THE MINERAL WEALTH OF BRAZIL

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PREFACE

It may be said that little is known of the true extent of the mineral resources of Brazil. The data which is divulged in publications or reports accessible only with difficulty by the public are, with rare and significant exceptions, antiquated and thus do not fully correspond to the needs of the interested.

Some years ago, while serving in the Brazilian Consulate in Yokohama, Japan, the writer had the opportunity of assisting Consul Raul Bopp in the preparation of Geografia Mineral *which had as its objective the evaluation of the international importance of the mineral wealth of Brazil. This book, published in Japan and distributed in Brazil, attained a popularity far beyond the expectations of its authors and was depleted with surprising rapidity. At practically the same time, there was edited in the city of São Paulo a book which described the mineral situation within the country,* A Riqueza Mineral do Brasil, *written by Mr. S. Froes Abreu. Being the work of a technician of unquestionable authority in this field, it may be said to be one of the most complete upon this subject. Later, Consul Josias Leão of the Commercial and Economic Division of the Ministry of Foreign Affairs wrote a monograph of great value,* Mines and Minerals in Brazil, *for distribution in the United States in which was included much information hitherto unpublished. The edition of* Mines and Minerals in Brazil *is now completely exhausted, the editors continuing to receive requests for copies, principally from the United States. In preparing, in 1940, the annual edition of the survey of the Ministry of Foreign Affairs,* Brazil, *the writer, with the assistance of Harry S. Ikuta and Americo Cury, members of the Centro de Estudos Economicos, and the orientation of the Director-General of the Departamento Nacional da Produção Mineral, Dr. Luciano Jacques de Morais, organized a compilation of the above works which had been published. It was thus possible to present an actualized survey of the mineral situation which was further amplified with new data in another book by this writer,* Historia das Indastrias no Brasil, *published in 1941.*

This present publication is a continuation of the above works on minerals with additions of new information as it has become available. There was the guiding thought of presenting a retrospective panorama of the production and trade in minerals in the country and the avoidance of excessively technical aspects of the problem, bringing out the economic aspects, inasmuch as it is certain that the War will bring modifications of great importance to the mineral industry in Brazil. In this connection it is of interest to point out that, in 1913, minerals represented but 1.70% of the total exports of the country, rising to 6.42% in 1917. With the return of peace and the reorganization of international trade, the importance of minerals declined and in 1935 accounted for 1.01% of the total. By 1939, its participation in the whole had increased, amounting to 5.40%, while in 1940 it had already attained 10.35%.

Today, the interest in minerals in the country is much more accentuated and in addition may be said to be more profound since the development of the iron and steel industry, metallurgical industry as well as the building materials industries has attained an impressing upward rhythm due in no small part to the increased capacity of absorption of the internal market. Upon this subject, the writer had the opportunity of describing in greater detail in a booklet, Chegou a Vez dos Minerais, *published in 1939.*

Taking a significant part in the development of the mineral industries is that of official action particularly evident during the Vargas Administration which in the legal aspects notes the enactment of the Codes of Mines and Waters which is the fundamental legal document on the industry. In the sphere of economics, the reader will note the progress made in a perusal of the statistics, which were purposely divided, whenever possible, into the decade previous (1920-9) to the installation of the Vargas Administration and in five-year periods which followed. An important phase of official action which deserves particular mention also is that on the part of the Ministry of Foreign Affairs which besides being in constant contact with overseas sources or markets be it in the field of the exportation of Brazilian minerals or the importation of foreign raw materials or production equipment, maintains relations with the official bodies. However, there is another phase in Brazilian diplomacy which has been exceedingly fruitful during the present term of Minister Oswaldo Aranha in which, besides the exceptionally large number of treaties and agreements signed which facilitate the exportation of Brazilian minerals, there were realized the huge loans which made possible the construction of the large scale iron and steel works of Volta Redonda in Estado do Rio and others which accelerated the improvement of the internal transportation system in order to accomodate, in no small part, the distribution of the minerals from mine to factory or export port.

There may be mentioned, in addition, the great interest manifested in the industry in the state of Minas Gerais, which in part may be traced to that which arises naturally, accounting as the state does for about 50% of the national total, and that which in greater part may be said to arise from the

desire of the State Administration to guide and maintain constant touch with the activity. The thoroughness of the latter is apparent upon a perusal of these pages in which there is evident the statistics on the production and industrial organization in that state for all minerals produced there these in reality, being the resumé of more detailed data.

Although there was the desire to avoid highly technical data, there was, necessarily, the inclusion of the principal geological aspects of the problem for which there was freely used the valuable publications and suggestions of the Departamento Nacional da Produção Mineral whose members are realizing a magnificent work which could little be improved. The writer also had the good fortune of having at his disposal the facilities of the Library and Archives of the Conselho Federal de Comercio Exterior through the kindness of the Director of the Secretariat, Consul Raul Bopp, whose suggestions proved a great incentive in this work. In addition, the writer wishes to mention the collaboration received from the Director of the Federal Serviço da Estatistica Economica e Financeira, Mr. João de Lourenço, Mr. Ribeiro da Costa, Director of the Departamento Estadual de Estatistica of the state of Minas Gerais and Mr. Mario Beni, Secretary-General of the Conselho de Expansão Economica of the state of São Paulo.

Grateful acknowledgements are hereby extended to the valuable cooperation of the members of the Conselho Federal de Comercio Exterior and Centro de Estudos Economicos, Americo Cury, Octavio Malta, Waldemar Pinna, Dona Bluma C. Wainer, Dona Dulce Barbosa and Harry S. Ikuta, the latter being entrusted with the translation and adaptation of the text to the English.

In the attempt to present a statistical picture of the mineral industry with the scanty elements at hand, it was necessary, in none too few cases, to apply personal interpretations to the vague terminology utilized at times in the references and may have given rise to shortcomings which are to be regretted. It may be noted, however, that it was always with the view in mind of presenting as conservative an estimate as possible that guided the final word.

It must be pointed out that the colloquial terminology, "Estado do Rio" (State of Rio), which refers to the state of Rio de Janeiro was adopted throughout the book for purposes of clarity inasmuch at it would otherwise appear as "Rio de Janeiro", and thereby give rise to the confusion which is unavoidable due to the world-wide fame of the city of Rio de Janeiro which, in addition, is itself a federated unit.

In view of difficulties often encountered abroad in the comprehension of the terminology of the Brazilian monetary system which does not strictly follow the orthodox decimal system, the writer wishes to add, by way of explanation, that the mil-réis, *the standard unit of currency, when translated means* one thousand reals, mil *being one thousand and* réis, *the plural form of* real *in Portuguese. One* conto-de-réis *which when abbreviated is* conto and *is equivalent to* 1,000 *milréis.*

Rio de Janeiro, May 23rd., 1941.

JOSE JOBIM

THE MINERAL WEALTH OF BRAZIL

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GENERAL SURVEY

GENERAL SURVEY

The debt that Brazil owes to minerals in the development of the country is incalculable; the discovery of the country itself was the result of the hopes and dreams of the Portuguese navigators of a rich source of gold in the New World. It was the driving force of the pioneering movements into the hinterland by the *entradas* (scouts) and *bandeirantes* (pioneers) from the Northeast and Southeast in the Seventeenth and Eighteenth Centuries in their incessant searches for gold, silver, diamonds and emeralds. In the Nineteenth Century, Colonial Brazil became Independent Brazil and thoughts turned to more solid foundations for the country. Dom João VI revoked the ruling of the Metropolis (Portugal) prohibiting the establishment of iron works in Brazil and once again, the few iron plants, which today might be classed in the category of forges, began operations. Studies of the lead of Abaeté were also made. However, the vital element, coal, was absent and studies of the Rio Grande do Sul mineral in the South were ordered. Unfortunately, there were no technical services organized as yet and the highest authority on some samples received from that State was a blacksmith... There was thus contracted in 1875, Professor Henry Gorceix, to organize the Escola de Minas de Ouro Preto (Minas Gerais). Later, there are the discoveries of the students of this school, Brazilian trained on Brazilian minerals, which resulted in works and studies on the copper of Baía, the molybdenum of Santa Catarina, the gold of Minas Gerais, the diamonds of Baía, the lead of Abaeté, the ferro-nickel of Santa Catarina, the oil shale in Baraú, the coal of the South, the platinum and palladium in Minas Gerais and numerous others. However, it was an era of studies and but little progress was noted in the development of the underground resources of Brazil.

With the turn of the Century, the trend was towards exportation of the easily available minerals despite some favorable development in the domestic iron and coal industries. The World War of 1914-18 accentuated this development to some extent and until the present Administration, there was little stress placed on the expansion of this industry due in no small part to the lack

of working hands and the "golden era" of coffee which was returning such fabulous riches that minerals and its utilization in local industry was a matter of secondary importance. The fortunes accumulated gave rise to the prevailing thought that the best was and will always be produced abroad.

The democratization of values with the appearance of the Vargas Administration has placed the emphasis on Brazil through the development of domestic industry, be it in the field of agriculture and livestock, mining or manufacturing. There was the adoption of the policy of Hamilton which the United States had put into operation over 150 years previously. Today one finds the underlying policy with relation to minerals being that of building up the manufacturing aspect of the industry, even at the expense of importing the raw material until the domestic mineral is studied and made available. Thus, there are reductions in the imports of the manufactures based on minerals in favor of the importation of the crude or semi-manufactured product.

It is difficult to establish the exact mineral output of Brazil but in considering the non-transformed products, one finds that the leading product, is gold accounting, as it does, for about 20% of the total which is estimated to have been 700,000 contos while limestone, coal, precious and semi-precious stones, salt, manganese and iron ore, follow in order of importance, their relative percentages being 19%, 10%, 6%, 5%, 4% and 4% of the total respectively.

The principal mining state is Minas Gerais, which was named as such in the past due to its mineral wealth, and which today contributes to about 50% of the total output. Her principal mineral is gold while of decreasing importance are the precious and semi-precious stones, manganese, iron ore and limestone. Following Minas Gerais is the state of São Paulo with 13% of the total output, the principal product being limestone. Rio Grande do Sul with her coal production and other minor minerals accounted for 12% while Estado do Rio, the fourth most important, had an output based largely on limestone which represented 8% of the total. It is to be noted that with the exception of Rio Grande do Sul, the remaining three states form a compact group in the Southeastern section of Brazil accounting for 71% of the total mineral output of the country.

As a point of interest, however, it may be pointed out that the output of iron, steel and cement alone equal more than one-half of the total mineral production of the country.

As will be noted in Table 1, the exports of minerals in 1940 have shown an increase of 409% since 1930. Whereas gold, manganese and carbonados accounted for 44.1% and 33.3% and 6.2% respectively of the total and proved to be the principal crude and semi-manufactured mineral exports, in 1940, diamonds, manganese and rock crystals were the largest representing 36.7%, 14.6% and 12.6% of the total respectively. Eight products were valued at more than 1,000 contos in 1930; in 1940, there were 15 products with more than this value. In 1930, there were 25 export products; in 1940, there were

57 such products. There is thus evident, the breaking away from the exportation of selected items and the increase in the number of products, some of which have come to play an important part in this trade as is true of bauxite, beryllium, iron and steel semi-manufactures, tungsten, semi-precious stones, rutile and columbite and thus provide a partial index to the increased activity in this field.

In the field of imports it will be noted that the largest overseas purchases at the installation of the Vargas Administration were gasoline, coal, cement and fuel oil while in 1940, the principal were coal, iron and steel semi-manufactures and gasoline, there being a decided increase in the interval from 248,000 contos to 1,165,600 contos or 370%. Compared to this is the development in the exports which, as was noted, rose from 43,600 to 221,800 contos or 409%.

