Indiana had a further improvement in the mineral-water trade during 1908, the figures reported showing an increase in quantity of nearly 20 per cent and in value of over 16 per cent. The total sales reported amounted to 615,429 gallons, valued at $590,879. The high value placed on the medicinal waters of French Lick accounts for the average price of $0.96 reported. Exclusive of the output of these springs, the average retail price for the State was $0.27. In spite of the fact that 3 new springs reported sales for the first time in 1908, the Blue Lick, Hunter Mineral, and Knott's Mineral, the total springs reporting sales decreased from 17 in 1907 to 15 in 1908. Only a little more than 2 per cent of the total sales is used for table purposes. The medicinal use of the water accounts for the gain in spite of business depression. There are resorts at 8 of these springs, with accommodations for more than 4,000 people, and the water at 8 is said to be used for bathing purposes. Very little water from the springs reporting was used for the manufacture of soft drinks.

The springs reporting sales are as follows:

Blue Cast Magnetic Spring, Woodburn, Allen County.
Blue Lick Spring, Blue Lick, Clark County.
Cartersburg Mineral Spring, Cartersburg, Hendricks County.
Coats Springs, Logan Township, Pike County.
Colomagna Spring, Columbus, Bartholomew County.
Hunter Mineral Springs, Kramer, Warren County.
King's Mineral Spring, Dallas, Clark County.
Knott's Mineral Spring, Porter, Porter County.
McCullough Spring, Oakland City, Gibson County.
Mineral Spa Lithia Spring, near Richmond, Wayne County.
Mudlavia Lithia Spring, Kramer, Warren County.
Paoli Lithia Spring, Paoli, Orange County.
Pluto, Proserpine, and Bowles Springs, French Lick, Orange County.
Terre Haute Artesian Mineral Spring, Terre Haute, Vigo County.
West Baden Mineral Springs, West Baden, Orange County.

IOWA.

The sales for 1908 amounted to 493,500 gallons, or an increase of 288 per cent over the output for 1907. This gain is due to the large output reported from one place as caused by active exploitation. The value also increased, although the average retail price fell from $0.24 to $0.11, the spring receiving the highest price for its water in 1907 reporting no sales in 1908. Two new springs reported, the Council Bluffs Mineral and the Manawa Mineral, so that the total number reporting remains the same. About four-fifths of the water sold is used for medicinal purposes. It was also reported that 317,500 gallons were used during the year in the manufacture of soft drinks. The 6 springs reporting sales are as follows:

Colfax Mineral Wells, Colfax, Jasper County.
Council Bluffs Springs, Council Bluffs, Pottawattamie County.
Heston's Springs, Fairfield, Jefferson County.
Manawa Mineral Spring, Storm Lake, Buena Vista County.
Ottumwa Mineral Spring, Ottumwa, Wapello County.
White Sulphur Spring, Linnwood, Scott County.

KANSAS.

The output of mineral waters in Kansas during 1908 showed a small increase, largely due to sales from new springs, the total sales amounting to 370,943 in 1908, a gain of 8,691 gallons, or 2.40 per cent over 1907. The value, however, increased $12,926, or 21 per cent, to $74,380. The retail price rose from $0.17 to $0.20 per gallon. There were 2 new springs added to the list, the Artesian Pure and the Jewel County Lithium, increasing the total number reporting to 16. Less than one-fourth of the total sales is used for table purposes, the bulk of the water being used for medicinal purposes. There are resorts situated at 6 of the springs with total accommodations for about 900 people, and the water at 6 is used for bathing. In addition to the figures given above, it was reported that 76,679 gallons went into the manufacture of soft drinks.

Those springs from which reports are available are as follows:

Abilena Spring, Willowdale Township, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Artesian Pure Spring, near Hutchinson, Reno County.
Blasing's Natural Medical Spring, near Manhattan, Riley County.
Boon Vichy Spring, Topeka, Shawnee County.
California Spring, Franklin County.
Chautauqua Springs, Chautauqua, Chautauqua County.
Crystal Spring, Coffeyville, Montgomery County.
Geuda Springs, Cowley County.
Ironton Mineral Spring, Wetmore, Nemaha County.
Jewell County Lithium Spring, near Mankato, Jewell County.
Merrill Spring, Carbondale, Osage County.
Phillip's Mineral Spring, Topeka, Shawnee County.
Sun Mineral Spring, Morrill, Brown County.
Sycamore Mineral Spring, Brown County.
Waconda Spring, near Cawker City, Mitchell County.

KENTUCKY.

Increased activity by proprietors of some medicinal springs caused the mineral-water output of Kentucky to rise during 1908 to 797,186 gallons, valued at $66,112, as compared with 736,920 gallons, valued at $72,373 reported in 1907, an increase in quantity of over 8 per cent and a decrease in value of nearly 9 per cent. The retail price fell from 10 cents in 1907 to 8 cents in 1908. No new springs reported, the total number being 2 less than for 1907. The output is about evenly distributed between table and medicinal waters. A considerable quantity was used in the manufacture of soft drinks. The reporting springs are as follows:

Anita Springs, La Grange, Oldham County.
Beechwood Springs, Beechwood, Owen County.
Blue Lick Spring, Blue Lick Springs, Nicholas County.
Drennon Springs, Henry County.
Glen Lily Spring, near Bowling Green, Warren County.
Hamby's Salts, Iron and Lithia Springs, Dawson Springs, Hopkins County.
Lexington Lithia Springs, Lexington, Fayette County.
Renfro White Sulphur Spring, Lexington, Fayette County.
Robson Spring, Fort Thomas, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.
Smith Medical Well, near Kelly, Christian County.
White's Diamond Spring, Crab Orchard, Lincoln County.

LOUISIANA.

Returns from Louisiana show a decrease in the quantity of mineral water sold during 1908, although one new spring was added to the list, the Ozone. The total reported sales were 400,500 gallons, valued at $52,020, the average retail price being $0.13. There are now 3 springs making returns, at 2 of which there are resorts accommodating more than 2,500 people, and the water at one is used for bathing. The springs reported that 137,500 gallons went into the manufacture of soft drinks. The springs are as follows:

Abita Springs, Abita Springs, St. Tammany Parish.
Krotz Well, Krotz Springs, St. Landry Parish.
Ozone Spring, Covington, St. Tammany Parish.

MAINE.

There were gains and losses reported by Maine springs; the general stagnation in business kept down demand, but several new springs reported, and the net result was a slight increase in the mineral-water output. The sales increased from 1,161,832 gallons in 1907 to 1,182,322 gallons in 1908, a gain of 20,490 gallons, or 1.7 per cent. The value, however, decreased from $414,300 to $394,346, a loss of 4.8 per cent. The average price obtained fell from 36 cents to 33 cents per gallon. Several springs failed to make returns, and several that sold water in 1907 sold none in 1908. There were 5 new springs reporting for the first time, the Oak Grove, Pine, Sanford Crystal, Skowhegan Crystal, and Twin Mountain Mineral, the total springs reporting being 27. The statistics for the last five years have been as follows:

Production and value of mineral waters in Maine, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	23	1,535,955	$428,083	1907	26	1,161,832	$414,300
1905	29	1,167,787	246,159	1908	27	1,182,322	394,346
1906	28	1,368,113	424,678				

Practically all of Maine's output is used for table purposes. There are resorts at only 2 of these springs, accommodating over 600 guests, and the water at 3 is said to be used for bathing purposes. In addition to the sales, it was stated that 311,320 gallons went into the manufacture of soft drinks.

The 27 reporting springs are as follows:

Bakers Puritan Spring, Old Orchard, York County.
Crystal Mineral Spring, Auburn, Androscoggin County.
Forest Springs, Litchfield, Kennebec County.
Glenrock Mineral Spring, Greene, Androscoggin County.
Glenwood Spring, Augusta, Kennebec County.
Glenwood Spring, St. Albans, Somerset County.
Highland Spring, Lewiston, Androscoggin County.
Indian Hermit Spring, Wells, York County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Oak Grove Spring, Brewer, Penobscot County.
Pejepscot Spring, Auburn, Androscoggin County.
Pine Spring, Topsham, Sagadahoc County.
Poland Spring, Poland, Androscoggin County.
Pownal Mineral Spring, New Gloucester, Cumberland County.

Raymond Spring, North Raymond, Cumberland County.
Rocky Hill Spring, Fairfield, Somerset County.
Sabattus Mineral Spring, Wales, Androscoggin County.
Sanford Crystal Spring, Sanford, York County.
Seal Rock Spring, Saco, York County.
Skowhegan Crystal Spring, Skowhegan, Somerset County.
Switzer Spring, Prospect, Waldo County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Ticonic Mineral Spring, Winslow, Kennebec County.
Twin Mountain Mineral Spring, Lewiston, Androscoggin County.
Underwood Spring, Falmouth Foreside, Cumberland County.
Wawa Lithia Spring, Ogunquit, York County.

MARYLAND.

Returns from Maryland show a decided decline for 1908 in the mineral-water trade, sales amounting to 806,673 gallons, as compared with 1,023,562 gallons reported in 1907, a loss of 216,889 gallons, or 21.19 per cent. The value decreased in even greater ratio, from $110,039 in 1907 to $75,858 in 1908, a falling off of $34,181, or 31.06 per cent. The average price declined from 11 to 9 cents. No new springs were added, the total number reporting being 8. The bulk of the Maryland water is used for table purposes. There are resorts at 4 of these springs, with total accommodations for more than 600 people, and the water at 2 is used for bathing purposes. A small quantity was reported as used in the manufacture of soft drinks. The springs from which returns were available are as follows:

Altamont Spring, near Deer Park, Garrett County.
Blue Ridge, Buena Vista, and High Rock Springs, Blue Mountains, Washington County.
Carroll Springs, Forest Glen, Montgomery County.
Chattolanee Spring, Chattolanee, Baltimore County.
Mardela Mineral Spring, Mardela, Wicomico County.
Takoma Spring, Takoma Park, Montgomery County.

MASSACHUSETTS.

Returns from Massachusetts for 1908 indicate a slight decline in the volume of the mineral-water trade and a slight increase in value of water sold. The figures reported are 4,395,049 gallons, valued at $227,907, an average price of 5 cents per gallon. In 1907 the figures reported were 4,661,115 gallons, valued at $208,579, the average price being 4 cents per gallon. As has been stated in previous reports, the low price obtained for Massachusetts water is due to the manner in which much of it is marketed, being sold in bulk, by the week or month, for drinking purposes in factories. Mills closed for longer or shorter periods account for much of the loss in 1908. The statistics for the last five years have been as follows:

Production and value of mineral waters in Massachusetts, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	56	5,214,068	$353,485	1907	51	4,661,115	$208,579
1905	59	4,202,263	208,419	1908	61	4,395,049	227,907
1906	53	3,857,955	210,152				

Several new springs were added to the list, the Goulding, Howe, Mount Vernon, Pine Grove Mineral, Puritan, Rocky Hill Crystal, Sippican, White Diamond, and Ye Cape Cod Pilgrim, increasing the total number reporting to 61. Less than 2 per cent of the total is used for medicinal purposes. In addition to the sales it was stated that 628,798 gallons were used in the manufacture of soft drinks. The 61 reporting springs are as follows:

Abbotts Spring, Methuen, Essex County.
Ballardvale Spring, Andover, Essex County.
Beaver Dam Spring, Scituate, Plymouth County.
Belmont Crystal Spring, Belmont, Middlesex County.
Belmont Hill Spring, Everett, Middlesex County.
Burnham Spring, Methuen, Essex County.
Cadwells Crystal Spring, East Woburn, Middlesex County.
Chapmans Crystal Mineral Spring, Stoneham, Middlesex County.
Crescent Spring, Brockton, Plymouth County.
Diamond Spring, Lawrence, Essex County.
El-Azhar Spring, Lowell, Middlesex County.
Everett Crystal Spring, Everett, Middlesex County.
Farrington Silver Spring, Milton, Norfolk County.
Garfield Spring, Weymouth, Norfolk County.
Goulding Spring, Whitman, Plymouth County.
Granite Rock Spring, Brockton, Plymouth County.
Highland Spring, West Abington, Plymouth County.
Hillcrest Spring, Rowley, Essex County.
Howe Spring, Millbury, Worcester County.
Hygiene Spring, Lawrence, Essex County.
Indian Spring, Brockton, Plymouth County.
Katahdin Spring, Lexington, Middlesex County.
King Philip Spring, Mattapoisett, Plymouth County.
Leland Spring, Natick, Middlesex County.
Lexington Spring, Lexington, Middlesex County.
Lovers Leap Deep Glen Spring, West Lynn, Essex County.
Massasoit Spring, West Springfield, Hampden County.
Milton Spring, Milton, Norfolk County.
Monatiquot Spring, South Braintree, Norfolk County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Lowell, Middlesex County.
Mount Vernon Spring, Lawrence, Essex County.
Nemasket Spring, Middleboro, Plymouth County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Norwood Spring, Norwood, Norfolk County.
Oak Grove Spring, Lawrence, Essex County.
Pearl Hill Mineral Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pine Grove Mineral Spring, Ware, Hampshire County.
Pocahontas Spring, Lynnfield Center, Essex County.
Puritan Spring, Andover, Essex County.
Purity Spring, Spencer, Worcester County.
Ravenwood Spring, Gloucester, Essex County.
Robbins Springs, Arlington Heights, Middlesex County.
Rock Spring, Newburyport, Essex County.
Rocky Hill Crystal Spring, Amesbury, Essex County.
Sager Spring, Whipple Hill, Essex County.
Sand Springs, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Simpson Spring, South Easton, Bristol County.
Sippican Spring, Marion, Plymouth County.
Sterling Spring, West Lynn, Essex County.
Stevens Spring, Lawrence, Essex County.
Sunnyside Spring, Franklin, Norfolk County.
Swampscott Spring, Swampscott, Essex County.
Trapelo Spring, Belmont, Middlesex County.
Undine Crystal Spring, Brighton, Suffolk County.
Valpey Spring, Lawrence, Essex County.
White Diamond Spring, near Adams, Berkshire County.
Whitman Spring, Whitman, Plymouth County.
Ye Cape Cod Pilgrim Spring, South Wellfleet, Barnstable County.

MICHIGAN.

Michigan continued to show an increase in mineral-water trade during 1908, the sales increasing from 1,472,679 gallons in 1907 to 2,004,433 gallons in 1908, an increase of 531,754 gallons, or 36.11 per cent. This gain was largely due to new production reported, amounting to nearly 750,000 gallons. The value, however, decreased considerably, due to lower prices, from $127,133 in 1907 to $88,910, the average price for the year being 4 cents.

Statistics of output for the last five years are shown in the following table:

Production and value of mineral waters in Michigan, 1904-1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	19	3,385,675	$118,422	1907	19	1,472,679	$127,133
1905	17	2,684,800	277,188	1908	24	2,004,433	88,910
1906	19	902,528	73,357				

There were 6 new springs added to the list, the Arctic, Cooper Farm, Eastman Springs, Harrison Springs, Pantlin, and Silver Springs, increasing the total number reporting to 24. About 95 per cent of the total is used for table purposes. There are resorts at 7 of these 24 springs, with accommodations for 1,278 guests, and the water at 7 is said to be used for bathing purposes. In addition to the sales, 1,279,953 gallons were reported as used for the manufacture of soft drinks.

The 24 springs making returns are as follows:

Andrews Magnetic Mineral Spring, St. Louis, Gratiot County.
Arctic Spring, Grand Rapids, Kent County.
Battle Creek Spring, Battle Creek, Calhoun County.
Bromo-Hygeia Well, Coldwater, Branch County.
Clarks Red Cross Mineral Spring, Big Rapids, Mecosta County.
Cooper Farm Spring, Birmingham, Oakland County.
Crystal Springs, Grand Rapids, Kent County.
Davis Springs, Topinabee, Cheboygan County.
Eastman Springs, Benton Harbor, Berrien County.
Harrison Springs, near Grand Rapids, Kent County.
Lansingwald Spring, Grand Rapids, Kent County.
Midland Mineral Spring, Midland, Midland County.
No-Che-Mo Mineral Spring, Reed City, Osceola County.
Ogemaw Spring, Maltby, Ogemaw County.
Pagoda Spring, Mount Clemens, Macomb County.
Pantlin Spring, Grand Rapids, Kent County.
Ponce de Leon Spring, Paris Township, Kent County.
Prosit Flowing Well, Flint, Genesee County.
Salutaris Spring, St. Clair, St. Clair County.
Sanitas Spring, Topinabee, Cheboygan County.
Silver Springs, Grand Rapids, Kent County.
Sterling Spring, Crystal Falls, Iron County.
Victory Spring, Mount Clemens, Macomb County.
White Oak Spring, near Battle Creek, Calhoun County.

MINNESOTA.

Minnesota, which leads all other States in mineral water sold, showed a notable increase in 1908, due largely to the returns made by producers who have not reported before, the sales amounting to nearly 11,000,000 gallons. The water at the majority of the springs or wells is not highly mineralized, being sold merely as pure water to citizens of Minneapolis and St. Paul. This accounts for the relatively low price of 5 cents per gallon. According to the returns received there were sold during the year 10,985,536 gallons of water, with a value of $551,986, which, compared with the output of 9,654,030 gallons, valued at $524,800, in 1907, was a gain in quantity sold of 13.79 per cent and in value of 5.18 per cent. The following table shows the record of output for the last five years:

Production and value of mineral waters in Minnesota, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	4	902,500	$21,545	1907	8	9,654,030	$524,800
1905	6	7,681,650	132,970	1908	11	10,985,536	551,986
1906	7	8,621,979	175,677				

Three new springs reported sales for the first time, the Bryn Mawr, Deep Mineral, and Owens-Glenwood, the total number reporting being 11, an average of nearly a million gallons each. Less than 1 per cent of the total reported output was sold as medicinal water, but 261,715 gallons additional were used for soft drinks. There are no resorts at any of these springs, nor is the water in any case used for bathing. The 11 reporting springs are as follows:

Bryn Mawr Spring, Minneapolis, Hennepin County.
Deep Mineral Spring, Crookston, Polk County.
Glenwood-Inglewood Spring, Minneapolis, Hennepin County.
Highland Spring, St. Paul, Ramsey County.
Indian Medical Spring, Elk River, Sherburne County.
Mankato Mineral Springs, near Eagle Lake, Blue Earth County.
Owatonna Vichy Spring, Owatonna, Steele County.
Owens-Glenwood Spring, Glenwood, Pope County.
Red Star Spring, Cold Spring, Stearns County.
Rock Spring, Shakopee, Scott County.
Trio Siloam Spring, Austin, Mower County.

MISSISSIPPI.

There was a considerable decline in the mineral water output of Mississippi during 1908, partly due to business depression, very few proprietors reporting larger sales than in 1907. In addition one large spring failed to report. The reported output was 257,200 gallons, valued at $52,780, an average price per gallon of 21 cents. Compared with the 1907 figures there appears to have been a decrease in quantity of 168,300 gallons, or over 39 per cent, and in value of $40,570, or over 43 per cent. One new spring reported, the total number remaining the same. About three-fourths of the output is classed as medicinal. There are resorts at 6 of the springs, with total accommodations for about 625 guests, but the water at only one is said to be used for bathing purposes.

The 11 reporting springs are as follows:

Arundel Lithia Spring, near Meridian, Lauderdale County.
Browns Wells, near Hazelhurst, Copiah County.
Castalian Spring, near Durant, Holmes County.
Godbold's Mineral Well, Summit, Pike County.
Mammoth Spring, Mammoth Springs, Perry County.
Robinson Springs, near Pocahontas, Madison County.
Stafford Mineral Springs, Vossburg, Jasper County.
Vossburg Lithia Spring, Vossburg, Jasper County.

MISSOURI.

The output of mineral waters reported from Missouri continued to increase, the gains coming from old springs that pushed sales and from springs that reported for the first time. The sales amounted to 682,821 gallons, valued at $86,043, an average of 13 cents per gallon, against 667,232 gallons reported the previous year, valued at $103,314, indicating an increase in quantity of 2.3 per cent, but a decrease as to value of 16.7 per cent, the average price declining 2 cents. Eleven new springs were added to the list, as follows: Deep Well, Fountain of Youth, Grand River Mineral, Harris Springs, Nek-Roc, Regent, Siloam, Soterian, Sulpho-Saline, Tootle Mineral, and Windsor, the total number reporting increasing from 18 to 30. There are resorts at 19 of these springs, with total accommodations for more than 10,000 people, and the water at 11 is used for bathing. About one-third of the output is classed as table water, the other two-thirds being regarded as medicinal. In addition to the sales, it was stated that 69,842 gallons were used during the year in the manufacture of soft drinks. Those springs from which reports are available are as follows:

American Spring, St. Louis, St. Louis City County.
B. B. Mineral Spring, near Bowling Green, Pike County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Blue Lick, Black Sulphur, Gum, and Sweet-Litho Springs, Blue Lick, Saline County.
Bochert Springs, near De Soto, Jefferson County.
Crystal Lithium Spring, Excelsior Springs, Clay County.
Cusenbary Spring, near Kansas City, Jackson County.
Deep Well Willow Springs, Howell County.
El Dorado Springs, Eldorado Springs, Cedar County.
Excelsior Lithia Spring, Excelsior Springs, Clay County.
Fountain of Youth Spring, Jerico Springs, Cedar County.
Grand River Mineral Spring, Mercer County, near Lineville, Iowa.
Harris Springs, near Madison, Monroe County.
Haymaker Spring, Mercer County, near Lineville, Iowa.
Hornet Mineral Springs, Bowling Green, Pike County.
Jackson Lithia Spring, Mount Washington, Jackson County.
Kalinat and Ionian Lithia Springs, near Bowling Green, Pike County.
McAllister Springs, McAllister Springs, Saline County.
Nek-Roc Spring, Burlington Junction, Nodaway County.
Regent, Siloam, Soterian, and Sulpho-Saline Springs, Excelsior Springs, Clay County.
Salt Sulphur Well, Excelsior Springs, Clay County.
Sparkling Lithia Well, Excelsior Springs, Clay County.
Soda-Carbonic Spring, Excelsior Springs, Clay County.
Sweet Springs, Sweet Springs, Saline County.
Tootle Mineral Spring, Hale, Carroll County.
White Sulphur and Big Black Springs, Monegaw Springs, St. Clair County.
Windsor Spring, Windsor, Henry County.

MONTANA.

The mineral water output of Montana apparently fell off considerably during 1908, but 1 of the 2 springs credited to the State failed to make a report. This water is used mainly for table purposes. The reporting spring is as follows:

Lissner's Mineral Spring, Helena, Lewis and Clark County.

NEBRASKA.

The addition of 2 new springs in 1908 makes it possible to publish the totals for Nebraska separately. The reported output of 1908, however, is less than that of 1907, being 48,498 gallons, valued at $11,047, the average retail price being 23 cents. About two-thirds of the total sales go for table water. There are no resorts at these springs, and at none is the water used for bathing purposes. There was a small quantity reported as used in the manufacture of soft drinks. The 3 springs reporting sales are as follows:

Blue Valley Spring, Hebron, Thayer County.
Shogo Lithia Springs, Milford, Seward County.
Victoria Mineral Spring, New Helena, Custer County.

NEW HAMPSHIRE.

There was considerable increase in the mineral-water trade of New Hampshire during 1908, due to the success of several springs in getting new customers. The output increased 143.19 per cent, from 343,500 gallons in 1907 to 835,349 in 1908. The value also increased from $164,943 in 1907 to $259,520 in 1908, an increase of $94,577, or 57.3 per cent, the average price falling to 31 cents. This falling off in price is not due to any diminished demand for water, but more probably to the fact that a number of new springs reporting obtained a lower price for the water than the older and better established springs. Four additional springs reported for the first time, the Cohas, Mount Madison, White Mountain Mineral, and Willow, increasing the total number to 9. About three-fifths of the output is used for table water, the remainder being medicinal. There is a resort at one of the springs, and the water at one other is used for bathing. In addition to the sales, 241,331 gallons were said to have been used in the manufacture of soft drinks. The springs from which reports are available are as follows:

Cohas Spring, Londonderry, Rockingham County.
Granite State Spring, Plaistow, Rockingham County.
Lafayette Mineral Spring, Derry, Rockingham County.
Londonderry Lithia Well, Londonderry, Rockingham County.
Mount Madison Spring, Gorham, Coos County.
Pack Monadnock Lithia Spring, Temple, Hillsboro County.
White Mountain Mineral Spring, Conway, Carroll County.
Willow Spring, South Nashua, Hillsboro County.
Wilton Mineral Spring, near Wilton, Hillsboro County.

NEW JERSEY.

New Jersey passed the million-gallon mark in sales, the output amounting to 1,199,023 gallons, valued at $126,603, an average price of 11 cents, the same as reported for 1907. The gain in output is the result of a few large springs pushing sales. These figures show an increase of 22 per cent in quantity and of 23 per cent in value over the reported production of 982,445 gallons, valued at $103,082, in 1907. The following table shows the output for the last five years:

Production and value of mineral waters in New Jersey, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	9	188,450	$24,870	1907	11	982,445	$103,082
1905	10	394,060	45,397	1908	13	1,199,023	126,603
1906	9	585,215	65,186				

Three new springs reported, the Mount Tabor, Pilgrim, and Washington Rock, thus increasing the total number to 13. Only a small quantity of New Jersey's output is used for medicinal purposes, the bulk being used as table water. None of these springs is used as a resort, nor is the water at any of them used for bathing. There was, however, a small quantity reported as used in the manufacture of soft drinks. The 13 reporting springs are as follows:

Alpha Mineral Spring, Springfield, Union County.
Culm Rock Spring, Pluckemin, Somerset County.
Hatawanna, Budd Lake, Morris County.
Indian Spring, near Rockaway, Morris County.
Ironrock Mineral Springs, Camden County.
Kalium Spring, Collingswood, Camden County.
Kanouse-Oakland Spring, Oakland, Bergen County.
Mount Tabor Spring, Mount Tabor, Morris County.
Pilgrim Spring, Ridgefield Park, Bergen County.
Red Rock Spring, Spring Valley Road, Bergen County.
Trinity Springs, Morsemere, Bergen County.
Washington Rock Spring, Warrenville, Somerset County.
Watching Spring, North Plainfield, Union County.

NEW YORK.

Although a number of springs, notably some at Saratoga Springs and vicinity, reported diminished sales because of business depression, yet the gains by others and the output from new springs caused an increase in the sales of mineral waters during 1908 compared with 1907. The production amounted to 8,007,092 gallons, valued at $877,648, an average price of 11 cents, a gain of 830,277 gallons, or 11.6 per cent, and of $191,074, or 27.8 per cent, over the figures reported for 1907. The average price per gallon increased 2 cents. In volume of output New York ranks second, next to Minnesota, among the mineral water producing States. In value of output it is surpassed by Wisconsin only. Six new springs were added to the New York list for 1908, the Cold Spring, Diamond Rock, Gramatan, Lehn Rock, Mount Beacon, and Shell Rock, thereby increasing the total number reporting to 47.

The statistics of production for the last five years have been as follows:

Production and value of mineral waters in New York, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	41	6,352,517	$783,244	1907	41	7,176,815	$686,574
1905	40	5,619,878	652,680	1908	47	8,007,092	877,648
1906	42	6,481,074	893,476				

More than two-thirds of the total output is used for table purposes. There are 6 resorts at these springs, accommodating over 20,000 people, that capacity being claimed for Saratoga Springs alone, but the water at only 3 is used for bathing purposes. The relatively slight quantity of 53,000 gallons was reported as used in the manufacture of soft drinks.

The 47 reporting springs are as follows:

Artesian Lithia Spring, Ballston Spa, Saratoga County.
Artesian Natural Mineral Spring, Franklin Springs, Oneida County.
Baldwin Mineral Spring, Cayuga, Cayuga County.
Boonville Mineral Springs, near Boonville, Oneida County.
Breesport Spring, Breesport, Chemung County.
Briarcliff Spring, Briarcliff Manor, Westchester County.
Chemung Spring, Chemung, Chemung County.
Chemung Valley Spring, Elmira, Chemung County.
Cold Springs, New York Mills, Oneida County.
Crystal Springs, near Oswego, Oswego County.
Deep Rock Spring, Oswego, Oswego County.
Diamond Rock Spring, Cherry Creek, Chautauqua County.
Elixir Spring, Clintondale, Ulster County.
Elk Spring, Oswego, Oswego County.
Geneva and Red Cross Mineral Springs, Geneva, Ontario County.
Glacier Spring, Franklin Springs, Oneida County.
Gramatan Spring, Bronxville, Westchester County.
Great Bear Spring, near Fulton, Oswego County.
Hide Franklin Spring, Ballston Spa, Saratoga County.
Hornby Sulphur Spring, Hornby, Steuben County.
Lehn Rock Spring, Williamsville, Erie County.
Massena Mineral Spring, Massena Springs, St. Lawrence County.
Monarch Spring, Matteawan, Dutchess County.
Mount Beacon Spring, near Matteawan, Dutchess County.
Mount View Spring, Poughkeepsie, Dutchess County.
Os-We-Go Spring, Oswego, Oswego County.
Pleasant Valley Spring, Rheims, Steuben County.
Putnam Spring, near Peekskill, Westchester County.
Red Jacket Mineral Spring, Seneca Falls, Seneca County.
Saratoga Springs, Saratoga County:
- Arondack Spring.
- Chief Spring.
- Congress Spring.
- Geyser Spring.
- Hathorn Spring.
- High Rock Spring.
- Patterson Spring.
- Royal Spring.
- Saratoga Carlsbad Spring.
- Saratoga Seltzer and Emperor Spring.
- Star Spring.

Setauket Spring, Setauket, Suffolk County.
Shell Rock Spring, near Rensselaer, Rensselaer County.
Split Rock Spring, Franklin Springs, Oneida County.
Sun-Ray Spring, Ellenville, Ulster County.
Vita Spring, Durkeetown, Washington County.
Washington Lithia Spring, Ballston Spa, Saratoga County.

NORTH CAROLINA.

North Carolina's output of mineral water decreased during 1908, in spite of some 30,000 gallons sold by springs reporting for the first time. The sales were reported as 160,195 gallons, valued at $27,163, as compared with 193,479 gallons, valued at $40,302, reported in 1907, a decline of 17.20 per cent in quantity and 32.6 per cent in value. The average price per gallon fell 4 cents to 17 cents. Four new springs reported, the Derita Mineral, Lincoln, Sherrill Mineral, and Smith Mineral, making the total number of springs reporting 18. Nearly 90 per cent of the total output of the State is used for medicinal purposes. Resorts are situated at 11 of the springs, with accommodations for nearly 1,500 people, and at 8 the water is used for bathing purposes. In addition to the sales, there were 11,200 gallons used in the manufacture of soft drinks. The 18 reporting springs are as follows:

All Healing Spring, Alkalithia Springs, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Cleveland Springs, near Shelby, Cleveland County.
Derita Mineral Spring, near Charlotte, Mecklenburg County.
Haywood White Sulphur Spring, near Waynesville, Haywood County.
Hot Springs, Hot Springs, Madison County.
Jackson Springs, Jackson Springs, Moore County.
Lincoln Spring, Lincolnton, Lincoln County.
Mida Spring, near Charlotte, Mecklenburg County.
Moore's Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, near Littleton, Warren County.
Seven Springs, Seven Springs, Wayne County.
Sherrill Mineral Spring, near Harrisburg, Cabarrus County.
Sparrow's Spring, Kings Mountain, Cleveland County.
Vade Mecum Spring, Vade Mecum, Stokes County.

NORTH DAKOTA.

North Dakota entered again in 1908 the list of mineral water producing States, one spring reporting large sales of water, both for medicinal and table uses. The total returns from this spring are combined with those of other States having less than three producers. The name of this spring is—

Gordon Spring, Michigan, Nelson County.

OHIO.

The demand for pure water in several cities stimulated Ohio's mineral-water trade in 1908. The sales reported increased 872,977 gallons, or 56.81 per cent. The value, however, increased only 2.8 per cent, due to a fall in the average price from 8 to 5 cents. There were 3 new springs added to the list, the Providence, Schoenbrun, and Spring Grove Mineral, the total number reporting being 27. The statistics of production during the last five years are given in the following table:

Production and value of mineral waters in Ohio, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	13	3,223,958	$306,566	1907	24	1,536,621	$121,531
1905	23	943,114	117,733	1908	27	2,409,598	124,938
1906	27	1,790,767	164,007				

By far the larger proportion of Ohio's output is used for table purposes, which accounts for the low price received for the water. There are resorts at 6 of the springs, accommodating about 350 people altogether, and at 4 the water is used for bathing purposes. The quantity used by all the springs for soft drinks during the year amounted to 250,490 gallons. The 27 reporting springs are as follows:

Arcturus Lithia Springs, Summit County.
Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Springs, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Collingwood Springs, Toledo, Lucas County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Spring, near Martins Ferry, Belmont County.
Deerfield Spring, Deerfield, Portage County.
Fargo Mineral Spring, Ashtabula, Ashtabula County.
Jefferson and Benson Springs, Bloom Township, Fairfield County.
Maple Grove Mineral Spring, near Chillicothe, Ross County.
Navahoe Spring, near New Paris, Preble County.
Oak Ridge Mineral Springs, Greenspring, Sandusky County.
Odevene Spring, Delaware, Delaware County.
Painesville Mineral Spring, Painesville, Lake County.
Providence Spring, Columbus, Franklin County.
Quakerdale Spring, Colerain, Belmont County.
Reynold's Artesian Well, Greenspring, Sandusky County.
Ripley Bromo Lithia Spring, Ripley, Brown County.
Sandrock Spring, Canton, Stark County.
Schoenbrun Spring, near New Philadelphia, Tuscarawas County.
Spark Mineral Spring, Bryan, Williams County.
Spring Grove Mineral Spring, Springfield, Clark County.
Sulphur Lick Spring, near Chillicothe, Ross County.
Tallewanda Mineral Spring, College Corner, Preble County.
Wheeler Mineral Spring, Youngstown, Mahoning County.
Wood's Lithia Spring, near Bridgeport, Belmont County.

OKLAHOMA.

The mineral-water trade of Oklahoma is rapidly becoming important, the sales for 1908 amounting to 534,114 gallons, valued at $52,779, an increase of over 666 per cent in quantity and of 618 per cent in value, as compared with the output in 1907. The increase in population has no doubt caused many spring-water companies to start business. Six new springs reported for 1908—one returning sales of 270,000 gallons—the Chelsea Well, Claremore Radium Wells, Harper Artesian Bromide Well, Nowata Radium Well, Osage Well, and Vinita Artesian Well, raising the list of reporting springs to 9. Although about four-fifths of the output is said to be used for medicinal purposes the average price was 10 cents per gallon. Most of it was drawn from artesian wells. There are resorts at 5 of these springs, with total accommodations for over 5,000 people, and the water at the same 5 is used for bathing purposes. The 9 reporting are as follows:

Artesian Wells, Sulphur, Murray County.
Chelsea Well, Chelsea, Rogers County.
Claremore Radium Wells, Claremore, Rogers County.
Germicide Well, Wagoner, Wagoner County.
Harper Artesian Bromide Well, Sulphur, Murray County.
Lewis Crystalline Lithia Wells, Oklahoma City, Oklahoma County.
Osage Spring, near Tulsa, Tulsa County.
Nowata Radium Well, Nowata, Nowata County.
Vinita Artesian Well, Vinita, Craig County.

OREGON.

Oregon's output of mineral water for 1908 showed a small increase both in quantity sold and in value, though it did not come up to the production reported in 1906 of 30,850 gallons. The figures given for 1908 were 25,350 gallons sold, at a value of $8,830, showing an increase of 1,125 gallons and of $3,274 over the production of 24,225 gallons, valued at $5,556, reported in 1907. The price obtained for the water during the year was 35 cents, against 23 cents reported in 1907. No new springs were listed, the total number reporting being 6. A little over half of the water is reported to be used for medicinal purposes. There are resorts at 4 of the springs, accommodating about 150 guests, and at 2 the water is used for bathing purposes. A small quantity was also reported as used in the manufacture of soft drinks. Those springs reporting sales are as follows:

Boswell Springs, Nos. 1 and 2, Boswell, Douglas County.
Cascade Mineral Spring, Cascadia, Linn County.
Colestin Spring, Colestin, Jackson County.
McBean's Soda Spring, near Seneca, Grant County.
Wagner's Spring, Soda Springs, Jackson County.
Wolfer Spring, Hubbard, Marion County.

PENNSYLVANIA.

Though some of the well-established springs stated that demand had been reduced, the output of mineral waters from Pennsylvania during 1908 showed considerable increase in quantity, due largely to new production reported, though the value declined somewhat. The production amounted to 1,430,489 gallons, against 1,287,063 gallons reported in 1907, a gain of 143,426 gallons, or 11.14 per cent. The value declined from $235,807 in 1907 to $197,497 in 1908, the average price for 1908 being 14 cents. Several new springs were added, as follows: The Brookside, Carnegie Alkaline and Lithia Mineral, Hiawatha, Polar Springs, Seely, and Sweet Spring, raising the total number reporting to 32. The statistics for Pennsylvania for the last five years have been as follows:

Production and value of mineral waters in Pennsylvania, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	21	743,050	$90,465	1907	28	1,287,063	$235,807
1905	27	1,322,594	194,113	1908	32	1,430,489	197,497
1906	27	1,506,286	280,054				

About two-thirds of the output is used for table purposes. Resorts are situated at 13 of these springs, accommodating in all about 3,700 guests, and at 6 the water is used for bathing purposes. In addition to the sales quoted, it has been stated that 185,738 gallons were used during the year for soft drinks. The 32 reporting springs are as follows:

Bedford Chalybeate Spring, near Bedford, Bedford County.
Bedford Mineral and Sweet Springs, near Bedford, Bedford County.
Brookside Spring, Wilkinsburg, Allegheny County.
Bruce Subrock Spring, Pittsburg, Allegheny County.
Carnegie Alkaline and Lithia Mineral Spring, Carnegie, Allegheny County.

Cloverdale Lithia Spring, near Newville, Cumberland County.
De Profundis Aperient, and Chalybeate Springs, Saegertown, Crawford County.
De Vita Mineral Spring, Cambridge Springs, Crawford County.
East Mountain Lithia Spring, near Factoryville, Wyoming County.
Ephrata Mountain Crystal Spring, near Ephrata, Lancaster County.
Glacier Spring, Ephrata, Lancaster County.
Glen Summit Spring, Glen Summit Springs, Luzerne County.
Gray Mineral Spring, Cambridge Springs, Crawford County
Harrison Valley Mineral Spring, Harrison Valley, Potter County.
Hiawatha Spring, Mount Hope, Lancaster County.
Kecksburg Artesian Mineral Spring, Kecksburg, Westmoreland County.
Lang Spring, Venango, Crawford County.
Magnesia Springs, Cambridge Springs, Crawford County.
Pavilion Spring, South Mountain, Berks County.
Petticord Spring, Cambridge Springs, Crawford County.
Polar Springs, Morrisville, Bucks County.
Pocono Mineral Spring, near Wilkesbarre, Luzerne County.
Pulaski Spring, Pulaski, Lawrence County.
Ross-Common Spring, Ross-Common, Monroe County.
Seely Spring, Salem Township, Luzerne County.
Shohola Spring, Walker Lake, Pike County.
Springboro Mineral Spring, Springboro, Crawford County.
Tuckahoe Mineral Spring, near Northumberland, Northumberland County.
Whann Lithia Spring, Franklin, Venango County.
White House Spring, Neversink Mountain, Berks County.
Wilson Spring, Mount Pocono, Monroe County.

RHODE ISLAND.

The 9 Rhode Island springs reporting sales sold 594,208 gallons during 1908, an average of over 60,000 gallons per spring. There was a large increase over the production reported for 1907, principally production reported for the first time, amounting to 142 per cent in quantity and to 130 per cent in value. The average value per gallon, $0.07, has been the same for the last three years. Five new springs reported for the first time, the Banner, Crown, Girard, Prophet, and Sockanosset. Practically all of the output is used for table purposes. There are no resorts at these springs, nor at any is the water used for bathing. The 9 reporting springs are as follows:

Banner, Cranston, Providence, Providence County.
Berry Spring, Pawtucket, Providence County.
Crown Spring, East Providence, Providence County.
Girard Spring, North Providence, Providence County.
Gladstone Spring, Narragansett Pier, Washington County.
Holly Mineral Spring, East Woonsocket, Providence County.
Ochee Spring, Johnston, Providence County.
Prophet Spring, near Providence, Providence County.
Sockanosset Spring, Cranston, Providence, Providence County.

SOUTH CAROLINA.

The output of mineral waters from South Carolina springs declined during 1908, 10 of the 13 springs reporting decreases in business. Part of the lessened output credited to the State is due to the failure of 3 springs to make returns, and part to an increased proportion of the output of several springs being used for making sweetened beverages. According to statements received there were sold 271,572 gallons at a value of $70,937, the average price obtained being $0.26. These figures show a decline of 515,182 gallons, or 65.48 per cent in quantity, and of $124,245, or 63.64 per cent in value. One spring, the Charleston Artesian Well, reported for the first time, the total number being the same as for 1907. There are resorts at 5 of these springs, with total accommodations for about 1,000 guests, but the water at only one is used for bathing. In addition to the sales given above, it was stated that 262,795 gallons were used for sweetened beverages during the year. The 13 reporting springs are as follows:

Antley Springs, St. Matthews, Orangeburg County.
Bryan Springs, Young Island, Colletin County.
Buffalo Lick Springs, Carlisle, Union County.
Cherokee Spring, Spartanburg, Spartanburg County.
Charleston Artesian Well, Charleston, Charleston County.
Chick Springs, Chick Springs, Greenville County.
Cokesbury Sulphur Spring, near Cokesbury, Greenwood County.
Glenn Springs, Glenn Springs, Spartanburg County.
Glowing Springs, Dresden, Abbeville County.
Harris Lithia Spring, Harris Springs, Laurens County.
Rives Mineral Spring, near Lancaster, Lancaster County.
White Diamond Lithia Spring, near Kings Creek, Cherokee County.
White Stone Spring, White Stone Springs, Spartanburg County.

SOUTH DAKOTA.

The mineral-water output of South Dakota showed a large increase for 1908, the result of one establishment making a nominal charge for water that had been furnished free. Of the 3 springs reporting, 2 are used as resorts with accommodations for over 2,500 guests, and the water at all 3 is used for bathing. In addition to the sales the reporting springs used a small quantity in the manufacture of soft drinks. Following are the springs reporting:

Minnehaha Springs, Sioux Falls, Minnehaha County.
Minnekahta Spring, Hot Springs, Fall River County.
Siloam Mineral Spring, Hot Springs, Fall River County.

TENNESSEE.

According to returns received the output of mineral waters in Tennessee during 1908 showed a slight decline as compared with that of 1907, the value decreasing in larger ratio, due to lower prices being quoted. The sales amounted to 712,912 gallons, valued at $68,693, as compared with 758,312 gallons, valued at $85,249, in 1907, a loss of 5.99 per cent in quantity and of 19.42 per cent in value. The average price declined from 17 to 10 cents. No new springs reported, and 3 were dropped from the list, lowering the total number reporting to 14. Ten of the 14 Tennessee springs reporting are resorts, where the water is furnished free to guests at the hotels, so that the sales reported do not represent the quantity of mineral water consumed. The 10 resorts have accommodations for about 1,600 guests, and the water at 7 is used for bathing. The names of the springs reporting sales are as follows:

Deep Cave Mineral Well, Eastland, Davidson County.
East Brook Springs, Cumberland Mountains, Franklin County.
Gammons Spring, near Tate Spring, Grainger County.
Hinson Springs, Hinsonsprings, Henderson County.
Horn Springs, Horn Springs, Wilson County.
Idaho Springs, near Clarksville, Montgomery County.
Pioneer Lithia Spring, near Nashville, Davidson County.
Red Boiling Springs, Redboiling Springs, Macon County.
Richardsons Lockeland Spring, near Nashville, Davidson County.
Riovista Spring, Davidson County.
Tate Spring, Tate Springs, Grainger County.
Whittle Springs, Whittle Springs, Knox County.
Willow Brook Spring, Craggie Hope, Cheatham County.
Wright's Epsom-Lithia Spring, Mooresburg, Hawkins County.

TEXAS.

Texas continued to show an increase in springs reporting sales and in total mineral-water output, the sales reported for 1908 amounting to 1,586,634 gallons, valued at $151,032, an average price of about 10 cents. Compared with the 1907 figures of 1,146,279 gallons, valued at $152,233, this was an increase of 440,355 gallons, or 38.4 per cent in quantity, and a decrease of $1,201, or 0.8 per cent in value, the average price for 1907 being 13 cents. The statistics in the State for the last five years have been as follows:

Production and value of mineral waters in Texas, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	14	1,142,500	$64,923	1907	23	1,146,279	$152,233
1905	28	1,526,970	144,421	1908	36	1,586,634	151,032
1906	28	1,045,315	122,085				

The 15 new springs reporting are as follows: Artesian Well, Austin Well, Brock's Mineral Well, Carbon Mineral Well, Edward's Well, French Well, Haskell Mineral Wells, High Island Mineral Well, Key's Wells, Lamar Wells, Texas Carlsbad and Palo Pinto Wells, Roach Well, Sheboygan Mineral Wells, Woodward Vichy Spring, and X-Ray Spring, the total number of springs reporting being 36. Practically all of the output is said to be used for medicinal purposes. Resorts are situated at 21 of these springs, with accommodations for nearly 15,000 people, and the water at 15 is used for bathing purposes. There was also a small quantity reported as used in the manufacture of soft drinks. The 36 springs reporting sales are as follows:

Allison, Crystal, and Patterson Springs, Oran, Palo Pinto County.
Artesian Well, near Beaumont, Jefferson County.
Brock's Mineral Well, near Denton, Denton County.
Burdette Well, near Lockhart, Caldwell County.
Carbon Mineral Well, Carbon, Eastland County.
Carlsbad Dyspepsia Spring, Blossom, Lamar County.
Dullnig Mineral Well, near San Antonio, Bexar County.
Edward's Well, Weatherford, Parker County.
Farrier Spring, Dalby Springs, Bowie County.
Georgetown Mineral Wells, Georgetown, Williamson County.
Haskell Mineral Wells, Haskell, Haskell County.
High Island Mineral Well, High Island, Galveston County.
Key's Wells, Salado, Bell County.
Love Mineral Well, Weatherford, Parker County.
Marlin Hot Wells, Marlin, Falls County.
Milford Mineral Wells, Milford, Ellis County.
Mineral Wells, Palo Pinto County:
  Austin Well.
  Barber Wells.
  Congress Well.
  Crazy Well.
  French Well.
  Gibson and Sangcura Wells.
  Indian Well.
  Lamar Well.
  Star Well.
  Texas Carlsbad and Palo Pinto Wells.
Port Arthur Mineral Well, Port Arthur, Jefferson County.
Rains Tioga Mineral Well, Tioga, Grayson County.

Red Mineral Springs, Mount Pleasant, Titus County.
Roach Well, near Mount Pleasant, Titus County.
Rosborough Spring, near Marshall, Harrison County.
Sheboygan Mineral Wells, near Weatherford, Parker County.
Texarkana Wells, Texarkana, Bowie County.
Tioga Mineral Wells, Tioga, Grayson County.
Woodward Vichy Spring, Woodward, Lasalle County.
X-Ray Spring, Whitesboro, Grayson County.

UTAH.

There was no change in the list of mineral springs in Utah, only one reporting sales. The output is all used medicinally. This spring is—

Deseret Spring, Deseret, Millard County.

VERMONT.

The returns from Vermont showed an increase in the quantity of mineral water sold, amounting to 21.74 per cent over the 1907 output. The value, however, decreased from $19,948 in 1907 to $16,380, a loss of $3,568, or 17.89 per cent. The average price also declined from 23 cents to 15 cents in 1908. No new springs reported for 1908, and 2 were idle throughout the year, thus reducing the total number listed to 5. More than half of the output is classed as table water. There are resorts at 3 of these springs, accommodating 1,060 people and at 2 the water is used for bathing. Those springs reporting sales are as follows:

Brunswick Sulphur Springs, Brunswick, Essex County.
Clarendon Spring, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.
Missisquoi Spring, Sheldon, Franklin County.
Vermont Spring, West Haven, Rutland County.

VIRGINIA.

There was a falling off in the sales of mineral water reported from Virginia springs during 1908, due partly to the cessation of business following the close of the Jamestown Exposition, and to the failure of one large spring to make returns. According to figures received the total sales amounted to 2,009,614 gallons, valued at $207,115, an average price of 10 cents per gallon. Compared with the output of 1907, these figures show a decline of 17 per cent in quantity and of 52 per cent in value. There were 6 springs reported for the first time or after several years of no sales, the Basic, Brugh's, Coppahaunk, Iron-Lithia, Roanoke Lithia, and Trois Fontaine Lithia, the total number reporting being 46. The following table shows the condition of trade for the last five years:

Production and value of mineral waters in Virginia, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	35	2,117,420	$281,998	1907	44	2,442,075	$431,770
1905	37	2,340,287	549,102	1908	46	2,009,614	207,115
1906	43	1,997,207	418,908				

A little over half of the total output of the State is sold as table water. Resorts are situated at 18 of these springs, with accommodations for over 2,000 guests, and the water at 9 is used for bathing purposes. In addition to the sales reported, it was stated that 119,672 gallons were used in the manufacture of soft drinks. Following is the list of reporting springs:

Alleghany Spring, Alleghany Spring, Montgomery County.
Artesian Well, Mulberry Island, Warwick County.
Basic Spring, Basic City, Augusta County.
Bath Alum Springs, McClung, Bath County.
Bear Lithia Spring, near Elkton, Rockingham County.
Beaufont Spring, near Manchester, Chesterfield County.
Bellfont Lithia Spring, near Manchester, Chesterfield County.
Berry Hill Mineral Spring, near Elkwood, Culpeper County.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Buckhead Lithia Spring, Buckhead Springs, Chesterfield County.
Burnetts Spring, Hudson Mill, Culpeper County.
Brugh's Spring, Botetourt County.
Campfield Lithia Spring, Chesterfield County.
Como Lithia Spring, East Richmond, Henrico County.
Coppahaunk Lithia Springs, Waverly, Sussex County.
Crockett Arsenic Lithia Spring, Crockett Springs, Montgomery County.
Days Point Artesian Lithia Spring, Isle of Wight County.
Diamond Spring, near Waterway, Princess Anne County.
Erup Mineral Spring, near Glencarlyn, Alexandria County.
Farmville Lithia Springs, Farmville, Cumberland County.
Fonticello Lithia Spring, near Manchester, Chesterfield County.
Golindo Spring, near Cave Station, Augusta County.
Harris Anti-Dyspeptic Spring, Burkeville, Nottoway County.
Holly Lithia Springs, near Swansboro, Chesterfield County.
Iron-Lithia Springs, Tip Top, Tazewell County.
Jeffress Spring, Jeffress, Mecklenburg County.
Kayser Lithia Springs, Staunton, Augusta County.
Lone Jack Spring, near Lone Jack Station, Campbell County.
Magee's Chlorinated Lithia Spring, Clarksville, Mecklenburg County.
Massanetta Spring, Penn Laird, Rockingham County.
Mecklenburg and Old Dominion Mineral Springs, Chase City, Mecklenburg County.
Nye Lithia Springs, Wytheville, Wythe County.
O'Connell Lithia Spring, near Staunton, Augusta County.
Otterburn Lithia Spring, near Amelia, Amelia County.
Paeonian Spring, Paeonian Springs, Loudoun County.
Powhatan Spring, near Ballston, Alexandria County.
Roanoke Lithia Spring, near Roanoke, Roanoke County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Spring, near Staunton, Augusta County.
Stribling Springs, near Mount Solon, Augusta County.
Trois Fontaine Lithia Spring, near South Hill, Mecklenburg County.
Virginia Etna Lithia Springs, Vinton, Roanoke County.
Virginia Lithia Springs, near Manchester, Chesterfield County.
Virginia Magnesian Alkaline Spring, near Staunton, Augusta County.
Wallawhatoola Springs, Millboro, Bath County.
Wyrick Mineral Spring, Crockett, Wythe County.

WASHINGTON.

The returns from Washington showed a decrease in quantity and an increase in value. The sales amounted to 38,900 gallons, valued at $13,650, which, compared with the 1907 output of 68,400 gallons, valued at $10,820, was a decrease in quantity of 29,500 gallons, or 43 per cent, and an increase in value of $2,830, or 26 per cent. The average price reported for the year was $0.35, against $0.16 in 1907. One new spring reported, the Diamond Mineral, the total number reporting being 5. More than two-thirds of the total output is used for table purposes. There are no resorts at these springs, but at one the water is said to be used for bathing purposes. In addition to the sales reported, a small quantity was used in the manufacture of soft drinks. The 5 reporting springs are as follows:

Diamond Mineral Spring, Auburn, King County.
Olympia Hygeian Spring, Tumwater, Thurston County.
Table Rock Spring, near Moffett Springs, Skamania County.
Wild Pigeon Spring, Cowlitz County.
Yakima Mineral Springs, Yakima County.

WEST VIRGINIA.

The returns from West Virginia for 1908 showed a decline of 4 per cent in output, the sales amounting to 130,295 gallons, valued at $79,915, against 135,809 gallons reported in 1907, valued at $79,659. The average price rose to 61 cents per gallon. There were no new springs reporting, and 1 was temporarily out of business, thus decreasing the total number of reporting springs to 9. By far the larger proportion is used for medicinal purposes. There are 5 resorts situated at the springs, with accommodations for about 3,075 guests, and the water at 6 is used for bathing. The 9 springs reporting sales are as follows:

Alum Springs, near White Sulphur Springs, Greenbrier County.
Barilithic Spring, Webster Springs, Webster County.
Greenbrier Springs, Bargers Springs, Summers County.
Green Sulphur Spring, Green Sulphur Springs, Summers County.
Man-A-Cea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Stratford Magnesia Spring, Ohio County.
Webster Springs, Webster Springs, Webster County.
White Sulphur Spring, White Sulphur Springs, Greenbrier County.

WISCONSIN.

The financial depression following the panic of 1907 materially reduced the sales of mineral water from Wisconsin. The reported output decreased from 6,839,219 gallons in 1907 to 6,084,571 gallons in 1908, a falling off of 754,648 gallons, or 11 per cent. The value also decreased, but in smaller ratio, the average price increasing 1 cent, from 22 cents in 1907 to 23 cents in 1908. This State holds third place in quantity of mineral water sold, but leads all others in value of the product. The following table gives the statistics of output for the last five years:

Production and value of mineral waters in Wisconsin, 1904–1908.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	25	6,586,834	$1,546,535	1907	29	6,839,219	$1,526,703
1905	27	6,656,834	1,454,715	1908	28	6,084,571	1,413,107
1906	27	7,702,718	2,397,694				

No new springs reported sales during 1908, and 1 which has heretofore reported an output was idle, thus decreasing the total number of springs reporting to 28. Resorts are situated at 5 of the springs, accommodating about 7,000 people, but the water at only one is said to be used for bathing purposes. In addition to the sales reported, it was stated that 1,051,325 gallons went into the manufacture of soft drinks.

The 28 reporting springs are as follows:

Allouez Spring, Green Bay, Brown County.
Alta Spring, Dunfield, Lincoln County.
Bay City Spring, Ashland, Ashland County.
Bethania Spring, Osceola, Polk County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Darlington Mineral Spring, Darlington, Lafayette County.
Elim Mineral Spring, Milwaukee, Milwaukee County.
Hiawatha Springs, Hiawatha Springs, Rock County.
Lebenswasser Spring, Green Bay, Brown County.
Maribel Mineral Spring, Maribel, Manitowoc County.
Nee-Ska-Ra Spring, Wauwatosa, Milwaukee County.
St. John Mineral Spring, Green Bay, Brown County.
Salvator Spring, Green Bay, Brown County.
Sanitas Fountain Spring, near Oshkosh, Winnebago County.
Sheboygan Mineral Spring, Sheboygan, Sheboygan County.
Solon Springs, Solon Springs, Douglas County.
Waukesha Springs, Waukesha County:
- Almanaris Spring.
- Anderson's Spring.
- Arcadian Spring.
- Bethesda Spring.
- Clysmic Spring.
- Crystal Rock Spring.
- Glenn Rock Spring.
- Imperial Spring.
- Roxo Spring.
- Silurian Spring.
- White Rock Spring.

Wautoma Rainbow Mineral Spring, Wautoma, Waushara County.

WYOMING.

The list of Wyoming springs remains the same, only one reporting sales. The spring is a resort; the water is drunk by guests at the hotel and used for bathing. A small quantity is used for soft drinks. This spring is—

Saratoga Hot Springs, Saratoga, Carbon County.

MONAZITE AND ZIRCON.

By Douglas B. Sterrett.

MONAZITE.

INTRODUCTION.

The extensive application of the oxide of thorium in the manufacture of mantles for incandescent gas lights creates a large demand for minerals containing thorium. Of the latter, monazite is found to be far the most abundant, and is therefore the principal source of thoria. Dr. Charles Baskerville [a] mentions 80 minerals in which thorium has been found. Some of these would possess high commercial value as a source of thorium if found in sufficient quantity. Among these may be mentioned thorianite with 58 to 89 per cent of thoria, auerlite with 70 per cent, calciothorite with 59 to 60 per cent, thorite with 48 to 72 per cent, uranothorite with 48 to 52 per cent, and thorogummite with 41 to 42 per cent. Auerlite has been found in small quantities in the zircon mines of Henderson County, N. C. Frank L. Hess [b] describes the occurrence of several thorium-bearing minerals along with the other rare-earth minerals in the famous Baringer Hill locality, Texas. These are mackintoshite, thorogummite, nivenite, and yttrialite; they are of scientific interest rather than of commercial value as a source of thoria. Thorianite and thorite, especially the former, are found in quantities of commercial value in Ceylon.

Monazite is a phosphate of cerium, lanthanum, praseodidymium, and neodidymium with a variable percentage of silica and thoria. The proportion of thoria in monazite ranges from less than 1 per cent to more than 20 per cent. The average quantity in monazite obtained for commercial purposes varies between 3 and 9 per cent. The color of the monazite ranges from grayish to yellow, to reddish, to brownish, and greenish. The luster is resinous and is especially brilliant on cleavage faces. Monazite is opaque to translucent and subtransparent. The specific gravity ranges from 4.9 to 5.3 and is generally over 5, so that the mineral is readily concentrated by ordinary methods of washing. The mineral is brittle, with a hardness of 5 to 5.5. Monazite generally occurs in small crystals with brilliant faces in the original rock matrix. These crystals are rounded by attrition when set free from the rocks and deposited in gravel beds by streams.

[a] Thorium: Eng. and Min. Jour., December 26, 1908, p. 1241.
[b] Rare-earth minerals in Llano County, Tex.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 286–294.

The bulk of the world's supply of monazite for the preparation of thorium nitrate used in the manufacture of incandescent gas mantles comes from Brazil. The Brazilian monazite is exported to foreign countries, principally Germany and Great Britain, for manufacture. The plants manufacturing thorium nitrate from monazite in the United States are supplied entirely by the domestic production. Up to the present time all the monazite produced for commercial purposes in the United States has come from North Carolina and South Carolina. Monazite occurs in a number of other States, and apparently promising deposits have been tested in Idaho and Georgia. The monazite region of North Carolina and South Carolina is a northeast-southwest belt 20 to 30 miles wide and over 150 miles long. This belt lies wholly within the Piedmont Plateau and borders closely on the Blue Ridge, to whose general course it is roughly parallel.

Monazite occurs in quantities of commercial value in the Carolinas in the form of sand in alluvial gravel deposits. These deposits are situated in the bottom lands along creeks and streams, in the stream beds, and in some cases in terrace formations. The gravels of these deposits vary in richness, and probably do not often run over 1 per cent monazite. The gravel beds range from one foot to several feet in thickness, and they cover areas varying from a few square yards to many acres. Occasionally, the rock formations similar to those from which the monazite is derived carry an appreciable amount of monazite. In no cases, however, have these rocks been found rich enough for profitable working on a large scale.

The usual method of mining monazite is by concentration in sluice boxes. In some cases Wilfley or other concentrating tables, operated by gasoline motors, are used to separate the monazite from the gravel. The crude sand thus obtained ranges from 15 per cent to 60 or 70 per cent monazite. By treatment with electro-magnetic machinery, the grade of the sand is raised to about 90 per cent monazite with an available content of 4½ to 5 per cent of thoria. The monazite is shipped in this form to the manufacturers, and there turned into nitrate with a thoria content of 48 to 50 per cent.

The Centerville Mine and Milling Company, with monazite and gold properties at Centerville, Idaho, and office in Chicago, reports extensive preparations for work during 1909. The preparations consist of a 9-mile ditch to bring water to the claims, and equipment of a Pindar table, two Wilfley tables, magnetic separating machinery, and engines for operating them. Mr. S. K. Atkinson, manager of the company, states that the magnetic separator cleans the concentrates from washing to about 97 per cent monazite, and that this has a thoria content of 5 per cent. Considerable zircon and some gold will be obtained during the concentration of the monazite. The mine was operated on an experimental basis during part of 1908, though no concentrates were sold.

PRODUCTION.

The production of crude monazite sand in the United States during 1908 amounted to 1,521,866 pounds, averaging about 25 per cent monazite. The crude concentrates yielded 422,646 pounds of refined sand, averaging about 90 per cent monazite and valued at $50,718, or 12 cents per pound. Of this production North Carolina yielded

310,196 pounds, valued at $37,224, and South Carolina, 112,450 pounds, valued at $13,494.

The following table gives the production and value of monazite from 1893 to 1902, inclusive; of monazite and zircon in 1903; of monazite, zircon, gadolinite, and columbite in 1904; of monazite, zircon, and columbite in 1905; of monazite and zircon in 1906 and 1907; and of monazite in 1908.

Production, in pounds, of monazite in the United States, 1893–1908.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1893	130,000	$7,600	1901	748,736	$59,262
1894	546,855	36,193	1902	802,000	64,160
1895	1,573,000	137,150	1903	[a] 865,000	65,200
1896	30,000	1,500	1904	[b] 745,999	85,038
1897	44,000	1,980	1905	[c] 1,352,418	163,908
1898	250,776	13,542	1906	[d] 847,275	152,560
1899	350,000	20,000	1907	[e] 548,152	65,800
1900	908,000	48,805	1908	422,646	50,718

[a] Including 3,000 pounds of zircon, valued at $570.
[b] Including the small production of zircon, gadolinite, and columbite.
[c] Including a small quantity of zircon and columbite.
[d] Including 1,100 pounds of zircon, valued at $248.
[e] Including 204 pounds of zircon, valued at $46.

The production of monazite concentrates in the United States in 1908 was less by 125,302 pounds in quantity and $15,036 in value than in 1907. All of the decrease in production occurred in North Carolina, the output of South Carolina showing a considerable increase in quantity and value in 1908 over 1907. The production of monazite in North Carolina came from the following six counties, named in the order of their importance: Rutherford, Cleveland, Burke, Gaston, Lincoln, and Iredell. The bulk of the supply came from the first two counties named, with only a small output from the others. The production from South Carolina came from Greenville and Cherokee counties.

IMPORTS AND EXPORTS.

According to the Bureau of Statistics of the Department of Commerce and Labor there were no imports of monazite into the United States during 1908. Thorium nitrate is imported, however. The quantity and value of these imports during the last six years are given in the following table:

Imports, in pounds, of thorium nitrate into United States, 1903–1908.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	64,520	$232,155	1906	40,090	$139,929
1904	58,655	249,904	1907	51,441	152,666
1905	52,378	269,504	1908	65,289	173,239

There was an increase of 13,848 pounds in quantity and of $20,573 in value of imports of thorium nitrate in 1908 over 1907. As shown by this table, the price per pound in foreign markets of the thorium nitrate imported in 1908 was $2.65 as against $2.97 in 1907.

The exports of monazite in 1908 were very small and consisted of a small shipment by one company to Germany.

While the production of monazite in the United States in 1908 was less than in 1907, the consumption of thorium nitrate was slightly greater in 1908 than in 1907. That is, the decrease in the manufacture of thorium nitrate in the United States, due to smaller production of monazite, was more than counterbalanced by the increase in imports of manufactured thorium nitrate. During some years the production of thorium nitrate from monazite in the United States has amounted to considerably over one-half the consumption. In 1908, however, the imports of thorium nitrate were much larger than the home production. The increased consumption of thorium nitrate in times of financial depression is due to the fact that a larger number of people use gas light as a matter of economy in place of the more expensive electric light. The illumination obtained by the use of an incandescent mantle with gas more nearly approaches that of the electric light than an ordinary gas light does. Hence the demand for these mantles increases with the need for greater domestic economy.

CEYLON.

The occurrence of monazite in Ceylon is again mentioned by James Parsons,[a] principal mineral surveyor, and the discovery of new occurrences of thorianite are described. The known rich alluvial deposits of thorianite were practically exhausted in 1906, and during 1907 but little active work was done on the known occurrence of thorianite in place.

ZIRCON.

According to Dr. Joseph Hyde Pratt, state geologist of North Carolina, there was no production of zircon in North Carolina during 1908.

The deposit of zircon in the Wichita Mountains, Okla., mentioned in this report for 1907, is being examined by Messrs. Hackney & Sons, of La Harpe, Kans. No shipments of zircon were made from this locality during 1908.

---

[a] Ceylon Administration Repts., 1907, pt. 4, p. E6.

PEAT.

By Charles A. Davis.

INTRODUCTION.

At no time in the present generation has the interest of the general public in obtaining information relating to the peat resources of the country been greater than during the fiscal year 1908–9. Such information has been sought by all classes—large investors looking for undeveloped natural resources that may be safely and profitably exploited; manufacturing and engineering companies seeking to learn the possibilities of utilizing the substance either for the production of power or as the source of raw material upon which to base industries; and owners of large and small tracts of peat land, who hoped, apparently, that the value of their property might be increased practically or potentially by their inquiries. The investors, however, while showing interest in the abstract questions relating to the substance itself, have apparently not forgotten the fact that many peat-fuel plants have been established in the last six or eight years in various parts of the country and have been idle after short seasons of experimental production. Yet it is probable that there was a greater profitable output of the different kinds of products of peat than ever before; and, in fact, it may be said that for the first time peat products have appeared of which a record may be made in this publication.

An important step in the direction of actual progress was that taken by the men who have been most thoroughly convinced of the great economic possibilities of the peat resources of the country and who have organized a national society for the purpose of advancing the general knowledge regarding the utilization of peat for all the purposes to which it is adapted.

Doubtless the widely prevalent feeling that there are possibilities in utilizing peat for fuel, but only in the remote future after the supply of coal and other mineral fuels is gone and wood is no longer available, has been due in part to the agnostic and sometimes antagonistic attitude of those to whom the country has looked for guidance in such matters. The position has been taken that in a country so marvelously endowed with wood, coal, mineral oils, and that most perfect of all fuel, natural gas, there was no place for peat, despite the fact that it is estimated by competent observers that 10,000,000 tons of that material are elsewhere prepared annually for use as fuel by various processes, and that smaller quantities are manufactured into bedding for stock, into packing material, into fertilizer filler, into powder or mull for disinfection and other sanitary purposes, and into a variety of articles of less importance. The feeling has seemed to be that, supposing its use desirable, peat for fuel could not be put on the markets in the United States profitably, even as a substitute or auxiliary fuel. The time seems to have come, however, when the utilization of low-grade fuels is not only desirable but even necessary, if certain kinds of manufacturing are to be carried on in parts of the country at a distance from centers of coal production.

PREPARATION AND USE.

The peoples of northern Europe have been forced by natural and economic conditions to make progress in methods of preparing fuels of this grade and of using them in the most economical way before a similar need was apparent in the United States. Much can be learned, therefore, from a brief résumé of the latest stages of development of the commercial use of peat for fuel and other purposes it Europe that will be serviceable to those who may wish to try it for some of these uses in the parts of this country where it is found in quantities large enough to attract attention.

The first thought with regard to peat is its use as fuel for domestic purposes—for cooking and heating in private houses—and this, until within a comparatively short time, has been its chief use in the countries of northern Europe, where the common people have used it from very early times.

It is particularly suited to such purposes, as, when properly prepared and dried, it makes a good, hot fire; burns with a long, clear flame; and makes but a small amount of ash and no clinkers. It is also as clean to handle as wood, and, although bulky, it is light in weight. It kindles easily, and when the drafts are properly controlled and the grate and fire box rightly adapted to the fuel, it makes a durable fire. Its theoretical heating value is between that of good wood and good coal, but, because of the small waste in ash, clinkers, cinders, and smoke, its real value is doubtless near, if not equal to, that of many kinds of coal that are in use for domestic purposes. In calorific value, when air dried, it ranges from five-eighths to five-ninths of the calorific value of the best bituminous coals.

The methods most in use for preparing peat for common fuel in Europe and those most successful from the commercial point of view are (1) to cut it with special spades into blocks or bricks and air dry these by exposure to wind and sun for a few weeks, when they may be stacked under cover. The product is known as "cut peat;" it is bulky and friable and practically is used only for local consumption. (2) To dig it by hand or machinery and grind it in a machine similar to a brickmaker's pug mill—a cast-iron vertical or horizontal cylinder with one or more central shafts armed with spirally arranged cutting knives that meet projections from the walls of the cylinder. The peat is put into the mill wet and is ground and macerated, and then pressed through the outlet as a prismatic strand of thoroughly pulped material that is cut into bricks as it emerges and is received on pallets of wood, on which it is removed to drying grounds or racks and dried by exposure to the air. After two weeks or more it is removed to storage sheds, where it is stacked for a time, and then used. In one plant making peat coke in Germany some 40,000 tons of finished product are made in this way in a season at a cost of less than $1.75 per ton. Many smaller plants using this method of preparation are in operation throughout northern Europe, and the cost of production is reported to range from 75 cents to about $2 per ton. In Holland this "machine peat," as it is called, sells for more than the coal imported from England—from about $4.50 to $6 per ton.