Despite the progress registered, it must be said that Brazil is still in the phase of discoveries with the intensive exploitation of minerals limited to but few. In the pages that follow it will be noted that the ratio of worked deposits to the total is, in many cases, of small magnitude while among those that are worked, a comparatively large number are open cut mines which can mean but one thing other than the mere casual fact that the deposit is an outcropping of mineral which Nature endowed to Brazil — that a larger part of the underground mineral wealth of Brazil which necessitates a gallery system is not explored as yet. This suggests two of the most serious problems in minerals today, that of the lack of a sufficient number of technical experts and a sufficiently large budget for prospecting.

The lack of financial outlays for prospecting is evident in the case of petroleum in Lobato in the state of Baía. For 15 years prospects were carried out with a total expenditure of 5,000 contos. In the 1938 budget, the Administration decided to include 9,000 contos for the one year alone. The result was surprising in that in January 1939, Brazil had her first oil well in operation.

The insufficiency of technical experts may be traced to historical factors. For centuries, the elite of Brazil was educated in the European continental schools in Letters and Arts with a decided minority turning to the practical Sciences. When the Vargas Administration entered into power there were more superior schools than today the larger part being Law schools. Since then numerous professional schools were created with the existing institutions also being amplified. Today Brazil has more students in the professional schools than France or Holland, countries which are classed among the most industrialized. Added to this trend is the education which is extended by the Army and the private enterprises which have opened new opportunities to all social classes, the spirit of competition alone doing much to raise the intellectual level in these sciences. The very fact that each mine presents a different problem is further reason for the necessity of training numerous experts.

Another serious problem is that of transportation, the freight costs to seaboard ports being at times 35 to 40% of the FOB price. In other cases, the lack of means of transportation dismisses any possibility of exploration even with the concentration or smelting of the ores on the locale. A fairly helpful situation has been created with the opening of many provisional dirt roads

which permit truck transportation, but here again, there is the problem of rivers which are numerous in the Southeast region where the majority of the deposits of minerals are located. Water transportation is strictly against development in view of the fact that the navigable courses are towards the interior rather than towards the Atlantic coast. Another is that of the lack of rolling equipment which greatly burdens the load capacity bearing in mind the fact that the largest mining activity is also in the region of the greatest agricultural and pastoral activity. The Five-Year program of the Administration fortunately gives due emphasis to this necessity and has resulted in the opening of an average of 30 kilometers of roads annualiy and the heavy imports of railroad equipment in recent years.

The financial aspects of the problem continue with their difficulties although there is a noticeable change as it refers to the transformation of minerals as for instance the installation of the large scale iron and steel works in Volta Redonda in Estado do Rio, the lead and silver concentration plant in the state of São Paulo, and the aluminum reduction plant in Ouro Preto, all built or to be built through Government aid.

It is of importance to point out however, that despite some of the shortcomings in the industry, the technical analytical work is carried out seriously and with care, not only in the head institute in Rio de Janeiro but in the divisional laboratories there being many who are dispatched from the Departamento de Produção Mineral to the remote interior regions to give special attention to particular minerals which interest the government or which may be of some interest to private parties, a continuation of the excursions of the *bandeirantes* who in the former centuries worked with pick and shovel and depended upon luck but who today work with measuring and testing instruments and depend upon the slide rule.

MINERALS

Table 1

EXPORTS OF BRAZIL

MINERALS	UNIT	QUANTITY				MILREIS			
		1930	1935	1939	1940	1930	1935	1939	1940
TOTAL	Tons	215,398	114,674	637,786	630,421	43,570,374	14,017,250	125,932,104	221,812,706
Stones and Earths:	Kgs.	16,237,861	884,000	2,884,788	6,632,517	2,839,732	2,568,729	28,065,650	45,857,059
Asbestos	"	—	—	—	2,940	—	—	—	3,163
Sand or silicates	"	—	400,000	87,612	159,545	—	20,000	46,699	2,703
Kaolin	"			19,608	196,950	—	—	9,106	68,836
Refractive sands and earths	"	119,403	—	19,976	370,913	37,933	—	9,610	180,297
Gravels, n. e.	"	—	—	60,750	101,020	—	—	18,450	31,636
Rock crystal	"	410,591	230,862	677,552	1,103,021	1,449,759	998,701	19,096,411	27,862,945
Powdered slate	"	—	—	—	860	—	—	—	2,025
Marble	"	24,860	6,184	79,050	269,940	8,500	5,000	53,896	261,167
Beryllium ore	"	—	—	275,886	1,472,067	—	—	167,072	721,217
Agates (uncut)	"	245,411	55,843	4,041	15,321	341,198	81,273	25,030	76,765
Stones, n. e.	"	—	56,363	763,652	1,328,551	—	555,063	538,346	654,331
Talc (crude)	"	—	—	50	—	—	—	213	—
Mica	"	51,618	109,678	435,183	1,117,474	565,932	889,248	7,890,719	15,755,722
Salt, rock and evap.	"	16,500	23,135	435,183	1,117,474	2,190	6,284	202,299	170,455
Stones and earths, n. e	"	14,370,478	1,935	14,080	260	434,220	3,160	7,800	1,000
Precious Semi-precious and Rare Minerals:	"	3,234	1,777	2,146	1,982	23,228,783	471,440	42,484,799	98,036,149
Diamonds	Carats	614	201	203,729	254,396	1,101,597	279,700	39,466,657	81,403,316
Aquamarines	"	—	—	380,163	233,807	—	—	1,663,352	13,469,090
Amethysts	"	—	—	1,089,895	25,199	—	—	129,208	194,524
Garnets	"	—	—	—	270	—	—	—	4,473

MINERALS: EXPORTS OF BRAZIL (Continuation)

MINERALS	UNIT	QUANTITY				MILREIS			
		1930	1935	1939	1940	1930	1935	1939	1940
Topazes	Carats	—	—	489	5,563	—	—	3,646	197,005
Tourmalines	"	—	—	42,144	26,003	—	—	170,929	1,280,980
Semi-precious stones, n. e.	"	—	—	590,250	95,060	—	—	40,193	306,990
Carbonados	"	205	155	12,582	11,510	2,709,476	182,440	1,020,914	1,179,771
Precious stones, n. e.	Grams	...	...	—	—	170,782	9,300	—	—
Gold	"	3,229,979	—	—	—	19,246,928	—	—	—
Ores:	Tons	193,315	110,240	611,094	255,548	15,427,250	9,509,309	46,032,896	52,704,660
Bauxite	Kgs.	—	—	18,278,795	82,020	—	—	2,842,055	30,305
Chrome	"	10,000	5,000	3,754,188	4,572,000	400	650	417,675	1,090,603
Lead	"	840,000	91,430	946,562	295,700	840,000	71,717	394,571	134,363
Copper	"	—	—	97,000	—	—	—	11,640	—
Iron	Tons	11	47,184	396,938	255,548	3,276	1,428,345	18,903,606	16,185,003
Manganese	"	192,122	60,669	189,003	222,713	14,486,477	6,675,913	20,640,055	32,311,317
Ilmenite	Kgs.	79,962	286,767	10,150	12,190	12,788	146,596	12,158	20,056
Rutile	"	—	—	488,640	498,589	—	—	1,297,476	1,406,901
Monazitic sands	"	15,000	—	47,760	180,000	2,000	—	9,520	133,691
Columbite	"	—	—	34,822	15,269	—	—	361,172	307,212
Zircon	"	236,659	1,779,998	1,462,966	1,620,829	82,309	899,688	648,864	508,514
Tantalite	"	—	—	24,271	27,117	—	—	428,725	428,314
Wolfram (tungsten)	"	—	—	7,900	10,000	—	—	65,379	149,945
Nickel	"	—	56,200	—	—	—	6,000	—	—
Ores, n. e.	"	—	168,760	—	1,521	—	280,500	—	5,800
Oils, Fuels and Betuminous Mat.:	"	19,200	8,564	500	6,900,342	2,180	960	475	818,980
Coal	"	19,200	8,564	500	6,900,000	2,180	960	475	818,596
Crude tar	"	—	—	—	342	—	—	—	1,384
Iron and Steel:	"	—	—	23,415,520	30,668,686	—	—	8,748,904	20,799,197

Pig iron	"	—	—	23,413,520	22,147,472	—	—	8,739,556	11,321,604
Iron, bars, strips, etc.	"	—	—	—	3,882,088	—	—	—	4,452,987
Iron, plates, sheets, etc.	"	—	—	—	4,539,191	—	—	—	4,748,791
Ferro-manganese	"	—	—	1,000	—	—	—	4,674	—
Ferro-nickel	"	—	—	—	88,979	—	—	—	237,839
Ferro-silicon	"	—	—	1,000	—	—	—	4,674	—
Steel, bars, strips, etc.	"	—	—	—	9,640	—	—	—	31,454
Special wire for springs	"	—	—	—	119	—	—	—	3,332
Scrap iron	"	—	—	—	1,197	—	—	—	3,190
Other metals:	"	—	—	10,255	122,549	—	—	154,223	1,778,423
Brass and other copper alloys	"	—	—	10,255	122,549	—	—	154,223	1,778,423
Base Metals:	Kgs.	—	—	—	3,600	—	—	—	70,506
Aluminum, bars, plates, etc.	"	—	—	—	3,600	—	—	—	70,506
Metalloids:	"	—	—	762	—	—	—	869	—
Unused metals	"	—	—	762	—	—	—	869	—
Minerals, Not Classified:	"	6,813,538	3,537,863	348,920	433,827	2,064,379	1,476,212	431,851	915,374
Tinplate scrap	"	1,053,525	2,424,434	310,000	—	96,072	232,838	53,912	—
Scrap metal, n. e.	"	5,745,965	25,019	—	—	1,909,812	49,039	—	—
Goldsmith's dust	"	13,069	18,840	19,303	19,518	52,380	292,700	366,900	610,000
Lime	"	699	8,224	4,410	12,080	115	880	3,906	8,601
Cement	"	—	—	15,207	402,229	—	—	7,133	296,773
Calcium carbide	"	—	1,061,346	—	—	—	900,755	—	—
Minerals, not classified, n. e.	"	280	—	—	—	6,000	—	—	—
Raw Materials and Preparations for Ind. Purposes, Not Class.	"	9,540	1,786	29,160	176,716	8,050	600	12,436	831,366
Marine blue	"	—	—	—	158,471	—	—	—	790,459
Powdered metallic paints	"	—	—	—	1,245	—	—	—	26,389
Colored earths	"	—	—	29,160	17,000	—	—	12,436	14,518
Graphite	"	9,540	1,786	—	—	8,050	600	—	—