There have been several peat-fuel plants equipped in the United States for making air-dried "machine peat," "pressed peat," or "condensed peat," as it is variously called, and a few of them were operated for longer or shorter times during the season of 1908.

Peat fuel prepared in this way, according to the climate of the place where it is made, has from 12 to 25 per cent of moisture when thoroughly air dried, and its theoretical calorific value is lowered about in proportion to the amount of moisture it contains. In this form it may be successfully used for all domestic purposes and for steam production by burning under steam boilers. As high as 6 pounds of water per pound of dry peat used may be evaporated from and at 212° F. in the boiler, although generally the quantity of water is less.

When used as a source of producer gas in gas producers, peat is generally first made into machine peat. It is prepared in the same way when it is made into peat coke, and as the cost of equipping a machine-peat plant is small, this preparation is one that can be very generally applied.

Briquets of dry peat, pressed into shape without a binder, have been successfully made in at least two plants in Germany, and they have also been made in several other plants from peat mixed with coal dust or other powdered fuel and tar or pitch and pressed while warm into shape in a briquetting press. The peat is prepared for briquetting by partly air drying it and then reducing it to a powder, which is dried still further in rotary or plate driers heated by exhaust steam or waste gases. It is then pressed in the mold of a briquetting press.

Peat briquets are more compact than machine peat, and, if so heated in the press that the tar is volatilized somewhat, they may have a higher calorific value. Generally, it may be said that the peat has the calorific value per unit of weight increased but slightly by briquetting, but its value per unit of volume is considerably greater after briquetting than before. The cost of plants for briquetting is considerably greater than that of plants for making machine peat, and although several of these plants have been erected in the United States, none were in operation during 1908. In Europe, so far as has been reported, there are no plants in operation that take the peat wet from the bog, dry it artificially, and briquet it by practically a continuous operation. Many such plants have been tried, but all that are operating now partly air dry the peat after it is dug.

The nearest approach to such a continuous process is the one apparently just emerging to a commercial stage of development in England—the Elsenberg wet carbonizing process—in which the wet peat after it is dug is macerated and pumped into a boiler of peculiar construction, where it is subjected to steam under high pressure at a temperature of 150° to 155° C. for a short time while being forced through the tubes of the carbonizer. The heat blackens the peat but does not vaporize much of the volatile matter at the temperature used. After this treatment, it is reported, the water can be removed by pressure to any required degree, and the peat may be formed into very hard, durable briquets of higher fuel value than the original peat. A plant for making peat fuel by this process is very expensive.

Peat charcoal and peat coke are being manufactured in considerable and increasing quantities in Germany and Russia, where these products are used instead of wood charcoal in iron manufacture and other metallurgical processes, including copper refining and steel making, for which its freedom from sulphur and phosphorus renders it especially valuable. The poorer grades are used as fuel.

Of the many attempts to work out processes for making peat coke on a commercial scale, none have yet proved profitable that did not utilize the condensible and fixed gases for by-product recovery and fuel. The by-products that may be saved by a properly planned recovery plant are practically those obtained from wood distillation where the wood is made into charcoal in properly constructed retorts or ovens, namely, tar and the illuminating and fuel oils that can be made by redistilling it, creosote and asphaltum, ammonium sulphate, acetate of lime or acetic acid and acetone, methyl or wood alcohol, and certain permanent gases that possess good fuel value. The recovery and purification of these chemical substances requires a large preliminary investment for equipping and keeping up the plant, and the technical work demands constant supervision by well-trained men. Peat-coke and by-product plants, therefore, are more costly to build and need larger capital for maintenance than those for the other methods of treating peat for fuel purposes. If a good market for the by-products is already in existence, as is the case for most of those mentioned, which are staples with large actual consumption established, the coke should be obtained at a low cost per ton and should sell at a sufficiently high price to pay a fair interest on the capital invested. The amount needed to establish the smallest practicable unit for making peat coke with by-product recovery plant on the system most successfully worked out in Europe is reported to be $160,000, of which $60,000 is for working capital. The system mentioned was devised by Dr. M. Ziegler and is now represented by three well-equipped coke works in Europe, the oldest being more than ten years old. In this system the peat is coked in vertical retorts of fire brick and iron, the gases of distillation being led through condensing chambers until they are deprived of the tar and tar water, and are then conducted back to the furnaces and there burned. The stack gases are then led to secondary retorts, where their heat is used partly to coke inferior grades of peat. The concentrating and redistilling of the by-products, in part at least, is done by the heat of the gases; and in the most recent modification of the process the last stage of drying the peat bricks is done by what would otherwise be waste heat.

The Bamme peat-coking process exemplified in a single plant in Germany is another system, using retorts with by-product recovery, and differing in minor details only from that described.

Peat powder is being used in increasing quantities in blast burners of special construction for firing under boilers in brick, glass, and cement making; and it is apparently applicable to many of the metallurgical operations where gas may be used. When the powder is properly prepared and the firing is rightly controlled, the peat in powder form becomes nearly or quite as efficient a fuel as gas. It is known that this process of preparing and firing peat has been tested in Sweden and in Canada, but no reports of its use in this country have been received.

Peat was also tried long ago for making illuminating gas, and was actually used for some time in the last century to light certain European towns. If made in properly planned and heated retorts it makes a good quality of illuminating gas, especially after it has been enriched by adding the lighter gases obtained by fractioning the tars. Peat is not used for this purpose at the present time so far as reported, in either Europe or America.

The most recent fuel use of peat is that for making it into power and fuel gases, the former being thoroughly tested more recently than the latter. Power and fuel gases are made by heating the fuel from which they are derived in cylindrical furnaces lined with fire brick. The simplest form of the gas producer, as such furnaces are called, is a tall cylinder with a grate near the bottom and an opening for the air to enter, below which is placed a shallow tank of water into which the ashes fall and which serves also to seal up the bottom of the cylinder so that air can not leak into the fuel bed. At the top of the cylinder are the openings for the introduction of fuel and the outlet of the gas generated, and at intervals down the sides there are gas-tight doors for cleaning and repairing the inside of the producer. The gas producer differs from the ordinary heating furnace chiefly in the degree of the combustion. In the gas producer the heat obtained by the complete combustion of the bottom layers of a thick fuel bed converts the rest of the fuel into gases that can still take up oxygen into chemical combination and that thus have fuel value; the only other products, theoretically, are inert gases and ashes. In furnaces of ordinary kinds the fuel of a thin fuel bed is completely oxidized for generating heat, and the products are inert gases and ashes.

The growth of the use of gas as fuel for running gas engines of the explosive type has of late years been very rapid, especially since it has been found that low-grade producer gas and blast furnace gases are much more efficient in proportion to the number of heat units per cubic foot than the high-grade and more costly gases obtained by distilling coal in retorts. Thus it is reported that a gas engine which gave 100 horsepower with natural gas, which has a high calorific value per cubic foot, gave about 80 horsepower with producer gas, which has only about one-fifth as high calorific value as the natural gas. Moreover, in the gas producer the fuel economy is so great that grades of fuel that could not be used for steam generation may be used with entire satisfaction, and among the fuels now being used for the purpose of obtaining power and fuel gases in Europe peat is finding a steadily growing use. Well-prepared peat yields from about 40,000 to over 80,000 cubic feet of producer gas per ton of dry matter when gasified in a correctly designed gas producer, and the gas has quite as high calorific value per cubic foot as gas made from coal in the same type of producer. The types of gas producer which have given the most satisfactory results with peat are the pressure and the down-draft, because these types admit of ridding the gas more thoroughly of tarry and other substances than the suction type, in which the engine is connected directly with the apparatus of the gas producer and develops the charge of gas it uses by the suction stroke of its piston. The suction gas producer has, however, been used successfully with peat in Europe as well as the other types.

A step beyond the generation of gas alone in the gas producer is taken in the by-product recovery producer, in which some of the compounds obtained in purifying the gases by condensation of the aqueous and tarry substances distilled from the fuel are concentrated and redistilled in special apparatus, which constitutes the recovery plant. The substances thus obtained in peat gasification are the same as those mentioned in connection with coking peat in retorts; the one now most sought is ammonia, which is fixed as ammonium sulphate by passing the gas from the gas producer through towers where it is brought into contact with a fine spray of dilute sulphuric acid.

The quantity of ammonium sulphate obtainable from peat in this way is dependent on the quantity of combined nitrogen in the peat, the type of gas producer used, and the temperature of the combustion zone of the fuel bed, the quantity of ammonia obtained for a given grade of peat being largest when the combustion is carried on at the lowest possible temperature. The Frank and Caro process for making producer gas from peat with ammonium sulphate as a by-product is dependent on the principle of the Mond gas producer using coal, and like that controls the temperature of the combustion in the producer by the use of large amounts of superheated steam. This process, as is the case in by-product recovery generally, is a commercial success only in large installations in power plants where at least 5,000 horsepower is to be used. If attempted with small plants the amount of by-products obtained is so small that the recovery, while technically entirely possible, is carried on at a financial loss, because of the high-priced labor needed and of the expensive processes and equipment required. Authentic reports from Europe show that the Frank and Caro process is now being embodied in at least two large plants, one in Germany and one in Italy; a third is reported from England.

The Woltereck process of making ammonium sulphate from peat with the incidental recovery of acetic acid and paraffin wax is not a by-product process, but the inventor claims for it that it is a method of making the chemical products directly by the low-temperature combustion of wet peat containing as much as 80 per cent of water. It is further asserted that the ammonia obtained as ammonium sulphate is more in quantity than can be accounted for by the nitrogen shown by analysis to be contained in the peat, and that, therefore, some of the nitrogen must be obtained from the air and enters into composition with hydrogen as the moist air is passing over the fire in the wet peat. This process has been developed to a stage where a large factory with an estimated output of 5,000 tons of ammonium sulphate per year is reported nearly or quite ready for operation in Ireland. The inventor of the process claims a minimum production of 5 per cent of ammonium sulphate for the dry peat treated and the maximum production reported from test runs is over 12 per cent; but the cost of building a plant of commercial size runs up into hundreds of thousands of dollars.

The Woltereck process for utilizing peat represents the most scientific phase of the subject reached in Europe, and has yet to prove that it possesses the merit claimed for it; but the value of peat for producer gas and power plants seems now to be established.

Equally well established by the testimony of many independent observers are the uses of peat as material for bedding for stock and for packing, as well as for deodorizing and disinfecting, which seems to be rapidly increasing in various European countries. In addition to these uses, powdered peat of heavy black types that are rich in nitrogen is dried and sold for filler for certain kinds of artificial fertilizer. Large quantities of dry peat powder or mull are also used to absorb the refuse molasses of sugar factories and refineries, and the mixture is sold as a stock food, which from official reports on its use seems to possess great value when properly prepared. The processes of preparing peat for these uses are simple and require small outlay of capital compared with that for making any type of peat fuel except machine peat. For peat or moss litter for stock, the more mossy fibrous kinds of peat give the best results. The peat is cut or dug out in blocks, dried by exposure to the air, and then roughly shredded or torn apart by revolving cylinders armed with hooked knives. From this machine it is conveyed to screens, which remove the very coarse and very fine material; thence it passes to a press in which it is formed into bales and is then ready for shipment. The finer matter removed by the screens is also baled and sold under the name of "mull" for deodorizing, filtering, disinfecting, and packing purposes. The litter is reported to be better, more absorbent, and more durable bedding for stock than any of the substances generally used, and its deodorizing and aseptic properties make it desirable for use in city stables and dairy barns. A single plant for making peat-moss litter and mull is operated at Garrett, Ind.

The use of the powdered peat as a filler or adulterant in artificial fertilizers is of recent origin, but is one that seems to be growing rapidly as the desirable qualities of the substance are more fully appreciated. Peat was doubtless used at first because of its color and of the small percentage of combined nitrogen that it contained. It has been found, however, that by its use easily decomposable substances like slaughterhouse refuse, tankage, etc., which are rich in nitrogen, can be kept from decomposing; that it prevents caking in fertilizers by absorbing moisture and thus insuring that the mixtures containing it are always ready for use; that its deodorizing qualities make it possible to pack and ship strong-smelling nitrogenous fertilizers; and that of itself the peat is a fertilizer of no little value. Most of these claims can be substantiated, and if the nitrogenous materials mentioned are to be used for agricultural purposes, it is likely that they can best be prepared by mixing them with powdered dry peat.

The method of preparing peat for this purpose is simple and, although more costly than that for making moss litter, does not involve the use of any such capital as is required for briquetting or coking peat fuel. The peat is dug, dried as much as possible by exposure to the air on the surface of the bog, then gathered up and put into a drier of the rotary type, where the moisture is reduced by artificial heat to about 10 per cent. It is then screened and stored, although sometimes it is put in sacks before shipment. The basis of sale is the percentage of nitrogen content, the amount of moisture contained, and the color and fineness of the material.

Objection has been made by agricultural chemists that the nitrogen in peat is not available for plants, and hence that the peat filler should not be used in fertilizers, as it makes the nitrogen content appear higher than it really is. It is probable, however, that a part of the nitrogen of the peat is immediately available for plants and that the effect of the substance on the fertilizer and soil is, on the whole, such that it offsets the slight deception mentioned.

At the present time the manufacture of fertilizer filler is the largest industry based on peat in the United Sattes, and factories for preparing it have been operated in New Jersey, Pennsylvania, New York, Ohio, Indiana, Illinois, and Florida; some of these, however, have not been carried beyond experimental stages.

Besides the sale of peat in this form for fertilizer filler, dry, powdered peat is sold under the name of humus as a fertilizer for supplying organic matter to the soil used for growing cultivated plants in pots, as in greenhouses.

Peat has also been used as the source of fibrous matter for a variety of woven fabrics but only on an experimental scale. Cloth of various sorts and coarse blankets have been thus made, but the weakness of the fiber obtained and the small percentage of it in most kinds of peat occurring in the United States make this use purely of academic interest. In northern Europe, however, an industry has been established in preparing peat fiber for use in making mattresses for hospitals, for which purpose its cheapness and its antiseptic and deodorizing properties make it especially valuable.

Paper has also been made from peat, or from peat fiber mixed with other paper stock, and a complete paper mill for making cardboard was established on a peat bog at Capac, Mich., in 1906, but was not in operation in 1908. Few kinds of peat have enough fiber to make good paper or pulp, and in still fewer kinds are the fibrous materials in such a good state of preservation that they make a strong paper. In addition, the coloring matter of peat is very permanent and hard to bleach, so that only brown paper can be made and only a coarse product is obtainable, except at prohibitive cost.

It is reported from Denmark and France that ethyl or grain alcohol has been made from coarse fibrous peat by treating the peat with dilute sulphuric acid, neutralizing the resulting liquid with lime, and, after concentrating the resulting sugary solution, fermenting it with a special kind of yeast. The alcohol thus obtained is concentrated by distillation. This process is an old one and is possible with any vegetable matter containing cellulose, but many attempts to make it a commercial success have failed, and it is hardly probable that the manufacture of alcohol from peat will ever be conducted on any considerable scale in the United States, where great quantities of raw materials much better suited for the purpose than peat are annually wasted.

A more promising use for peat than making it into alcohol is its manufacture into a structural material resembling wood, but differing from wood in being unabsorbent and practically fireproof. The peat used for this purpose is of fibrous character, and it is prepared by disintegrating it thoroughly and mixing it with certain mineral and cementing substances; it may then be pressed under hydraulic pressure into blocks and sheets of any desired size and shape. The resulting material is tough and hard, but may be cut readily and takes a high polish. It makes good paving blocks and is said to resist wear better than some materials now in use. The production of this substance seems not to have reached any considerable amount, even in the locality where it was invented.

Other minor uses for peat have been reported from time to time, but they are of little importance at present and few of them give promise for the future.

The important uses of peat that may be expected to develop in the United States in the near future are for fuel in the regions of its greatest abundance, for bedding for stock and for disinfecting purposes, and for the manufacture of fertilizers and fertilizer fillers. Other uses may develop as the possibilities of the material become better known, or as cheap raw materials are needed for purposes for which the different kinds of peat are fitted.

As fuel for power purposes the greatest field for peat lies apparently in its use in the gas producer, but it should find ready sale for domestic use and to some extent as fuel for boiler firing in burning lime, brick, and pottery, for which it is said to be particularly well adapted.

PRODUCTION.

The regions in the United States that have peat beds of sufficient size and depth to be worked on a commercial scale are found to lie almost entirely outside the territory in which the coal fields and supplies of other natural fuels are known to occur in abundance.

It is also evident that the peat beds of those parts of the country where they occur will play no inconsiderable part, at least as a supplementary or auxiliary fuel, if its use develops, when it is stated, that it seems certain that the estimate of 12,000,000,000 tons of air-dry fuel for the country, exclusive of Alaska, is a conservative one.

Peat occurs in workable beds at many places in the States lying north of the Ohio and east of the Missouri rivers, in the coastal portions of the Middle and South Atlantic and Gulf States, and in a narrow strip along the Pacific coast from southern California northward to the boundary between the United States and Canada. Peat beds occur throughout Minnesota, Wisconsin, Michigan, New York, New England, New Jersey, and Florida, in the eastern part of the Dakotas; in northern Iowa, Illinois, Indiana, Ohio, and Pennsylvania; in eastern Virginia, North Carolina, South Carolina, and Georgia; and, probably, near the coast in the Gulf States. In the States with coal, there is little overlapping of the coal fields and of the areas where commercially valuable peat beds are of common occurrence.

Below is given the quantity of the various peat products made in the United States during the season of 1908.

PEAT FERTILIZER FILLER.

Eight companies reported a total production of 23,000 tons of peat fertilizer filler. The prices obtained ranged from $4.50 to $5.85 per ton and averaged $5.27 per ton at the plant. No satisfactory information was obtainable as to the cost of production, but this is relatively high at most of the plants because of the cost of artificial drying. The total estimated value of the product at the average selling price was $121,210; the actual value as sold was not determined, as not all of the producers gave the prices obtained.

PEAT FUEL.

The peat fuel made during the season of 1908 was all machine peat, and the quantity was insignificant. Five plants were operated in a small way at times during the year, and there was an estimated production of 900 short tons, of which about 250 tons were reported as sold. The largest quantity was reported by the Pacific Utilities Corporation, of Los Angeles, Cal., estimated at 300 tons. The highest price reported at which sales were made was $7.50 per ton, also in California. Sales were also reported at $5.50 and $5 per ton, and the cost of production at $2.50 and $3.75 per ton; these costs were said to be high because of adverse factory conditions, such as poor equipment, unskilled laborers, and small production.

PEAT MOSS LITTER.

Peat moss litter was manufactured at but a single plant in the United States, that of the John E. Baker Moss Company, Garrett, Ind. The material is sold in bales weighing 225 pounds per bale at $1.25 per bale at the factory in less than carload lots, a slight concession being made on large orders. The total production for 1908 was 8,000 bales, valued at $10,000.

IMPORTS.

There were imported for consumption into the United States 7,640 long tons of peat moss, valued at $45,344 in 1906; 7,950 long tons, valued at $46,881, in 1907; and 8,102 long tons, valued at $45,414, in 1908.

During the fiscal year 1908 the imports of peat moss at the chief ports of entry were as follows:

Imports of peat moss, fiscal year 1908.

	Long tons.
New York	6,578
Philadelphia	1,068
Boston	305
Baltimore	151
	8,102

Peat fiber amounting to a few tons was also imported as an experiment.

PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

Considering the general depression in business during 1908 the production of precious stones did not suffer so great a falling off as might have been expected. While the output of certain gems was considerably smaller in 1908 than in 1907, the production of others was greatly increased. Notable among the decreases was the output of sapphire, the principal part of the production of which came from a single mine in Montana—as against four mines in operation in 1907. Greatly increased activity in turquoise mining in the Southwestern States was combined with an unusually large output. This activity has extended well into 1909, and an even greater number of mines are being developed than in 1908. The demand for turquoise matrix has been large and is much greater than for the higher-priced pure blue gems. The output of variscite gems was greatly increased, and the value for 1908 was nearly double that for 1907. This has resulted largely through the successful efforts of the Occidental Gem Corporation of Salt Lake City to place its product on the market under the name "amatrice." The production of tourmaline was again large. An interesting feature in the tourmaline industry consisted of considerable purchases by Chinese dealers for use in the Orient.

The tendency to use all varieties of matrix stones is increasing. This is especially true of those minerals having the bright blue and green colors that are found with copper ores. In fact nearly any minerals or rocks stained with these colors and showing odd patterns are pressed into service as souvenir gems for tourists, etc. Several minerals that show pleasing colors or unique patterns when cut and that were formerly not thought of as gems have been placed on the list of semiprecious stones during the last few years. Among these are the chrysoprase-colored smithsonite from New Mexico called "bonamite;" the serpentine cat's-eye, "satelite;" copper-stained chalcedony or blue chrysoprase from the copper mines near Globe, Ariz., and pebbles of compact epidote found along Arkansas River in Colorado. Interest in the native gems of Colorado as amazon stone, amethyst, beryl, agates, etc., is being revived, partly through the prospecting work of J. D. Endicott, of Canon City, Colo. A new supply of rhodonite of attractive color has been obtained in California and is being cut as a matrix gem.

AGATE, MOSS AGATE, ETC.

WYOMING.

The production of moss agate in the United States comes principally from the Wilde and Deercorn mine, 2 miles northwest of Guernsey, in Laramie County, Wyo. This mine contains three claims and is located near the top of a hill or small mountain about 400 feet above the adjoining valley. The base and lower slopes of this hill are composed of red quartzites, phyllites, hornblende, and greenstone schists. These rocks are mapped under the name Whalen group by W. S. T. Smith[a] and are referred to the Algonkian age. The top of the hill is composed of limestone and quartzites resting unconformably on the Whalen group and dipping to the west at a low angle. These rocks belong principally to the Guernsey formation of Carboniferous age as mapped by Smith.

The moss agate occurs in an irregularly shaped vein, varying from less than 1 inch to nearly 2 feet in thickness and cutting nearly vertically across the bedded limestones. This vein strikes northeast and has been opened at two places about 200 yards apart. At the southwest opening an open cut and drift about 75 feet long have been made on the vein. The openings do not reach a greater depth than 15 feet. The upper few feet of the limestone exposed in the opening has a light flesh color, and the lower layer is red and is banded. The vein appears to pinch out in places in the light-colored layer of limestone and does not reach the surface a few feet above the tunnel. In the floor of the tunnel the moss agate had a thickness of nearly 2 feet in one place and pinched down to a few inches in a short distance. Small stringers of moss agate occur in some of the vertical seams crossing or branching out from the main vein. The moss agate does not appear to be firmly attached to the wall rock, but is separated from it by a deposit of white chalky chalcedony or silica, and in places by layers of columnar calcite crystals. The vein filling is chalcedony or agate with a few small botryoidal chalcedony and drusy quartz lined cavities through it. The greater part of the chalcedony has abundant black moss-like arborescent and dendritic markings throughout. The agate varies in quality from opaque cloudy white to subtranslucent to translucent or subtransparent. The latter material furnishes the finest stone for gem purposes. The white and subtranslucent agate is plentiful, and contains smaller portions of clearer fine gem material distributed through it. The translucent agate is also found in smaller rounded masses with a chalky coating over their surfaces. The black stains (of manganese oxide) occur through both the cloudy and the translucent agate, with all the variations of form characteristic of the mocha stone or moss agate. The better grades furnish very fine gem material, and the cloudy varieties are suitable for mosaic and small ornaments, for which a portion is used. Blocks of several hundred pounds weight of cloudy white agate with translucent portions were seen around the mine, and it is reported that a 1,000-pound block was once obtained which was almost entirely composed of moss agate of good quality. About 3½ tons of rough moss agate were mined during 1908, though none was sold.

---

[a] Hartville folio (No. 91), Geol. Atlas U. S., U. S. Geol. Survey, 1903.

Much of the chalcedony and jasper lying on the surface near the moss agate mine has black dendritic markings. This material occurs in varying shades of red, yellow, and green, and some would furnish attractive stones for watch charms and similar uses if cut.

CALIFORNIA.

J. A. Edman, of Meadow Valley, Cal., reports the occurrence of abundant agates of different varieties on the shore of the southern end of Goose Lake in Modoc County.

COLORADO.

Willis T. Lee [a] mentions the occurrence of a seam of nodular silica, resembling imperfectly formed agates, as a remarkably persistent feature of the Morrison formation of the nonmarine Jura rocks of Colorado. The silica is evidently a deposit from solution and often occurs in concentric bands of different colors. The seams bearing this agate-like material are usually only a few inches thick and have a clay filling in the internodular spaces.

J. D. Endicott has obtained some agate from Garden Park, 8 miles north of Canon City, Colo., similar to the above, but he states that it came from the inside of fossil dinosaur bones. Some of it has a peculiar structure that may be the original bone structure. This agate has bright red, yellow, and gray colors, and makes a beautiful curio gem for watch charms when polished. Mr. Endicott also obtains agates with peculiar structure from the Curio Hill locality, 8 miles southeast of Canon City. These agates are translucent, with blood-red spots through them either in layers or bands or more or less regularly distributed through the mass. The latter pattern has been called St. Stephen stone. Mr. Endicott has cut a small quantity of translucent bluish chalcedony found at Thirty-one Mile Mountain, 7 miles west of Guffy, Colo. This chalcedony has an agate structure showing faint banding. The blue color is of a light shade, though pronounced. It is not the bright blue found in the blue chrysoprase or copper-stained chalcedony of Globe, Ariz. The effect of the cut gem is very pleasing. Another variety of chalcedony found in Colorado by Mr. Endicott has an amethystine color. This cuts to a pretty cabochon gem. These fancy agates and chalcedony gems are delicately marked and have beautiful colors. They should be in large demand for the tourist trade and also for wider sale when people become acquainted with them.

AMBER.

INDIA.

Burma.—The production of amber from the Myitkyina district of Burma in 1907 was 44 hundredweight, with a local value of £385,[b] a decrease of 173 hundredweight from 1906. The output in 1908 was 49 hundredweight, valued at £364.[c]

---

[a] The Morrison shales of southern Colorado and northern New Mexico: Jour. Geology, vol. 10, No. 1, 1902, p. 44.

[b] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.

[c] Advance statement of production of minerals in India in 1908 by the Director of the Geological Survey of India, June 10, 1909.

RUSSIA.

Amber was discovered in Transuralia on the Isset River about a century ago.[a] This deposit was in a brown coal formation, and since this coal formation is now to be worked it is hoped new deposits of amber will be found.

AMETHYST.

COLORADO.

A deposit of cloudy amethyst has been worked in a small way in Fremont County, 12 miles northwest of Canon City and 1 mile south of Twelvemile Park. This deposit was opened some years ago by prospectors in search of gold, the amethyst being mistaken for fluorite, which was considered a good indication of that metal. In March, 1907, the claim was relocated by J. D. Endicott, of Canon City, as a gem deposit. Three openings have been made—a shaft 25 feet deep, a pit 15 feet deep, and another pit 10 feet deep.

The country rock is biotite granite gneiss whose schistosity strikes N. 40° E. with a dip of 30° SE. Small dikes or veins of coarse granite or pegmatite with dark red feldspars cut the granite gneiss. Some of these dikelets are badly epidotized, with the result that the red feldspars with yellowish-green epidote form a rock with a pleasing combination of colors for small ornamental purposes. The amethyst is found in a vein or system of veinlets, ranging from several inches to 3 feet in thickness associated with a pegmatite streak. The amethyst occurs in streaks and veinlets varying from less than 1 inch to 3 or 4 inches in thickness and opening out into irregularly shaped pockets 8 or 10 inches across. The greater part of these streaks are vertical and parallel to the walls of the veins, though in some cases they are inclined and transverse to the vein. The veinlets are made up of layers of amethyst and smoky quartz crystals with comb structure. Nearly all the cavities have been completely filled with amethyst, so that few are obtained with perfect crystal form. Pink calcite forms a part of the vein filling in places. The wall rocks have been partly decomposed and hardened by silicification. The order of formation of parts of the vein appear to be: Fissuring, silicification of wall rock, deposition of calcite, more fracturing, deposition of smoky quartz, deposition of amethyst, deposition of shells of white quartz or amethyst crystals.

The cloudy amethyst is translucent, with patches of deep amethyst color scattered through paler portions. When cut "en cabochon" or in beads this gem is very attractive for scarf pins, cuff buttons, or necklace stones. It is probable pieces of sufficient size could be obtained for umbrella handles or similar small ornaments, as some of the crystals are 2 inches thick.

PENNSYLVANIA.

Dr. Edgar T. Wherry, of Lehigh University, reports the occurrence of amethyst at several localities in southeastern Pennsylvania. Crystals of fairly good color, though generally somewhat cloudy, are found on the farm of a Mr. Copple about 1 mile east of Media, Delaware County. These crystals of amethyst occur in pockets in decomposed mica schist and are sometimes as much as 2 inches long.

[a] Min. Jour. London, October 17, 1908.

LAKE SUPERIOR REGION.

A large specimen of amethyst weighing 200 pounds is reported to have been sold by Alexander Meads, of Marquette, Mich.[a] The amethyst was found some forty-five years ago in a cave on the north shore of Lake Superior. It is stated to be a fine specimen.

AZURMALACHITE, MALACHITE, ETC.

ARIZONA.

Besides the true azurmalachite gems, composed only of azurite and malachite, there are impure forms consisting of smaller amounts of these minerals mixed through a rock or other mineral matrix. Such is the azurmalachite from the John Kay mine at Mineral Park, Ariz. This variety appears to be a badly altered fine-grained white porphyry which has been brecciated, decomposed, partly silicified, and the seams filled in with azurite and malachite. Portions of this rock are soft and have a hardness of 4 to 5, while parts which have been silicified are harder through the presence of much free quartz. The azurite and malachite occur in veinlets or seams and irregular masses through the rock. The veinlets range from paper thickness to an eighth of an inch thick and are very numerous in some specimens. These seams cut each other at various angles and ramify throughout the rock in an irregular manner. In places blue azurite is the principal colored mineral, in others green malachite, while the two often occur in the same specimen. The azurite veinlets appear to have been introduced later than the malachite. Brecciation of the rock and cementation by copper carbonates has been far reaching, so that some of the material has a marked speckled appearance.

NEVADA.

Mr. William Kley, of Denver, Colo., kindly sent to the office of the Survey a gem cut from a copper ore obtained from a mine in Nevada by I. F. Peck, of Denver. The stone consists of granular quartz with much blue azurite in the interstices. It resembles chrysocolla in appearance. As a souvenir gem it should find a market in the tourist trade.

BERYL, AQUAMARINE, ETC.

COLORADO.

The Mount Antero locality in Chaffee County, Colo., has furnished many fine specimens and considerable gem beryl, topaz, phenacite, and quartz crystals. These gems would doubtless be mined regularly if the locality were more accessible. The great elevation of the deposits, with the accompanying dangers from landslides on the steep talus slopes, exposure to severe thunderstorms, difficulty of transporting tools and supplies, and the short season (two to three months) when it is possible to work, has necessarily limited extensive development of these deposits. Practically all of the workings are simply pits from 4 to 8 feet in width and depth, and many consist of but one or two blasts in favorable places. Gem deposits have been found on the top of White Mountain at an elevation of about 13,900

[a] Manufacturing Jeweler, August 13, 1908.

feet above sea, and one-half of a mile south of the top of Mount Antero, on the west slope of Mount Antero, and on smaller peaks to the east of it. Former glaciers have left their marks in the region by cirques, moraines, and lakelets in the surrounding valleys. The gem locality is reached from the little town of Alpine, or from Fisher station, on the narrow-gage branch of the Colorado and Southern Railroad between Buena Vista and Gunnison. From Alpine the distance is about 8 miles and the climb about 5,000 feet. Over half of the trip can be made on burro or mule back.

The mass of Mount Antero and White Mountain is composed of quartz monzonite with local variations. Along the divide half a mile southwest of White Mountain an abrupt change of character to more basic rock is indicated by an area of dark-brown soil on Calico Mountain. The talus slopes and angular gravel-covered surfaces of Mount Antero and White Mountain appear light gray and frost-white in contrast to Calico Mountain. On parts of White Mountain, especially near the beryl deposits, the rock is muscovite granite composed of orthoclase with microperthite intergrowths, oligoclase, quartz, muscovite, and a little biotite. Magnetite, apatite, and zircon are present as accessories.

The beryl, quartz, phenacite, and topaz crystals occur in miarolitic cavities and pockets in the granite and granitic phases of the quartz monzonite. The pockets occur in streaks or are isolated and occupy no definite arrangement with respect to each other. The crystallization along the streaks and around the miarolitic cavities is coarse, and the rock may be called pegmatite. One streak or vein of pegmatite with its gem-bearing pockets is 15 inches thick where exposed in a pit. This streak can be traced for some distance in a northeast direction across the ridge near the top of White Mountain by loose beryl and quartz crystals in the angular gravel soil formed by the disintegration of the rock and in blocks of the granite lying on the surface. As exposed in the pit the vein consists of pegmatite, much crystallized clear and smoky quartz penetrated by beryl crystals, crystals of phenacite, muscovite mica, feldspar, violet and green-colored fluorite, etc. Crystals of beryl and quartz occur scattered along the top of the ridge from the summit of White Mountain for about 200 yards to the southwest. In places many crystals may be found loose in the gravel, indicating the position of a gem pocket.

With the exception of smoky and clear quartz, beryl is the most abundant specimen and gem mineral found at the Mount Antero locality. The beryl occurs in transparent clear crystals from small size to those measuring 2 centimeters in diameter and 6 centimeters in length. Many of the crystals are badly etched or corroded, especially on the ends projecting into cavities. The color of the beryls varies from clear light blue to pale and deep aquamarine green. Blue beryl is very plentiful "frozen" in the rock, either in the granite, pegmatite, or quartz. Much of the frozen beryl is badly checked and flawed. That from the cavities is generally clear and of gem quality. The other minerals—phenacite, topaz, and fluorite—are closely associated with the quartz and beryl, and often attached to them. Phenacite crystals attain the size of the beryl and are generally colorless. S. L. Penfield[a] has described the beryl, bertrandite, and phenacite from Mount Antero. He discussed the etching of the

[a] Beryllium minerals from Colorado: Am. Jour. Sci., 3d Ser., vol. 40, 1890, pp 489–491.

beryl and its probable relation to the formation of the two associated beryllium minerals—bertrandite and phenacite.

Beryl crystals have been found rather plentifully at the Amazon claim of J. D. Endicott, 6½ miles north of Texas Creek on East Gulch, Fremont County, Colo. The country rock at this mine is contorted mica and hornblende gneiss. The gneiss is cut by a large irregular mass of pegmatite which outcrops as a small cliff on the west side of the valley. The pegmatite contains irregularly shaped quartz masses of pale rose color, ranging from a few inches to several feet across. Beryl crystals are exposed at six or eight places in the cliff and range from less than an inch to a foot in diameter. They are mostly opaque and yellowish to greenish in color. Indications of gem quality were seen in fragments of one crystal, and a few gems have been cut. Mica occurs in crystals 4 and 5 inches across, and a few crystals of columbite are found.

PENNSYLVANIA.

Dr. Edgar T. Wherry, of Lehigh University, states that beryl is found at many places in Chester and Delaware counties in southeastern Pennsylvania. The best locality is probably at the quarry of C. J. Leiper, at Avondale, Delaware County. The beryls are found here in pegmatite cutting the coarse granitic Baltimore gneiss. The beryl crystals range in size up to 2 inches in diameter and 4 inches in length. They have a bright green to golden-yellow color, though the majority are badly flawed and opaque. Occasionally clear crystals of gem quality are obtained. In the fall of 1908 some rusty beryl crystals were found about half a mile to the north of this place during the grading of a road. Good specimens are expected when the locality is opened as a quarry for building stone, as is the present intention. Almandite garnet is found with the beryl at some of the localities and in some cases is suitable for cutting into gems.

UTAH.

Maynard Bixby, of Salt Lake City, reports the discovery of a new beryl locality on Ibapah Mountain in Tooele or Juab counties, western Utah. The beryl has a blue color with patches of gem quality. Details of the find are lacking, though it seems the beryls were found in gulch gravels and not in place.

NEW HAMPSHIRE.

Edwin Passmore, of Boston, Mass., reports the discovery of a ledge carrying light-green, light-yellow, and golden-colored beryl near Danbury, N. H. A portion of a broken crystal of dark yellow color found at this locality was valued at about $150. The crystals are associated with massive feldspar and will have to be removed with care to prevent breaking.

NORTH CAROLINA.

The Virginia-Carolina Gem Company of Shenandoah, Va., reports prospecting work on its aquamarine deposit near Mica, Mitchell County, N. C. The mine adjoins the property of the American Gem and Pearl Company and is probably the old Hungerford mine.

BRAZIL.

According to A. S. Atkinson[a] aquamarines have been mined at a number of localities in Brazil. Some remarkable gems are obtained, and a few years ago one weighing nearly 6 pounds was found near Arassuahy. Records report a 15-pound green aquamarine found in 1814. The best gems come from the island of Alegre and are prized for their rich colors and brilliant luster.

CALAMINE.

MEXICO.

A very beautiful variety of calamine, suitable for gem purposes, has been brought to light by Charles H. Beers, of the Ysabelita Mining Company, of San Pedro, Chihuahua, Mexico. Mr. Beers first noticed this material in the possession of a Yaqui Indian, who placed it before his shrine beside the cross and candle. The Indian informed him it was a guard against sickness, accidents, etc., and a sign of success. Mr. Beers obtained all the material possible from the Indian, amounting to about 400 pounds in the rough, and learned that it probably came from the Sabinal district near the Adventure mine, or perhaps in the Santo Domingo region in the Sierra Madre Mountains. The Indian was later killed in a mine, so that at present the locality from which the material was obtained is not definitely known.

The calamine occurs in masses of gray, green, and blue colors, the blue prevailing. The Indian's name for the blue calamine was "buena fortuna." Specimens of the blue calamine, one a cabochon-cut gem kindly furnished by Mr. Beers, consist of translucent material, with a curved banded structure and fibrous or radial crystallization across the banding. The banding is evidently due to calamine deposited from solutions in mammillary layers of translucent blue and white colors. The crystallization has been from a center outward in radial lines, and gives a fibrous or silky appearance. Mr. Beers calls attention to the resemblance of a section of this material to the rising sun and believes this to be the cause of attraction for the Yaqui Indians. The gem cut from this calamine is very pretty.

CALIFORNITE.

CALIFORNIA.

Collier and Smith, of San Diego, Cal., report that about 2 tons of rough californite was obtained at their mine on the South Fork of Indian Creek, 10½ miles from Happy Camp, Siskiyou County, Cal. None of this material was disposed of during 1908. The good grades of californite or jade—as it is sometimes called—are sold for about $50 a pound.

---

[a] Mining for gems in Brazil: Eng. and Min. Jour., June 19, 1909.

CHRYSOPRASE.

ARIZONA.

John L. Riggs, of Chloride, Ariz., reports the occurrence of chrysoprase near the summit on the west slope of the River Range or Black mountains, Mohave County. The deposits are about 20 miles west of Mineral Park. Two claims have been taken up and are owned by Mr. Riggs and the Walker Brothers. Mr. Riggs kindly sent a set of labeled specimens, among which were the following minerals and rocks: Country rock, decomposed, fine-grained, light-colored porphyry with small quartz phenocrysts. Perlitic volcanic glass with associated dark-red jasper. Red jasper or chert gangue mineral in chrysoprase veins. Brecciated vein matter composed of black flint, red and brown jasper, gray and white chalcedony, and small chrysoprase particles of rich green color. Brecciated brown and gray chert cut by two seams of pale-colored chrysoprase and white chalcedony. Breccia composed of white and gray translucent chalcedony, red jasper, and dark-colored chrysoprase, adhering to decomposed light-colored porphyry; this material is part of the vein. Dark-green chrysoprase, rather cloudy, in milky-white chalcedony or chert, some with a reddish-purplish color. A mass measuring 6 by 3 by 3 inches and smaller pieces of finely granular apple-green chrysoprase; float material. Only a limited amount of prospecting has been done and part of this is only assessment work, so that the deposits have not been proven. Judging from color and quality exhibited by some of the small seams and patches of chrysoprase, it is reasonable to hope for high-grade gem material. So far the latter has been found only in pieces too small to be of much value for cutting. The large lumps of low-grade chrysoprase, occurring as float on the surface, may find a use in cheap jewelry. Some of the brecciated specimens, with the several colored varieties of chalcedony and jasper, would yield handsome small ornamental stones. Portions of the white, purplish, and translucent gray chalcedony with streaks of chrysoprase would yield an odd though attractive semiprecious stone.

CALIFORNIA.

Some of the chrysoprase mines of Tulare County, Cal., were operated during 1908. Among these were the Venice Hill mine and the Porterville mine; the latter was described in this report for 1906. The Himalaya Mining Company, of New York, owns the Porterville mine and cuts the high-grade gem material obtained. The remainder is shipped to Germany for cutting.

A. A. Prim, of Visalia, also operated a chrysoprase deposit at Venice Hill, owned by Franklin Playter, of Boston, Mass.

DATOLITE.

A quantity of massive datolite is obtained from certain of the Lake Superior copper mines each year and a portion is used for gem purposes. Datolite is a basic orthosilicate of boron and calcium and commonly occurs in white or colorless crystals. Otto Borreson, of Hancock, Mich., submitted samples from the Franklin mine for examination. This material comes from the upper levels of the mine and some of it contains so much copper that it is crushed and smelted along with the regular ore. The gem material varies in color from pure opaque enamel white in a compact granular variety to cream, yellowish, pink, and purplish in more translucent material. There are also dark to black streaks and mottlings through the massive datolite of different colors. The colors in the datolite are due to the presence of native copper more or less finely divided. Apparently the purplish tints are due to extremely finely divided copper, and the pink and yellow tints are caused by larger scales and particles of copper visible to the naked eye or through a hand glass. Some of the specimens are attached to trap rock, much epidotized in places with native copper. These specimens furnish attractive material for small ornaments and some are suitable for gems. The datolite is cut into stones for scarf pins, cuff buttons, watch charms, etc. They are sold by jewelers in the copper-producing section of Michigan and also more widely in the gem markets.

DIAMOND.

UNITED STATES.

Arkansas.—A pamphlet issued by the Arkansas Diamond Company of Little Rock, containing the statements of the original investors, the mining engineer, and the geologist of the company will prove of interest to many people. An article giving an outline of the discovery, developments, and possibilities of the deposit has been written also by the company's mining engineer, John T. Fuller.[a] Mr. Fuller calls attention to the fact that the term "blue ground" is a misnomer and is little understood by the average prospector. The "blue" refers to the bluish-green color of the unweathered serpentinized peridotite encountered below the zone of yellow weathered material at the surface. On exposure to weather, the "blue," which is really in the form of rock, disintegrates to a grayish-green or yellowish-green friable mass which is more properly a "ground." The peridotite of the Arkansas Diamond Company mine is essentially similar to that of the South African diamond mines. Since the peridotite in the latter mines varies greatly in appearance, not only in different mines but often in different parts of the same mine, it is not expected that a close comparison between details can be made. The occurrence of the Arkansas peridotite in the form of a pipe, the manner in which it weathers, the presence of unaltered portions called "hardibank," and of minerals commonly found associated with diamonds are points of similarity.

On over half of the area of the peridotite outcrop the rock has weathered to depths varying from 20 to 60 feet, so that it will require but a minimum of blasting to mine. The material that can be thus removed is estimated at 1,500,000 cubic yards. In the work of testing the deposit the yield of diamonds was promising and amounted to 540 stones, of which 505 weighed together 217 carats. Three cut stones were found to be brilliant and were valued at from $60 to $175 per carat, with an average value of $104 per carat. A parcel of rough unsorted stones from the mine will be easily worth $10 per carat. The only way to obtain a true idea of the value or possibilities

[a] Eng. and Min. Jour., January 16, 1909.

of such a deposit is to wash at least 50,000 cubic yards of rock with the proper type of washing machines. Small test runs on certain parts of the peridotite outcrop indicate at least a content of 0.21 carat per load of 16 cubic feet. The possibilities of cheap mining in Arkansas are great, since there is an abundant supply of water and timber near by and coal should be obtained at reasonable rates.

Mr. Stifft, of the Stifft Jewelry Company of Little Rock, Ark., reports that over 700 diamonds have been found up to July 1, 1909.

According to reports [a] the Ozark Diamond Mining Company, of Little Rock, has taken up the Mauney property, covering 8 acres of the peridotite outcrop adjoining the land of the Arkansas Diamond Company, and is engaged in prospecting it. A number of diamonds are reported to have been found.

The discovery of a new peridotite deposit in Arkansas has been described by A. H. Purdue.[b] This deposit is located a little over 2½ miles northeast of the original area and 3 miles south of east of Murfreesboro. It was discovered by M. N. Burgess, of Murfreesboro. The peridotite outcrops on the north slope of a hill whose top is covered with 10 to 12 feet of "plateau gravel" cemented into conglomerate. The gravel débris covers portions of the hill slopes and, along with the depth of soil and vegetation on the latter, renders it difficult to determine the boundaries of the peridotite. The peridotite covers at least 2½ to 3 acres of land, though the actual area may be found to be still greater.

From macroscopic examination this peridotite appears to be identical with that of the original area described by Kunz and Washington.[c] The rock weathers readily, and on the outcrop has disintegrated into soil and bowlders up to the size of a man's fist. The soil is green, brown, and yellow according to stages of oxidation. Rather hard fragments of peridotite thrown out of pits go to pieces after a few days' exposure. The formations cut by the peridotite are referred most probably to Cretaceous age, and the peridotite is probably synchronous with the peridotite of the original area. In the original area more resistant portions of the peridotite have withstood weathering and have formed knobs and elevations extending in a northeast-southwest direction. The new area lies in this same general line.

This new peridotite area has been taken up by the American Diamond Mining Company, and prospecting work has been started. Reece Lamb, vice-president of the company, reports that seven diamonds have been found, along with several garnets and numerous quartz crystals.

California.—The United States Diamond Mining Company has continued prospecting work on its property near Oroville. According to reports the shaft is 180 feet deep, and several small diamonds and chips have been found. As yet no authentic report of these finds has been received at the Survey.

Kentucky.—Press reports indicate continued prospecting in the peridotite areas of Elliott County, Ky., during 1908. Reports state that two diamonds have been found, though details and official confirmation of these discoveries have not been received.

---

[a] American Jeweler, December, 1908.
[b] Econ. Geology, vol. 3, 1908, pp. 525–528.
[c] Trans. Am. Inst. Min. Eng. Bimonthly Bull. No. 20, pp. 187–194.

SOUTH AFRICA.

Griqualand West.—The twentieth annual report of the De Beers Consolidated Mines [a] shows a large decrease in the number of loads of "blue" raised and washed and in the quantity and value of diamonds obtained. The total production of blue ground at all the mines—De Beers, Kimberley, Wesselton, Bultfontein, and Dutoitspan—was 5,497,782 loads of 16 cubic feet, as against 9,010,686 loads in 1907, and the total quantity washed was 4,965,323 loads in 1908 as against 6,626,291 loads in 1907. The stock of blue on the floors was increased from 9,391,603 loads in 1907 to 9,955,123 loads in 1908. The number of carats of diamonds won from all the mines and from the tailings and débris was 2,177,191, as compared with 2,619,872 carats in 1907. The number of carats of diamonds won per hundred loads remained the same as in 1907 in the De Beers and Kimberley and Bultfontein mines and showed a slight decrease in the Wesselton and Dutoitspan mines. The average cost of mining and depositing the blue was lowered in the De Beers, Kimberley, and Wesselton mines and slightly increased in the Bultfontein and Dutoitspan. The cost of washing and winning the diamonds was materially lowered in all the mines. The value of the diamonds produced, calculated on the basis of diamonds sold, was £3,354,524, as compared with £6,452,597 in 1907. Owing to the severe depression in the diamond market, the output of diamonds was not all sold, and those disposed of brought a slightly lower price than in 1907. The amount distributed in dividends during 1908 was £800,000, as against £2,550,000 in 1907. The payment of this amount in dividends was much to the company's credit, considering the general depressed condition of the diamond market and the fact that no diamonds were sold during the last five months of the year. By closing the De Beers and Dutoitspan mines and reducing the scale of the work at the others the operations were reduced step by step to about 35 per cent of what they were during 1907. This accomplished the purpose of maintaining the price of diamonds, especially those of better grade, though the increased output of the Premier mine made this difficult. Attention is called to the fact that about 30 per cent by weight of the parcels of diamonds sold by the company contains 70 per cent of the values.

A new diamond field was proclaimed at Harrisdale, 14 miles from Kimberley, on July 16, 1908,[b] and the best prospects were hastily taken up. This diamond deposit consists of alluvial gravel wash, running from 4 inches to 3 feet in thickness. Water is scarce and has to be pumped from Vaal River, 7 miles off, and then carried 5 miles by donkeys. The ground was prospected by a few men before the field was opened, and £20,000 worth of diamonds were reported as won in six weeks. The diamonds are of excellent quality and average about £8 per carat.

Transvaal.—The production of diamonds in Transvaal [c] during the fiscal year 1908 amounted to 2,184,490 carats, valued at £1,879,551, an increase of 639,154 carats in quantity and a decrease of £323,960 in value, as compared with 1907. The production came principally from the Premier mine, though eleven other companies and the allu-

---

[a] Twentieth Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1908.
[b] Mining World, October 17, 1908.
[c] Ann. Rept. Gov't Min. Eng., Transvaal, 1907.

vial diggings at Christiana contributed a small portion. The production from the alluvial diggings amounted to 1,387 carats, valued at £4,617. The production at the Premier mine [a] for the year ended October 31, 1908, amounted to 2,078,825 carats, an increase of 188,838 carats over 1907. The value of the output was £1,536,719, or 14s. 9d. per carat. The prices received were lower than in previous years, due in part to the poor market for diamonds and in part to a slight deterioration of the quality of the output. The contract with the Diamond Buying Syndicate has been broken, but the company has established sales offices in London, and the price of diamonds is not to be lowered indiscriminately.

Orange River Colony.[b]—The production of diamonds in the Orange River Colony during the fiscal year ending June 30, 1908, is given by Burnett Adams as 505,452 carats, valued at £1,069,942, as compared with 398,700 carats, valued at £1,222,202, in 1907. The yield in carats per 100 loads washed was 10.38 in 1908 as compared with 10.19 in 1907. The average price per carat fell from 60s. 6½d. to 42s. 1d. through the unstable condition of the diamond market. The production came principally from the Jagersfontein, Koffyfontein, Voorspoed, and Roberts Victor mines, with a smaller part from prospecting and developing work at the Ebenezer, Lace, and Monastery mines. The yield from the Vaal River alluvial diggings amounted to 5,447 carats, valued at £18,217, or 66s. 10½d. per carat. The largest diamond found in the alluvial diggings during the year weighed 59¼ carats and was valued at £385. That the prospects of the Roberts Victor mine are good is shown by the declaration of a 25 per cent dividend [c] in March, 1909. The projection of an intrusion of nondiamond-bearing ground into the diamond-bearing area was found to be local and offered no serious drawback to the operations of the mine. The Lace diamond mine has been purchased by the Crown Diamond Mining and Exploration Company [d] and is expected to be actively worked under the new management.

German Southwest Africa.—Considerable interest has arisen from the discovery of a new diamond field in German Southwest Africa during 1908.[e] The diamond deposit occurs in a belt about 1 mile wide and stretching in an arc from Luderitz Bay southward 30 miles to Elizabeth Bay. The diamonds occur in a coarse sand associated with agates and the more valuable forms of quartz. They are generally in fairly perfect octahedral crystals ranging from one-fifth to three-fourths of a carat in weight. No large stones are found. The quality of the stones is good and the color generally pure white, though some have a yellow shade.[f]

Consul Thomas H. Norton, Chemnitz,[g] reports that up to December 31, 1908, about 40,000 carats of diamonds had been found, whose estimated value was $269,000. It is the policy of the German Government to hold a monopoly over these diamond deposits and to regulate development in such a way as to assure proper protection of mining interests and to prevent uneconomic methods of exploitation.

---

[a] Eng. and Min. Jour., April 24, 1909.
[b] Mines Dept. Orange River Colony, Fifth Ann. Rept., 1908, Bloemfontein.
[c] Min. Jour., London, March 20, 1909.
[d] Min. Jour., London, February 6, 1909.
[e] U. S. Daily Cons. Repts., April 2, 1909.
[f] Eng. and Min. Jour., December 19, 1908.
[g] Idem.

All of the diamonds are to be cut in Germany, and it is estimated that the wages paid for the work will amount to $500,000 annually at the present rate of production of the field. The diamonds are to be taxed at such a rate that the miners will secure about one-half the profit. Mining consists in simple sieving, washing, and picking out of diamonds. Almost no capital for machinery has been required so far and the work is done by natives with white overseers.

The extent of the diamond field is being found to be greater than at first thought. Diamonds have been found along the coast to the south about 150 miles from Luderitz Bay and 75 miles from Orange River.[a] That the deposits have formed from alluvial deposits is thought probable, and Orange River is pointed out as a possible original source.

SOUTH AMERICA.

Brazil.—The geology of the diamond-bearing highlands of Bahia—Chapada Diamantina, as a portion of it is called—has been described by J. C. Branner.[b] This region lies northwest of Bahia and south and southeast of Rio Sao Francisco. About it comparatively little is known. Two railroads approach but do not penetrate this area, and travel must be accomplished with mules. The region is semiarid, and the climate hot, though healthful. Much of the country is covered with catinga forests, a tough, scrubby growth of timber. The country is fairly well watered along the streams, though subject to droughts away from them.

The following is an outline of the geology with probable ages of the formations: Along the coast to the north of the city of Bahia is a series of Cretaceous and Tertiary strata resting on pre-Cambrian schists, gneisses, and granites. The latter extend from the sedimentaries along the coast westward to the highlands and form a nearly level plain with a few scattered hills and peaks over it. The Serra de Jacobina is the first mountain range of the highlands and is composed of the conglomerates, shales, schists, and quartzites of the Minas series, 1,000 meters thick, and of Cambrian age. The bedding of this series strikes nearly north with the range and dips steeply to the east or is vertical. The crystalline rocks also appear on the west of the Jacobina Range. To the west of this is the great Tombador Range, composed of 400 meters of nearly horizontal Cambrian sandstones and quartzites resting directly on the crystallines. The edges of these beds of the Tombador formation, which dip gently westward, form great walls or scarps on the east. The Tombador beds can be traced northward toward Rio Sao Francisco, where they cap the flat-topped mountains or form the monoclinal ridges of that region. Above the Tombador beds are the Jacuipe flints, about 100 meters thick. Above these are 500 meters of the Caboclo formation, of Devonian age, composed of gray, red, yellow, black, and cream-colored shales. The upper part of this formation is in contrast with the overlying false-bedded pinkish sandstones, conglomerates, and quartzites of the Lavras series, of Carboniferous age. This series carries the diamonds and is about 700 meters thick. The Lavras series is overlain by 350 meters of red Triassic sandstones, very like the Triassic sandstones of New Jersey and Connecticut. These have been called the Estancia red beds. The last series exposed is the

[a] Min. Jour., London, March 20, 1909.

[b] Eng. and Min. Jour., May, 15, 1909.

Salitre limestones and marbles, about 300 meters thick and of Jurassic age.

Diamonds and carbonados are found together in this region, and their mining constitutes an important industry of Bahia. The source of the diamonds and carbonados has been pretty definitely traced to the Lavras series, though Dr. Branner has never seen one in place in these rocks. The streams and river gravels have been found richest in diamonds where they flow through or over large areas of the Lavras beds. No eruptive rocks occur in the Lavras beds which could possibly give rise to all the diamonds and carbonados of the region. Areas of serpentine have been found in the crystalline rocks that underlie the sedimentary rocks. It is possible the diamonds originated in peridotite in these crystalline rocks, and were later washed out and deposited with the Lavras beds.

The most productive area has been that between Sincoro on the south and Morro do Chapeo on the north. Whether this is due to a particular richness of the beds in this area or to the favorable supply of water, or to both, is not known. Mining methods used have been crude, practically all work being done by hand. The possibilities of mechanical apparatus, especially dredges, should be tested. In the stream beds and places where the natives have been able to work there is but little virgin gravel left. In swamp and marsh lands along the river not accessible to the natives it is probable rich deposits still exist and could be worked with dredges. Dredges must operate under difficulties in this region, however, as transportation facilities are poor and repair shops and factories a long way off.

British Guiana.—The exports of diamonds from British Guiana during the calendar year 1908 amounted to 4,968 carats,[a] valued at $40,872, as against 2,220 carats, valued at $17,550, in 1907. The shipments between January 1 and May 12, 1909, amounted to 1,095 carats,[b] valued at $7,350. A new deposit of diamonds was discovered near the Dukwarri Cataract, about 115 miles from the mouth of Cuyuna River.[c] Two parcels of stones weighed 138 carats, showing that the diamonds of this deposit are small in size, as are those from the other deposits of British Guiana.

INDIA.

The production of diamonds in India during 1908 amounted to 140.75 carats, valued at £940,[d] against 628 carats, valued at £2,784[e] in 1907. These figures represent the production in the States of Panna, Charkhari, and Ajaigarh, in central India. A few diamonds are reported found in the Anantapus district of the Anadras Presidency, though no statistics have been obtained.

AUSTRALIA.

New South Wales.[f]—The production of diamonds in New South Wales during 1907 amounted to 2,539 carats, valued at £2,056, a decrease of 288 carats in quantity and of £64 in value from 1906.

[a] Min. Jour., London, February 6, 1909.
[b] Min. Jour., London, June 5, 1909.
[c] Min. Jour., London, May 5, 1909.
[d] Advance statement of the production of minerals in India in 1908 by the director of the Geological Survey of India, June 10, 1909.
[e] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.
[f] Ann. Rept. Dept. Mines, New South Wales, 1907, p. 59.

The average size of the diamonds was small, though one fine white stone was found at Copeton that weighed $3\frac{3}{4}$ carats and was sold locally for £17. The greater part of the output came from the vicinity of Copeton, in the Tingha division.

The discovery of a volcanic breccia or agglomerate[a] at Snodgrass, 20 miles west of Delegate, led to the prospecting for diamonds in that region. The rock resembles the diamond matrix in the pipes of the mines of South Africa and contains rounded eclogite lumps as in those mines. The rock occurs at the contact between granite and Silurian slates and sandstones. No diamonds have yet been found.

DIAMOND INDUSTRY.

The crisis which the diamond industry of the world recently faced is past and the conditions are fast becoming normal. With the exception of a 5 per cent increase in the price of the rough diamonds from the Wesselton mine, the price of rough diamonds has remained practically stationary.[b] The increase in price of high-grade rough diamonds is taken as an indication of a growing demand for these and a decided betterment of the industry. The value of the rough diamonds has fluctuated but little, although an increase in the price of polished stones[c] of as much as 15 per cent in three months is reported. Dispatches from the foreign diamond markets, as Amsterdam and Antwerp, report the presence of large American buyers as a good sign of a revival of the diamond trade.

The imports of diamonds and other precious stones into the United States has again returned to nearly the normal amounts, and is strong indication of the general betterment of industrial conditions. Nearly the usual number of diamond cutters have returned to work in the United States, and it is to be hoped that this industry will increase with the change effected in labor conditions.

Cullinan diamond.—A noteworthy event in the diamond world during 1908 was the successful cutting and polishing of the great Cullinan diamond, and the presentation of the same to the King and Queen of England on November 21.[d] The diamond weighed about 3,025 carats and was cut into 9 large stones and a number of smaller ones.[e] These gems were (1) a pendaloque or drop brilliant, weighing $516\frac{1}{2}$ carats, dimensions, 2.322 inches long and 1.791 inches broad; (2) a square brilliant, weighing $309\frac{3}{16}$ carats, 1.771 inches long by 1.594 inches broad; (3) a pendaloque, weighing 92 carats; (4) a square brilliant, weighing 62 carats; (5) a heart-shaped brilliant, weighing $18\frac{3}{8}$ carats; (6) a marquise brilliant, weighing $11\frac{1}{4}$ carats; (7) a marquise brilliant, weighing $8\frac{9}{16}$ carats; (8) a square brilliant, weighing $6\frac{5}{8}$ carats; (9) a pendaloque, weighing $4\frac{9}{32}$ carats; (10) 96 brilliants, weighing $7\frac{3}{8}$ carats; (11) a quantity of unpolished "ends" weighing 9 carats.

The first and second of these are larger than any cut diamond in the world. Even the Kohinoor diamond, weighing $102\frac{3}{4}$ carats, is less than half the size of the smaller one of the two large Cullinan stones. All the polished gems from the Cullinan are without flaw and of remarkable brilliancy and luster. In place of the normal

---

[a] Pittman, E. F., Australian Min. Standard, April 7, 1909.
[b] Jewelers' Circ. Weekly, June 16, 1909.
[c] Jewelers' Circ. Weekly, December 9, 1908.
[d] Jewelers' Circ. Weekly, November 25, 1908.
[e] Jewelers' Circ. Weekly, November 11, 1908.

58 facets on a brilliant, the largest stone has 77 facets and the second 66 facets, which add greatly to the beauty of the gems.

Origin of diamonds.—In a paper read before the Geological Society of South Africa[a] F. W. Voit discusses the nature and origin of kimberlite and its relation to the diamonds found with it in South Africa. Doctor Voit prefers to call kimberlite an agglomerate rather than a breccia. From the abundance of pyroxene and other minerals besides olivine and a suspicion of the presence of feldspar in some cases, the rock is evidently not a peridotite, but might more appropriately be called porphyritic pyroxenite. In places it is difficult to determine whether a rock is kimberlite or diabase, and chemically there is a transition from the one to the other. In many places diamonds are found where it would be difficult to explain their presence otherwise than as having weathered out of the diabase beds forming the surface rocks on some of the plateau regions. The so-called bowlders of eclogite found at some of the mines described by Doctor Bonney can very readily be explained as segregations in the magma or as inclusions with edges and corners dissolved off by the action of the kimberlite magma. The brecciation evident in portions of the kimberlite bodies could readily have taken place during the extensive serpentinization the latter have undergone with consequent large increase of volume by hydration. The same agency may have caused the breaking of some of the diamonds, though this phenomenon is also readily explained in other ways.

EPIDOTE.

J. D. Endicott, of Canon City, Colo., has had a quantity of compact epidote cut "en cabochon" with pleasing results, for use in scarf pins, cuff buttons, etc. This epidote is found in the unconsolidated drift material 2 miles south of Canon City. The drift has been deposited in terraces and beds over former table-lands and slopes south of Arkansas River. The epidote is found as pebbles associated with cobbles and pebbles of granite, quartz porphyry, trap, pegmatite, cyanite rock, jasper, chert, iron ores, chalcedony, quartz, etc. Pebbles of granite and diorite have a similar variety of epidote in streaks and irregular patches through them, indicating the probable source of the gem material. Only the very fine-grained compact variety of epidote furnishes good gems. The greater part is too coarse-grained and brittle for cutting. The colors range from light pistache or yellowish green to dark olive-green. Occasionally a bright-red patch of jasper is included in the epidote, giving somewhat the effect of bloodstone. The epidote is hard, and if sufficiently compact takes a beautiful polish. It has found favor in the local markets in Colorado and should be received elsewhere.

FELDSPAR GEMS—AMAZON STONE, MOONSTONE, ETC.

COLORADO.

The Pikes Peak region has long been famous as a source of beautiful crystals of amazon stone and associated smoky and clear quartz. One of the most prolific areas has been that called Crystal Park by collectors, lying from 2 to 4 miles southwest and south of Manitou

[a] Abstracted in Eng. and Min. Jour., April 17, 1909.

Springs and extending southeasterly from the east side of Cameron Cove along the slopes of the mountains for a distance of 3 miles. Numerous prospect holes in the Crystal Park region with the less valuable crystals left on the dumps show the past activities of mineral collectors. Fine quartz crystals occur at numerous places outside of the Crystal Park region and especially to the northwest, toward Pikes Peak, more amazon stone has been found.

The rock of this region is principally coarse biotite granite composed chiefly of light flesh-colored potash feldspars, a white plagioclase feldspar, gray quartz, and biotite mica. Pegmatite occurs in dikes, veins, and irregular masses through the granite. The crystals of amazon stone occur in the cavities or pockets in the pegmatite. The pockets vary from less than 1 inch to nearly 2 feet across. Some of these pockets are miarolitic cavities in the granite, around which the crystallization is coarse and the same as in pegmatite. In some cases the miarolitic pockets are connected by seams or veinlets, and can be readily traced for yards. In other cases the pockets are isolated, and others may or may not be found near by. The pockets are lined with crystals of amazon stone, smoky and clear quartz; occasionally topaz and phenacite are present. The crystals of amazon stone are generally well developed, and vary in size from a fraction of an inch to 3 or 4 inches square. The color ranges from gray to bright green and is often richer in one portion of a crystal than in another. The crystals from the shallow prospects are often more or less stained with iron rust both on their surfaces and along cleavage cracks. The rust may be removed with oxalic acid to prepare the crystals for mineral collections and for sale as gem material. Quartz crystals are found ranging from a fraction of an inch to several inches across, either singly or in clusters of parallel grown crystals. Some are colorless, though the majority are more or less clear smoke colored, sometimes very strongly so. They furnish fine cabinet specimens for mineral collections. Whitman Cross [a] and W. F. Hillebrand describe the occurrence of the specimen minerals of this region. Those observed were microcline, albite, biotite, quartz (smoky and clear), fluorite, columbite, gothite, hematite, and limonite, arfvedsonite, astrophyllite, and zircon. As much as a ton of crystals have been found in one pocket.

Amazon stone and crystals of the associated specimen and gem materials, quartz, topaz, and phenacite, were mined by J. D. Endicott during 1908 in the Crystal Peak region 4 miles north of Florissant, Teller County. The occurrence of these minerals at this locality is evidently similar to that of the Pikes Peak region. The country rock in each case is coarse granite. Mr. Endicott states that the crystals are found in leads of pegmatite, which can be traced from a few feet in some cases to over a hundred yards in others. In the deposits opened the pegmatite is nearly in blanket form. The amazon stone occurs in streaks and pockets in the interior of the "veins" and attains a thickness of 1 foot in places; in other places it is absent. Troughlike depressions occur in places in the cavities, and in these the amazon stone is stained and coated with films of oxide of iron. Evidently the troughs served as channels for a later deposition of limonite from solutions. Some of the amazon stone is of good gem quality and has a rich green and blue-green color. Other stones are pale or badly

---

[a] Minerals from Pikes Peak : Am. Jour. Sci., 3d ser., vol. 24, 1882, pp. 281–286.

stained with iron. The crystals obtained in mining are often quite perfect and would make fine cabinet specimens. Many crystals of smoky quartz and a few of phenacite and topaz were obtained in 1908 during the work for amazon stone. The Crystal Peak region is noted for the fine specimens of these minerals it has yielded. W. E. Hidden[a] has described phenacite, topaz, xenotime, and fayalite from this locality. Cross and Hillebrand[b] described a fragment of a clear greenish tinged topaz crystal measuring 9 centimeters on an edge. This was but the corner of what must have been a very large crystal.

PENNSYLVANIA.

Dr. Edgar T. Wherry reports the occurrence of amazon stone with sunstone at the Mineral Hill locality about 1 mile west of Media, Delaware County, Pa. These minerals are found loose in the soil, where they are brought up from pegmatite ledges by the action of frost.

GARNET.

UTAH.

For many years the Navajo Indians have collected the rich red pyrope garnets found on their reservation and sold them to tourists or at the trading stores. The exact locality at which these garnets were found and their mode of occurrence has always been more or less indefinitely known. Within the last few years the quantity of garnets collected by the Indians has been decreasing, and many of the traders that formerly bought quantities of garnets now state that they are becoming very scarce. A partial explanation for this seems to be that whereas the greater part of the garnets was formerly brought to trading posts in Arizona and New Mexico and to stations along the Santa Fe Railway, a considerable part is now traded at points in Utah and goes out through Salt Lake City. Tourists still buy these garnets from the Indians along the railroad, though they generally obtain only small and inferior gems. A visit to the garnet field was made possible through the kindness of Mr. J. L. Hubbell, of Ganado, Ariz., who furnished the necessary guide and equipment to reach the locality, as he did also for the trip by the writer to the peridot locality described in subsequent pages.

Clear red garnets associated with peridot gems weathered out of basic rocks are found at several places around and to the north of Fort Defiance. As a rule the garnets from these localities are small and not often sufficiently large for cutting. The supply of gem garnets comes from close to the Utah-Arizona line about 12 miles southwest of the mouth of the Chin Lee Valley and San Juan River in Utah. It has commonly been reported that the gems came from Arizona, though Don Maguire, of Ogden, Utah, reported the locality as Utah. The garnets occur in an elevated region a few miles north of the Arizona-Utah line, about 100 miles west of north of Ganado, Ariz., and over 120 miles northwest of Gallup, N. Mex. After visiting the locality one can readily appreciate the value of the "Arizona ruby," as the garnet is called. It is necessary to make a long trip over sandy and rocky trails with many miles between water pools or springs, and at its end garnets of good size and quality are not found

[a] Mineralogical notes: Am. Jour. Sci., 3d ser., vol. 29, 1885, pp. 249–250.
[b] Minerals from Pikes Peak: Am. Jour. Sci., 3d ser., vol. 24, 1882, pp. 281–286.

abundantly and, when found, are on an arid stretch of country several miles from water.

The geology of Arizona and Utah in the Navajo Reservation has been little studied, and in the limited time given for the trip to the garnet region but few notes were obtained to add to the general knowledge. The route followed led over the mesa country north from Ganado and down the valley of Nasklini Creek to Chin Lee at the mouth of Canyon de Chelly. From Chin Lee, through a mistake of the Indian guide, a northwesterly course was followed to a point within a few miles of Agathla Needle, some 25 miles S. 60° W. of the garnet fields. From this point the route led down Gypsum Valley, which drains into the Chin Lee Valley near its mouth. The garnet field is several miles northwest of this canyon. The return trip was made over the elevated country south of the garnet fields, across the Chin Lee Valley nearly opposite the mouth of Carriso Creek, up Carriso Creek to Bradley's store, and then south to Chin Lee.