MINERALS

Table 2

IMPORTS OF BRAZIL

MINERALS	UNIT	QUANTITY				MILREIS			
		1930	1935	1939	1940	1930	1935	1939	1940
TOTAL	Tons	2,865,118	3,228,968	2,900,823	2,677,144	248,094,666	731,300,038	975,807,368	1,165,633,881
Stones and Earths:	"	68,187,622	12,979,893	20,688,986	12,005,494	11,888,935	8,698,812	13,969,777	11,492,071
Abrasives	Kgs.	59,154	72,237	99,873	101,883	185,411	273,333	423,027	426,769
Asbestos	"	136,333	31,198	44,735	247,000	183,357	69,200	160,201	585,486
Sand and silicates	"	—	357,220	473,989	275,124	—	532,583	480,883	276,584
Gravels, n. e	"	1,231,845	797,113	1,100,667	1,021,544	447,086	669,268	1,027,453	1,115,665
Alabaster, plaster, etc.	"	9,519,541	4,493,782	84,938	47,349	3,614,837	2,679,700	73,590	57,972
Slate	"	(1)	(1)	526,108	443,325	(1)	(1)	438,255	380,266
Lithographer's stone	"	(1)	(1)	53,784	25,579	(1)	(1)	161,806	64,486
Marble	"	(2)	(2)	11,648	4,503	(2)	(2)	6,015,507	2,411,596
Chalk (crude)	Grms	3,386,062	3,379,234	3,806,562	2,456,775	1,015,014	1,770,148	1,395,827	1,325,351
Chalk (prepared)	Tons	(3)	(3)	15,828	8,419	(3)	(3)	68,485	37,444
Flint	"	(1)	(1)	37	69,639	(1)	(1)	4,720	70,342
Stones, n. e.	"	5,243,535	1,906,222	669,874	268,413	1,902,535	2,418,234	647,021	271,968
Borax (natural)	"	(1)	(1)	259,743	939,126	(1)	(1)	466,067	1,797,860
Cryolite	"	(1)	(1)	200,132	214,415	(1)	(1)	738,037	1,088,117
Gypsum (crude)	"	(3)	(3)	114,002	33,376	(3)	(3)	120,743	51,775
Gypsum (prepared)	"	(3)	(3)	74,615	64,958	(3)	(3)	232,319	174,991
Talc (crude)	"	(1)	(1)	475,665	301,185	(1)	(1)	461,200	248,696
Graphite	"	(1)	(1)	79,189	72,151	(1)	(1)	260,235	278,961
Salt, rock or evap	"	48,611,152	1,942,887	95,185	37,285	4,540,695	286,346	34,875	22,130
Rocks and earths, n. e.	"	(1)	(1)	866,060	874,348	(1)	(1)	859,526	805,612
Precious, Semi-precious and Rare Minerals:	Kgs.	916	570	3,616	5,970	785,506	3,265,638	2,755,132	6,115,089
Gold, cubes or sheets	"	13,112	36,241	300	—	35,205	250,176	6,534	—
Gold, bullion	"	2,800	6,993	5,874	186,957	10,792	136,599	116,215	3,925,550
Platinum	"	9,271	34,906	14,052	3,023	115,074	625,406	312,082	66,001
Silver (bars)	"	848,300	416,596	3,514,559	5,772,070	103,094	152,152	957,675	1,450,024

Silver (leaf)	"	42,816	75,395	—	—	10,693	3,634	—	—
Radium and radio-ative prod.	Milligr.	—	—	—	181	—	—	—	144,026
Precious stones, n. e.	Grms	...	...	267	1,125	510,648	2,097,655	1,279,358	498,531
Stones, n. e.	"	—	—	80,485	300	—	—	54,678	30,779
Precious, semi-precious and rare minerals, n. e.	"	—	...	500	1,000	—	16	28,590	178
Metallic Minerals, N. E.	Kgs.	—	—	—	187,768	—	—	—	3,122,309
Metallic minerals, n. e.	"	—	—	—	187,768	—	—	—	3,122,309
Fuels, Oils, and Betuminous Mat.:	Tons	2,721,799	2,958,313	2,690,951	2,495,553	394,777,210	475,736,849	666,167,638	817,715,177
Alphalt	"	8,680	6,799	10,988	9,678	2,498,509	3,221,429	5,100,307	5,264,842
Mineral waxes or resins	"	—	69	53	64	—	293,730	270,409	413,126
Coal	"	1,745,826	1,314,692	1,200,784	1,149,544	118,525,542	136,331,784	198,227,607	269,426,700
Briquettes	"	174,611	78,149	127,447	36,360	13,224,198	9,380,901	21,770,487	9,755,449
Coke	"	21,509	44,486	54,240	23,338	2,057,597	6,761,146	14,601,881	9,686,580
Distilled coal products	"	208	5,457	86	4	261,931	1,841,905	103,853	16,384
Crude oil	"	374,457	2,376	42,293	49,266	42,198,050	1,452,798	16,048,102	21,884,261
Industrial vaseline	"	—	—	79	125	—	—	183,019	290,250
Pharmaceutical vaseline	"	154	374	348	32	388,748	1,431,327	1,197,041	1,225,569
Lubricating grease	"	930	204	347	357	1,208,682	423,396	733,864	783,776
Lubricating compounds	"	—	544	—	—	—	1,085,729	—	—
Paraffine (crude)	"	903	1,114	557	688	1,004,170	2,177,933	919,003	1,738,416
Paraffine (prepared)	"	(4)	(4)	720	666	(4)	(4)	1,543,300	2,379,977
Gasoline (tank shipments)	"	279,495	276,328	354,503	361,750	139,172,940	132,862,093	153,508,548	190,287,362
Gasoline (tins)	"	—	—	15,584	6,648	—	—	14,587,162	8,082,916
Fuel oil	"	(5)	436,713	629,484	566,399	(5)	65,222,309	96,874,260	125,981,316
Diesel oil	"	(5)	(6)	94,957	127,693	(5)	(6)	27,934,987	45,119,528
Kerosene	"	90,465	94,119	94,562	101,647	46,842,147	65,552,075	39,753,666	49,348,584
Lubricating oils (refined)	"	24,561	34,550	42,579	42,059	27,394,686	45,235,565	63,187,790	65,644,844
Gas oil	"	(5)	(7)	19,584	16,160	(7)	(7)	6,907,222	7,698,186
Signal oil	"	(5)	(7)	198	149	(7)	(7)	201,255	197,366
Transformer oil	"	—	1,114	1,315	1,426	—	1,781,360	2,056,896	2,191,056
Industrial oil	"	—	2	—	—	—	11,720	—	—
Oils, n. e.	"	—	661,223	37	11	—	667,640	116,909	38,618
Asphalt, pitch and tar mixt.	"	(8)	(8)	197	195	(8)	(8)	305,573	242,285
Fuels, oils and bet. mat., n. e.	"	—	—	18	5	—	2,111	34,497	17,686
Iron and Steel:	Kgs.	50,407,443	98,566,197	90,502,492	95,780,374	25,411,205	98,659,910	131,593,398	177,114,330
Pig iron	"	1,953,680	499,789	857,905	428,646	514,360	421,648	326,949	529,506

MINERALS: IMPORTS OF BRAZIL (Continuation)

MINERALS	UNIT	QUANTITY				MILREIS			
		1930	1935	1939	1940	1930	1935	1939	1940
Iron, bars and rods	Kgs.	22,470,255	30,725,767	13,177,274	9,469,665	8,388,697	22,187,717	14,979,414	13,525,711
Iron, strips	"	6,212,489	13,301,522	9,225,094	7,253,037	4,692,240	14,876,445	14,063,150	14,825,451
Iron, sheets	"	11,647,523	28,092,904	33,106,031	39,520,351	5,950,370	26,657,731	45,759,265	64,752,130
Ferro-manganese	"	—	—	—	1,008,060	—	—	—	2,539,585
Ferro-nickel	"	—	—	—	538	—	—	—	3,701
Ferro-silicon	"	—	—	—	427,833	—	—	—	1,138,692
Steel, bars and roads	"	3,781,506	5,159,079	6,747,126	6,609,362	3,622,935	9,398,438	12,473,308	14,386,175
Steel, strips	"	—	1,276,802	4,886,937	6,367,495	—	2,778,663	8,744,490	16,005,947
Steel, sheets	"	2,029,720	2,987,514	9,787,587	10,892,077	1,170,714	4,441,719	14,445,050	25,017,642
Special steels	"	—	386,749	955,624	322,473	—	1,215,910	3,308,553	1,985,839
Misc. iron and steel plates	"	—	8,712,484	10,834,050	11,944,941	—	6,789,270	11,959,173	17,071,813
Filings	"	82,662	44,504	62,276	22,336	196,604	183,028	178,552	42,428
Steel wool	"	—	—	136,887	80,299	—	—	1,422,851	859,058
Solder	"	—	—	943,408	928,905	—	—	3,446,394	3,345,450
Iron and steel, n. e.	"	2,229,608	7,379,083	282,293	504,356	875,285	9,709,341	486,249	1,085,202
Base Metals:	"	9,420,382	20,408,552	26,381,088	20,306,501	23,533,002	67,519,728	106,031,590	95,193,125
Lead, sheets, folls, etc.	"	(9)	(9)	182,269	92,608	(9)	(9)	316,443	265,724
Lead (crude)	"	3,682,584	7,981,779	10,707,504	9,264,920	3,909,523	11,286,664	18,669,357	17,675,985
Tin (crude)	"	588,158	784,549	1,280,096	916,047	4,334,413	15,858,829	18,069,012	21,094,961
Copper, ing., bars, filing, etc.	"	2,847,027	804,556	6,768,183	4,153,057	8,570,369	2,790,208	34,247,514	22,712,470
Copper, sheets	"	1,334,335	9,353,553	2,661,627	2,579,868	5,253,317	35,095,968	16,579,294	17,024,503
Copper, leaf	"	749	2,257	—	—	39,581	218,405	—	—
Copper, filings	"	—	3,727	—	—	—	12,691	—	—
Brass and other copper alloys	"	(10)	(10)	1,366,927	909,782	(10)	(10)	9,385,826	8,452,697
Tin solders	"	(9)	(9)	47,125	73,161	(9)	(9)	557,908	883,380
Special base metal alloys	"	—	—	155.314	45.091	—	—	1,177,659	424,524
Zinc, bars and rods	"	(11)	(11)	2,258,581	2,041,153	(11)	(11)	5,031,547	5,774,799
Zinc, sheets and plates	"	(11)	(11)	477,231	83,652	(11)	(11)	1,203,593	341,716
Zinc (crude)	"	967,529	1,478,131	475,062	137,246	1,425,898	2,256,963	786,910	490,915
Base metals, n. e.	"	(12)	(12)	1,169	9,916	(12)	(12)	6,527	51,471