Descending from the mesa several miles north of Ganado one passes over several miles of petrified forests in which the trees are not so numerous as in the famous localities near Adamana. The formation in which the trees are embedded, however, appears to be identical with that near Adamana. The rock exposures in Canyon de Chelly and along the Chin Lee Valley north to the garnet locality appear to be similar and consist principally of red beds, largely cross-bedded sandstone and conglomerate. This sandstone forms great blocky vertical cliffs from one hundred to several hundred feet high along the Chin Lee Valley and the canyons entering it. This formation extends west from the Chin Lee Valley and northwest from Gypsum Valley, forming the semimesa country on which the garnet deposits occur. These red beds may correspond to those described by L. F. Ward[a] in the Little Colorado region to the south, referred to the Triassic age and provisionally thus accepted by N. H. Darton.[b] The red sandstones extend over 30 miles west of the Chin Lee Valley to the region around Agathla Needle. In the latter region basic rocks outcrop at numerous places and in several instances have formed sharp needle-like masses hundreds of feet high with small bases. Agathla Needle is evidently composed of such a rock and stands several hundred feet high. One of these hills or outcrops about 4 miles south of Agathla Needle was composed of two types of rock—one a dark, hard, dense basaltic rock with visible olivine phenocrysts and the other a dark-gray, somewhat porous olivine-mica rock. A few small pieces of peridot were found weathered out of this rock. Between Agathla Needle and the garnet locality basaltic and other basic rocks outcrop at several places both as needles and as dikes, cutting the sandstone formations.

The extent of the area over which gem garnets are found was not determined. Actual examination was limited to a stretch of country about 2½ miles long in a northwesterly direction and half a mile wide. From the apparent similarity of the formations around this strip it was judged that garnets should be found over an area of several square miles, probably 4 miles north and south and 5 or 6 miles east and west, while the field might extend several miles beyond a line of hills to the north.

---

[a] Mon. U. S. Geol. Survey, vol. 48, 1905, p. 45.
[b] Reconnaissance of part of western New Mexico and northern Arizona: Bull. U. S. Geol. Survey. (In preparation.)

The garnets are found on a series of mesa-like benches rising from Gypsum Valley on the southeast, and between 6,000 and 7,000 feet (barometric measurement) above sea level. The elevation increases slightly to the west in the mountains around Monument Pass. The benches and mesa on which the garnet deposits occur are nearly level in places and dip to the southeast in others. They are formed by different beds of the red sandstone formation, the edges of some of the beds standing as small cliffs over the next lower. In places the sandstone floors are bare; in others they are covered by wind-blown sand in layers varying from a few inches in depth to dunes many feet high. This sand is brought up principally from the red-sandstone country to the southwest, from which direction the prevailing winds of the region blow. The garnets are found in the sand and on the sandstone floors, associated with pebbles of feldspar sometimes with a moonstone luster, occasionally emerald-green diopside, red sugary quartz, and such rocks as granite, diorite, trap, etc. Some of the garnets and hard-rock fragments are rounded and polished on one or more sides by the action of the wind-blown sand as they lie exposed on the surface. This accounts for the smooth rounded surfaces so prevalent on many of the garnets from the Navajo country. The garnets may be uncovered by a wind from one direction and then covered up by that from another, or vice versa. By the shifting of the dunes the position of the garnets is changed so that different sides are exposed for polishing by the wind-blown sand.

The source of the garnet over the mesa country is in a stratum of coarse, unconsolidated drift or gravel that rests on the more elevated part of the red sandstone on the northwest of the area examined. This drift is over 100 feet thick and is composed of bowlders, which vary from stones weighing many tons to cobble size, mixed through a matrix of pebbles and sand. The gravel and bowlders consist of biotite granite gneiss, porphyritic biotite granite gneiss, hornblende or diorite gneiss, partly epidotized trap and basaltic rocks, epidote hornstone, soapstone, tremolite asbestos, sugary quartz, and large blocks of light gray colored fossiliferous limestone of Carboniferous age. Just where the origin of this conglomeration is to be sought is not known. The general appearance of the drift is that of a glacial deposit. Glaciation has taken place in the San Francisco Mountains [a] of Coconino County, Ariz., and moraine deposits have been formed. The latter are thought to be of rather recent age, probably Quaternary. Whether there has been glaciation in the slightly higher country west and northwest of the garnet deposits is not known. It is probable that the garnet-bearing drift deposits are of greater age than the glacial deposits of the San Francisco Mountains, for the former are covered with a stratum of hard white sandstone and are at almost as great an elevation as any of the surrounding region. The presence of such quantities of crystalline and ancient rocks in the drift can not be explained by very recent action, as these rocks do not outcrop near the locality.

The garnets are scattered through the drift, though not plentifully, and are carried down with it to the mesa country below during erosion. It seems the garnets undergo a partial concentration on the mesas

[a] Ward, L. F., Glaciation of the San Francisco Mountains, Arizona: Jour. Geology, vol. 13, 1905, pp. 276–279.
Robinson, H. H., Geology of the San Franciscan volcanic field, Arizona: Prof. Paper U. S. Geol. Survey. (In preparation.)

during the breaking down and washing away of its loose matrix. The latter takes place readily when the protecting cover of hard sandstone is removed. In one place near the garnet-bearing formation some ant hills were found to be built up of over half garnet chips ranging up to 2 or 3 millimeters across. The remainder of the mineral grains of these ant hills consisted chiefly of cleavage chips of orthoclase feldspar, with a smaller amount of hornblende gneiss rock fragments, grains of quartz, epidote, etc.

The garnets found in this region range in size from small grains to over 3 centimeters in diameter. The larger ones are not perfect, being badly flawed and cracked. They often have a brownish-red color, and rarely contain gem material. The best gem garnets are not often over a centimeter or 12 millimeters in diameter, and the greatest yield of gems is in garnets of less than 8 millimeters in diameter. Garnets that will cut perfect gems over 3 carats in weight are scarce, while those ranging from 1 to 2 carats when cut are fairly plentiful. Stones of 1 carat and under are abundant. A garnet cut as an ordinary brilliant measuring 8 millimeters across and 5.5 millimeters thick will weigh about $2\frac{1}{2}$ carats. The garnets range in color from the beautiful rich Burgundy wine red characteristic of pyrope to lighter shades, with some of more or less cinnamon color. Some of the red garnets are so dark that the gems show little color and appear nearly black. In others the colors appear brilliant even under artificial light.

Imperfections occur in many of the garnets. These imperfections may be cracks or flaws or inclusions of dark spots or of other minerals. In the deeper-colored garnets flaws are often difficult to detect until the stone has been partly or wholly cut. The dark spots appear to be due to cavities in the garnet in some cases; in others they are caused by inclusions of other minerals. Among the minerals found associated with the garnets is emerald-green diopside, and in one specimen of garnet which had been split a small diopside crystal of pin-head size was found in the center. In another specimen a tiny garnet was found attached to a larger diopside crystal. Minute acicular inclusions are also present in some of the garnets. They are arranged according to certain directions of symmetry in the crystal and are probably rutile. These acicular or threadlike inclusions are so fine that they do not perceptibly affect the color and luster of the gems.

The garnets are collected by the Indians who search carefully over the sandy country below the drift. Apparently no methods are used to find the gems that may be concealed below a few inches of sand, but only those on the surface are looked for. The shifting of the sand uncovers garnets at one time and covers them up at others, and therefore renders the possibilities of new finds attractive. No water can be obtained except in rainy seasons to wash for the garnets, so that this method of concentration can not be used. By the use of screens it seems possible much material could be worked over with good results. The sand could be thus eliminated, and the garnets are rather easily picked out from other pebbles. Screens varying in size of mesh from four-fifths to one-fifth of an inch would be very serviceable in screening and separating the material for hand picking. In the majority of cases the garnets are richest near the bottom of dunes or sand beds, and that portion should therefore be sieved.

The larger garnets are now difficult to obtain; but it is probable that the "Arizona ruby" will again become more plentiful when the Indian learns to work a little more systematically for this gem.

COLORADO.

J. D. Endicott, of Canon City, Colo., has taken up two claims for garnets on Grape Creek, 2 miles S. 75° W. of Canon City. The country rock is biotite schist-gneiss, garnetiferous in streaks. It strikes north of east to east and west and dips 45° N. Pegmatite is associated with the gneiss in places. The portion prospected for garnets consists of a garnetiferous streak in which the garnets are rather plentiful and of some size. Certain smaller bands and lenses in the "vein" up to 8 or 10 inches thick are richer in garnets than the rest of the rock. The garnets are found in crystals varying from minute size to over 3 inches in diameter, wrapped in biotite in the gneiss. The greater part of the garnets are more or less crushed and fractured. The cutting material, though mostly small, comes from the solid portions of the crystals not injured by fracturing. The color is the beautiful red to pinkish red of almandite or precious garnet, and handsome gems of about 2 carats' weight have been cut.

Specimens of spessartite garnet and topaz are still obtained from Ruby Mountain on the east side of Arkansas River opposite Nathrop, Chaffee County, Colo. The deposit is on public land and is visited intermittently by collectors chiefly for mineral specimens, though some garnets suitable for cutting are obtained. The work done by each collector does not usually exceed a few blasts in the most favorable places. The locality has been described by Whitman Cross,[a] and the following notes are prepared principally from his description:

The garnets and topaz occur in cavities in a rhyolite of probable Tertiary age. The rhyolite outcrops in three places—in Ruby Mountain, a hundred yards north of Ruby Mountain, and on the west side of the river opposite Ruby Mountain. Ruby Mountain is a hill about 200 feet high and a quarter of a mile long, running north of west and east of south parallel with the course of the river. The upper and larger part of the hill is composed of white to pinkish-gray rhyolite of very fine grain with more or less flow banding of light and darker layers. The lower portion of the hill where outcrops are not covered with talus on the southeast and northwest ends are composed of gray volcanic glass with perlitic texture. This perlite contains numerous round particles of obsidian up to the size of a pea. On the east side of the hill are rhyolitic tuff beds which, in an exposure on the north of the hill, dip about 20° E. Cross mentions vertical contact between the rhyolite and inclosing Archean gneiss.

The crystal-bearing cavities are larger and more abundant in the rhyolite in the upper part of the hill. These cavities are lithophysæ as in the Utah topaz locality described later. The cavities range in size from a millimeter cross section to more than 5 centimeters in greatest dimensions. They are elongated in the direction of the flow lines in many places or are composed of numerous smaller joining cavities in this direction. Some of the lithophysæ shells are fairly

[a] Topaz and garnet in rhyolite: Am. Jour. Sci., 3d ser., vol. 31, 1886, pp. 432–438.

well developed in concentric layers, though generally the cavities are very irregular in shape and inclusions. The walls of the cavities are generally drusy with tiny brilliant crystals which Cross determined to be sanadine. Small quartz crystals also occur in the cavities though no tridymite has been found. The garnets have a transparent deep-red to cinnamon-red color and are of the spessartite variety. Crystals of over a centimeter in diameter are rare and the average size is about 2.5 millimeters. The crystals have sharp edges and brilliant faces in the cavities. Generally only a part of the crystal form is developed, for the surfaces are very rough where the garnet is attached to the matrix. The predominant crystal form is the trapezohedron (211) with a small development of the dodecahedron (110). Several garnets often occur in the same cavity, with or without topaz. The topaz is less plentiful than the garnet and of about equal dimensions. The crystals are attached to the walls of the cavities and to the shells in different positions, so that in some cases doubly terminated crystals occur. The forms observed in the order of their prominence are given by Cross as: M(110), L(120), O(221), C(001), F(021), Y(041), A(100), G(130), and F(201). The crystals are clear wine pink or yellow while in the unbroken cavities in the rock, but fade to colorless or tinted pale bluish on exposure to the light.

Cross[a] describes also a similar occurrence of garnet in a coarse rhyolite at Chalk Mountain, near Fremont Pass, Colorado. A specimen of rhyolite with small garnets in a cavity was given to the writer by Mr. J. D. Endicott, of Canon City. This specimen was from the Gudger mine near Westcliffe, Custer County, Colo., and appears to come from an occurrence similar to that described above.

JADE.

BURMA.

The production of jade (jadeite) in the Myitkyina district of upper Burma during 1907 amounted to 3,590 hundredweight,[b] with a local value of £18,998; this is an increase of 1,375½ hundredweight over 1906. Part of the jade is used locally, part carried overland to southwest China, and the greater part is exported through Rangoon, principally to China. The exports through Rangoon during 1907 amounted to 2,636 hundredweight, valued at £49,643. The production in 1908 was 3,367 hundredweight, valued at £22,332.[c]

The occurrence and origin of jadeite in the Kachin Hills in the Myitkyina district, upper Burma, has been carefully discussed by A. W. G. Bleeck.[d] Jadeite is found at three places in the Kachin Hills, at Tawmaw, Hweka, and Mamon. At Tawmaw the deposits consist of a metamorphosed igneous dike intruded into serpentine. At Hweka the jadeite occurs in bowlders in a conglomerate. The jadeite bowlders are quarried from the slope of a hill and are sometimes found of large size. At Mamon the jadeite is found in bowlders in the alluvial deposits and bed of Uru Chaung River.

---

[a] Sanadine and topaz from Colorado: Am. Jour. Sci., 3d ser., vol. 27, 1884, pp. 94–96.
[b] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.
[c] Advance statement of the production of minerals in India in 1908, by the Director of the Geological Survey of India, June 10, 1909.
[d] Rec. Geol. Survey India, vol. 36, pt. 4, 1908, pp. 254–285.

Professor Bleeck concludes that the jadeite was formed by the metamorphism of an albite-nepheline rock, both of these minerals being found with the jadeite in places. The change would be represented chemically by $NaAlSiO_4$ (nepheline) + $NaAlSi_3O_8$ (albite) = $2NaAlSi_2O_6$ (jadeite). Under certain conditions albite-nephelite rock might form, while under conditions of high pressure, during consolidation or after, jadeite with a much lower molecular volume would be produced. The color of pure jadeite is stainless white and specimens closely resemble marble in appearance. The rich emerald-green colored jadeite is the most highly prized and is not abundant compared with the white or dull-green varieties. Some jadeite has a pale amethystine color. The emerald-green color of the best variety of jadeite is due to chromium; the dull-green color of other varieties is due to iron; and the amethystine color is supposed to be caused by the presence of manganese.

JASPER, PETRIFIED WOOD, ETC.

ARIZONA.

Probably the largest jasper deposits in the world are those of the petrified forests of Arizona. It is not alone the sight of so many petrified trees that causes wonder to the visitor, but the large variation of brilliant colors displayed by these trees. The deposits have been described by L. F. Ward,[a] and their beauties portrayed by many writers. Geologically the petrified forests may be briefly described as occurring in formations of Triassic age. The trees were not petrified in place except in a few instances, but were washed down from high levels and scattered over large areas or accumulated in comparatively confined areas. They were deposited in and covered by a conglomeratic sandstone stratum overlying purplish and gray marl beds. This stratum now forms the capping over large areas of mesa country. In their present positions the petrified trees are visible where the sandstone has been cut into by the erosion of valleys and gulches and washes. Some of the trees remain in the sandstone, while others, principally fragmentary, have been dropped into the washes by the erosion of their parent rock. In a few cases the petrified tree trunks are preserved nearly whole, while as a rule they occur in fragments large and small. The smaller material is abundant over large areas, and in places the large blocks or sections of trees are numerous.

The trees have been petrified by silica in its various forms with varying quantities and kinds of impurities acting as pigments and furnishing widely diverse colors. The general form of the tree trunks and limbs and a few details of structure have been preserved during petrification, though the minute detail of structure seen in some petrified woods is wanting. The mineral matter composing the trees is largely jasper with varying amounts of chalcedony and quartz. The jaspers range from brilliant red, through orange to yellow in color. The large number of shades of these colors, particularly the reds, is striking. From the brownish and maroon reds there are all gradations as terra cotta, cardinal, scarlet, cherry-red, etc., to orange,

[a] Geology of the Little Colorado Valley, Ariz.: Am. Jour. Sci., 4th ser., vol. 12, 1901, pp. 401–413. Petrified forests of Arizona: Ann. Rept. Smithsonian Inst. for 1899, 1901, pp. 289–307.

and from orange yellow through ocher and drab to corn yellow. Some pieces have a suggestion of green in the yellow, giving an olive tint. These colors in the jasper are sometimes solid over areas of several square inches and then again are banded or irregularly mixed with other colors. The colored jaspers occur mixed with and in patches scattered through gray cherty chalcedony or through translucent gray chalcedony. Streaks and splotches of black jasper or flint lend contrast to the varied colors of the jaspers. The luster of some of the petrified wood is dull and cherty, though a part is brighter, and some even glassy. Occasionally amethyst and quartz crystals are found in cavities in the petrified trees or coating over limbs.

Many of the petrified forests of Arizona, especially those near Adamana and Holbrook, are protected by law against material being carried off. Visitors are generally allowed to take off a few pounds, however, as souvenirs or material from which to cut souvenir ornaments or gems. Even if one does not procure such specimens, a visit to the petrified forests always proves of great interest, especially to one interested in mineral objects of natural beauty. A trip to the forests is not difficult, and two areas of petrified trees can be seen in half a day's drive from Adamana, on the Santa Fe Railway.

Petrified forests are known to exist in other regions of Arizona, and some of these are doubtless outside of the regular reservation and where they could be used to procure material for polishing. If it is not possible to find such areas, a small area might be set aside where petrified wood could be obtained for use in ornamental work. Petrified forests occur in the Navajo Indian Reservation between Ganado and Chin Lee and have been reported farther west in the Moqui Reservation.

CALIFORNIA.

Mrs. Gertrude S. McMullen, of the Southwest Turquoise Company, of Los Angeles, Cal., kindly sent in a specimen of jasper from near Hart, Shasta County. This material is from a deposit owned by Hart & McCullum. It is composed of layers of white, gray, yellow, and red jasper in peculiar straight and curved bands. It appears to be slightly granular though very fine grained and susceptible to a fair polish. The material will be used in jewelry under the name "creolite."

LABRADORITE.

OREGON.

Maynard Bixby, of Salt Lake City, Utah, reports the discovery of a new deposit of labradorite in southern Oregon. The labradorite ranges from a colorless glassy variety resembling quartz to dark, showing fine red, salmon, and green tints. Mr. Bixby states that the mineral would yield handsome gem material.

CANADA.

Dr. E. S. Ward, of Rochester, N. Y., reports an importation of several hundred pounds of labradorite from Nain, Labrador, for gem purposes. There is a considerable demand for a good grade of this stone for jewelry purposes, especially in the West.

LAPIS LAZULI.

CALIFORNIA.

A company has been formed in Los Angeles, Cal., under the name of the Lapis Lazuli Mining Company[a] to operate a deposit of lapis lazuli in the Death Valley region of San Bernardino County. Mrs. Margaret Robertson, president of the company, states that the mineral has been thoroughly tested and pronounced lapis lazuli. So far only surface material has been obtained while assessment work was being done on the claim. Development work is to be started in the fall.

MOONSTONE.

VIRGINIA.

Specimens of rough moonstone were received from Henry Mackay, Hewlett, Va., where they were obtained from a mica mine. This moonstone is a variety of orthoclase feldspar and occurs in pockets in veinlets of partly kaolinized feldspar in a decomposed mica gneiss formation. The pockets range from the size of an egg to that of a cocoanut. Gems cut from this material display a certain amount of the chatoyancy of moonstone, but not so strongly as in the Ceylon gem. The particular pieces examined were slightly yellowish and not the pure white of good moonstone. It is possible that a better grade will be found in this locality.

CEYLON.

James Parsons,[b] principal mineral surveyor of Ceylon, reported the discovery of a new deposit of moonstone in the village of Weragoda, in the southern province. Some of the moonstones are of the fine blue variety. They are found in white kaolin, under about 4½ feet of black mud, in a swampy region. It is probable the moonstone is derived from leptynite (acidic granulite), as in the Kandy district of Ceylon, whence the bulk of the world's supply of moonstone is obtained.

OPAL.

NEVADA.

L. F. Denio, of Denio, Oreg., reports the discovery of opal in Humboldt County, about 20 miles south of the Oregon state line and 40 miles east of the California state line. The opal has been found over an area 7 miles long by 1 mile wide. Two groups of claims, about 5 miles apart, have been located on the best prospects. The character of the opal is different in these two groups, one furnishing a brilliant black stone, the other blue, green, and red opals. Much petrified wood occurs in the region, with which good opal is sometimes found in seams or attached to the outside of the petrified wood. The regular supply of opal is in a decomposed porphyry of brownish red color. Basaltic rock outcrops nearby. Only limited prospecting work has been done so far.

---

[a] Los Angeles Mining Review, May 1, 1909.

[b] Ceylon Administration Rept., pt. 4, 1907.

J. B. Stott kindly sent in specimens of opal from a deposit being tested by himself near Austin, Lander County. The specimens consisted of common white opal, yellowish opal, lilac-tinted opal, and milky opal. Some of the specimens displayed a faint flash or fire when viewed in certain positions. Mr. Stott reports a 100-foot incline sunk on the deposit in which the quality of the opals improves with depth. The opal occurs as a core in balls of partly silicified rock whose nature could not be determined. The specimens examined contained cores of opal 1½ inches through in balls 3 to 4 inches in diameter. Mr. Stott states that the opal-bearing balls occur in a seam of blue clay, about 2 feet thick, between black and red lava beds.

UTAH.

James V. Brooks, of Milford, has sent to the Survey a specimen of banded red, brown, yellow, gray, white, and colorless opal. The exterior of the specimen had a white sintery coating or crust as if deposited by a hot spring or similar agency. The specimen measured 2½ inches by 1 inch by three-fourths of an inch in thickness and was evidently broken from a large slab. The opal is common opal and does not display any fire. It is highly colored, resembling the rich colors of jasper. The specimen shows interrupted periods of deposition, as some of the layers are flat and straight as in onyx, and the others are wavy and cut through portions of the onyx-like bands. This opal takes a good polish and might be used for small ornaments, mosaics, or even curio jewelry. It is not unlike richly colored Mexican onyx or onyx marble in appearance.

AUSTRALIA.

New South Wales.—The value [a] of precious opal produced in New South Wales in 1907 amounted to £79,000, which is greater than for any other year since 1903. The White Cliffs division of the opal region furnished £66,000 and the Lightning Ridge field in the Walgett division supplied the remainder.

Queensland.—The production [b] of opal in Queensland during 1907 is estimated at £3,000, the same as in the two preceding years. For several years previous to 1904 the production was much greater, and the total production since 1890 is estimated at £158,695. During seasons of drought the opal production is large, as the farmers take up mining as a means of livelihood. During 1907 the season was favorable for crops, and the opal production was consequently small.

PERIDOT.

ARIZONA.

Peridot suitable for gem purposes is found in two regions in Arizona. The first one discovered was that north of Fort Defiance, in the Navajo Indian Reservation, about which little has been written. The other region is near Rice, or the old Talklai post-office in the White Mountain Apache Indian Reservation. At the latter locality the peridots are found in the original basaltic rock matrix, as well as loose in the soil. In the Navajo Reservation gem peridot is

---

[a] Ann. Rept. Dept. Mines, New South Wales, 1907, p. 59.
[b] Ann. Rept. Under Secretary of Mines, Queensland, 1907, p. 18.

probably to be found at several localities; it appeared to be fairly plentiful at the only locality visited, about 10 miles north of Fort Defiance, a mile or two west of the Arizona-New Mexico line. This locality is on and around the ranch of Navajo Charlie. An Indian guide reported the occurrence of gem peridot and garnet on two prominent knobs several miles east of this locality in New Mexico. Small peridots, occasionally large enough for cutting, are found at Black Rock, an outcrop of basic rock near Fort Defiance. The peridot locality near Navajo Charlie's could be reached from Fort Defiance, though the trip was made from Ganado, 35 miles west southwest, across by the Zilh-Tusayan Butte.

The rocks between Ganado and the peridot locality consist chiefly of red and grayish sandstones and conglomerate, with an outcrop of volcanic rock forming Zilh-Tusayan Butte. Petrified wood is scattered over much of the region, especially between Ganado and the Butte. The red sandstone probably belongs chiefly to the undifferentiated Triassic as mapped by N. H. Darton.[a] East of Zilh-Tusayan Butte the red sandstone forms a large area of mesa and gently sloping country extending to near and around the peridot area. The peridot is associated with volcanic rocks which occupy a basin or depression 200 to 300 feet deep, partly surrounded by red sandstone mesa or plateau country. The volcanic rocks outcrop over an area a mile long east and west and three-fourths or more of a mile north and south. The basin is drained by a wash which enters from the northwest, turns east across it, then south along the sandstone contact on the east side, and finally cuts across the sandstone to the east near Navajo Charlie's house. Several hollows and washes enter from different sides. A prominent wash from the southwest, running in part along the sandstone contact on that side, enters the other wash at the outlet of the basin, where a gorge has been cut through the red sandstone. The volcanic rock outcrops from small isolated hills in the valley or from ridges extending from the sides into the valley. The valley floor, where many of the peridots are found, is low and flat in places.

The character of the volcanic rock varies in different exposures, some of the differences being due to texture and grain and others due to variation of composition. It was not possible to make a careful petrographic study of the different types, though it is hoped this may be done later, hence type names will be used in a provisional way. The volcanic rocks are of three types—coarse monzonite porphyry, orthoclase basalt, and peridotite agglomerate. These rocks are associated with one another in places apparently in an intricate way, and their relations were not determined.

The monzonite porphyry is a spotted gray rock with white orthoclase and oligoclase phenocrysts measuring up to 2 centimeters across. Biotite phenocrysts are abundant also. The groundmass is very fine grained and consists of feldspar laths, with some biotite and ægirite. A few rounded, corroded quartz crystals are present. All of the monzonite porphyry seen was badly altered, and in some the biotite had gone over to chlorite completely, giving the rock a dull greenish cast which resembled serpentine except for the remnants of white feldspar crystals scattered throughout.

---

[a] Reconnaissance of part of western New Mexico and northern Arizona: Bull. U. S. Geol. Survey. (In preparation.)

The orthoclase basalt is a dark-gray to nearly black rock, in places rather dense and fine grained and in others medium grained. A porphyritic texture is locally present. The rock is composed of augite, olivine, biotite, orthoclase, iron ores, and a little ægirite. Weathering or partial weathering renders the rock lighter in color.

The peridotite agglomerate is a dark-greenish rock altering to a dark reddish on partial weathering. It is composed of olivine, largely altered to serpentine in places, enstatite, a little diopside, and iron ore, with much yellowish serpentine filling. More or less limonite staining is present in some specimens. The olivine and serpentinized olivine occurs in rounded grains and in fragments of brecciated grains through the serpentine. Portions of the peridotite contain inclusions of rounded and angular fragments of foreign material, as quartz or sandstone. Rounded pebbles of granular olivine or peridot are also present as inclusions. Some of the peridotite was observed to contain many rounded and corroded grains of transparent peridot from pinhead size up to those as large as a pea. Small emerald-green diopside crystals are also scattered through the peridotite.

The different rocks present different degrees of resistance to weathering and consequently occupy varying positions with respect to the topography. The several ridges extending from the hard sandstone boundaries into the basin of volcanic rocks are composed chiefly of the more resistant orthoclase basalt. These ridges also contain areas of peridotite and monzonite porphyry in places. The latter two rocks appear in the lower ground and in some of the low, rounded hills in the valley. One of these hills, about 100 feet high, north of the center of the basin, is formed by peridotite agglomerate, resembling kimberlite, and monzonite porphyry, which have resisted erosion longer than the surrounding rock. This hill is now being rounded off into angular talus and gravel slopes by weathering.

Peridot is found more or less plentifully at several places in the valley. Some of these are at the foot of the hills or ridges of peridotite and others are on the flat valley floor. Specimens were gathered in the talus and wash at the foot of the ridge back of Navajo Charlie's house, especially below outcrops of peridotite agglomerate. In the valley wash a half to three-quarters of a mile northwest of the house peridot was found in several bare, sandy places. Some of the ant-hills, 1 to 2 feet high, in one of these patches were found to be built up of over 75 per cent of peridot grains. The remainder consisted of garnet, quartz, rock fragments, diopside, etc. These grains range up to 4 millimeters in diameter, and are carried in from the surface over an area of many square feet around the ant-hills. They are not brought from the ground underneath the hills as is thought by some persons. The nests are built above ground and are covered with the grains of mineral. The ants use no selective method, but take the most available grains. The richness of the ant-hills in peridot therefore indicates the abundance of that mineral in the soil. Larger grains of peridot suitable for gem purposes are not found on the ant-hills, but loose in the soil. From the occurrence of the peridot near and below the peridotite agglomerate outcrops and the presence of gem-quality peridot in good-sized grains in this rock, it is evident that the gem is derived from the agglomerate. The abundance of small grains of olivine or peridot both in the same soil as the large grains and in the peridotite, combined with the tendency to disintegration of the latter, also strengthens this view.

Among the minerals associated with the peridot are garnet, emerald-green diopside, quartz, calcite, titanic iron, and others. The garnets have a beautiful red color, varying from deep pyrope-red to cinnamon-red, and are mostly small, under 5 millimeters in diameter. Occasionally garnets and diopsides of sufficient size to cut are found.

The peridots display a large range of colors or shades of the same colors. Some have a beautiful light yellowish-green color, others have richer green or a stronger yellow tint. Some are a brownish green, and others are regularly brown in color. Practically all are transparent and clear, though some are slightly smoky or contain visible dust specks through them. Under the microscope these dust specks appear as minute hexagonal plates with a dirty brown color. Some peridots are clear throughout, but contain a few scattered black spots. Others contain minute cavities which appear on polished surfaces as tiny pits. A few blades of an emerald-green mineral, probably diopside, were observed inclosed in a peridot gem. Beautiful gems are cut from some of the peridot from this region. Some of the perfectly clear golden-green stones, so much admired, are obtained in gems of 3 to 4 carats weight. Gems weighing from 1 to 2 carats are fairly abundant. The darker yellowish-green stones could be obtained plentifully.

The peridots occur in rounded and fragmentary grains with rough pitted surfaces and some rather smooth cleavage faces. Some of the surfaces are deeply pitted or corroded, as if attacked by the magma in which they were contained. This corrosion is present on the peridot still embedded in the peridotite agglomerate, and is therefore not caused by later corrosion. The grains and specimens found range up to three-fourths of an inch in larger diameter.

The peridot region has been searched over so often by the Navajos that large gems of rich yellowish-green color are difficult to find. Small pebbles of peridot are abundant. It is probable that a large supply of gems could be obtained by plowing or working up favorable areas of the valley and allowing the rain to wash out the gems. Some of the soil is dry and sandy, and in this it might pay to size off the pebbles with sieves and then pick over for gems. This would have to be done without water during the greater part of the year, as the stream bed in the valley is dry.

QUARTZ, ROCK CRYSTAL, RUTILATED QUARTZ, ETC.

ARKANSAS.

Reports of the discovery of diamonds near Delaney in Madison County appeared during the year in the press. Specimens sent to the Survey by W. L. Anderson, of Delaney, proved to be quartz of very clear limpid quality.

TEXAS.

J. C. Melcher, of O'Quinn, Fayette County, reports that a number of the clear colorless quartz pebbles found in that region were cut during 1908. Cut specimens sent to the Survey were perfectly clear and colorless and would be very satisfactory as souvenir gems.

PENNSYLVANIA.

George O. Simmons, of Brooklyn, N. Y., reports the occurrence of small ruby-red rutile crystals on quartz and rutilated quartz at Howard House, Delaware County, Pa.

VERMONT.

George Davidson, of South Royalton, reports the occurrence of a large deposit of quartz in that region. A few specimens of crystals have been obtained for cabinet use, and massive material has been sold for rough specimens.

BRAZIL.

According to A. S. Atkinson[a] the best quartz and rock crystals of Brazil come from the Cristaes Mountain in the State of Goyaz. The output has been large from this region, and mining has been carried on for many decades. Undeveloped deposits still exist. Yellow quartz is exported from Goyaz and is sold in considerable quantity for cheap jewelry. It resembles topaz and is sold for that mineral.

ROSE QUARTZ.

SOUTH DAKOTA.

Rose quartz of a more or less pale color is found at numerous places in the Black Hills. It is associated with the pegmatite rocks of the region and is found at several of the mica mines. Material suitable for gem purposes has been mined in quantity at the Red Rose mine only. The latter mine is 6½ miles S. 50° E. of Custer in a small gulch draining into French Creek. The mine was first taken up some years ago by a Mr. Demerau and was sold to eastern parties for $300. After the claim was allowed to revert it was relocated and is now held by Samuel Scott, of Custer.

The operation of obtaining rose quartz at the Scott mine consists simply in blasting the massive quartz from the face of a large ledge and selecting the material of suitable quality. The rose quartz occurs in a ledge 6 to 15 feet thick that stands from 10 to 30 feet high along the south wall of a small gulch. It outcrops for a distance of over 100 yards and is found at points 200 yards apart. The quartz is part of a large pegmatite which has an east and west strike and cuts directly across the schistosity of the cyanite-muscovite-biotite gneiss country rock with a steep dip. The strike of the gneiss on the south side of and close to the pegmatite is about north and south with a vertical dip. Part of the quartz is white; a large part is pale rose; some is of a rich dark rose color, and some has a purplish rose tint. The dark rose color occurs through the quartz over areas 10 to 12 feet across. Solid clear translucent to transparent flawless rose quartz of deep color is obtained in pieces up to 2 inches in diameter. The greater part is more or less checked with flaws, or is marked with cloudy lines running through the quartz in various directions. These lines represent joint planes, the walls of which have been firmly cemented together again with quartz. In many cases these seams resist fracturing as strongly as the solid quartz, so that they do not impair the strength of gems cut from such material. One prominent

[a] Mining for gems in Brazil: Eng. and Min. Jour., June 19, 1909.

set of these seams lies nearly flat in the rock. The ledge is fractured by uncemented joints into large blocks. The most prominent set of these joints has a northwest direction and is vertical.

That the rose quartz will hold its color well for all gem purposes is shown by the persistence of the rose color on the outcrop of this mineral where it has been exposed to the weather for long periods. Other places blasted into several years ago hold the same rich color on their surfaces as within the mass of the rock. Rose quartz can be obtained in quantity and in large blocks at this mine. It is reported that one block was sawed into two table tops, measuring 18 by 30 inches. The massive rose quartz is sold for from 3 to 25 cents per pound, according to depth of color and number of flaws or seams. Selected material brings from $8 to $12 per pound.

COLORADO.

Rose quartz has been found at several localities in Colorado, especially in Fremont County. One of the most promising of these is the Wild Rose claim, located in May, 1907, by J. D. Endicott, of Canon City. The Wild Rose claim is 6 miles north of Texas Creek and is located on a steep mountain side about 500 feet above and one-third of a mile west of the junction of Echo Canyon and East Gulch. The country rock is highly crumpled cyanite-mica gneiss and schist, cut by hornblende schist beds. The rose quartz occurs in a large mass or ledge that forms a part of a pegmatite body. The pegmatite is also mica bearing, and may be mined for this mineral at some time. The rose quartz outcrops for about 150 feet in a north and south direction along the mountain side. The outcrop stands about 20 feet high, though the true thickness of the mass could not be determined, as its dip was not known. Other smaller masses or segregations of quartz occur through the pegmatite. The greater part of the quartz of the pegmatite has at least a pale rose color, though some is white. Portions have a deep enough color and are clear enough to serve for gem purposes. Clear translucent to transparent pieces of flawless rose quartz up to 2 inches in thickness can be obtained, and also large blocks for ornamental purposes.

CALIFORNIA.

W. D. Parson, of Freeman, Cal., reports the discovery of a deposit of rose quartz of good color in Kern County. Much of the material near the surface, at least, is more or less flawed, so that specimens of large clear or translucent material are difficult to obtain. Mr. Freeman states that the color of the quartz is good and that the quality will probably improve on opening the deposit deeper.

RHODONITE.

CALIFORNIA.

J. A. Edman, of Meadow Valley, Cal., reports a large amount of rhodonite obtained from and around the Peters mine, near Taylorsville, Indian Valley, Plumas County, Cal. F. Stansfield, of the Jupiter Consolidated Jewel Company, reports this rhodonite to be of fine pink or flesh color marked with black lines. It is becoming popular for the same uses as other opaque and matrix stones.

RUBY.

BURMA.

The production of ruby, sapphire, and spinel in the Burma ruby mines district during 1907[a] amounted to 334,535 carats, valued at £95,114, as compared with 326,855 carats, valued at £95,540, in 1906. Of the total value of the output, ruby amounted to £93,428, and sapphire and spinel to £1,686. The production for 1908 was 211,194 carats, valued at £47,921.[b]

The occurrence of rubies in the Kachin Hills of upper Burma is described by A. W. G. Bleeck.[c] The rubies are found in the soil and alluvial deposits as well as in river gravels on the eastern slopes of the mountain range between Naniazeik and Manwe. The rock of this mountain range is chiefly granite and crystalline limestone. The crystalline limestone contains various contact metamorphic minerals as garnet, spinel, chondrodite, graphite, forsterite, besides valuable rubies and spinels. Doctor Bleeck calls attention to the theory of origin of the ruby advanced by Messrs. Brown and Judd that the rubies of the Burma ruby mines district were of purely chemical inorganic origin, and then presents evidence of the sedimentary chemico-organic origin of the limestones of Naniazeik and Manwe. It is probable that the ruby-bearing limestones of both districts were formed by similar agencies.

SAPPHIRE.

MONTANA.

Of the four companies producing sapphire in Montana during 1907 only one was in operation during 1908. This was the New Mine Sapphire Syndicate, working on the original deposit of blue sapphire in Fergus County. The discovery of a new deposit of sapphire about 3 miles from the old mine in Fergus County, between Middle and South forks of Judith River, has been reported, though not authenticated.

INDIANA.

Attention was called by Dr. O. C. Farrington, of the Field Columbian Museum of Chicago, to the prospecting for sapphire in placer gravels by R. L. Royse, of Martinsville, Ind. Mr. Royse reports this mineral found in the auriferous glacial drifts of Morgan County. Nearly all the sapphire found has a bronze color with a marked sheen or chatoyancy due to minute regularly arranged inclusions. One gem cut "en cabochon" from such material gave a very fine cat's-eye effect, with a brownish to reddish flash. Mr. Royse calls it oriental girasol, a name which may be used with a certain degree of accuracy.

INDIA.

Kashmir.—The production of sapphires during 1907 from the Kashmir mines[c] amounted to 305,682 carats, valued at £3,144, as compared with 2,837 carats, valued at £1,327, in 1906. The large

---

[a] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.
[b] Advance statement of the production of minerals in India in 1908, by the Director of the Geological Survey of India, June 10, 1909.
[c] Rec. Geol. Survey India, vol. 36, pt. 3, 1908, pp. 164-170.

increase in quantity and small increase in value was due to the recovery of large quantities of lower grade stones along with the few gems of high value.

Burma.—A small quantity of sapphire is obtained from the ruby mines each year, and during 1907 [a] it amounted, along with spinel, to £1,686 in value.

SATELITE, SERPENTINE CAT'S-EYE.

CALIFORNIA.

The variety of serpentine mentioned in this report for 1907 as cat's-eye has been named "satelite" by the Southwest Turquoise Company, of Los Angeles, Cal. This company obtains the mineral from Tulare County where it is found in serpentine associated with asbestos. It resembles chrysotile asbestos in some particulars but is harder and has a rather coarse splintery cleavage in place of the fine fibrous cleavage of asbestos. The color is opaque greenish gray along the fibers and dark green across them. The cat's-eye effect is perfect when the gem is cut cabochon. Satelite is being introduced in the gem markets and has been favorably received in the western cities.

SMITHSONITE, "BONAMITE."

NEW MEXICO.

The apple-green smithsonite, which so much resembles chrysoprase in color, from Kelly, N. Mex., has been called "bonamite" by Goodfriend Brothers of New York. This firm has cut and sold a quantity of this material. This smithsonite has been found in large quantities in the mine of the Tri-Bullion Smelting and Development Company, and occurs as a thick crystalline coating or incrustation over the walls of cavities. It assumes mammillary and globular forms with drusy surfaces. The gem is as beautiful as chrysoprase, though greatly inferior in hardness.

SPHENE.

NEW YORK.

Dr. E. S. Ward, of Rochester, N. Y., reports a quantity of sphene sold for gem purposes during 1908. This came principally from Switzerland, though a small quantity of old stock from the Tilly Foster mine, New York, was also used. This sphene yields very brilliant gems with a strong play of colors or fire.

THULITE.

NORTH CAROLINA.

Thulite or rose-colored zoisite occurs in the mica mines in North Carolina associated with feldspar, in which it forms patches and groups of crystals, sometimes radiated. Thulite is found at the Flat Rock mine and furnishes attractive gems when cut cabochon with the inclosing feldspar.

---

[a] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.

NORWAY.

Dr. E. S. Ward, of Rochester, N. Y., reports several hundred pounds of thulite imported from Norway for gem purposes.

TOPAZ.

UTAH.

The following notes on the occurrence of topaz in the Thomas Range, Utah, have been abstracted from an article by Horace B. Patton.[a] This occurrence of topaz was first discovered by Henry Engelmann, geologist of an expedition across the Great Basin of Utah in 1859. Little was heard of the locality or of the topaz crystals after this, however, until a trip was made to the region and numerous specimens were collected in 1884 by Prof. J. E. Clayton, of Salt Lake City. Since that time numerous collectors have visited the locality and brief descriptions of the occurrence and crystals have been written.

The topaz is found in the Thomas Range of mountains about 40 miles north of Sevier Lake and a little over 40 miles northwest of Deseret. Locally the mountains are called the Dugway Range, and the topaz locality Topaz Mountain. Topaz Mountain is 8 miles northwest of Joy, Juab County. The Thomas Range at this point consists of a much dissected table-land whose southeast face rises precipitously some 1,000 to 1,200 feet above its base for a distance of 4 or 5 miles. The part called Topaz Mountain is that portion along the southeast side where topaz crystals have been found most abundantly.

The rocks of this portion of the Thomas Range are of volcanic origin and rest on sedimentary formations of undetermined age. The only sedimentary rock exposed near the topaz locality is a bluish-gray limestone. Above this, in order, are rhyolite tuffs and lava flows, andesitic at the base, with several hundred feet of the more acidic rhyolite above. The later rhyolite flows compose the bulk of the volcanic rocks, and the latest of these contain the most topaz. The rhyolite varies in color from white to light brown or brownish gray. It shows no trace of glass and is apparently not porphyritic. In places it is massive; in other places flow structure is marked. Macroscopically the rock appears to be somewhat kaolinized, though under the microscope the feldspars are seen to be very little altered. The microscopic characters indicate a devitrified glassy lava. Lithophysæ[b] occur in varying quantity through the rock, and are more abundant in certain portions where flow structure is but little developed or absent. They are also more plentiful in light-colored rhyolite with an evident crystalline texture than in the darker and more dense portions. In quarrying, fine specimens of lithophysæ with numerous crystal-lined concentric shells are obtained. The crystals on these shells are quartz and sanadine. On weathering under desert conditions the rock disintegrates to sand, which is swept away by

[a] Topaz-bearing rhyolite of the Thomas Range, Utah: Bull. Geol. Soc. America, vol. 19, 1908, pp. 177–192

[b] Lithophysæ (stone bubbles) are cellular cavities in acidic, glassy, or finely crystalline lavas. They consist of concentric shells of crystalline material grouped about a cavity or core. The layers are composed of crystals of such minerals as quartz, tridymite, feldspar, topaz, garnet, etc. In cross section the shells may present an appearance somewhat like the petals of a partly opened rose. In diameter, lithophysæ range from a fraction of an inch to an inch or two.

the winds, so that soil accumulates only in more favorable places while the rock is left bare. The delicate shells of the lithophysæ are first attacked and hollowed out by erosion. The small cavities thus formed are enlarged and by uniting with others form miniature caverns, some of them several feet across. Thus the rock presents a rough porous surface suggestive of a huge dry sponge.

Three types of topaz crystals are recognized from this locality—fine transparent, rough opaque, and smooth opaque varieties. The opaque crystals make interesting cabinet specimens. The transparent crystals occur principally in lithophysæ cavities, and less often in irregular cavities with no trace of lithophysæ structure. The topaz crystals are more abundant in the lithophysæ where the latter are characteristically developed. The clear crystals grow upon the walls of the cavities, being attached at one or both ends or along part of or on a whole side. Clusters of topaz crystals occur in some of the cavities. The crystals are also scattered over the surface, where they have been left by the disintegration and erosion of their matrix. The crystals vary from a beautiful wine color with brown tint to absolutely colorless. The natural color of the crystals in the rock unexposed is the wine color, and this fades on exposure to the light. After exposure for fifty to seventy hours to sunlight, even the deeper-colored crystals become practically colorless. The wine color of the crystals fresh from the rock is quickly destroyed by heating. All the crystals found exposed to the atmosphere are perfectly colorless, though it sometimes happens that a cluster of crystals is partly embedded in the surface, in which case the buried portions have retained their color, while those exposed to the light are perfectly colorless. The brilliancy of these transparent topaz crystals is exceptionally high and does not seem to be affected by exposure to weathering. The majority of the crystals are very small and but a small percentage are over one-fourth or one-eighth of an inch long.

The rough opaque topaz crystals occur scattered through the solid rhyolite, and occasionally project into cavities where the free portion is transparent. These crystals are larger than the transparent ones and range from half an inch up to 2½ inches in length. They generally have rough prism faces and ragged ends. The interior is crowded full with minute quartz grains and crystals which average about 0.05 millimeter in diameter. One crystal examined showed that the quartz grains compose about one-sixth of the bulk of the crystal.

The smooth opaque topaz crystals are similar to the rough opaque, except that the faces are smooth and better developed. They were found at two places only, and were embedded in fragments of rhyolite tuff that had been caught up in the rhyolite flow. An analysis of one of these smooth opaque crystals, based on the excess of silica, indicated that 18.78 per cent of the material was quartz.

Both the transparent and the opaque topaz crystals were probably formed by the same processes—that is, by vapors or solutions contemporaneous or nearly so with the final consolidation of the rock. The crystals in the cavities grew practically unhindered, while those in the rock formed where the feldspar had been removed. In the latter case the topaz included the resulting silica as quartz grains and crystals.

Specular hematite occurs in minute flakes 1 or 2 millimeters in diameter in the cavities and attached to rough topaz crystals. A few spessartite garnets occur in the cavities with the topaz at this locality, and 3 or 4 miles to the west numerous garnet specimens were found in fair-sized crystals. Bixbyite was found adhering to rough topaz crystals.

Though topaz crystals are present over a large area, they are abundant over a limited area only, probably half a mile across. The weathering of the topaz-bearing rhyolite has left topaz crystals scattered abundantly over the surface. These crystals are mostly very small and brilliant though a few large transparent crystals have been found. The tiny crystals shine brilliantly in the sunlight, making it difficult to locate larger crystals by their reflections.

The transparent topaz crystals, when of sufficient size for cutting, make very brilliant gems, though perfectly colorless. They are sold under the name of "white topaz," and are an attractive souvenir for tourists. The crystals are also highly prized for collection purposes on account of their transparency and the quality of the crystal faces. A. N. Alling[a] has described the following forms: Pinacoids, b (010), c (001); prisms, m (110), l (120); macrodome, d (201); brachydomes, f (021), y (041); pyramids, i (223), u (111), o (221), e (441).

TEXAS.

P. H. and R. L. Parker, of Streeter, Mason County, report a production of about 25 pounds of topaz crystals, some of which are of gem quality. This topaz occurs in pockets, partly filled with clay, in a pegmatite "vein" cutting a gneiss formation. Topaz is found at other localities in this region, and a new discovery was made by the Parker brothers 12 miles north of Streeter. At the new locality topaz in good crystals is reported to occur with blue feldspar.

SOUTH AMERICA.

Brazil.—A. S. Atkinson[b] reports that old topaz mines of Boa Vista and Seramenhain in the basin of Arassuahy River have been reopened successfully by deep mining methods after the open-cut work had been abandoned. Work is successful at the José Correa and Coxambee mines also. The gems occur in a gravel bed at a depth of about 20 feet. The topazes are valued for the beautiful light to dark-yellow and deep-rose shades displayed by them, combined with perfect transparency. A specimen in the Museum at Rio Janeiro obtained from Jequitinhanha River at Ouro Preto weighs nearly 2,000 grams. It has a beautiful color, and is perfectly transparent and absolutely flawless.

TOURMALINE.

MAINE.

The following notes on tourmaline and other gem minerals in Maine have been prepared from an article by W. R. Wade.[c]

The gem-bearing area of Maine is about 70 miles long and 15 miles wide, extending from Auburn to Newry. The principal gems are tour-

[a] Topaz from the Thomas Range, Utah: Am. Jour. Sci., 3d ser., vol. 33, 1887, p. 146.
[b] Mining for gems in Brazil: Eng. and Min. Jour., June 19, 1909.
[c] Gem-bearing pegmatites of western Maine: Eng. and Min. Jour., June 5, 1909.

malines and beryl and are found in pegmatites. The latter are partially banded, consisting of a layer of graphic granite next to the hanging wall, a streak of very coarse pegmatite, the "mineral sheet" carrying the gems, a band of nearly pure potash feldspar, a garnet streak, and another band of graphic granite next to the foot wall. The tourmaline occurs in pockets, and the beryls are generally embedded in the "mineral sheet."

The mine of the Maine Tourmaline Company, at Auburn, is on the gentle slopes on the southeast side of Mount Apatite. The pegmatite outcrop forms a ledge from 5 to 10 feet high and strikes northwest with a low northeast dip. The country rock is mica schist which, with the pegmatites, is cut by two small trap dikes. The structure of the pegmatite is as follows: Upper graphic granite 4 to 6 feet thick, "mineral sheet" 2 to 5 feet thick, feldspar zone below about 2 feet thick, thin garnetiferous streak, lower graphic granite about 8 feet thick. Mining is carried only to the garnet streak between the lower graphic granite and the feldspar streak. The mine is opened by three cuts, the largest of which is 30 by 50 feet across and 14 feet deep. The rock is removed by blasting and the mineral sheet by small blasts and pick where gem pockets are thought to be near. Near the pockets transparent clevelandite and graphic tourmaline quartz are encountered. Closer to the pockets lepidolite occurs and is often associated with muscovite crystals, sometimes intergrown with it in the pockets. The upper part of the pockets is generally lined with beautifully crystallized quartz, mica, and clevelandite; the lower part contains porous decomposed potash feldspar; occasionally pink and green tourmaline crystals are grown into the upper crystallized surface of the pocket, though generally the gems are in the clay at the bottom. Many of the tourmaline crystals are broken or badly flawed, though a few perfect ones are found. A number of the pockets are barren or "dead pockets," and contain large quantities of lepidolite and apatite. The quartz crystals in the gem pockets are coated with a thin crust of minute crystals; those in the "dead pockets" do not have this coating. This mine yields principally green and pink tourmalines, the latter in smaller quantity. In 1904 a series of pockets were opened which contained fine dark-blue tourmaline of nearly oriental sapphire shade.

The cost of mining a ton of rock at the Maine Tourmaline Company's mine during 1904 and 1905, exclusive of superintendence and office expenses, was as follows: Labor, 28.3 cents; fuel, 2.3 cents; explosives, 5.9 cents; repairs, renewals, oil, etc., 0.4 cent; total, 36.9 cents.

The Pulsifer mine is near the Maine Tourmaline Company's mine at Mount Apatite. The deposit was opened in 1901 or 1902 by a small open cut. One of the products of this mine consisted of nearly 3,000 transparent purple apatite crystals all found in one pocket. The largest crystals were about 2 inches long. The tourmaline crystals occur very much as described above, and are of fine pink and green color. The small cut has yielded many beautiful crystals.

The Towne lease was taken up by the Maine Feldspar Company and operated by a steam drill and derrick. The company worked for feldspar and left the gems to Mr. Towne as a royalty. About $1,500 worth of green tourmaline was obtained during 1907.

In the Hatch mine, near the top of Mount Apatite, feldspar is the principal product. Some tourmaline was obtained from the first opening made in 1882.

The Berry mine, about 2 miles south of Mount Apatite, is chiefly a feldspar deposit. Pink and green tourmaline of gem quality are occasionally found.

The Merrill mine is in the township of Hebron, about 16 miles northwest of Mount Apatite. The "vein" is 12 to 14 feet wide, and lies in mica schist. Only a small amount of work has been done here, though some very deep-colored red tourmalines were obtained.

COLORADO.

C. A. Beghtol, formerly of Canon City, mined for tourmalines at two places north of the Royal Gorge of the Arkansas during 1906 and 1907. These were the Royal Gorge No. 1 mine, 5 miles N. 70° W. of Canon City, and the Royal Gorge No. 2 mine, 4 miles due northwest of Canon City. The No. 1 mine is in the east wall of a canyon entering the Royal Gorge from the north and about 200 yards from the gorge and about 300 feet above the bottom of the canyon. The country rock is muscovite-biotite gneiss, cut by numerous pegmatites ranging from an inch to several feet in thickness. The pegmatites are approximately conformable with the gneiss, which strikes about northeast with a nearly vertical dip. The tourmalines were found in a vein along the northwest side of a 4-foot pegmatite. The pegmatite has resisted erosion better than the inclosing gneiss and stands out as a high wall on the steep side of the canyon. The vein was found through a distance of only 6 feet, and then pinched out. It is reported to have been a lens-shaped pocket nearly a foot thick in the thickest part and to have yielded some very fine pink, green, and colorless tourmaline crystals. No further work was done after the gem pocket had pinched out. A quartz streak along the wall of the pegmatite contained much well-crystallized black tourmaline and small mica crystals.

The No. 2 mine is on the dissected plateau north of the Royal Gorge and about 2 miles from the gorge. It is in a low oval hill about 200 yards east of the Mica Hill mica mine. Each of these hills is composed of pegmatite inclosed in contorted biotite and hornblende gneiss. The two outcrops of pegmatite do not appear to be connected, and have yielded unlike minerals. In the mica mine both beryl, in crystals up to 6 inches in diameter, and columbite, in masses of several pounds weight, have been found. The pegmatite of the No. 2 mine contains colored tourmaline and lepidolite or lithia mica. The lepidolite has been found in streaks and irregular masses up to several inches in thickness in a number of places in the pegmatite. Much of the tourmaline is associated with the lepidolite, though some is inclosed in feldspar and quartz. At the time of the writer's visit no pockets or cavities with tourmaline crystals were exposed, and the tourmaline observed was "frozen" in the pegmatite. The colors observed in different crystals and in different parts of the same crystals were light and dark lilac pink, light and green, and very dark indigo color (blue). Part of the tourmaline is partly decomposed or altered to a softer mineral, though still retaining the form and colors of the tourmaline. The greater part is opaque to translucent, though some transparent gem material is reported to have been found.

CALIFORNIA.

The production of tourmaline in the United States during 1908 reported to the Survey was greater than during 1907 by 1,160 pounds. This production came from California, Connecticut, and Maine, the bulk of it coming from California. In California the principal output was from the mines of the Mesa Grande region, with a smaller output from the Rincon, Ramona, and Pala districts. The principal producers reporting from Mesa Grande were the Himalaya Mining Company and the San Diego Tourmaline Mining Company. The latter company reports a large production of green tourmaline, with one perfect stone weighing 55 carats after cutting. A quantity of pink tourmaline was obtained also.

Edward H. Davis, of Mesa Grande, Cal., states that a large quantity of tourmaline was purchased in San Diego by Chinese and Japanese agents during 1908. Principally the checked gem material suitable for cabochon cutting is purchased for the Orient. It is thought to be used in bead necklaces with jade by the wealthier classes.

BURMA.

The production of tourmaline from the ruby mines district of Burma during 1907 amounted to 20 pounds, valued at £293,[a] a large decrease from that of 1906, which amounted to 193 pounds, valued at £1,001.

BRAZIL.

A. S. Atkinson[b] mentions tourmaline mining as one of the most important industries of Brazil. The deposits occur over a large area extending from Itamarandiba northeastward to Piauhy River, a branch of the Arassuahy, and thence west and northwest as far as Boqueirao and San Antonio das Salinas, State of Minas Geraes. In the districts of Theophilo Ottoni and Arassuahy about 800 persons are engaged in tourmaline mining. The gems occur in granite and pegmatite veins along the river banks, where they are washed out by the natives in some quantity. At Theophilo Ottoni the tourmaline occurs in gravel beds under several feet of forest soils. These deposits are stripped and worked rather systematically. The gems here are of ordinary bottle-green color, though they are obtained in such quantity as to pay well. Perfectly transparent green tourmalines are obtained from the Larangeiras mine at Arassuahy, in the district of Itinga. A deposit of blue and red tourmaline has been found rather recently at San Miguel, not far from the Larangeiras mine. So far most of these tourmalines are badly checked so that only small gems can be cut from them.

TURQUOISE.

The production of turquoise in the United States during 1908 was large and came from New Mexico, Nevada, Arizona, California, and Colorado. The demand for turquoise matrix was greater than for the higher grade pure stone, though considerable of the latter was produced along with the matrix material. The production of turquoise matrix and turquoise amounted to nearly 15 tons, for which the

---

[a] Rec. Geol. Survey India, vol. 37, pt. 1, 1908.
[b] Mining for gems in Brazil: Eng. and Min. Jour., June 19, 1909.

value was estimated as $5 per pound for the roughly selected material at the mines. No attempt has been made to separate according to quantity and value the production of selected pure turquoise from that of the matrix. Some of the producers furnished such statements; the majority gave the production as a whole.

NEW MEXICO.

The turquoise production in New Mexico during 1908 came from the Burro Mountains and Little Hachita Mountain regions in Grant County, and from Cerrillos, Santa Fe County. In the Burro Mountains the turquoise output came from a new deposit, opened by W. R. Wade, of the Azure Mining Company, and a small quantity from the Porterfield mine, described in this report for 1907. Mr. Wade [a] describes the deposit opened by him as an irregular dike or neck of porphyry, probably granite porphyry, of rather fine grain. The turquoise occurs in a soft altered zone, in which the feldspars are largely kaolinized. This zone follows a set of parallel slips on the western side of the porphyry mass. The deposit has been exposed through a width of 40 feet and a length of 125 feet by 2 shafts with tunnels at the 20-foot and 40-foot levels. A tunnel is to be driven in at a lower level in the side of a canyon. Though originally opened for turquoise matrix, considerable pure turquoise has been found, one nugget weighing 1,500 carats. Several pounds of pure vein turquoise was obtained from near this nugget, and in one place the vein was 3 inches wide.

Mr. Wade states that the deposit was worked by the Aztecs down to the present first level. The workings are so old that they are only seen when encountered in the drifts and crosscuts. The ancients evidently filled in the openings and the filling has become so hardened that it is often easiest to remove it by blasting. Numerous stone implements and fragments of charcoal are found in these old workings.

M. W. Porterfield and George W. Robinson report the development of a turquoise deposit in the Little Hachita Mountains. This deposit is about 6 miles west of Hachita Station. The turquoise is found in seams in porphyry. The principal yield is stated to be in high-grade matrix, though some pure turquoise is obtained.

NEVADA.

The production of turquoise in Nevada during 1908 came from Esmeralda, Nye, and Washoe counties. In Esmeralda County, near Millers, the Himalaya Mining Company operated the Royal Blue mine, formerly owned by William Petry, of Los Angeles. Mr. Petry also worked at this locality part of the year, and the remainder of the year in Nye County. H. W. Lindemann, of Denver, Colo., reported the purchase of a small quantity of turquoise at Reno, Washoe County; this material may have come from another locality. The Himalaya Company reports a large production of fine gem turquoise. Other companies operated for turquoise in Nevada during 1908, but failed to report the results of their work. A discovery of turquoise has been reported, however, at Searchlight, Lincoln County.[b] It is said that a stone weighing 320 carats and worth $2,600 was found.

[a] Letter dated January 11, 1909.

[b] Jeweler's Circular Weekly, March 3, 1909.

ARIZONA.

The production of turquoise in Arizona was all from Mohave County, where turquoise is found in the hills to the east and south of Mineral Park. These hills are Ithaca Peak, 1 mile east of Mineral Park; Aztec Mountain, 1½ miles southeast of Mineral Park and 1 mile south of Ithaca Peak; and on the end of the ridge one-third of a mile west of south of Mineral Park. Turquoise is also reported to have been found on a mountain four-fifths of a mile east of south of Mineral Park. There are several mining companies and individuals interested in turquoise claims in this district. Some of these operate intermittently; others work their claims regularly. At the time of visit (September, 1908), four companies were mining turquoise. The following is a list of the companies and individuals owning or operating turquoise mines or claims in the Mineral Park region: Aztec Turquoise Company, 13 claims; Arizona Turquoise Company, a portion of William Tell claim; Los Angeles Gem Company, a portion of William Tell claim; Southwest Turquoise Company, four claims; James Uncapher, one claim; Mineral Park Turquoise Mining Company, two claims; John Caswell, one claim; Mrs. John Kay, one full claim and fractions of two claims.

The turquoise deposits of Mineral Park are in certain of the hills and peaks along the west side of the Cerbat Range of mountains, at elevations ranging from 4,500 to 5,000 feet above sea level. According to F. C. Schrader[a] the greater part of these mountains are composed of pre-Cambrian gneisses and schists cut by later granites and porphyries. Prominent among the pre-Cambrian rocks are hornblende gneisses and schists and granite gneiss, which outcrop in the country around the hills in which the turquoise is found. The turquoise occurs in certain of the later intrusive porphyries, whose outcrops form rugged rocky hills and peaks. Two varieties of porphyry are recognized, granite porphyry and quartz porphyry, evidently phases of the same rock with variations in texture. The change from one to the other often occurs in different parts of the same turquoise deposit, and may take place within a few feet. The granite porphyry is typical of that rock, being composed chiefly of phenocrysts of quartz and orthoclase in a medium-grained groundmass of the same minerals. Remnants of altered biotite crystals are observed in thin section. Large quantities of muscovite, probably chiefly secondary sericite, occur in some of the porphyry. Microcline, zircon, and secondary epidote are also sometimes present. In the quartz porphyry the phenocrysts are the same as in the granite porphyry and the groundmass is finer grained. In one thin section examined the groundmass was very fine grained and exhibited a partial spherulitic texture, as in rhyolite. The partly corroded, glassy quartz phenocrysts are more prominent macroscopically in the quartz porphyry than in the granite porphyry. Both types of porphyry have undergone more or less alteration, especially around the turquoise deposits. Besides the sericitization, the feldspars of the rock are also partially kaolinized, and the biotite mica, when present, has been altered or removed. Accompanying the decomposition of the porphyries there was a silicification in which quartz was deposited in joints and seams through the rock and even between the grains. In this way the rock has been hardened so that it resists erosion

[a] Mineral deposits of Mohave County, Ariz.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 55-59.

strongly and forms rugged hills. The outcrop of the decomposed silicified porphyries are often rough, with projecting quartz veinlets and seams or hard silicified portions standing above the softer feldspathic material. The latter has been removed from the surface by erosion in some places, leaving cavities between the quartz veinlets and masses. In places the rocks are much stained by limonite, both along joints and seams of quartz or turquoise. The brown limonite stains evidently come from formerly existing iron sulphides, and in one place remains of the sulphide were still visible along a badly stained turquoise veinlet. The rock is more or less stained blue and green with copper, especially where altered and kaolinized. It appears that some of the turquoise may have formed directly from kaolin by the addition of phosphate and the copper stains, for specimens are found that show a gradation from good turquoise to soft semiturquoise and to copper-stained kaolin, and, furthermore, balls or patches of material, which may have once been feldspar phenocrysts, are found that range from kaolin to semiturquoise to turquoise. In one of the mines the semiturquoise, about 4 in hardness, contained a good deal of phosphate, with alum and copper sulphate through it. It appeared to have formed from kaolin and had assumed a nodular form. Portions contained large amounts of free alum and small amounts of free copper sulphate. The color of this semiturquoise was a beautiful dark turquoise blue in places and lighter shades in others. Evidently much of the turquoise has been deposited from solution, for it occurs in seams, veinlets, and veins, and in patches or streaks in quartz seams and veinlets occupying original joints or fissures in the rock. Occasionally there is a tendency for nuggets or nodules to develop, especially in the larger veinlets, or veins, or in masses of kaolinized feldspar. The turquoise in the veinlets and seams does not often assume a nodular form, as is common in the deposits in the Burro Mountains of New Mexico.

The principal work of the Aztec Company has been on the Monte Cristo claim, on the southeast end of Ithaca Peak, near the top; the Queen claim, on the south side of the west end of Ithaca Peak; the Peacock claim, on the north side of Aztec Mountain; and the Aztec and Turquoise King claims, on the south side of Aztec Mountain.

The Monte Cristo claim extends N. 85° W. over the top of the southeast end of Ithaca Peak. Below and to the southwest of the top of the mountain two openings have been made on the precipitous slopes. At the west end of these a 15-foot tunnel has been driven in from a small open cut. The rock is decomposed, silicified quartz porphyry, containing many quartz seams. Some good, pure turquoise has been obtained in this opening, chiefly in the quartz seams. Nodules and nuggets of semiturquoise saturated with alum and a little copper sulphate were associated with the turquoise in the rocks. This material desiccates and cracks open where exposed to the dry air. The other cut on the southwest side of the ridge is large and has yielded much good turquoise. E. J. McNulty, superintendent of the mine, states that about 2 tons of selected rough turquoise has been shipped from this cut in the last six years. This work encountered large seams of good turquoise, one ranging from 6 to 8 inches in thickness. A tunnel is being driven through the top of the ridge N. 15° E. from the open cut. This tunnel was 140 feet long at the time of the visit and was to be carried 25 feet farther through to rich turquoise ground on the northeast side of the ridge. It was necessary to open this tunnel in order to remove the waste from the opening on the northeast side of the ridge directly above the Arizona Turquoise Company's mine, since the waste rock could not be cast on the Arizona Turquoise Company's property. By removing through the tunnel the waste can be dumped on the Aztec Company's own land. Several seams of turquoise were found in the tunnel, one lying nearly flat and associated with quartz. The small openings above the Arizona Turquoise Company's property expose a number of seams of good turquoise with quartz.

The Queen claim extends west of north over a small knob on the western end of Ithaca Peak. The work consists of several small open cuts and two short tunnels at the base of the cliffs on the south side of the knob and at the top of the talus slope. The rock is decomposed, silicified granite porphyry, with quartz veinlets cutting it at all angles. The turquoise occurs in seams alone and with quartz, kaolin, limonite, and shows a tendency toward a nodular form. Much of the turquoise is too soft and of too pale color for good gem purposes, though it could be used for low-grade matrix stones. Some of it has a greenish color. Irregular lumps of soft pale turquoise, measuring 2 to 3 inches across and 5 to 6 inches long, were seen on the dump.

In the Peacock claim a streak of turquoise was opened by pits and an open cut 6 to 20 feet deep, all within a length of about 150 feet. The inclosing rock is decomposed, silicified granite porphyry. The turquoise occurs in a main vein 6 to 8 inches thick, striking N. 30° W., with a dip of 80° E., and in cross joints or seams, a prominent set of which had a strike of N. 60° E. and a dip of 55° SE. The better turquoise is found in the thin seams, and much of that in the large seam is pale colored to nearly white.

The Aztec claim was opened by the Aztecs in prehistoric times, and a large quantity of the stone implements used by them were found in the ancient workings. The workings consisted of pits filled with rubbish and a few small tunnels 15 to 20 feet long. The recent work consists of an open cut 60 feet long, east and west, and 12 feet deep in the hillside, with two irregular openings driven in from the main cut. One of these is a shaft 30 feet deep. The rock is decomposed, silicified porphyry, cut by many quartz seams and veinlets. The turquoise occurs principally in seams striking nearly east and west with a low dip to the south. The seams are irregular in size and open out from films into sheets 1 to 2 inches thick. The thicker portions have a pale color and are sometimes greenish. About a dozen of the east and west streaks were encountered in the workings, along with a few streaks running in other directions. A white clay streak, encountered in the tunnel, appears to have cut off the turquoise veins beyond it. No real high-grade turquoise has been obtained from this claim. Lower-grade material is abundant, however, and large quantities could be obtained for matrix stones if demanded.

The Turquoise King claim, a few hundred yards west of the Aztec claim, has been opened by several pits and cuts with results similar to those in the Aztec claim.

Small pieces of turquoise found around the ancient workings and on Aztec Mountain indicate that the ancients obtained a better grade of turquoise than that now found. It is therefore thought probable that the same material will be found again.

The Aztec Turquoise Company ships for cutting only the best pure blue turquoise and high-grade matrix. Large quantities of low-grade, soft, and offcolor rough and matrix material is thrown away or buried. The gems are cut at the company's shop in New York and the pure stones are guaranteed. They are marked on the back with an AZT monogram occupying the space of one letter. The best turquoise comes from the Monte Cristo claim. It has a rich deep blue color and takes a brilliant polish. The matrix stones show pleasing contrasts between the dark blue of the turquoise and the dark-brown limonite stains, with sometimes gray quartz or rock fragments.