Special Metals:	Kgs.	622,102	1,240,640	1,734,260	1,713,448	3,878,302	12,292,327	16,355,966	17,069,088
Silico-aluminum alloy base	"	—	—	—	225,620	—	—	—	677,413
Aluminum (crude and prep.)	"	519,992	1,105,821	1,674,289	1,127,066	2,920,415	8,877,005	14,818,409	11,997,005
Aluminum scrap	"	—	—	—	229,788	—	—	—	1,819,406
Mercury (crude)	"	4,257	3,090	6,397	5,989	147,397	320,923	395,573	632,037
Mercury (prepared)	"	—	—	1,503	1,549	—	—	110,173	184,079
Nickel (crude and prepared)	"	52,026	80,880	51,554	63,218	423,168	1,530,881	1,015,954	1,287,650
Chrome and tungsten	"	—	50	—	—	—	2,611	—	—
Special metals, n. e.	"	45,827	45,799	517	5,120	387,322	1,561,107	15,857	94,793
Metalloids and Various Metals:	"	4,505,764	15,518,448	23,355,235	24,306,827	1,961,843	11,753,812	15,386,801	18,215,278
Argon	"	—	—	3,011	794	—	—	382,139	110,586
Liquified and compressed gases	"	—	938,358	9,509	13,771	—	3,440,887	209,449	246,814
Helium and other rare gases	"	—	1,693	2,970	17	—	235,563	82,177	14,424
Iodine (crude)	"	—	—	7,853	11,316	—	—	334,614	600,941
Iodine (prepared)	"	—	—	4,057	2,264	—	—	240,397	198,682
Sulfur, bar	"	4,200,019	13,694,457	22,614,630	23,430,391	1,514,710	6,966,200	12,591,203	14,536,267
Sulfur powdered	"	—	688,105	410,140	377,037	—	454,898	360,101	392,429
Sulfur, purified	"	—	26,268	199,810	293,998	—	35,283	150,989	220,242
Selenium	"	—	(13)	1,451	981	—	(13)	113,563	81,002
Phosphorus	"	—	(13)	13,342	15,860	—	(13)	200,425	328,747
Metalloids n. e.	"	—	(13)	7,985	175	—	(13)	102,377	13,622
Antimony (industrial)	"	(14)	(14)	73,717	146,209	(14)	(14)	339,407	1,220,223
Antimony, arsenic and bismuth	"	305,746	169,504	—	—	447,133	618,411	—	—
Potassium and sodium	"	—	63	—	—	—	2,590	—	—
Metalloids for analysis and scient. uses	"	—	—	1,163	1,401	—	—	53,678	55,848
Metalloids n. e.	"	—	—	6,097	12,613	—	—	226,282	197,451
Mineral Products, Not Classified:	"	552,165	115,467,234	41,148,179	22,873,368	47,285,676	18,886,162	10,948,639	7,577,387
Lime	"	167,662	35,832	26,485	45,296	59,433	44,801	36,483	45,102
Cement, magnesium	"	(16)	(15)	118,915	57,141	(16)	(15)	108,530	112,902
Cement, white	"	(16)	1,235,422	6,145,682	4,341,036	(16)	864,637	3,229,309	2,566,023
Cement, common	"	384,503	114,154,000	34,833,565	14,896,408	47,226,243	17,351,350	7,389,271	3,666,021
Cement, "ferro"	"	—	—	—	1,034	—	—	—	1,781
Cement, n. e.	"	(16)	—	170	3,490,532	(16)	—	834	1,007,482
Glass, powdered, tubes, etc.	"	—	—	18,141	32,731	—	—	172,504	163,101
Mineral pord., not classified	"	—	41,980	5,221	9,190	—	625,374	11,708	14,975

MINERALS: IMPORTS OF BRAZIL (Continuation)

MINERALS	UNIT	QUANTITY				MILREIS			
		1930	1935	1939	1940	1930	1935	1939	1940
Iron, bars and rods	Kgs.	22,470,255	30,725,767	13,177,274	9,469,665	8,388,697	22,187,717	14,979,414	13,525,711
Iron, strips	"	6,212,489	13,301,522	9,225,094	7,253,037	4,692,240	14,876,445	14,063,150	14,825,451
Iron, sheets	"	11,647,523	28,092,904	33,106,031	39,520,351	5,950,370	26,657,731	45,759,265	64,752,130
Ferro-manganese	"	—	—	—	1,008,060	—	—	—	2,539,585
Ferro-nickel	"	—	—	—	538	—	—	—	3,701
Ferro-silicon	"	—	—	—	427,833	—	—	—	1,138,692
Steel, bars and roads	"	3,781,506	5,159,079	6,747,126	6,609,362	3,622,935	9,398,438	12,473,308	14,386,175
Steel, strips	"	—	1,276,802	4,886,937	6,367,495	—	2,778,663	8,744,490	16,005,947
Steel, sheets	"	2,029,720	2,987,514	9,787,587	10,892,077	1,170,714	4,441,719	14,445,050	25,017,642
Special steels	"	—	386,749	955,624	322,473	—	1,215,910	3,308,553	1,985,839
Misc. iron and steel plates	"	—	8,712,484	10,834,050	11,944,941	—	6,789,270	11,959,173	17,071,813
Filings	"	82,662	44,504	62,276	22,336	196,604	183,028	178,552	42,428
Steel wool	"	—	—	136,887	80,299	—	—	1,422,851	859,058
Solder	"	—	—	943,408	928,905	—	—	3,446,394	3,345,450
Iron and steel, n. e.	"	2,229,608	7,379,083	282,293	504,356	875,285	9,709,341	486,249	1,085,202
Base Metals:	"	9,420,382	20,408,552	26,381,088	20,306,501	23,533,002	87,519,728	106,031,590	95,193,125
Lead, sheets, folls, etc.	"	(9)	(9)	182,269	92,608	(9)	(9)	316,443	265,724
Lead (crude)	"	3,682,584	7,981,779	10,707,504	9,264,920	3,909,523	11,286,664	18,669,357	17,675,965
Tin (crude)	"	588,158	784,549	1,280,096	916,047	4,334,413	15,858,829	18,069,012	21,094,961
Copper, ing., bars, filing, etc.	"	2,847,027	804,556	6,768,183	4,153,057	8,570,369	2,790,208	34,247,514	22,712,470
Copper, sheets	"	1,334,335	9,353,553	2,661,627	2,579,868	5,253,317	35,095,968	16,579,294	17,024,503
Copper, leaf	"	749	2,257	—	—	39,581	218,405	—	—
Copper, filings	"	—	3,727	—	—	—	12,691	—	—
Brass and other copper alloys	"	(10)	(10)	1,366,927	909,782	(10)	(10)	9,385,826	8,452,697
Tin solders	"	(9)	(9)	47,125	73,161	(9)	(9)	557,908	883,380
Special base metal alloys	"	—	—	155.314	45.091	—	—	1,177,659	424,524
Zinc, bars and rods	"	(11)	(11)	2,258,581	2,041,153	(11)	(11)	5,031,547	5,774,799
Zinc, sheets and plates	"	(11)	(11)	477,231	83,652	(11)	(11)	1,203,593	341,716
Zinc (crude)	"	967,529	1,478,131	475,062	137,246	1,425,898	2,256,963	786,910	490,915
Base metals, n. e.	"	(12)	(12)	1,169	9,916	(12)	(12)	6,527	51,471

Special Metals:	Kgs.	622,102	1,240,640	1,734,260	1,713,448	3,878,302	12,292,327	16,355,966	17,069,086
Silico-aluminum alloy base	"	—	—	—	225,620	—	—	—	677,413
Aluminum (crude and prep.)	"	519,992	1,105,821	1,674,289	1,127,066	2,920,415	8,877,005	14,818,409	11,997,005
Aluminum scrap	"	—	—	—	229,788	—	—	—	1,819,406
Mercury (crude)	"	4,257	3,090	6,397	5,989	147,397	320,923	395,573	632,037
Mercury (prepared)	"	—	—	1,503	1,549	—	—	110,173	184,079
Nickel (crude and prepared)	"	52,026	80,880	51,554	63,218	423,168	1,530,681	1,015,954	1,287,650
Chrome and tungsten	"	—	50	—	—	—	2,611	—	—
Special metals, n. e.	"	45,827	45,799	517	5,120	387,322	1,561,107	15,857	94,793
Metalloids and Various Metals:	"	4,505,764	15,518,448	23,355,235	24,306,827	1,981,843	11,753,812	15,386,801	18,215,278
Argon	"	—	—	3,011	794	—	—	382,139	110,586
Liquified and compressed gases	"	—	938,358	9,509	13,771	—	3,440,887	209,449	246,814
Helium and other rare gases	"	—	1,693	2,970	17	—	235,563	82,177	14,424
Iodine (crude)	"	—	—	7,853	11,316	—	—	334,614	600,941
Iodine (prepared)	"	—	—	4,057	2,264	—	—	240,397	198,682
Sulfur, bar	"	4,200,019	13,694,457	22,614,630	23,430,391	1,514,710	6,966,200	12,591,203	14,536,267
Sulfur powdered	"	—	688,105	410,140	377,037	—	454,898	360,101	392,429
Sulfur, purified	"	—	26,268	199,810	293,998	—	35,263	150,989	220,242
Selenium	"	—	(13)	1,451	981	—	(13)	113,563	81,002
Phosphorus	"	—	(13)	13,342	15,860	—	(13)	200,425	328,747
Metalloids n. e.	"	—	(13)	7,985	175	—	(13)	102,377	13,622
Antimony (industrial)	"	(14)	(14)	73,717	146,209	(14)	(14)	339,407	1,220,223
Antimony, arsenic and bismuth	"	305,745	169,504	—	—	447,133	618,411	—	—
Potassium and sodium	"	—	63	—	—	—	2,590	—	—
Metalloids for analysis and scient. uses	"	—	—	1,163	1,401	—	—	53,678	55,848
Metalloids n. e.	"	—	—	6,097	12,613	—	—	226,282	197,451
Mineral Products, Not Classified:	"	552,155	115,467,234	41,148,179	22,873,368	47,285,676	18,886,162	10,948,639	7,577,387
Lime	"	167,662	35,832	26,485	45,296	59,433	44,801	36,483	45,102
Cement, magnesium	"	(16)	(15)	118,915	57,141	(16)	(15)	108,530	112,902
Cement, white	"	(16)	1,235,422	6,145,682	4,341,036	(16)	864,637	3,229,309	2,566,023
Cement, common	"	384,503	114,154,000	34,833,565	14,896,408	47,226,243	17,351,350	7,389,271	3,666,021
Cement, "ferro"	"	—	—	—	1,034	—	—	—	1,781
Cement, n. e.	"	(16)	—	170	3,490,532	(16)	—	834	1,007,482
Glass, powdered, tubes, etc.	"	—	—	18,141	32,731	—	—	172,504	163,101
Mineral pord., not classified	"	—	41,980	5,221	9,190	—	625,374	11,708	14,975

MINERALS: IMPORTS OF BRAZIL (Continuation)

MINERALS	UNIT	QUANTITY				MILREIS			
		1930	1935	1939	1940	1930	1935	1939	1940
Industrial Raw Materials and Preparations, Not Classified:..	Kgs.	9,622,236	6,472,885	6,057,881	4,411,158	11,572,987	16,187,800	12,598,427	12,020,029
Indigo	"	204,904	119,072	33,370	14,848	551,823	710,991	275,469	230,944
Titanium powder	"	202,896	4,125,074	1,512,618	1,306,739	375,333	7,551,352	3,123,100	2,792,976
Metallic paint materials	"	487,661	269,837	5,597	5,083	790,719	691,255	127,790	138,596
Carbon black	"	—	—	897,096	915,852	—	—	2,614,514	2,745,625
Paris green	"	687	142,926	83,964	175,163	3,461	848,040	648,373	1,347,169
Colors or paints, n. e	"	3,100,239	456,584	92,616	195,708	3,137,365	1,819,240	1,139,423	1,994,669
Turpentine	"	2,082,083	801,846	3,345,744	1,753,349	2,745,378	1,881,742	4,489,288	2,600,589
Colored earths	"	646,423	177,122	48,211	37,004	1,206,876	564,741	111,497	90,324
Vitrifiable coatings	"	—	338,444	—	—	—	1,495,065	—	—
Industrial raw materials and preparations not clssfd. n. e.	"	2,897,343	41,980	38,665	7,412	2,762,032	625,374	68,973	79,137

NOTE: (1) — Included in "Stones, n. e."
(2) — " " "Alabaster"
(3) — " " "Chalk (crude)"
(4) — " " "Paraffine (crude)"
(5) — " " "Crude oil"
(6) — " " "Fuel oil"
(7) — " " "Oils, n. e."
(8) — " " "Asphalt"
(9) — Included in "Crude lead"
(10) — " " "Sheet copper"
(11) — " " "Zinc (crude)"
(12) — " " "Special metals, n. e."
(13) — " " "Liquified and compressed gases"
(14) — " " "Antimony, arsenic and bismuth"
(15) — " " "Cement, white"
(16) — " " "Cement, n. e."