The portion of the William Tell claim worked by the Arizona Turquoise Company is directly below and adjoins on the south the Monte Cristo claim of the Aztec Turquoise Company. The deposit is on the steep, cliff-like northeast slope of Ithaca Peak, down which the waste rock from the workings slide several hundred feet. The operations consist of a cut in the mountain side with a working face nearly 50 feet high. This face is carried back by steps or benches 12 to 15 feet high. Deep holes are drilled and the rock of the successive benches pushed out on to the floor of the cut by blasts. In this way masses weighing several hundred tons are loosened and broken so that they can be sledged and the turquoise picked out. Where patches of fine blue turquoise occur they are carefully chipped out with gads and chisels. The turquoise is closely sorted, only the better grades being shipped. The greenish, pale blue, and soft turquoise is discarded and destroyed. Some very fine pure blue turquoise of deep color is obtained, though the principal yield is in matrix gem material. Guy Atlee, superintendent, states that occasionally lumps of over a pound in weight of nearly pure turquoise are obtained. The lumps are generally of matrix and come from enlarged portions of the turquoise seams. The latter occur plentifully in parts though without definite position through the rock. In the workings no attempt is made to follow particular seams through any distance, but the rock is quarried as a whole, and the turquoise seams and patches are picked out of the blocks. The method of the occurrence of the turquoise in decomposed, silicified quartz porphyry is the same as in the Aztec Company's mine directly above. The gem material is all shipped and cut at the company's plants in New York and Denver.

The deposit of turquoise worked by the Los Angeles Gem Company, a few hundred feet northwest of that of the Arizona Turquoise Company, is also located on the very steep northeast slope of Ithaca Peak, above a rocky cliff. The mining, which is under the supervision of E. E. Peck, president of the company, is open-cut work. Large masses of rock are broken down by blasting, and the turquoise is removed by carefully breaking the blocks. The turquoise occurs in seams cutting decomposed, silicified quartz porphyry in various directions. The principal yield is in matrix turquoise, though some pure turquoise also is obtained. The gems are shipped to Los Angeles where they are cut in the company's shop. An odd stone was recently cut by this firm showing a blue letter Y of turquoise in a gray matrix. This stone was sent to a student at Yale University. The cutting so as to obtain the Y was made possible through a split turquoise veinlet, and shows the possibilities of turquoise matrix in yielding occasionally appropriate souvenir gems.

The principal work of the Southwest Turquoise Company has been on the Ithaca turquoise claim on the steep eastern rough slope of Ithaca Peak. The mountain side has been stripped in a northwest-southeast direction for about 75 feet for the face of an open cut. It is probable that all the rock will be quarried and the turquoise cobbed out as at the other mines, though up to the present the work has been directed toward certain richer portions of the working face. The turquoise occurs in seams in the decomposed silicified quartz porphyry. Certain well-marked seams or veinlets had a strike north of east with a nearly vertical dip, while others crossed these at various angles. W. J. Tarr, superintendent of the mine, stated that the cross seams were richest at the crossing of the main seams. Quartz veinlets cut the rock in different directions, and some carry patches of turquoise. In some of the quartz seams small crystals of quartz with a rough comb structure occur. Pyrite was seen along certain veinlets which were much stained with limonite by its weathering. The turquoise is often greenish near the rusted pyrite. The grade of turquoise obtained is much the same as at several of the other mines. There is considerable soft, pale-colored turquoise besides the better grades.

James Uncapher, of Mineral Park, owns the Ithaca claim extending N. 70° W. over the top of Ithaca Peak. No extensive mining has been done on this claim, though good turquoise has been obtained from the several prospect openings. The turquoise is associated with both decomposed silicified quartz and granite porphyry. Turquoise has been exposed at three places on the claim, and indications are found at other places. At the prospect at the west end of the summit of Ithaca Peak turquoise seams and vainlets are plentiful. Quartz seams, both alone and with turquoise, also cut the rock in various directions, while brown limonite stains are prominent in many of the gem and quartz veinlets. Only small veinlets have been left exposed, though large ones are reported to have been found during the prospecting work. The color of the turquoise at this prospect seems to be good, and with the brown stained quartz furnishes a good matrix stone. The deposit is well located for quarrying on a large scale, with facilities for disposing of the waste.

On the north side of Ithaca Peak, on the Ithaca claim, turquoise has been found over an area of about 50 by 100 feet in the rock outcrops and in a few small test pits. Still farther down the mountain side and below the Los Angeles Gem Company's mine, two cuts with smaller openings have been made for turquoise. The latter has also been found in the rock outcrops close to the pits. The rock is cut by many quartz veinlets at this point, and some of these veinlets trend toward the workings of the Arizona and Aztec companies higher up the mountain. The turquoise exposed in the openings occurs in seams or veinlets and in irregular splotches of variable size; the color of part of it appeared to be good.

The claims of the Mineral Park Turquoise Mining Company are over a mile west of Ithaca Peak, near the summit of a rough ridge. Three openings have been made by W. J. Wilson, manager of the company. The rock is decomposed, silicified granite porphyry, cut in places by many seams of quartz. The granite porphyry is cut by two or more dikes of fine-grained dense white porphyry or aplite. These do not appear to bear any relation to the deposition of the turquoise, however. An open cut at this mine was made in the end of the ridge in a very rugged rock outcrop. Some good turquoise is reported to have been found here, though the streaks of gem failed or were not successfully followed in the workings. At the two openings about a hundred yards to the east some very good grade turquoise and large lumps of off-colored green turquoise were found. These occur in veinlets and seams through the granite porphyry and with the quartz seams.

John Caswell of Mineral Park owns a claim with a turquoise deposit in the cliffs and at their foot in the knob at the west end of Ithaca Peak. This claim was not visited, though promising specimens of turquoise matrix were seen that had been obtained during assessment work on the claim.

The claims of Mrs. John Kay are on the slopes below the cliffs on the southwest side of Ithaca Peak and below the Monte Cristo claim of the Aztec Company. These claims were not examined, though considerable turquoise matrix is reported to have been mined. Almon Stone, of Los Angeles, Cal., reports a specimen of matrix weighing 34 pounds from this mine. The estimated value for this rough lump was $50. The bulk of the matrix is valued at $1 to $5 a pound.

COLORADO.

The mine of the Colorado Turquoise Mining Company consists of ten claims situated 13 miles S. 60° E. of La Jara, Conejos County. Ancient workings are reported to have been found on the outcrop of the turquoise, with a few antique stone implements around them. The mine is in a low hill among the group of small hills in the mesa country about 1½ miles west of the Rio Grande.

The higher hills west of the mine are capped and partly composed of beds of basaltic rock. The turquoise is associated with a partly decomposed trachytic rock which in places bears quartz or is quartz porphyry. This rock is a dense, very fine-grained white rock, composed chiefly of feldspar. Secondary sericite and kaolin are present. Much of the trachyte is badly stained with brown limonite not only along joints and seams but through the rock, often in concentric layers or shells. This feature is very like that at the old turquoise mine on Mount Chalchuitl, near Cerrillos, N. Mex. In places kaolinization has been very extensive, and nearly pure kaolin has resulted; in other places small quantities of quartz are present, generally as phenocrysts. A dike of fine-grained, dark-greenish to black rock, probably a variety of phonolite, cuts across the trachyte in a northerly direction. The crest of the hill or ridge in which the turquoise occurs is capped with a ledge of dense-gray to light-brownish chert or hornstone, about 20 feet thick and outcropping in a direction N. 70° W. Diorite or andesite outcrops to the east of the turquoise-bearing rock, part being on the company's property.

The turquoise occurs in seams and joints and occasionally in irregular masses in the trachyte. The seams vary from paper thickness to over one-quarter of an inch in thickness. The most prominent set of joints bearing turquoise appear to strike north of east and have veinlets branching from them in various directions. A small amount of nodular turquoise is found. The color of the turquoise ranges from pale blue to strong turquoise or sky blue. Some has a greenish color, and semiturquoise occurs in veinlets or nodules in places. The matrix of much of the turquoise is more or less strongly stained with brown limonite, which furnishes attractive contrasts with the blue of the turquoise. The better quality of the veinlet turquoise is very hard and has a smooth, conchoidal fracture.

The turquoise deposit has been tested and developed by numerous pits, shafts, and tunnels. The prospectus issued by the company reports over 1,100 feet of such work done. The depth attained in the most promising working is about 65 feet. There are several crosscuts and test workings from the main working. The company expects to drive an incline, already started, from the southwest under the more promising portion of the turquoise deposit. It is thought this incline will open up better turquoise at a greater depth. This is doubtful, however, as it has not been definitely shown that good turquoise ever occurs plentifully at depths greater than about 200 feet. Moreover, the quality of the turquoise found at a depth of 65 feet was but little if any better than that nearer the surface.

VARISCITE.

UTAH.

The mineral variscite has been called by various trade names when cut as a gem. Three deposits producing gem variscite have been operated in Utah. The first one was discovered in October, 1894, and belongs to Don Maguire, of Ogden. It is situated about 2 miles from Mercur, in Utah County. G. F. Kunz[a] mentioned this occurrence and suggested the name "utahlite" for the gem. It was subsequently called "chlor-utahlite," and is now known by both names. Another deposit of variscite was discovered in 1905, 9 miles west of Stockton. This is described by Doctor Kunz[b] as "utahlite (variscite)." The gem material from this locality has since been called "amatrice" by the Occidental Gem Corporation, of Salt Lake City, as described in this report for 1907, and by E. R. Zalinski.[c] John A. Maynes, of Salt Lake City, reports the discovery of a new deposit of variscite in the extreme southwestern part of Utah. A company has been formed to develop this property and cut their own gem material, which is to be sold under the mineral name "variscite." The colors of the variscite seen in specimens kindly furnished by Mr. Maynes were dark to light green, with which was associated some white phosphatic mineral, chert, and chalcedony. Some of the variscite has crystals of gypsum associated with it, though the gem material can be readily separated from such specimens.

Amatrice.—The following description of the amatrice mine has been prepared from the article by E. R. Zalinski, mentioned above, and from notes taken by the writer during a brief visit to the mine in August, 1908:

The amatrice mine is 14 miles S. 65° W. of Tooele, in a small rounded knob among the foothills, on the eastern slope of the Stansbury Mountains. This knob has been called Amatrice Hill and has

[a] Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 4, 1894, p. 602.
[b] Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 1351.
[c] Amatrice, a new Utah gem stone: Eng. and Min. Jour., May 22, 1909.

an elliptical shape with a north and south elongation. It stands about 200 feet above the adjacent slopes and bench lands on the north, east, and south, and about 75 feet above the spur connecting it with the Stansbury Mountains on the west. The elevation, as obtained by barometer, was 5,700 feet. The region is very dry, and water is hauled 16 miles to the mine. It is possible a small supply of water could be obtained by digging in Hickman Canyon, a mile and a half to the south. Development work at the mine has not been extensive and consists of three small open cuts and a crosscut prospect tunnel. The work in the cuts has not been carried to a greater depth than 8 feet.

The country rock at the amatrice mine is limestone and quartzite. Hard, dense, dark-brown, calcareous quartzite forms the summit of Amatrice Hill. The eastern slope of the hill is composed of beds of siliceous or sandy and cherty limestone of light to dark gray color and striking N. 20° W. with a dip of 60° W. Typical quartzite outcrops prominently to the northeast of the hill, with the same dip and strike as the formations in the hill. On the south side of the hill fossils were found in the limestone by Mr. Zalinski. They were identified by George H. Girty, of the United States Geological Survey, as of Carboniferous age, probably upper Carboniferous, belonging to the Weber quartzite or upper "Coal Measures" limestone of the Fortieth Parallel Survey. In a manuscript copy of Mr. Zalinski's report, the occurrence of porphyry resembling monzonite, about a quarter of a mile southwest of the amatrice deposit, is mentioned. This porphyry is cut by a set of joints or fractures corresponding to those in which the amatrice occurs, showing that the amatrice fissuring was subsequent to the intrusion of the porphyry.

The amatrice occurs in the limestone in fissured and brecciated zones, which strike nearly with the bedding of the limestone and have a steeper dip to the west. These breccia zones have been strongly mineralized by the deposition and replacement of chalcedony, chert, variscite and allied phosphates, and of a small amount of pyrite with brown limonite stains. In many cases the various minerals have assumed a concretionary structure, either with one mineral about another, or with layers of different color in the same mineral. In other cases seams of one mineral have cemented the fractures of older and crushed minerals, preserving the brecciated structure. Three amatrice-bearing streaks have been opened by small cuts. These are known according to the type of gem material each produces, as the "jade" and "cobweb" cuts, close together and on the southeast side of the hill, and the "apple-blossom" cut about 100 yards east of north of the other two. An outcrop of good amatrice appears a few yards south of the "jade" cut, and loose pieces have been found at several places on the hill. The deposits appear to be local, however, and no variscite has been found to the north or south of Amatrice Hill.

Amatrice owes its attractiveness to the wide variation of colors of the different constituent minerals, and the variety of combinations and patterns displayed by these colors. The constituent minerals are chalcedony, chert, variscite, and probably wardite and allied phosphates. Brown limonite stains in seams and through the different minerals form a strong contrast with the variscite. The chalcedony varies from translucent to opaque gray to yellow and yellowish green in color. The chert is gray to yellowish and brown, and grades into chalcedony. The variscite ranges from deep emerald or grass-green to pale shades of green and to white. Wardite is green, bluish green, and white, and is probably associated with other phosphates. The structure of the different minerals in amatrice is nodular, concentric, oolitic, and brecciated. These varieties of structure are not limited to one mineral, but occur in the several minerals composing amatrice. The variscite generally occurs in nodules in chert and chalcedony, sometimes with an indistinct banding and gradation from deep green to pale green and white. In places the variscite has been shattered and recemented with seams of chalcedony, different colored variscite, or other white phosphates. An oolitic texture is present in some of the variscite and associated matrix. Much of the chalcedony and chert have a typical nodular and concretionary structure, and in many cases an agate-like banding. The dark color of some of the chert and the limonite-stained breccia furnish a strong contrast with the light and dark green and white variscite and associated minerals.

Part of the variscite found in the "jade" cut has a deep, translucent green color resembling jadeite, especially near the borders of the nodules. The interior of the nodules generally has a lighter apple-green color, and sometimes a gray or white core. The matrix adjoining the nodules is chiefly dark brown and gray chert and chalcedony, though some have a yellowish color. It is firmly attached to the nodules, so that gems can be cut showing the strongly contrasting colors of the two. In size the variscite nodules range from less than a quarter of an inch to over an inch across.

The amatrice from the "cobweb cut" has a structure resembling that of cobwebs or the markings on a turtle's back. This mottling is not confined to the variscite, but is evident in the chert and chalcedony matrix around the nodules. The appearance is due to a fracturing of the first deposit of these minerals and the deposition of different kinds of mineral, or the same mineral with different colors, in the fractures. A typical turtleback variety of amatrice is composed of light-green variscite in which a network of deep-green variscite has been deposited. The amatrice in the "cobweb" cut occurs both in nodules of yellowish and gray phosphatic minerals with chert and in irregular cherty masses. The nodules, which may or may not carry variscite, range up to several inches in diameter. Some of them are much stained with limonite, as is the cherty matrix.

Some of the gems from the "apple-blossom" cut display the effect of apple blossoms among green leaves. This is due to the intimate association of oolitic particles and nodules of green variscite and a white phosphate mineral with chalcedony. In some specimens the chalcedony contains small spots of purple which heighten the effect of blossoms. The greater part of the solid variscite from this cut has a paler and less pleasing color than that from the jade cut, and owes its beauty to the combination with the other matrix. Masses of variscite and phosphate minerals with chalcedony and chert, 2 or 3 feet across, are found in the "apple-blossom" cut. Such masses are composed of large and small concretions and nodules of variscite and the different associated minerals.

Amatrice is especially adapted for jewelry where matrix stones are desired. It has bright colors of its own, and does not resemble the green seen in discolored turquoise matrix. The variety of combinations of matrix and colors is probably greater than that found in turquoise, and the rich green of amatrice is more attractive in certain classes of jewelry than the blue of turquoise. The gems are generally cut in rounded or cabochon forms and are used in rings, scarf pins, brooches, necklaces, pendants, etc. Amatrice is becoming popular and the Occidental Gem Corporation reports a production of about 45,000 carats during 1908. The gems are retailed at $1 to $3 a carat.

Utahlite.—The utahlite or chlorutahlite mine is in Clay Canyon, 1½ miles west of Fairfield, Utah County, at the south end of the Oquirrh Mountains. It is operated intermittently whenever a new supply of gem material is needed. The deposit is located at the foot of the hill on the north side of the canyon, a few feet above the bottom. The walls of the canyon, or more properly valley, are not steep at this point. Development consists of a tunnel 110 feet long, driven nearly north into the hill, and an open cut with a small incline. The tunnel did not cut the variscite lead. The country rock exposed in the workings is black limestone, which strikes about N. 50° W., with a dip of 22° N. The variscite lead has a steeper dip to the north, nearly 45°, with approximately the same strike as the limestone. The variscite occurs in concretionary nodules in a brecciated, more or less decomposed, zone. Practically everything in this zone has a nodular shape, including the blocks of limestone breccia, etc. Chert forms a prominent part of the filling of the mineralized zone and has been fractured and cemented by calcite seams and limonite stains. The nodules of variscite range from one-fourth of an inch to over 4 inches in thickness. The nodules have been more or less fractured, and the cracks have been filled in with yellow and white phosphate minerals. Some of the larger nodules contain two or more smaller nodules or irregular masses of variscite, inclosed in yellow and white matrix or shells. Most of the nodules are surrounded by banded layers of the yellow phosphate and some have white coatings also. The colors of the variscite range from deep grass or emerald green to paler shades and nearly white. The deeper colors show a tendency to appear near the borders of the nodules. Some of the variscite nodules yield large pure gems of beautiful color. Others furnish handsome matrix stones, though the number of variations of pattern and the contrasts of colors occurring in small areas are not so great as in amatrice. Some of the yellow phosphate mineral, with or without the white in seams through the massive variscite, furnishes exceedingly attractive gems.

The nodular and brecciated chalcedony and phosphate minerals associated with variscite at both the amatrice and utahlite mines would furnish handsome material for small ornaments of mosaic work, even where there is no green variscite present. The concretionary and agate-like structure of the nodules and the massive matrix with small nodules throughout give odd patterns and effects. Where the colors are marked, as in much of the yellow phosphate mineral and chalcedony the matrix could even be used for gem purposes.

NEVADA.

A specimen of variscite was received from E. W. Murphy, of the Blair office of the Tonopah Lumber Company, Esmeralda County. It is solid variscite with an apple-green to dark-green color, and occurs in vein form somewhat like turquoise. Specimens of a yellowish mineral resembling the phosphates associated with variscite in Utah accompanied the variscite.

ARKANSAS.

Crystallized variscite has been found in Montgomery County, and described by A. H. Chester.[a] It occurs as incrustations and shells on quartz, with a semiglobular radiated structure. The color varies from translucent and transparent emerald to bluish green to nearly colorless.

PRODUCTION.

The value of the output of precious stones in the United States during 1908, furnished in part by the producers and estimated in part from the quantity of the production, was consideably lower than in 1907. A great decline in the production of sapphire was in part offset by a large increase in the production of turquoise. The decrease in the production of sapphire was due to the closing down of work by three of the large sapphire producers in Montana. The general depression in trade conditions did not affect the demand for turquoise matrix, though the market for pure turquoise was dull during much of the year. The production of californite during 1908 was not notably different from that of 1907, though none of the output was sold and has therefore not been added to the table of production. Some gems show a considerable increase in 1908 over 1907. Among them are azurmalachite, benitoite, amazon stone, garnet, variscite, etc.

There is a production of several varieties of gems each year for which it has not been possible to obtain figures. Among these are chlorastrolite, thompsonite, datolite, and agates from the Lake Superior region, chalcedony moonstones, anthracite coal for ornamental purposes, jet, etc. It is hoped figures of production of these minerals may be obtained hereafter. One of the chief difficulties arises from the irregular way in which many of these minerals are collected and the diverse channels through which they pass in reaching the jewelry trade. It is not possible to obtain accurate figures of production of many varieties of precious stones produced regularly. The necessity of estimating the value, in certain cases, of part of the production from the quantity, sometimes without knowing the quality of the material, causes great uncertainty. As the reports received from the producers often do not state whether their figures are for rough, selected, or cut gems, the values will often show large discrepancies from previous years and will not represent a definite quantity or quality of material.

---

[a] Am. Jour. Sci., 3d ser., vol. 13, 1877, pp. 215-217.

Production of precious stones in the United States in 1906, 1907, and 1908.

	Value.			Remarks on 1908 production.
	1906.	1907.	1908.	
Agates, chalcedony, etc., moonstones, etc., onyx.	$800	$650	$1,125	California, Utah, and Michigan.
Amethyst	700	850	210	Colorado and North Carolina.
Azurmalachite, malachite, etc.	....	250	5,450	4,676 pounds; Arizona and Utah.
Benitoite	....	1,500	3,638	1,048 cut stones, rough material, still unsold.
Beryl, aquamarine, blue, pink, etc.	9,000	6,435	7,485	California, North Carolina, New Hampshire, Maine, and Connecticut; partly cut gems.
Californite	....	a 25,000	....	Mined but not sold.
Catlinite	....	25	....	No production reported.
Chiastolite	25	20	....	Do.
Chlorastrolite	....	....	25	Michigan.
Chrysocolla	....	150	600	Arizona and California.
Chrysoprase	a 32,470	a 46,500	a 48,225	3,990 pounds; California, in the rough.
Cyanite	....	100	....	No production reported.
Diamond	....	a 2,800	a 2,100	362 stones; Arkansas.
Diopside	5	....	120	Utah and California.
Emerald	....	a 1,320	....	No production reported.
Epidote	....	60	....	Do.
Feldspar, sunstone, amazon stone, etc.	100	1,110	2,850	2,105 pounds; Colorado and North Carolina.
Garnet, hyacinth, pyrope, almandine, rhodolite.	3,000	6,460	13,100	California, Utah, and North Carolina, partly cut gems.
Gold quartz	....	1,000	1,010	Western States and North Carolina.
Jasper	....	675	....	No production reported.
Opal	....	180	50	20 pounds rough; Colorado.
Peridot	2,400	1,300	1,300	Chiefly from Arizona.
Phenacite	250	25	95	Maine, Colorado, and New Hampshire.
Petrified wood	150	325	....	No production reported.
Prase	50	....	....	Do.
Pyrite	....	400	....	Do.
Quartz, rock crystal, smoky quartz, rutilated, etc.	3,050	2,580	3,595	Several hundred pounds in the rough; some cut gems.
Rose quartz	4,000	6,375	568	6,500 pounds in the rough; South Dakota.
Rhodocrosite	....	150	....	No production reported.
Rhodonite	....	....	1,250	500 pounds; California.
Ruby	600	2,000	....	No production reported.
Rutile	....	200	....	Do.
Sapphire	39,100	a 229,800	a 58,397	1,655,402 carats; Montana and Indiana.
Smithsonite	....	800	a 1,200	New Mexico and Utah.
Spodumene, kunzite, hiddenite.	14,000	14,500	a 6,000	90 pounds; California.
Thompsonite	....	....	35	Michigan.
Topaz	1,550	2,300	4,435	California, Utah, Texas, and Colorado.
Tourmaline	a 72,500	a 84,120	a 90,000	3,300 pounds; California, Connecticut, and Maine.
Turquoise and matrix	22,250	23,840	a 147,950	29,590 pounds; Arizona, New Mexico, Nevada, and California.
Variscite, amatrice, utahlite	2,000	7,500	14,250	Utah, cut gems and in the rough.
	208,000	471,300	415,063	

a Estimated.

IMPORTS.

The importation of precious stones into the United States in 1908, as reported by the Bureau of Statistics, showed a large decrease from that of 1907. The value of the imports was over 57 per cent less than in 1907 and about 69 per cent less than in 1906, in which year the imports were the greatest ever recorded. The imports of uncut diamonds showed the greatest decline, proportional to the value of imports, and unset cut diamonds fell to less than half that of 1907. The imports of diamonds for industrial purposes again showed an increase. The increase was in glazier's diamonds, while dust or bort showed a small decline.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1904 to 1908, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1904–1908.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers'.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1904	$73,054	$445,621	$10,234,587	$559	$13,439,023	$1,893,969	$1,142,150	$27,228,963
1905	6,851	190,072	10,281,111	741	20,375,304	4,144,434	1,847,006	36,845,519
1906	104,407	150,872	11,676,529	305	25,268,917	3,995,865	2,405,581	43,602,476
1907	410,524	199,919	8,311,912	......	18,898,336	3,365,902	680,006	31,866,599
1908	650,713	180,222	1,636,798	......	9,270,225	[a] 1,051,747	910,699	13,700,404

[a] Including agates. Agates in 1906, $20,130; in 1907, $22,644.

QUARTZ AND FELDSPAR.

By Edson S. Bastin.

QUARTZ.

INTRODUCTION.

Quartz, the most abundant of all minerals, occurs in a great variety of forms and is utilized commercially in many different ways. Certain transparent colored varieties, such as rose and smoky quartz and amethystine quartz, have a gem value and are discussed in the chapter on precious stones. Sand used for building, molding, and in glass and pottery manufacture, is also discussed in other parts of this volume, as are tripoli and sandstone and quartzite used for building purposes, and quartz used as an abrasive, although all these materials are nearly pure quartz. This chapter deals only with massive crystalline quartz (often called vein quartz), with flint, and with quartzite which is used for other than building or paving purposes.

MASSIVE CRYSTALLINE QUARTZ.

Quartz of this variety is usually white, though occasionally rose-colored or smoky. It occurs in veins or dikelike masses, unmixed with other minerals, or as a constituent of pegmatite. In the latter occurrence it is usually produced as an accessory in the mining of feldspar. The States producing massive crystalline (vein) quartz in commercial quantity in 1908 were Connecticut, Maryland, New York, Pennsylvania, Wisconsin, Tennessee, Montana, Colorado, and Arizona. Small quantities were formerly marketed from Maine, but these quarries are so far from the principal markets that the quartz can not now be sold at a profit.

QUARTZITE.

This rock may be described as a sandstone in which the spaces between the quartz grains have been completely or almost completely filled, either through a further deposition of quartz between the grains or through a recrystallization of the quartz of the original grains. The result is a solid mass of quartz. In Cherokee County, N. C., a hard, vitreous quartzite of Cambrian age is extensively quarried for use as a flux in copper smelting.

FLINT.

The name flint is properly applied only to quartz of exceedingly compact texture, dull surface, and perfectly conchoidal, splintery fracture. It commonly occurs in the form of more or less irregular nodules in limestones. Chert is another name applied to flint occurring in this way. Flint or chert nodules occur abundantly at several localities in the United States, notably in the Cretaceous limestones of central Texas, a locality in the west portion of the city of Austin being one of the most accessible. So far as known very little domestic flint has ever been commercially utilized except as road material. All of the true flint consumed in the United States comes from France, Greenland, Norway, and England. There the flint-bearing chalks occur along the seacoast in many places, and the flints are freed from their chalk matrix by the erosive action of the waves so that the human labor involved in obtaining them is relatively small. Many of the smaller and nearly spherical nodules are used in tube mills, but much of the material is fired in kilns and then ground for use in the pottery trade. The flints, which are usually gray to nearly black in their natural condition, become perfectly white on burning and fracture somewhat, so that crushing and grinding are facilitated.

METHODS OF GRINDING.

In the grinding of the massive forms of quartz two general processes are used, which may be called the "wet process" and the "dry process."

In the wet process the quartz may be crushed just as it comes from the quarry, or it may first be highly heated in kilns and then fractured by turning upon it a stream of cold water. The first crushing is effected by jaw crushers, or if the quartz has previously been burned it may be crushed in chaser mills. In a few mills the chasers revolve in wet pans and are periodically stopped to allow the crushed quartz to be shoveled out. After crushing, it is ground in "wet pans" provided with a pavement of flat-faced quartz or quartzite blocks over which move several large blocks of similar material, the crushed quartz being pulverized between these blocks and the pavement. The grinding in wet pans usually occupies about twenty-four hours, the load ground in a single pan varying from 1,200 to 1,800 pounds. From the wet pans the pastelike mass of quartz and water is drawn into settling troughs, the first settlings being in some cases returned to the pans for finer grinding. From the settling troughs it is shoveled out upon drying floors heated by steam or hot air, or else it is dried in small pans which are placed tier on tier on heated racks constructed of steam pipes. Finally the dried material is bolted to various degrees of fineness and packed in bags for shipment, or it may be shipped in bulk.

In the dry method of treatment the quartz is usually crushed first in a jaw crusher and then between crushing rolls. Quartz to be used for filters and for abrasive purposes is then screened to various degrees of fineness, and is packed in bags for shipment. In the manufacture of the finer grades for use in pottery, wood fillers, scouring soaps, etc., the material after leaving the roll crushers is ground in tube mills, either of the continuous or of the intermittent type. It is then graded to various sizes either by bolting or by a pneumatic process whereby the quartz powder is carried by a strong air current through a series of tubes and receptacles, the distance to which the quartz is carried being dependent upon its fineness.

USES.

Quartz of the kinds dealt with in this report is used for a great variety of purposes, the principal uses being in the manufacture of wood filler, pottery, paints, and scouring soaps. In pottery the quartz serves to diminish shrinkage in the body of the ware; it is used also in many glazes. Quartz for these purposes should be nearly free from iron-bearing minerals. In general the analysis should show less than one-half of 1 per cent of iron oxide. Finely ground quartz is used in paints in various proportions up to one-third of the total pigment used. Its chemical inertness prevents it from combining with other constituents of the paint and increases the resistance of the paint to the weather. Crystalline quartz is superior to silica sand for this purpose because the ground particles are highly angular and tend to attach themselves more firmly to the painted surfaces, thus giving the paint what is known as a "tooth" and after some wear affording a good surface for repainting. This angularity of the grains also renders the ground crystalline quartz superior to silica sand in the manufacture of wood fillers. In scouring soaps and polishers ground crystalline quartz is preferred to silica sand, not only because of its greater angularity, but because of its superior whiteness.

Massive quartz, crushed and graded to various degrees of fineness, is extensively used in the manufacture of sandpaper, sand belts, as a scouring agent, with sand-blast apparatus, etc. The qualities which render it particularly serviceable for these purposes are its hardness (No. 7 in the Mohs scale), which is slightly greater than that of steel, and its conchoidal fracture, the absence of definite cleavage planes causing it to crush to fragments with sharp, angular edges and corners. For such abrasive purposes massive quartz is far superior to sand or crushed sandstone, since the grains of the latter are likely to be more or less rounded. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and to some extent as a flux in copper smelting. Much ground quartz is used in filters, and some of the most finely pulverized grades are used in tooth powders and in place of pumice as a cleaner by dentists.

Within recent years crystalline quartz and also sand has been used to some extent in the manufacture of silicon and of alloys of silicon with iron (ferrosilicon), copper (silicon copper), and other metals. Ferrosilicon is largely produced in the electric furnace by using coke to reduce the quartz to the metallic state, and some iron ore or scrap iron to alloy with the silicon. The percentage of silicon in these alloys varies from about 10 to 80 per cent, according to the uses of the product. Ferrosilicon has been employed in the manufacture of steel as a deoxidizer and to prevent the formation of blowholes in steel ingots. Silicon is also produced in the electric furnace.[a] It

[a] Tone, F. J., Production of silicon in the electric furnace: Trans. Am. Electro-Chem. Soc., vol. 7, 1905, p. 243.

is a brittle crystalline body with a dark silver luster. Its specific gravity is about 2.4 and its melting point 1,430° C. The commercial product contains small percentages of iron, carbon, and aluminum. The great affinity of silicon for oxygen renders it useful for the reduction of metals such as chromium and tungsten in the electric furnace. It can readily be cast into rods, and because of its high electrical resistance, which is about five times that of carbon, it is used in the manufacture of rheostats and electrical heaters. Its resistance to nearly all acids, combined with the fact that it can be cast into molds, makes it possible also to use it in the manufacture of chemical ware. Silicon copper is used as a deoxidizer in making castings of copper and copper alloys.

Quartz may be fused in the electric furnace to make tubes, crucibles, dishes, and other articles which can be used for certain purposes in the chemical laboratory instead of porcelain and platinum wares. The fused quartz expands only very slightly when heated, its coefficient of expansion being about one-twentieth of that of glass. In consequence of this property, red-hot articles of fused quartz may be plunged suddenly into cold water without cracking. These wares soften only above 1,400° C. (2,552° F.). The principal drawback to the use of these wares, especially in quantitative chemical work, is that the somewhat rough character of their surfaces makes it difficult to wash thoroughly all material from the dishes.

PRODUCTION.

The Connecticut localities at which quartz is mined were described in detail in the report on the production of quartz and feldspar in 1907.[a] There were no new developments in 1908. The quarries of Westchester County, N. Y., have also been previously described by the writer.[b] Maryland and Wisconsin continued to be important producers. The quarries in these States were described in the report on the production of quartz and feldspar in 1907. In Pennsylvania no new developments were reported. The material quarried in Illinois is similar to that mined in Missouri and marketed under the name of tripoli and is included in the statistics for abrasives. The Ishpeming Gold Mines Company reports the opening of a quartz mine at Ishpeming, Mich., and a mill for fine grinding is in process of completion. Quartz is also mined at Golden, Colo.; Butte, Mont.; and Dewey, Ariz., the output being used wholly or in part by neighboring smelters. In the following tables the production of quartz is entered under the head of "Crude" or "Ground," according to the condition in which it was first placed upon the market. Nearly the whole production is eventually ground or finely crushed.

In order to show the total production of quartz, tables are appended which give the output of abrasive quartz in 1908 and the combined production of abrasive and other quartz in 1907 and 1908.

[a] Mineral Resources U. S. for 1907: U. S. Geol. Survey, pt. 2, 1908, pp. 846-847.
[b] Bull. U. S. Geol. Survey No. 315, 1907, pp. 294-309.

Production of quartz (exclusive of abrasive quartz) in the United States in 1907–8, by States, in short tons.

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907.						
Connecticut and New York	168	$450	10,387	$98,140	10,555	$98,590
Pennsylvania and Maryland	948	1,985	4,392	27,702	5,340	29,687
Other States	4,502	1,847	2,580	26,970	7,082	28,817
	5,618	4,282	17,359	152,812	22,977	157,094
1908.						
Connecticut and New York	980	1,750	9,227	56,700	10,207	58,450
Pennsylvania and Maryland	25	99	4,160	31,670	4,185	31,769
Other States [a]	22,500	30,594	1,933	17,833	24,433	48,427
	23,505	32,443	15,320	106,203	38,825	138,646

[a] Includes Arizona, Colorado, Montana, Tennessee, and Wisconsin.

Production of abrasive quartz in the United States in 1908, in short tons.

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Connecticut Maryland Massachusetts New York Pennsylvania Wisconsin	2,973	$4,876	5,518	$46,635	8,491	$51,511

Total production of quartz in 1907–8, in short tons.

	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Production of quartz (exclusive of abrasive quartz) in 1908	23,505	$32,443	15,320	$106,203	38,825	$138,646
Production of abrasive quartz in 1908	2,973	4,876	5,518	46,635	8,491	51,511
Total production of quartz in 1908	26,478	37,319	20,838	152,838	47,316	190,157
Total production of quartz in 1907	5,618	4,282	27,574	219,519	33,192	223,801

From this table it appears that in 1908 the total output of quartz, 47,316 short tons, exceeded that of 1907 in quantity by 14,124 tons, but declined in value $33,644. This seems to be accounted for by the larger quantity of quartz sold crude in 1908.

Production of quartz (exclusive of abrasive quartz) in the United States, 1903–1908, in short tons.

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	40,046	$38,736	15,187	$118,211	55,233	$156,947
1904	41,490	28,890	10,780	71,700	52,270	100,590
1905	39,555	33,409	11,590	70,700	51,145	104,109
1906	41,314	37,632	25,383	205,380	66,697	243,012
1907	5,618	4,282	17,359	152,812	22,977	157,094
1908	23,505	32,443	15,320	106,203	38,825	138,646

Nearly every producer reported unfavorable market conditions and decreased production, as compared with 1907. The increased total production is due to new accessions to the list of producers.

Imports.—The imports of flint and flint stones into the United States during 1908 were valued at $219,754 (unground), as against $288,371 in 1907 and $272,607 in 1906.

PRICES.

Pure crystalline quartz for use in the manufacture of pottery, abrasive soaps, paints, wood fillers, etc., brings usually from about $2 to $3.50 per long ton, crude, f. o. b. quarries, and the ground material brings from $6.50 to $10 per short ton f. o. b. mills, the price varying with fineness of grinding, distance from markets, etc. The purer varieties of quartzite used for similar purposes and for sandpapers sell, as a rule, at somewhat lower prices, the crude bringing from about $1 to $2 per long ton f. o. b. mines, and the ground from $6 to $8 per short ton f. o. b. mills. The finest grades of crystalline quartz ground to an impalpable powder and used for tooth powders, etc., may bring as high as $20 per ton f. o. b. mills. Imported French flints cost from $3.50 to $4 per long ton, f. o. b. Philadelphia, and can be delivered in Trenton, N. J., for less than $5 per long ton.

FELDSPAR.

PRODUCTION.

No general discussion of the characters, methods of mining, and uses of the feldspars will be given in this report. This information has been given at some length in the Mineral Resources reports on the production of quartz and feldspar in 1906 and 1907, and may be obtained from a bulletin shortly to be issued by the Geological Survey. This bulletin will contain all the available information of a practical character in regard to the feldspar deposits of the United States.

In the tables of production the material is entered as "Crude" or "Ground," according to the conditions in which it was first placed on the market. Practically the whole production is eventually crushed or ground.

The feldspar trade, like most others, suffered severely from the effects of the panic of 1907–8. The figures of the tables below show a decrease in 1908 of 12,240 short tons in the output of crude feldspar and of 9,085 short tons in the total output (including abrasive feldspar) of ground feldspar from the total production in 1907. This is a total decrease of 21,325 short tons, valued at $130,391. Nearly all producers reported unfavorable market conditions, and many of the smaller operators suspended business entirely.

Of the production for 1908 reported as feldspar, 12,861 short tons, valued at $43,686, was crushed pegmatite used for poultry grit and the manufacture of ready roofing. The average price of this material crushed was about $3.40 per ton f. o. b. mills. The average price of the feldspar used for pottery, enamel ware, glass making, and allied purposes was about $4 per short ton for the crude f. o. b. nearest shipping point to the mines. The average price of the ground feldspar was about $8.20 per short ton f. o. b. mills. New developments are mentioned below under the summaries by States.

Production of feldspar (exclusive of abrasive feldspar) in 1907–8, by States, in short tons.

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907.						
Maine	45	$110	16,428	$157,224	16,473	$157,334
New York	3,909	15,825	11,500	40,500	15,409	56,325
Connecticut	10,663	28,433	8,380	51,770	19,043	80,203
Pennsylvania	7,367	28,169	12,266	108,678	19,633	136,847
Maryland	7,169	23,672	3,895	34,081	11,064	57,753
Other States	1,927	5,607	1,000	5,000	2,927	10,607
Total	31,080	101,816	53,469	397,253	84,549	499,069
1908.						
Maine	168	375	13,751	123,034	13,919	123,409
New York	504	1,350	14,109	51,798	14,613	53,148
Connecticut	7,775	27,753	6,425	38,506	14,200	66,259
Pennsylvania	3,616	13,226	10,473	90,276	14,089	103,502
Maryland	6,217	21,076	3,517	30,774	9,734	51,850
Virginia and Minnesota	560	2,000	125	750	685	2,750
Total	18,840	65,780	48,400	335,138	67,240	400,918

Total production of feldspar in 1907–8, in short tons.

	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Production of feldspar (exclusive of abrasive) in 1908	18,840	$65,780	48,400	$335,138	67,240	$400,918
Production of abrasive feldspar in 1908			3,234	27,635	3,234	27,635
Total production of feldspar in 1908	18,840	65,780	51,634	362,773	70,474	428,553
Total production of feldspar in 1907	31,080	101,816	60,719	457,128	91,799	558,944

The production of feldspar (exclusive of abrasive feldspar) from 1903 to 1908 is given in the following table:

Production of feldspar (exclusive of abrasive feldspar), 1903–1908, in short tons.

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	13,432	$51,036	28,459	$205,697	41,891	$256,733
1904	19,413	66,714	25,775	199,612	45,188	266,326
1905	14,517	57,976	20,902	168,181	35,419	226,157
1906	39,976	132,643	32,680	268,888	72,656	401,531
1907	31,080	101,816	53,469	397,253	84,549	499,069
1908	18,840	65,780	48,400	335,138	67,240	400,918

FELDSPAR INDUSTRY BY STATES.

Maine.—No new developments were reported in the feldspar industry in Maine. The returns for 1908 showed an increase of 123 short tons in the production of crude feldspar over that produced in 1907, but a decrease of 2,677 short tons in the production of ground feldspar. The market conditions were in most cases reported to be poor.

New York.—Of the material classed as ground feldspar over 12,000 tons, with an average value of $3.40 per ton, was crushed pegmatite used for poultry grit and ready roofing. There was a very notable decrease in the crude spar of pottery grade produced as compared with 1907, but an increase in the crushed pegmatite, due principally to the fact that the Crown Point Feldspar Company became an important producer.

Vermont.—A feldspar quarry 2 miles from Chester Depot, in Windsor County, was opened by A. L. Stone in 1908, but as yet only sample shipments have been made. A mill is said to be in course of erection at Chester Depot. The property has not been visited by the writer.

Connecticut.—The quantity of Connecticut feldspar placed on the market in the crude state in 1908 was 2,888 short tons less than in 1907. The quantity marketed in the ground state, including abrasive feldspar, was 1,566 short tons less than in 1907. The product of the Eureka Mining and Operating Company's quarries is reckoned as marketed in the crude state, as the milling branch of this concern at Trenton, N. J., is incorporated under a different name (Eureka Flint and Spar Company). The Consolidated Feldspar Company reported the purchase of property adjoining its own at White Rocks from the Middlesex Feldspar Company. The Eureka Mining and Operating Company reported the opening by it of a new quarry in the town of Chatham, Middlesex County, close to the Connecticut River. All the firms producing feldspar for the pottery trade reported decreased productions and unfavorable market conditions.

Pennsylvania.—The only new development reported in the feldspar industry in Pennsylvania in 1908 was the opening of a quarry by the Twin Oaks Feldspar Company near Twin Oaks Station, in Delaware County. The production of crude feldspar in 1908 was 3,751 short tons less than in 1907. The production of ground feldspar was 1,793 short tons less than in 1907. Nearly every concern reported poor market conditions and decreased output. The Keystone Feldspar Company and a number of smaller producers suspended operations entirely because of the business depression.

Maryland.—No important developments were reported in the feldspar industry of Maryland during 1908. The market conditions were generally stated to be unfavorable. The new quarry of the Eureka Mining and Operating Company opened in 1907 near Granite was a heavier producer than in 1907, but most quarries showed a decreased output, and work at a number of the smaller ones was entirely suspended. The production of crude feldspar was 952 short tons less than in 1907, and of ground feldspar was 378 short tons less. As with its Connecticut output, the product of the Eureka Mining and Operating Company is listed as crude, the milling branch of this concern at Trenton being incorporated under a different name.

TALC AND SOAPSTONE.

By J. S. Diller.

INTRODUCTION.

The salient feature of the talc and soapstone industry for 1908 is the considerable decrease in the total output from the previous year, due to the general decline in trade conditions. The total output for 1908 was 117,324 short tons, a decrease of nearly 17 per cent from that of 1907.

The production of talc and soapstone was limited exclusively to the belt of ancient crystalline rocks which form the axis of the Appalachian Mountain system from Canada to Alabama. Talc or soapstone quarries were operated in ten States on the Atlantic slope, viz, Vermont, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, and Georgia.

In New York, the State which produced by far the larger part of the talc obtained in this country, and also at Hewitts, in North Carolina, the masses of talc have the form of layers or beds, conformably interstratified with marble, schists, and gneisses, after the manner of sedimentary rocks.

At some of the other localities, however, the deposits of talc and soapstone are less regular. Their mode of occurrence as well as their association and mineralogical composition strongly suggest that they have been derived from igneous rocks, such as pyroxenite.

VARIETIES AND CHARACTERISTICS.

In chemical composition, talc is a hydrous silicate of magnesia. Pure talc is generally foliated like mica, but may be fibrous. The laminæ, though flexible, are not elastic. Both foliated and fibrous forms of talc are abundant in different parts of the mines in New York.

The most distinctive physical features of talc are its softness, being easily impressed by the finger nail, and its greasy, soapy feel. It is practically infusible, not decomposed by ordinary acids, and a good nonconductor of heat and electricity. When highly heated, it loses a small amount of water, hardens, and becomes susceptible to polish. It varies in color from apple-green to white. Its softness, flexibility, and smoothness, in connection with its resistance to high temperatures and acids, are the qualities which render it most useful.

The massive form, usually gray, crystalline, and more or less impure, occurs in large bodies, and is commonly known as soapstone.

USES.

The practice in mining talc and soapstone and preparing it for use is for the most part either to saw it into slabs, as at the quarries in Virginia, or to grind it into powder, as at the mines in New York.

Being soft and sectile, it is easily sawed or carved into any shape, and is extensively used for washtubs, sanitary appliances, laboratory tanks and tables, electrical switchboards, hearthstones, mantels, fire brick, kiln linings, furnaces, cupolas, converters, gas burners, foot warmers, slate pencils, and "crayons" for marking iron, glass, and fabrics.

The powder of foliated talc is used instead of mica for imparting luster to wall paper. The powdered form of fibrous talc is extensively used in the manufacture of paper. On account of the strength and durability the minutely fibrous talc imparts to the paper, it is replacing china clay, which has been extensively used in the past and which renders the paper brittle. Talc has a wide use to-day as a pigment in high-grade paints. On account of its great natural stability, it should be well adapted to this purpose, but, as shown by the scientific section of the Paint Manufacturers' Association of the United States, its proportion to the other pigments with which it is used should be moderate. If used in excess, it cheapens and adulterates the paint. As a heat insulator, it is used for boiler and pipe coverings. It finds extensive use as a lubricant to lessen friction, also for polishing glass, dressing skins and leather, and making various toilet powders, as well as for dynamite and for sizing for cotton cloth.

It is said to have been used in adulterating sugar, baking powder, and flour. In response to an inquiry as to the use of talc for adulterating the articles of food mentioned, Dr. H. W. Wiley, chief of the Bureau of Chemistry, Department of Agriculture, replied:[a] "There is no doubt of the fact that it has been used for all these purposes to some extent. I have never found, however, any mineral substance of that kind in sugar. It has been extensively advertised for flour, but we have never found a sample of flour containing any of it. In so far as baking powders are concerned, I do not think we have ever found any. My impression is that the use of any kind of talc for the purpose mentioned is extremely limited, but there is no doubt that it has been used occasionally."

PRODUCTION.

The total production of all forms of talc in 1908 was 117,354 short tons, valued at $1,401,222, a decrease in quantity of over 16 per cent from the production of 1907, but a decrease in value of less than 9 per cent. The smaller decrease in value is due chiefly to the general advance in prices. The financial depression of 1903 was marked by a decline in output of talc of 11 per cent from the production of 1902. This was followed by four years of rapid rise in production and then by a marked decline of 16 per cent in 1908.

The diminished production applies to all the States except New York and Massachusetts. In New York the output increased 4 per cent and in Massachusetts the output, though not very large, was

[a] Official letter, dated April 20, 1909.

more than double that of 1907—a marked increase resulting from the erection of a new mill at Zoar, in Franklin County.

The following table shows the progress of the talc industry in recent years:

Production of talc and soapstone in the United States, 1880–1908, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880–1900	969,928	$11,224,652	1905	96,634	$1,082,062
1901	97,843	908,488	1906	120,644	1,431,556
1902	97,954	1,140,507	1907	139,810	1,531,047
1903	86,901	840,060	1908	117,354	1,401,222
1904	91,189	940,731			

The talc and soapstone quarried and prepared for market are most conveniently classified, as shown in the following table, into four classes or groups, viz, rough or crude, sawed into slabs, manufactured articles, and ground. The table shows the quantity produced in each class annually, the total value, and the average price per ton from 1905 to 1908.

Production of talc and soapstone in the United States according to varieties, 1905–1908, in short tons.

Condition in which marketed.	1905.			1906.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Rough	1,625	$10,483	$6.45	15,211	$40,337	$2.65
Sawed into slabs	4,779	80,879	16.92	4,980	83,563	16.78
Manufactured articles [a]	14,665	403,660	27.53	23,575	631,342	26.78
Ground [b]	75,565	587,040	7.77	76,878	676,314	8.80
Total [c]	96,634	1,082,062	11.20	120,644	1,431,556	11.87
	1907.			1908.		
Rough	25,538	$34,625	$1.36	3,013	$7,819	$2.60
Sawed into slabs	4,822	91,688	19.01	3,406	71,048	20.86
Manufactured articles [a]	23,484	648,475	27.61	16,336	442,624	27.10
Ground [b]	85,966	756,279	8.80	94,599	879,731	9.20
Total [c]	139,810	1,531,047	10.95	117,354	1,401,222	11.94

[a] Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantels, sinks, griddles, slate pencils, gas tips, burner blanks, crayons, and numerous other articles for everyday use.
[b] For foundry facings, paper making, lubricators for dressing skins and leather, etc.
[c] Exclusive of the quantity used for pigment, which is included among mineral paints.

Only 2.5 per cent of the product was sold crude in 1908, 3 per cent was sold sawed into slabs, 14 per cent was sold as manufactured articles; and 80.5 per cent was sold ground. When, however, we consider the values represented the percentages are very different. The value of the crude was one-half of 1 per cent of the total value, that of the sawed into slabs 5 per cent, that of the manufactured articles 32 per cent, and that of the ground 62.5 per cent.

The production of New York alone exceeded in quantity that of all the other States combined. In quantity and value Virginia ranks next to New York. The product in New York is all talc and it is all ground; in Virginia the product is soapstone, and it is sawed and manufactured into various articles. In North Carolina and Vermont there is greater variety in the production. By far the larger part of the product in both States is ground, yet here also a considerable part of the product is sold crude, sawed into slabs, and as manufactured articles.

Production of talc and soapstone, 1906–1908, by States, in short tons.

State.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Georgia	(a)	(a)	739	$11,473	(a)	(a)
Maryland	2,956	$23,310	5,064	32,250	(a)	(a)
New Jersey and Pennsylvania	13,981	52,961	17,103	46,871	4,648	$29,118
New York	61,672	557,200	67,800	626,000	70,739	697,390
North Carolina	4,009	66,729	4,085	74,347	3,564	51,443
Vermont	10,413	101,057	16,200	82,500	10,755	99,743
Virginia	23,624	590,800	26,278	631,880	19,616	458,252
Other States [b]	3,989	39,499	2,541	25,726	8,032	65,276
Total	120,644	1,431,556	139,810	1,531,047	117,354	1,401,222

[a] Included in "Other States."
[b] Georgia, Massachusetts, and Rhode Island, in 1906; California, Massachusetts, and Rhode Island, in 1907; Georgia, Maryland, Massachusetts, and Rhode Island, in 1908.

Production of talc and soapstone in the United States, 1880–1908, in short tons.

Year.	New York.		All other States.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1880–1900	629,925	$5,933,501	340,003	$5,291,151	969,928	$11,224,652
1901	69,200	483,600	28,643	424,888	97,843	908,488
1902	71,100	615,350	26,854	525,157	97,954	1,140,507
1903	60,230	421,600	26,671	418,460	86,901	840,060
1904	64,005	507,400	27,184	433,331	91,189	940,731
1905	56,500	445,000	40,134	637,062	96,634	1,082,062
1906	61,672	557,200	58,972	874,356	120,644	1,431,556
1907	67,800	626,000	72,010	905,047	139,810	1,531,047
1908	70,739	697,390	46,615	703,832	117,354	1,401,222
Total	1,151,171	10,287,041	667,086	10,213,284	1,818,257	20,500,325

IMPORTS.

The total imports of talc for consumption in 1908 were 7,429 short tons, a decrease of over 26 per cent from the imports of 1907. On the other hand, the average price per ton of the imports in 1908 increased 4 per cent over the average price of 1907. Only the better grades of talc produced are imported, which accounts for the higher average price for foreign as compared with domestic talc.

Talc imported into the United States, 1902–1908, in short tons.

Year.	Quantity.	Value.	Average price per ton.	Year.	Quantity.	Value.	Average price per ton.
1902	2,859	$35,366	$12.36	1906	5,643	$67,818	$12.02
1903	1,791	19,677	10.99	1907	10,060	126,391	12.56
1904	3,268	36,370	11.13	1908	7,429	97.096	13.07
1905	4,000	48,225	12.05				

TALC DEPOSITS, BY STATES.

NORTH CAROLINA.

North Carolina is the fifth State in the order of production, and has five active mines, of which that of the North Carolina Talc and Mining Company, near Hewitts, in Swain County, is the largest producer. A detailed description of the occurrence of talc and soapstone in the vicinity of Hewitts is given by Keith in the Nantahala folio and in the Contributions to Economic Geology for 1902.[a] The talc occurs as series of lenticular masses and sheets in the blue and white marbles of Cambrian age along the Nantahala Valley and Nottely River. Talc associated with limestone is most likely derived from sedimentary rock. It is found also in the Great Smoky conglomerate of Cambrian age, and in the Archean rocks, where its association with peridotites is such as to show that it is derived from igneous rocks.

The Cambrian marbles have a length of outcrop of about 40 miles in North Carolina and are continued in Georgia for a much greater distance. Talc is known to occur in more than twenty-five places along the marble belt of North Carolina, but is less common in Georgia. The lenticular bodies inclosed in the marble vary in size from mere scales to masses 50 feet thick and 200 feet long.

Owing to its soft nature, the talc does not withstand weathering, but readily crumbles down. It does not outcrop, therefore, and its position is indicated merely by fragments of weathered material on the surface. Thus, it is impossible to determine the full extent of the talc bodies, except where they are exposed by mining. For the same reason, it is probable that many bodies of talc have thus far escaped observation. Some of the bodies are so extensive that they resemble sheets of sedimentary matter. This is especially the case where the talc sheets grade into the adjoining sandstone beds. They are termed ''veins'' by the miners, but they have none of the characteristics of true veins.

The talc varies in color from dull white and opaque, where weathered, to dull bluish green or pale green and translucent, where the solid rock is freshest. Inasmuch as the methods of manufacture of the talc depend upon its softness, any impurities which may affect this quality are a detriment. Thus it happens that the occurrence of numerous acicular or prismatic crystals of amphibole or pyroxene greatly depreciate the value of some of the large deposits of talc. In North Carolina talc is mined partly in open cuts and partly in shafts and tunnels. By far the greater portion of it is ground to powder, but some of it is sawed into slabs and manufactured into small articles, such as pencils, crayons, and gas tips, as well as electrical and thermal insulators of various forms.

The talc deposits associated with the Murphy marble are readily accessible to the Southern Railway, but other deposits of talc which occur in the Great Smoky conglomerate, as well as the bodies of soapstone associated with dunite in the Archean rocks, though large, are so remote from transportation that they are generally undeveloped It is interesting to note, however, that since the extension of the railroad down the Little Tennessee from Bushnell one of the masses of

---

[a] Keith, Arthur, Nantahala folio (No. 143), Geol. Atlas U. S., U. S. Geol. Survey, 1907; also Bull. U. S. Geol. Survey No. 213, 1903, p. 443.

fine foliated talc in the conglomerate is being worked 2 miles southwest of Wayside and hauled to Hewitts to be ground.

Pyrophyllite.—Pyrophyllite, though unlike talc, in being a hydrous silicate of alumina instead of a hydrous silicate of magnesia, is so closely related to talc in many of its physical properties that it is mined and used for the same purposes, although it does not command so high a price as the best grades of talc. Moistened with cobalt solution and ignited, talc becomes pale red, and pyrophyllite under the same conditions becomes deep blue. Thus the two minerals may be readily distinguished.

In the region where it is mined, pyrophyllite is sometimes erroneously called agalmatolite, because of its general resemblance to the mineral so commonly used in China for small images.

The only mines of pyrophyllite in the United States are in Moore and Chatham counties, N. C., and they are widely separated from the talc and soapstone mines of the same State.

The pyrophyllite rock forms a narrow belt about 8 miles in length, northeast and southwest, which is crossed by Deep River near the middle, in the vicinity of Glendon, where the quarries are located. This belt is 500 feet in width and of considerable but unknown depth. It is bounded by siliceous and iron breccias, which separate it from slates. Not over 100 feet of the belt is workable, and of this only 25 per cent is commercial pyrophyllite. The principal impurity is quartz, arranged in veins and bands, with some chlorite and magnetite. The presence of impurities, chiefly quartz, in the pyrophyllite would make the ground product gritty, and it therefore causes considerable waste of the material mined. Pratt proposed to use this waste for fire brick.[a]

On the basis of its chemical composition, pyrophyllite has been regarded as more nearly allied to clay than to talc. From agalmatolite it differs in containing only a trace of potash.

The Durham and Charlotte Railroad at Glendon affords convenient transportation for the pyrophyllite. Two quarries reported production in 1908. There were also several other companies with mills erected actively engaged in prospecting and development.

VIRGINIA.

Virginia is by far the most important State in the production of soapstone. Over 90 per cent of the nearly 20,000 tons it produced was sawed into slabs for manufacturing laundry and laboratory appliances, while less than 10 per cent was ground into powder and used for foundry and other purposes where color and a high degree of purity is not essential.

Almost the whole of the soapstone in Virginia comes from a long, narrow belt running northeast from Nelson County into Albemarle County. It begins about 20 miles northeast of Lynchburg and lies nearly midway between the main line of the Southern Railway and the James River division of the Chesapeake and Ohio Railway. As these railroads are only about 6 miles apart, the facilities for transportation are favorable.

The geology of the soapstone belt has been briefly described by T. L. Watson,[b] state geologist, but until the belt has been definitely

[a] Pratt, J. H., North Carolina Geol. Survey Economic Paper No. 3, p. 99.
[b] Mineral Resources of Virginia, published by the Virginia-Jamestown Exposition Commission, 1907, p. 293.

mapped, the form, size, and relations of the soapstone to the adjacent rocks can not be clearly understood. The soapstone occurs in sheets, layers, or dikelike masses 100 or more feet in thickness and somewhat irregularly distributed throughout a belt nearly 30 miles in length and less than a mile in width. The general distribution of the soapstone strongly suggests conformable stratification with the quartzites and micaceous schists with which it is locally associated, but its more common and intimate association is with a greenish rock having decidedly the aspect of an eruptive and suggesting an igneous origin for the rock from which the soapstone is derived. In New York and North Carolina, where the layers of talc are clearly derived from a sedimentary rock, it is interbedded with limestone; but in Virginia there is no limestone near the soapstone.

The soapstone quarried varies in color from light bluish-gray to dark greenish-gray, and in hardness from that which is easily scratched by the finger nail to that upon which the finger nail makes no impression. The light-colored soft soapstone is the best grade and contains the most talc. The softness of the stone is in a large measure proportional to the talc it contains. The soapstone richest in talc is not only the easiest and most satisfactory to work, but is the best for most of the uses to which soapstone is applied. This best grade of soapstone, examined in thin section under a microscope, is found to be composed chiefly of scales of talc with a small proportion of chlorite and magnetite and traces of either or of both amphibole and pyroxene.

The dark-greenish soapstone, which occurs with the light colored more or less abundantly in all the quarries, owes its green color to the abundance of chlorite and its greater hardness in part to chlorite, but more particularly to the greater proportion of the silicates—hornblende and pyroxene—both of which are much harder than talc. Hornblende and pyroxene are the minerals from which, by alteration, the talc is derived. The dark-green hard grade of soapstone, if it were more altered so that the pyroxene and amphibole were changed to talc, would become the better grade of soapstone.

In May, 1909, when the writer visited the Albemarle-Nelson County soapstone belt, there were six plants in operation. Beginning at the northeast, they were as follows: The Virginia Soapstone Company, which from its large quarries at Schuyler supplied its two large mills, one at Schuyler and the other at Alberene; the Old Dominion, the Climax, the Phœnix, and the Piedmont, all in operation, with quarries and mills running; and the Eureka, which lately succeeded the Plumbers and at which the quarry only and not the mill was in operation.

All the quarries are well equipped with channeling machines and mills for sawing the slabs or shaping and dressing the manufactured articles. The excellent quality of this soapstone adapts it to a wide range of uses. Laundry tubs are the chief manufactured product, but it is used extensively for sinks and other sanitary devices, as well as for electrical appliances and cooking utensils.

There are two small soapstone quarries in Fairfax County—one near Clifton and the other near Wiehle. At Clifton the soapstone is ground, but at Wiehle, where it is much fractured, decomposed, and stained by oxide of iron, it is sold crude just as it is taken from the quarry.

NEW YORK.

New York easily outranks all other States in the production of talc. All of the output comes from a small district about a dozen miles southeast of Gouverneur, in St. Lawrence County, which has been worked for many years. The geology of the district and the genesis of the talc has been well described by C. H. Smith, jr.[a] Gneisses are the most abundant rocks of that region, but crystalline limestones form large irregular belts trending northeast and southwest in the gneiss parallel to its banded structure. Much of the limestone is suitable for building and monumental purposes, but the greater portion of it is impure and contains many more or less schistose layers in which the silicates, tremolite, and enstatite are the chief constituents.

One of the largest and by far the most important of the layers of schist yet discovered is in a limestone belt which stretches from Fowler northeastward to a point near Edwards, a distance of 7 miles, and contains the valuable talc deposits of that district. The schist is conformable with the limestone, into which it gradually passes, both above and below. Their relations are such as to indicate that both belong to the same formation and are of sedimentary origin.

The talc is not only intimately associated with tremolite and enstatite, but grades into them so completely as to demonstrate that the talc is derived from the tremolite and enstatite by alteration. In many places the talc shows more or less distinctly the bladed, columnar, or fibrous structure which characterizes tremolite and enstastite, but locally, in the mine at Talcville and more especially in the mines at Fowler, where there are slips in the schist, the talc is foliated.

The talc is limited to the schist from which it was formed and, from what may be seen in the large underground workings of the International Pulp Company's mine No. 3 at Talcville, it apparently is only the middle portion of the layer of schist that has been changed to talc, thus forming an irregular layer of talc within the layer of schist. The layer of talc varies in thickness from a few feet to over 50 feet, averaging perhaps about 20 feet, and is remarkably persistent. It has been mined locally to a depth of 550 feet and horizontally for a much greater distance, though it is probable that but a small part of the total deposit has yet been removed.

The mining operations do not extend throughout the length of the belt. They are most extensive toward the northeast end, about Talcville. Near the southwest end, in the vicinity of Fowler, operations are less active.

Three companies, the International Pulp Company, the Ontario Company, and the Union Talc Company, reported production in 1908, but in May, 1909, only the first two were in operation.

The International Pulp Company, having acquired the holdings from several independent companies, has become by far the largest producer of talc in the United States. The company has two mills running, both at Hailesboro. The mill, recently constructed of concrete, is said to have a capacity of 100 tons per day. Notwithstanding the low water of the talc belt in 1908 and the consequent decrease in the power of the mills, the output in the district was not only maintained but slightly advanced over that of 1907. The advance in output was accompanied by an advance in price from $8 to $10 per ton.

---

[a] The genesis of the talc deposits of St. Lawrence County, N. Y.: School of Mines Quart., vol. 17, No. 4, pp. 333–341.

The excellence of the fibrous talc for filling book and writing papers has given it a wide market, and much of it is exported to Europe, where it is replacing clay in the paper industry.

VERMONT.

Vermont was the third among the States in the production of talc and soapstone, having produced 10,755 short tons—about half as much as Virginia and one-seventh as much as New York. Its production in 1908 decreased in quantity 33 per cent from that of 1907; nevertheless the reported value of the output, in which much of the product was manufactured, increased about 29 per cent over that of 1907. It is the only State in which an increase in the value is coupled with a decrease in the quantity of the output. This is due to the fact that in 1908 a larger proportion of the production was sold manufactured than in the previous year.

There were eight operating mines in this State; six of these, producing 90 per cent of the state's output, sold their entire product ground; only two quarried and manufactured articles of soapstone.

According to G. H. Perkins, state geologist of Vermont,[a] talc occurs in beds of noticeable size in or near the towns of Granville, Moretown, Rochester, Stockbridge, Bridgewater, Roxbury, Duxbury, Lowell, and Johnson.

In the northern part of the State, near the village of Johnson, there is a small mine in talc schist so folded as to render mining difficult. There is some good talc, but the grade of most of it is lowered by the presence of small flakes of pyrite.

At East Granville the talc mined is a typical talc schist, and it stands on edge between other schists, of which mica schist is the most common. The talc is in the form of a bed and not of a vein. It is not entirely continuous, but is made up of a series of talc lenses in the same plane. The lenses range in thickness from a few inches to 30 feet and in length up to 200 feet. The mine is worked by several drifts running north on the bed into the steep hillside about 300 feet above the mill by the railroad station. The ore is carried to the mill by a gravity tramway. The mine exceeds the capacity of the mill, and part of the ore is shipped and ground by the paper company that uses it. The location of the mine with reference to topography, drainage, and transportation is decidedly advantageous.

About 12 miles farther south the same bed apparently is mined near Rochester and also at Stockbridge, but under somewhat less favorable conditions.

Three miles west of Chester talc is mined at Carlton's and is sold in Chester at the mill of the American Soapstone Finishing Company, which early in 1909 leased the Carlton quarry.

Near Windham is a mine and mill recently closed by litigation.

Professor Perkins remarks that there are extensive beds of soapstone in the towns of Cavendish, Grafton, Chester, Weathersfield, Athens, and Windham. Although some of the many masses of soapstone are of excellent quality, there is a large quantity unfit for use. In 1908 it was mined at three localities—Chester, Athens, and Perkinsville.

In Chester the Union Soap Company formerly worked two quarries, one, not now in operation, a few miles south of the village and

---

[a] Eng. and Min. Jour., October 7, 1908, p. 753.

the other at Athens, 10 miles away. The soapstone, well exposed in the open pits, is seen to form lenses within gneiss. The lenses are from 4 to 20 feet thick and 20 to 30 feet wide, and overlap. The stone is soft and easily sawed, turned, planed, or grooved. It is quarried by using channeling machines, but unfortunately the material varies. Much of it is cracked, but the smaller part is excellent.

The soapstone mill destroyed by ice some years ago at Perkinsville is being rebuilt, and already a part is in operation manufacturing tubs, sinks, furnaces linings, and numerous other objects.

OTHER STATES.

Georgia.—The Murphy marble of North Carolina extends far into Georgia, but the important deposits of talc associated with it in North Carolina have not been found to any great extent in Georgia. There are, however, several small but active mines in Murray County.

Maryland.—The Deland Mining and Milling Company at Bald Friar quarry, near Havre de Grace, was the only one operated during 1908 in Maryland, and it reports the same production as in 1907, although the total production of the State decreased about 29 per cent. The product was chiefly ground and sold[a] to the manufacturers of acid-proof and fireproof paints.

Pennsylvania.—In Pennsylvania there were two mines operating, one in Montgomery County, the Atlas Mineral and Machine Company, and the other in Northampton County, the J. O. Wagener & Co. mine, both in the eastern part of the State. The first locality is briefly referred to in the Philadelphia folio[b] as an old soapstone quarry (rose quarry) that has been recently reopened on the west bank of the Schuylkill and that furnishes material of good quality for stove and furnace linings, as a filler in the manufacture of paint and paper, and as a lubricant.

New Jersey.—In New Jersey, 2 miles north of Phillipsburg, is the mine of the Lizzie Clay and Pulp Company. In 1908 it was the only producing mine in the State. The production of Pennsylvania and New Jersey for 1908 decreased 37 per cent from that of 1907.

Rhode Island.—The Rhode Island Soapstone Company at Manville, in Providence County, was the only company operating in that State during 1908.

Massachusetts.—There were two producing mines in Massachusetts, the Berkshire Talc and Manufacturing Company in Dalton, in Berkshire County, and the Massachusetts Talc Company near Rowe, 3 miles north of Zoar, in Franklin County, where a new mill was erected in 1907, which raised Massachusetts to the distinction of being the only State, except New York, whose production in 1908 was greater than in 1907.

Of all the material reported from the mines in Georgia, Maryland, Pennsylvania, New Jersey, Rhode Island, and Massachusetts, a small production of crude was reported by only two. With this exception, all the product was ground. The great center of the sawed soapstone industry is in Virginia. South of Virginia, as well as north, approximately all of the talc is ground until Vermont is reached, where again a considerable part of the material is sawed.

[a] Maryland Mineral Industries, 1896–1907, Maryland Geol. Survey special publication, vol 8, pt. 2, p.160.
[b] Philadelphia folio (No. 162), Geol. Atlas U. S., U. S. Geol. Survey, 1908.

INDEX.

A.

H.

J.

K.

N.

Q.

R.

S.

T.

U.

U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

KNOWN PRODUCTIVE OIL AND GAS FIELDS OF THE UNITED STATES IN 190

COMPILED BY DAVID T DAY

1909

(Second Edition)

ESTIMATED OIL-BEARING AREAS IN THE UNITED STATES, BY STATES, IN SQUARE MILES.

Alaska	500	New York	300
Alabama	50	Ohio:	
California	850	Eastern	115
Colorado	200	Western	535
Idaho	10	Oklahoma	400
Illinois	200	Pennsylvania	2,009
Indiana	1,000	Tennessee	80
Kansas	200	Texas	400
Kentucky	400	Utah	40
Louisiana	69	West Virginia	570
Michigan	80	Wyoming	750
Missouri	80		
New Mexico	60		8,850

ESTIMATED NATURAL-GAS-BEARING AREAS IN THE UNITED STATES, BY STATES, IN SQUARE MILES.

Alabama	40	Ohio:	
Arkansas	100	Eastern	110
California	310	Western	165
Colorado	80	Oklahoma	500
Illinois	50	Oregon	20
Indiana	2,460	Pennsylvania	2,780
Kansas	260	South Dakota	80
Kentucky	290	Texas	130
Louisiana	110	Utah	40
Michigan	40	Washington	70
Missouri	70	West Virginia	1,000
Montana	40	Wyoming	120
New York	550		9,865

ED STATES IN 1908