METALLIC MINERALS

1. GENERAL SURVEY

The mining of metals in Brazil has always been intimately connected with gold and iron. In early history, there are references to the discovery of alluvial gold in about the year 1541 while that of iron seems to precede this, there being evidences that it was found in the early Sixteenth Century, soon after the discovery of the country. The first iron smelter was constructed in 1590 in Araçoiaba in Sorocaba, today Ipanema, of the then province of São Paulo and was followed in 1603 by the second plant in Ubata located near the first. Both worked until 1629 when the Edict of the Metropolis (Portugal) prohibited the operation of such plants and thus brought to an end the first phase of Brazilian iron production history.

São Paulo was also the first to develop the gold mining industry; the alluvials of the Ribeira do Iguape River and its tributaries were the sources of the precious metal which was found in such abundance that it was necessary to cast bars of the gold mined. The first smelter was established at Iguape in about 1637. São Paulo's supremacy however was upset with the discovery of gold in Minas Gerais in 1650. Production increased in an animated manner and it was not long before it became necessary to open special roads between the Capital, Rio de Janeiro, and the gold districts of that state. Mato Grosso and the *sertão* of Baía began production in 1719 while that of Goiaz took place in 1725.

The *Casas de Fundição* which acted as the controlling agents and collectors of the *fifths* (royal tax on mined gold) registered a production of about 832,000 kilograms during the period from the last years of the 17th Century to the year of Independence (1822). However, in addition to this quantity, there must be considered that which was clandestinely exported, evidence of which is found in the complaints frequently made of the fines levied on smuggling for which the Portuguese and Brazilians were punished but which the English were able to evade legally. A rough estimate, including this illegal production, would increase the total to about double the registered Colonial output to about 1,700 tons. In that period Brazil was the world's

largest producer; today, the Union of South Africa produces this quantity in four years.

There is little doubt that of this total the state of Minas Gerais produced about 70%, the state which today is said to have a "chest of iron and a heart of gold". It is also a noteworthy fact that at that time the annual average output was 14 tons while today it fluctuates from 8 to 10 tons per annum while some sources would place it at 20 tons per annum.

The lack of working hands with the greed of the rulers in Portugal, gave rise to slave traffic to the mining regions and there concentrated all activity on mining only, thereby creating an environment wherein agriculture and pastoral activity were absent. Thus, the gold alluvials were rapidly depleted.

The depletion of alluvial gold may be said to be the end of the so-called Mineral Cycle in Brazilian history and with it this Southeast and Central region composed of the mining states reverted to a more sedentary life based on the pastoral industry and was only revived definitely with the approach of coffee.

The new Mineral Age in this region, and practically speaking, all Brazil, begins with the introduction of the products of the Industrial Revolution, the machine, tools, large capital investments, etc., and the demands which the new products brought. Manganese was first worked at the close of the last Century, lead was smelted during the years after Independence, nickel, tungsten and chrome ore are 20th Century metals while others are characterized by their early discovery but late exploitation.

Although some mineral deposits of importance were discovered during the first decades of the Twentieth Century, it may be said that the greatest advances have been realized during the 1930-40 decade which commences with the present Administration. The results may be traced to two principal causes as it refers to the metallic minerals, first, the rapid development of the iron and steel industry, and second, the expansion of the metallurgical industry.

As is noted in the chapter relative to iron and steel, the outputs of pig iron, rolled iron and steel have increased 430% during the 1930-40 period which was not accomplished by the importation of iron ore or pig iron but by the utilization of domestic ores and the reduction of pig iron imports from 1,954 metric tons in 1930 to 429 metric tons in 1940 while at the same time increasing its exports from nil in the former year to 22,147 metric tons in the latter. The advantages of the increased production of iron and steel to the manganese industry of Brazil are self-evident while it may be noted that as it refers to nickel and other steel alloy metals, although production is still on a small scale, attempts toward the expansion of the output of these alloys have resulted in some exports which could not but dispell any fears of the lack of initiative in this direction. Particularly effective have been the efforts of the Army and official institutes in this technical orientation.

The general trend in the production of metallic ores is upward while at the same time there is the increasing importation of the crude or semi-finished metal in preference to the buying of the finished product. Exports of

ores continue irregularly with a slight increase in 1940 in some of them due to the effects of the War. There is thus a greater concentration and consumption of metallic minerals within the borders of Brazil which is accounted for by the progress in the metallurgical industry and which exists as a challenge to initiative in the ore mining enterprises. To give an example of the increase it is to be noted that the production of articles of iron, aluminum, copper and others which are subject to the Consumption Tax increased from 21.5 million kilograms in 1928 to 54.3 million kilos in 1939.

A significant characteristic of this industry is the lack of smelting or concentration plants. It will be noted that there is little if any importation of ores, the so-called "crude" product of official statistics referring to the transformed product, which bears out this point. There thus arises the question as to what are the causes for this apparent lack of interest and complacency in this highly necessary industry, a requisite under the ordinary circumstances in any country but particularly so in considering the additional reasons in Brazil — the lack of transportation facilities throughout the country which favors concentration or reduction on the locale and, the availability of water power sources. The lack of capital is one of the prime reasons as it refers to private enterprise while in second plane are those of the insufficient studies which if overcome might determine the size of deposits and properly evaluate the necessity of such installments. The case of the lead smelter of Ribeira de Iguape Valley is pertinent to this point. Previously, the extent of the deposits was a conjectural matter; with surveys ascertaining the potential value of the deposit, there was established a *semi-official* reduction and smelting plant in the absence of private initiative.

Another feature of the metallic minerals is that those which are being worked are centralized in the four states, Paraná, São Paulo, Minas Gerais and Baía. A favorable factor in this localization is that of a development which is traditional and dates back to Colonial days thus favoring the region with comparatively better transportation facilities as well as labor. Of importance also is the fact that the industrial section is situated within this region, particularly the iron and steel industry and thus gives rise to metallurgical needs which includes no small part of the metals which are used in alloys.

What the future holds for the metallic minerals in Brazil is an open question but a continuation of present trends would lead to the conclusion that there should be a smaller dependence upon the overseas market and a greater reliance upon the progress of the home metallurgical industry.

2. ANTIMONY

Antimony, a metal widely used in type metal, batteries, cable coverings and bearing metals, is found in but limited quantities in Brazil. Occurrences of some probable commercial value are found associated with zinc ores in Morro do Bule near Ouro Preto in the state of Minas Gerais and in Cananea in the

state of São Paulo. Of the two, the former is considered the more valuable.

Import statistics of this metal have been recorded separately only since 1937 in which year it amounted to 104 metric tons, the principal source having been England which supplied 64 metric tons. China, the world's leading producer, exported 27 metric tons to this market. In 1938, purchases overseas increased to 115 metric tons while in 1939, there was a decrease to 74 metric tons. In 1940, imports totaled 146 metric tons, the principal source in this year being the United States. Secondary sources were England and Belgium.

Recovery of secondary metal in Brazil is practically limited to that which is available from type metal.

3. ARSENIC

The uses of the metal, arsenic, as a metal are restricted the principal of which is that in lead as a hardener. Of small importance is that used in wiping solders, a relatively new development which is favored over the common lead-tin solder due to the more homogeneous nature of the product. However, it is as white arsenic that the major portion of the metal is employed in industry, significant in which is that proportion which is ultimately used in insecticides. Smaller amounts enter into the glass, soap, gasoline, pharmaceutical, ink, iron and steel and wood preserving preparations industries. In Brazil, the largest use is in agriculture as an insecticide, principally in the Southeast in the technological crops and also in the pastoral industry as sheep dip. It may be noted in this connection, however, that there is the increasing use of the vegetable insecticides such as *timbó* (derris), pyrethrum flower, etc., which are grown locally in substantial quantities and are important regional exports.

The leading world producers of white arsenic are Sweden, the United States and Mexico while France, Germany and Belgium are secondary producers. Of the estimated total of about 58,000 tons in 1939, Brazil produced 713 metric tons which places this country as the tenth largest in the world.

The leading exporting countries are Mexico, the United States, France and Germany. Brazil does not export due to the relatively heavy internal demand and thus must import, the quantity (385 metric tons) in 1938 placing this country in 10th place among world importers, the principal of which are the United States, England, Belgium and Argentina.

The state of Minas Gerais is the sole producing state of white arsenic at present, the output being the by-product of the mining of gold. After the extraction of gold, the tailings which contain arsenical pyrites (FeAsS) are burned and produce the oxide commonly called white arsenic.

Two companies produce white arsenic under this method being the St. John d'el Rey Gold Mining Company and the Cia. Minas da Passagem, the former being located in Nova Lima and the latter in Passagem. Due to the nature of production, it is impossible to give data as to arsenic alone although it may be noted that the two enterprises in their whole production have a capital of

196,600 contos, that of the St. John d'el Rey Company being 193,700 contos, and the Cia. de Minas da Passagem being 2,900 contos. There are 7,290 persons employed in the former company and 2,000 in the latter. There is another plant in Juca Vieira for which data are unavailable.

In 1933, the Brazilian output of white arsenic was 493 metric tons of which the St. John d'el Rey Company produced 322 metric tons or 65% of the total while the Cia. Minas da Passagem produced 171 metric tons or 35%. In 1934, production increased to 700 metric tons that of the former company being 408 metric tons and the latter 292 metric tons. Until 1940 the output evidenced a regular oscillation between the limits of 520 metric tons and 732 metric tons which is noted in the following: 1935 — 692 metric tons, 1936 — 732 metric tons, 1937 — 717 metric tons, 1938 — 520 metric tons and 1939 — 713 metric tons. In 1940, there was an increase of 53% over that of 1939 totalling 1,088 metric tons of which the St. John d'el Rey Company produced 966 metric tons or 89% of the total and the Cia. Minas da Passagem 122 metric tons.

It is of interest to note that in 1935, of the total production of the St. John d'el Rey Company, that of gold was valued at 64,359 contos or 98% of the total, that of white arsenic 1,391 contos or 2% and silver 159 contos or nil. In 1940, the corresponding values were 94,528 contos or 98% for gold, 2,415 contos or 2% for white arsenic and 159 contos or nil for silver. The Cia. Minas da Passagem produced 7,000 contos of gold and 335 contos of white arsenic in 1935 the relative proportions being 95% and 5% of the total respectively. In 1940, gold production had increased to 9,709 contos while that of arsenic production had decreased to 306 contos, the relative proportions in this year being 97% for gold and 3% for arsenic.

Official statistics of the Ministry of Agriculture place the value of output of these companies at an average of 2,386 milreis per metric ton in 1937, 2,265 milreis in 1938, 2,352 milreis in 1939 and 2,501 milreis in 1940. Other sources place the mine price of the white arsenic at 1,500 milreis per metric ton. In contrast to these are the import prices (CIF Brazil) which show the following changes over the same years: 1937 — 1,494 milreis, 1,697 milreis in 1938, 1,718 milreis in 1939 and 2,067 milreis in 1940.

4. ALUMINUM (Bauxite)

Aluminum which at one time was more rare and costly than gold or silver despite its being one of the most abundant of elements on the earth, is one of the newer metals and owes its wide industrial application to the discovery of a cheap and efficient process of manufacture in 1886. From the small but significant output of 16 metric tons in that year, production has steadily risen and in 1939, the world total is estimated to have exceeded 650,000 metric tons, the largest ever recorded.

The efforts of C. M. Hall, the discoverer of the above mentioned process, were largely confined to cryolite as a basic raw material; today, bauxite, a hydrated aluminum oxide, is the predominant source of this important

metal. In order of importance, France, the British Guiana, Hungary, Yugoslavia and Surinam are the largest producers of this clay, while Surinam, the British Guiana, Yugoslavia and Hungary are the largest world exporters. It is worthy of note, in this connection, that about 60% of the world's output is found in the Americas while 38% is exported from this continent.

In the absence of production data, the substitution of export figures places Brazil in 15th place among world producers. The larger part of the present output of Brazil comes from the Poços de Caldas Plateau in the state of Minas Gerais which contains two different types of mineral. The ore is rich and is mined by open cuts. The reserves of these deposits are estimated to be about 120,000,000 tons, 7,000,000 tons of which have already been studied. An analysis of the ore of this region being worked, which represents about 10% of the total available material, shows from 60 to 65% Al_2O_3 and is denominated gibbsite and bauxite clay. The remaining 90% of the deposits contains from 54 to 60% Al_2O_3 and does not serve for the direct manufacture of aluminum sulfate as is true of the former but could be given over to use as as aluminum raw material. At present it is not being worked. In this connection it may be mentioned that the former material contains 4 to 6% Fe_2O_3 while the latter has as much as 7 to 10%; less than 5% Fe_2O_3 is only obtained after careful selection. Approximately 220 persons are employed in the deposits of this region, which, it may be noted, produce about 95% of the total of the state. Other fairly important deposits in this state are those located in Saramenha, Lagoa do Bambá and Morro do Cruzeiro in the municipality of Ouro Preto now being worked by three firms, two of which work the clay together with ochres. The reserves are estimated to total 2,000,000 tons and are at present supplying mineral for the aluminum sulfate industry of São Paulo and also a plant in Ouro Preto.

Production data of the Departamento Estadual de Estatística of Minas Gerais give the following figures for output in the state in recent years and although they do not represent the total production of Brazil, they furnish a partial criterion as to trends in this branch of activity: 7,000 metric tons in 1937; 14,374 metric tons in 1938; 9,012 metric tons in 1939 and 10,000 (estimated) metric tons in 1940.

There are over 80 deposits of bauxite in Brazil and besides those mentioned above, those of some importance are to be found in Grauira Island and Maracassume in the state of Maranhão and Muqui in the state of Espirito Santo. Others of less importance are in Correntina and Barra do Mendes in the state of Baía and Entroncamento in Estado do Rio.

The Muqui deposits of the state of Espirito Santo are situated about 400 kilometers from Rio de Janeiro, 200 kilometers from the Port of Vitoria in the state of Espirito Santo and 90 kilometers from Barra do Itapemirim from which future shipments of ore will probably be made. The reserve of the deposit, according to the latest estimates, is about 1 million tons. Due to the difficulties of transportation, the Company is shipping only 6,000 tons annually.

With improvements in the capacity of the Leopoldina Railway which serves this company it is estimated that it will be possible to increase exportation to 30,000 tons annually.

The occurrences of bauxite on the coast of the state of Maranhão are interesting from the point of view of their composition, being phosphorous bauxite. The deposits are estimated to reach millions of tons, Trauira Island alone having a reserve of 10 million tons with a phosphorus base. Brazilian experts are undertaking studies with a view to obtaining a cheap process for the utilization of these reserves in the manufacture of phosphates and alumina as by-products. With the success of these efforts, it is believed they will be able to supply the total internal demand for the phosphatic fertilizers.

Among world exporters of bauxite, Brazil is in 12th place. Recorded exports of bauxite from Brazil begin in 1936 in which year they amounted to 7,000 metric tons, Argentina being the sole market. In 1937, Argentina was again the only purchaser having bought 8,770 metric tons of this ore. In 1938, of the total of 12,928 metric tons, shipments are recorded to Argentina, France and Uruguay, the respective amounts being 12,905 metric tons, 15 metric tons and 10 metric tons. In 1939, Argentina again was the only buyer, shipments having risen to 18,279 metric tons. In 1940 there was a drastic decline to 82 metric tons, the markets being Uruguay and Argentina.

The FOB price of the export product shows the following variations over the years: 1936 — 146 milreis per metric ton, 1937 — 213 milreis, 1938 — 193 milreis, 1939 — 155 milreis and 369 milreis in 1940, the latter being the highest in the export history of the mineral. The mine price of the crude product was 40 milreis per metric ton while that of the improved mineral was 130 milreis per metric ton.

* * *

Despite the presence of large and rich deposits of bauxite, there is no aluminum reduction plant of importance in Brazil. Thus consumption of bauxite is limited to other uses, viz., abrasives, aluminum sulfate and in refractory materials. It is reported that domestic consumption in 1936 was about 1,000 tons while in 1938 this, in all probability, had risen to 3,000 tons. It is doubted whether this can be increased appreciably under present circumstances due to the limited capacity of the plants employing this raw material. It may be noted, however, that there is a possibility of increase in consumption with the utilization of the phosphatic bauxite of the North for fertilizer. At present, the largest use for bauxite in Brazil is for the manufacture of aluminum sulfate while that for abrasives, cement and insecticides exists but to an exceedingly limited degree.

The reason for the absence of a reduction plant in Brazil rests on the lack of capital for investment, the factor of electrical power (1 pound of metal requires 10 to 12 kWH) being readily solved in the industrial Southeast. As to the other raw materials necessary in a minor degree, that is, soda ash, coke, tar

and pitch, coal and gas, and lime, all except the latter must be imported to a larger or smaller degree and present additional difficulties to the establishment of this industry in this country. There is thus an increasing necessity to augment imports of aluminum with the rising domestic consumption. In this connection there is an interesting development in the composition of this trade which reflect the trends in the domestic metallurgical aluminum industry.

In the 1920-9 period, the average annual imports amounted to 210 metric tons while in the 1930-4 quinquennium this had decreased to 110 metric tons. During the following five-year period, 1935-9, the average had declined again to 56 metric tons; the 1940 imports amounted to 122 metric tons. Contrasted to this decline is that of the rise in imports of the crude and semi-manufactures of this metal, the average of the 1920-9 period being 533 metric tons while that of the 1930-4 period rose to 620 metric tons. During the 1935-9 five-year period, imports more than doubled that of the previous period and amounted to an annual average of 1,399 metric tons, while that of 1940 aggregated 1,638 metric tons.

Recently, however, two professors of the Escola de Minas e Metalurgia of Ouro Preto of the state of Minas Gerais succeeded in preparing aluminum from the bauxite of the region, the first time it was ever accomplished in Brazil. Further reports make mention of the erection of a reduction plant in Ouro Preto in the near future by the Cia. Eletro-Quimica which at present is manufacturing aluminum sulfate in that city with the local bauxite. The planned process is the Bayer.

5. BERYLLIUM

Beryllium, or glucinium, is a metal which only recently has made its appearance in industry. Is is an aluminum silicate and occurs in various colors vaying according to the amount of metallic oxide which it contains. The rough forms are usually elongated prisms, sometimes flat with dimensions of centimeters and decimeters with occasional stones weighing hundreds of kilograms. Generally, the largest especimens are opaque and are only used for the metal, beryllium (glucinium).

The jewelry and the steel alloy industries consume practically all of the production. In the former industry, the crystal clear stones are used as either aquamarines or emeralds depending upon their chemical composition. In the latter industry, the opaque quality is used, serving as the ore for the metallic element. The opaque beryllium is found in comparative abundance in Brazil and in several other countries, usually in crystal formation in pegmatite veins.

The world sources of beryllium are the pegmatites of Canada, Madagascar, Mexico, United States, Sweden and Brazil. The most important sources in Brazil are the deposits of the Doce River basin, the northeast section of the state of Minas Gerais and the southern part of the state of Baía. There are also a considerable number of occurrences in the municipalities of Jardim de Seridó, Parelhas, Carnaubas and Acarí in the state of Rio Grande do Norte.

In 1937, of the total of 25 metric tons for the state of Minas Gerais, 23 metric tons was mined in the municipality of Sabinopolis. The other two tons were produced in the municipality of Conceição. Production in 1938 also totalled 25 metric tons while data for 1939 and 1940 are unavailable.

The production of the state of Baía totalled 4 kilograms in 1939.

Although the deposits of beryl in Brazil are considered among the most important in the world, it is only in recent years that the exploitation of it for the metallurgical industry has been initiated. In 1938, the 202,665 kilograms valued at 105,182 contos were exported to Italy, the sole market in that year, while in 1939, total exports amounted to 275,886 kilograms of which 204,561 kilograms were shipped to that country. The United States imported 68,014 kilograms while Germany and England bought the remainder.

The 200 metric tons shipped at the beginning of 1939 to Italy had an average BeO content of 11.87%. However, exporters are prepared to supply a product with a higher content, ranging from 13% to 14%. Considering the fact that the American product contains a maximum of 8% to 9% BeO, that of Brazil may be said to have a relatively high metal content.

It is interesting to note the changes in the markets for this mineral in 1940, the purchases of Germany increasing from the 1,295 kilograms in 1939 to 1,051,957 kilograms in the following year to represent 71% of the total. The latter amounted to 1,472,067 kilograms, nearly five times that of 1939. Italy, which was the principal market in 1939 did not buy in 1940. The purchases of the United States, the second largest market in 1940, increased substantially totalling 418,610 kilograms, while Japan provided a new market for this product, buying 1,500 kilograms.

No imports of beryllium metals or compounds are recorded separately in official statistics.

* * *

The emerald, a variety of the beryl family, found in the Serra das Eguas in the municipality of Brumado and Vila Nova in the municipality of Conquista, both of the state of Baía, is included in the chapter on Precious Stones. The beryls considered in this chapter are the blue and green aquamarines, morganite and the yellow beryl.

According to information obtained in the trade, Brazil's blue aquamarines are one of the most beautiful and highly prized gems among the semi-precious stones. In the state of Minas Gerais, three well-known places, Santa Maria in the municipality of Itabira, Marambaia in the municipality of Teofilo Otoni and that of Fortaleza, each produce their particular shade of aquamarine, the deepest colored stones coming from Santa Maria. In the trade, the rough stones are sold by the gram while the cut stones are traded by the carat.

The green and blue-green aquamarines are usually valued much inferior to the blue as are the yellow and citrine or cognac varieties and thereby give rise to the practice of heating them in order to turn them blue, a process

not infrequently carried out by the prospector himself. Such heating, however, must be carried out between the limits of 100° C. to 200° C. since the excessive application of temperature, such as, 400° C., turns the gem into an entirely useless milky colored stone.

The principal municipalities producing beryls in Brazil are listed the following table.

BERYLS

Table 3 LOCATION OF PRINCIPAL PRODUCING DISTRICTS

State of Minas Gerais: Itabira, Conceição, Ferros, Guanhães, Governador Valadares, Conselheiro Pena, Suassui, Teofilo Otoni, Arassuai, Fortaleza, Salinas, Jequitinhonha, Itamarandiba, Sabinopolis, Minas Novas, Caratinga, Carangola, Piracicaba, Manhassu, Caparaó, etc. These municipalities are all situated in the northeastern part of the state and is a region of gneiss and schists of mica, streaked with pegmatite and containing other stones such as tourmalines, topazes, columbite, radio- active minerals, etc.

State of Espirito Santo: Itambé, Conquista, Brumado, Alcobaça, Ituassu and Poções.

State of Goiaz: Itaberai and Capivarí.

Estado do Rio: Petropolis, Maricá, São Gonçalo and Macaé.

It may be noted that, in reality, all of the above regions form a sole region and are continuations of one another.

State of Paraíba: Soledade, Santa Luzia and Picui. These are usually found in pegmatites in gneiss and mica schists.

State of Rio Grande do Norte: Acarí, Parelhas, Seridó and Currais Novos. This is a continuation of the Paraíba region.

State of São Paulo: In the Serra do Mar (Coast Range) and in the municipalities near São Paulo.

Besides Brazil, other producers of aquamarines are India (1,252 grams in 1937) and South-West Africa (270 grams in 1938). In Brazil, the only available production data is that for the state of Minas Gerais and even as such includes the output of tourmalines. The most important producing municipalities are Teofilo Otoni, Arassuai, Capelinha and Sabinopolis. Others of secondary importance are Salinas, Itabira, Conceição, Itanhomi, Jequitinhonha and Antonio Dias. In 1937 the state produced 775 kilograms, 674 kilograms in 1938, 791 kilograms in 1939 and an estimated 1,000 kilograms in 1940.

The most highly valued morganites are found in Salinas and Arassuai in the state of Minas Gerais.

The state of Baía reports the exportation of 9 kilos of aquamarines in 1938, of 0.6 kilos in 1939, and 0.4 kilos in 1940.

The states of São Paulo, Estado do Rio and Paraíba only produce, practically speaking, the opaque beryl which is used for the production of glucinium.

Exports of aquamarines are recorded since 1938, the total in that year being 302 kilograms. By 1939 there was an increase to 380 kilograms while in 1940, exports more than tripled, totalling 1,169 kilograms. Germany purchased more than 90% of the total in the latter year while the United States was the second largest market. Other secondary outlets in that year were Great Britain, Peru and Sweden.

No imports of the beryl gemstones are recorded separately in official statistics.

During 1940, the mine price of aquamarines averaged 10,000 milreis per kilogram while that of export was 11,522 milreis.

6. BISMUTH

Bismuth is found in nature, principally in the native form but may also be encountered as the oxide, bismuth ochre (Bi_2O_3), or the sulfide, bismuth glace (Bi_2S_3). Bismuth is also recovered as a residue or concentrate in copper and lead smelters or as a by-product of other non-ferrous metal plants. The United States, Peru, Canada and Mexico supply about 90% of the total world output. About 90% of the total production is used in the medicinal and pharmaceutical industries while the remaining 10% is practically all used in the alloy form, principally for fusible plugs, sprinklers and safety devices and in solders. In Brazil, its use is limited to medicine, the others accounting for little if any demand.

In Brazil, bismuth is found in the São José de Brejauva region of the municipality of Ferros in the state of Minas Gerais. The deposits are worked for the semi-precious stones, beryls and aquamarines, the bismuth being extracted as a by-product. However, in March 1937, occurrences of bismuth were also found in the copper deposits of the Pedra Branca region in the states of Paraíba and Rio Grande do Norte in such quantities that they may be considered the richest deposits of this metal in Brazil. Analyses of the copper ores of the Pedra Branca region revealed relatively large quantities of bismuth, that of Riacho do Boi having as much as 3.0%. The ore of Poço do Trigueiro showed a 0.4% bismuth content while that of Poço Pedra Branca had 0.3%.

Other occurrences of bismuth are found in Mariana, Itabirito, Bonfim and Ferros in the state of Minas Gerais and in Iguape in the state of São Paulo. Of all these deposits, however, the São José de Brejauva is the only one being worked at the present time.

No data for the production, exports or imports of this mineral in Brazil are available.

7. CADMIUM

Cadmium, a metal which until a few years ago was used principally in the pigment and plating industries, has now found an important new use, that as an automobile bearing. It is now estimated that the strictly metallurgical uses of this metal now predominate with the rapid increase in the production of automobiles although there was a probable proportionate slackening of demand in 1939.

About 60% of the world output of cadmium is produced in North America, the United States, Canada and Mexico being the only countries in the Americas which have deposits which are being worked at present. In Europe, Belgium, Germany and Norway are the principal producers. Australia which at one time was the second largest producer in the world, today is the fifth most important.

The United States' output which is the largest in the world does not. however, fill the domestic demands and thus that country is required to import great quantities from the two other producers of the Continent.

In Brazil, there are several known occurrences of this metal which as in the other countries is found associated with the zinc ores, blende and calamine. Among these occurrences, that of Morro do Bule in Dom Bosco in the municipality of Ouro Preto in the state of Minas Gerais is of some significance. There exist other occurrences in Santa Luzia and Bomfim in the state of Baía. However, it is in the plumbiferous zinc district of Ribeira de Iguape in the state of São Paulo, one of the richest mineral zones in the country, where one finds the principal reserves of cadmium in Brazil. The difficulties of transportation which until recently had been impeding the exact knowledge of the potential riches of this region, are now overcome with a highway which the Instituto Tecnologico of the state of São Paulo built to serve the lead concentration and smelting plant established there. This road will no doubt facilitate the further knowledge of the region and consequently the exact location of the occurrences of cadmium.

Production and trade data as to this metal and its products are not classed separately to permit an estimate of its consumption in this country.

8. CHROMIUM

The quantities of chromite (principal ore of chrome) used in the world vary closely with the production of steel since about 85% of the metal is used in the manufacture of ferro-chrome, alloy steels, principally stainless steels, and as a refractory material either as a crude ore brick or a cement. The preponderant use in stainless steels is based on its property of imparting strength and resistance to corrosion. Its use as a plating material, though widespread, is relatively small due to the thinness of the layer applied. Another use for chrome is that in the field of chemistry in electroplating and in the

dyeing, tanning and pigment industries. Although the use of chrome for paints is of some importance the bulk of it is used in the leather industry in Brazil.

The world production of chrome has increased considerably in the last few years. Soviet Russia, which until 1937 was the largest producer was surpassed by Turkey in 1938, while Southern Rhodesia continues as the third most important producer. Others of importance are the Union of South Africa and the Philippines.

With the substitution of production data by that of exports Brazil is collocated as the 12th most important producer in the world and the second in the Americas. The production of the United States is less than Brazil, while that of Cuba is larger.

The principal deposits in Brazil which may be worked are in the interior of the state of Baía, in the zones served by the Estrada de Ferro Este Brasileiro, the most important being Campo Formoso, Queimados, Santa Luzia and Saúde. In all the deposits of Baía, the ore is either chromite or ferrous chromite. The amount of exposed chrome ore is estimated to be more than 400,000 tons, 280,000 tons in the Cascabulho deposit, 100.000 tons in the Santa Luzia and 20,000 in the other regions. The total reserves are estimated to be about 4,000,000 tons. The mines being worked at present are the Pedras Pretas, Barreiros and Boa Vista the production in 1938 and 1939 being 944 metric tons and 3,754 respectively. The principal deposits are 18 to 20 kilometers from the railway station, which in turn is 532 kilometers from the Capital and principal port of the state of Baía, Salvador.

In general, the mined ores contain 36% to 40% oxide of chrome but may be concentrated to 51% to 52%.

The mine of Boa Vista in the Saude region was discovered in 1919 and is at present being worked by the Porto Barradas & Cia. Ltd., of the city of Rio de Janeiro. The deposits of this mine are situated about six and a half kilometers from the Saude station. Although they contain a smaller quantity of chrome ore than of the Cascabulho and Pedras Pretas regions, they are favored with abundant water supplies for the concentration of the ore, a fact which is not true of the other two deposits mentioned above.

In the state of Minas Gerais in the municipality of Piuí, there is a deposit of 2,000 tons of chromite which despite its small size, contains a high percentage of Cr_2O_3, which according to the latest data available has, to the present day, not been obtained in other regions.

Exports of chromite from Brazil have been exceedingly irregular; it may be noted that the export for 1940 has been the largest in the last two decades and is at present the fourth most important among the ores exported. In the decade from 1920 to 1929, the exports averaged 341 metric tons annually while that of the 1930-4 period was two metric tons and that of the succeeding quinquennium 1,847 metric tons. From 1936 to 1939, exports were made to single countries, those in 1936 and 1937 being to Italy and those of 1938 to Germany. The shipments of 4,572 metric tons of 1940 were made to the Unit-

ed States and Germany, the purchases of the former attaining 4,064 metric tons and the latter, 508 metric tons. Coinciding with the record shipment is the record price obtained for the ore, that of 1940 (239 milreis per metric ton FOB Brazil) being double that of 1939 and practically 2-1/2 times that of 1937. The mine price of chromite averaged 200 milreis per metric ton in 1940.

With the possibilities of closer inter-American cooperation it is of interest to indicate that there are five continental sources, the United States, Cuba, Canada, Guatemala and Brazil, Brazil being, as was mentioned above, the second largest producer of these countries. Recent estimates point out the possibility of producing 100,000 tons annually with the improvement of transportation facilities which serve the region, particularly the railway transportation.

Brazilian imports of chrome metal are not classified separately due to their insignificance. Chrome salts and chromate imports, however, reach considerable quantities annually and in 1939 totalled 621 metric tons. Those for 1940 amounted to 582 metric tons, the principal source being the United States.

9. COBALT

Although exact data on world production is lacking, the general assurance of sufficient quantities in recent years has stimulated the development of new applications for the metal. The salts of this metal are used in animal husbandry and manufacture of driers for paints, varnishes and linoleum while the principal application of the oxides is in the ceramic industry. The metal itself is finding increasing use in the electroplating industry while that in stellite alloys, highspeed steels, magnet steel, etc., has also shown rapid development, particularly with the appearance of new combinations of alloy metals. The metal and salt also finds use as a catalyst. The principal application for cobalt is in the paint and building materials industry in Brazil.

Brazil is not, as yet, included among those countries which produce this important metal which is one of the most restricted in quantity in the world. Africa contributes with the largest percentage of the production; in Asia, Burma is the principal country while in the Americas, practically speaking, the only country which possesses deposits which are being worked is Canada.

France and the United States are the principal importers of cobalt ore. With regard to the salts and the oxides, the United States, England and Belgium are the largest importing markets.

In Brazil there has been encountered, in the state of Minas Gerais, some cobaltite and smaltite (arsenious cobalt) with deposits of black cobalt near Diamantina. The latter is found in large masses in the locality known as Bom Despacho in the western zone of Minas Gerais.

As is well known, the ores of cobalt are nearly always found accompanying nickel. Recently, there were observed occurrences of cobalt with the deposits of nickel in São José do Tocantins in the state of Goiaz. The first

analysis of the cobaltiferous manganese revealed the following composition: cobalt 3.44%; nickel 2.96% and manganese 30.68%. The cobalt content of these deposits of nickel, which are among the largest in the world, can only be exploited after being duly studied as will be done in the near future.

In this connection, it may be noted that the nickel exported in the past contained a relatively high content of cobalt.

Imports of cobalt metal are not record separately in Brazil; that of the oxide in 1939 totalled 7,741 kilograms while in 1940 it decreased to 4,865 kilograms, the principal source being Germany.

10. COLUMBITE AND TANTALITE

Columbium accompanies tantalum in most of its ores and is used principally in the ferro-alloys and ferro-colombium which is important in the manufacture of weldable high-speed steels while the metal is used in electronic tubes. Tantalum is rare and was discovered in 1802 although its use in industry only dates back to 1903 when used for incandescent lamps but this application was short-lived due to the appearance of tungsten. Another temporary use was that in battery chargers. However, its present use is based on its resistance to acid corrosion and thus finds application in chemical industry equipment and rayon spinnerets. Its hardness and high melting point make the metal fit for use in tantalum carbide, a constituent of hard cutting tool mixtures.

It was towards the end of 1929 that tantalum and columbium began to interest industry to an appreciable extent. The world production of these two metals, which in 1930 did not exceed 6 metric tons, by 1938, had attained 750 metric tons. Australia is the principal producer of tantalite while Nigeria is the leading producer of columbite. Basing production on exports, Brazil is the third largest in the world.

The United States is the most important world consumer and is supplied with tantalite principally by Australia and by Nigeria for columbite.

Occurrences of columbite have been reported in Brazil since the last decade of the past century in Ramalhete near Peçanha, in the River Doce Valley and in Santana de Suassuí, all in the state of Minas Gerais. However, the most important deposits are found in the states of Rio Grande do Norte and Paraiba where extensive workings have been realized since 1937. The principal producing municipalities are Jardim do Seridó, Parelhas and Acarí. Samples sent from the principal occurrences in Rio Grande do Norte and Paraiba to the Departamento Nacional da Produção Mineral showed that in the Picuí deposit the Ta_2O_5 content varied from 13.5 to 31.8% while that of Parelhas ranged from 31.8 to 32.3%. The ores of Capelinha show only traces of Nb_2O_5 and 82.5 to 86.6% Ta_2O_5. In 1939, the G. Valadares deposit of Minas Gerais produced 2,982 kilos of the total of 4,982 kilos being worked by a firm employing 12 miners.

Practically speaking, the exports of these two metals began in 1937, that of columbite rising from 11 metric tons in that year to 13 metric tons in 1938 and 35 metric tons in 1939. In the latter year, England was the largest market, having purchased 17,693 kilograms, while the second, the United States, bought 8,145 kilograms. Other important markets were Germany and Japan. In 1940, exports of columbite decreased to less than half of their 1939 quantity being but 15 metric tons. In this year, the United States was the leading market for this mineral purchasing 8,898 kilograms while Germany, the second largest outlet, bought 5,300 kilograms. The other purchaser was Japan whose imports from this country amounted to 1,071 kilograms.

Tantalite exports in 1938 amounted to 25 metric tons and fell to 24 metric tons in 1939. England purchased 11 metric tons in 1939 and the United States, 6 metric tons. Japan, Germany and Sweden were the other markets.

In 1940, the total exports of this mineral increased to 27 metric tons, 17,117 kilograms of which were to the United States, 6,000 kilograms to Japan and 4,000 kilograms to Germany.

The trend in columbite export (FOB) prices have been irregular but upward, the movement during the 1937-40 period having been the following: 1937 — 2,065 milreis per metric ton; 1938 — 13,195 milreis; 1939 — 10,370 milreis and 20,120 milreis in 1940. Contrasted to these prices are those in the state of Minas Gerais, one of the largest producers of this mineral, based on the local prices and the evaluation of the output of the state; 1937 — 20,000 milreis; 1938 — 15,490 milreis; 1939 — 16,796 and 17,000 milreis in 1940. It must be noted with regard to the latter that tantalite is included within this classification thereby giving rise to the relatively higher values. Crude mineral was priced at an average of 5,000 milreis at the mines. Tantalite export (FOB) prices show the following averages in the years in which it was shipped: 1938 — 15,128 milreis per metric ton; 1939 — 17,664 milreis and in 1940 — 15,426 milreis.

11. COPPER

Over 5,500 years ago, copper was used in the piping of water over the desert; present tests of this tube show that it will hold water without leaking. Copper was also employed in the early manufacture of utensils and thus places that metal in one of the earliest stages of the history of metals useful to Man. Today, its properties of conductivity, ductility and uniformity make it one of the most valuable and indispensable metals in the electrical industry. In Brazil, copper consumption is largely in the metal form while that for the sulfate is smaller but of significant importance.

Countries possessing large deposits of copper are relatively few, the most important being, the United States, Chile, Canada, Northern Rhodesia, the Belgian Congo, Japan, Germany and Brazil.

In Brazil, the copper ore deposits are found in various regions but principally in the states of Rio Grande do Sul, Baía and Paraiba. Of all these,

however, the only ones effectively exploited are those of the first mentioned state.

The discovery of the copper deposits in the state of Rio Grande do Sul dates back to 1825 while the working of the ore commenced between 1880 and 1890. The zone which possesses the richest occurrences is centered in Caçapava where the deposits of Camaquan, Seival, Crespo, Lavras, Bom Jardim, Andradas, etc., are situated.

The first mine in this zone to be worked was Camaquan, but since 1908 this mine has not been operating. Its location with respect to the means of transportation is a serious disadvantage because it is situated 90 kilometers north of one railway line and 190 kilometers to the south of another. All these distances must be covered by automobile. To all appearances, this mine is the one mentioned by K. Scott as being 3 kilometers from the Camaquan River and 80 kilometers from the Negro River. The copper is found in the native state containing 6.5% metal and 30 grams of gold per metric ton of ore. The reserve is estimated to be some tens of thousands of tons and its extraction facilitated due to the presence of gold which permits the working of the poorer ores with profitable results.

At present, the only mine in operation in the state of Rio Grande do Sul is at Seival and is being worked by the Empresa de Industrias Eletro-Quimicas of Porto Alegre.

In the state of Baía, there are important deposits in Caraiba 70 kilometers from the city of Bomfim. Five shafts were sunk to depths of three to twenty meters and all yielded ore. Further studies will give more concrete details but at present knowledge of the deposit is limited to the fact that it is extensive and has a high content of metal.

In the state of Paraiba, in the regions known as Picuí and Pedra Lavrada, some occurrences were studied in 1940 and showed a metal content ranging from 2% to 3%. Other studies have also been made in this region but on a smaller scale.

Small occurrences of copper ore are reported in the states of Minas Gerais, Santa Catarina, Maranhão and others but their extension or value are unknown due to the lack of sufficient investigation.

In more than 20 years of exports, there are only two years in which shipments of the ore are noted, once in 1920 and again in 1939. The exports of the former year amounted to 150 metric tons and 97 metric tons in the latter. The FOB export price of the ore was 123 milreis per metric ton; the mine price of the ore was 50 milreis in 1939.

In late years there has been a tendency towards the oscillation of the imports of copper semi-manufactures between the limits of 8,000 to 11,000 tons, that of 1939 being 10,797 metric tons, the largest to date. In 1940, there was an abrupt decrease to 6,733 metric tons. This compares with the 1920-9 average of 4,396 metric tons, the 4,577 metric tons of the following five-year period and that of 1935-9 which averaged 9,740 metric tons. Breaking down this trade into its component parts, one finds that imports of ingots and cast

units have tended to decrease while that of rolled and hammered plates has increased. (Table 2). The principal sources of supply of the ingots and cast units are Africa and Chile while those for rolled and hammered plates are the United States, Germany and Great Britain.

Contrasting the trend of copper semi-manufactures is that of the manufactures which in 1940 fell to a new low after having settled within the limits of two and a half to three thousand tons annually. This is based largely on the decline in imports of electric cable and wire which formerly accounted from 50% to 60% of the total of this classification. The large industry of the state of São Paulo engaged in the manufacture of this type of product bases its production on imports of the crude copper and the use of domestic ores and scrap. It may be noted that in 1940 for the first time there was an export of this product from Brazil, the amount being 26,165 kilograms. The FOB Brazil price was 6,428 milreis per metric ton. The vague terminology used in the export classification does not permit a direct comparison with imports, the closest possible products being bare wire which was priced at 7,875 milreis (CIF Brazil) and copper cable which had a unit price of 6,516 milreis.

Other manufactures of copper which are exported now are ornaments and other non-specified items which together totalled 171 contos for 1,969 kilograms. Thus the total copper manufactures exports aggregated 339 contos in 1940. The Plate Countries provided the best outlets for this product, the principal country being Argentina which purchased 18,656 kilograms and the second, Uruguay which bought 3,868 kilograms.

The consumption of copper sulfate in Brazil is approximately 2,400 metric tons per year. The extent to which the production of the mine in Seival which supplies the raw material necessary for the manufacture of the sulfate is increased will determine the decrease in the imports of this product; 1,708 metric tons were imported in 1938 which in 1939 fell to 502 metric tons and rose to 1,567 tons in 1940. The principal sources were formerly Belgium and Germany while in 1940, they were England and the United States. A secondary source for this product in Brazil in copper scrap.

12. GOLD

Gold is intimately connected with the history of Brazil and at one time played such an important part in the economy of the country that it had earned for itself a place in the economic cycles of Brazil which include those of sugar, pau-Brazil, rubber, coffee, etc.

Although there are considerable primary deposits within the country, the early exploitation of this precious metal was confined to the alluvials and continued at high levels while the occurrences permitted. However, with their depletion, production fell and Brazil which had attained the position of the leading producer in the world declined to a position which today is insignificant.

Today, the production of alluvial gold ranges from 1,300 to 1,500 kilograms according to official statistics which are in reality the gold purchases

of the Bank of Brazil to which all the mined gold within the country must be sold. However, scattered reports from the interior regions which are sparsely inhabitated and those from persons closely connected with the industry place the annual total at about 15,000 kilograms, the output of the state of Mato Grosso being about one-third of this total. Admitting such a figure and including the output of gold from the mines would place Brazil in 12th place among world producers.

The most recent discoveries of gold are in the state of Maranhão along the Turi-Assú and Gurupi Rivers. In the headwaters of the rivers there are primary deposits while in their lower courses, there are alluvials. At present, they are worked by extremely primitive methods and yield but 10 kilograms per month. The principal alluvial gold workings however, are in the states of Baía, Minas Gerais, Mato Grosso, Goiaz, Maranhão and Pará.

The presence of alluvial gold in the different regions of the country suggests the existence of extensive deposits of primary gold also. The industrial exploitation of gold in primary deposits was carried out by two companies in the state of Minas Gerais, the St. John d'El Rey Mining Co. and the Cia. Minas de Passagem, until 1934, in which year there appeared the St. George Gold Mine of São Paulo. By 1940, the number of companies had increased to six, four of which were located in the state of Minas Gerais, and two in the state of Paraná. The above mentioned São Paulo mining company operated from 1934 to 1936 but has not registered any outputs since the last date.

In the 1925-9 period, the average annual output of mined gold was 3,077 kilograms, all of which was produced in the state of Minas Gerais. During the following quinquennium, the output increased to 3,784 kilograms partly under the incentive of the gold purchase program adopted by the Bank of Brazil in 1934. This law, however, shows its true value in the 1935-9 period in which the average was 4,242 kilograms, the output of the state of Minas Gerais in 1939 being 4,492 kilograms and that of the state of Paraná 123 kilograms. From 1935, the trends in production are more clearly indicated in noting that they were the following since that year: 1935 — 3,713 kilograms, 1936 — 3,909, 1937 — 4,534, 1938 — 4,447, 1939 — 4,614, and 1940 — 4,660 kilograms. In the latter year, the 4,434 kilograms of the state of Minas Gerais accounted for 95% of the national total while the remaining 5% was produced in the state of Paraná which had an output of 226 kilograms.

The largest concern in the gold mining industry is the St. John d'El Rey Mining Company of Minas Gerais which works the mines at Morro Velho, Faria, Santa Catarina, Raposo, and Bicalho. The first named mine is 2,600 meters deep and works with material which yields 13 to 14 grams of gold per metric ton of ore. The daily production of the firm is about 11 kilos of gold, 2 kilos of silver and 2 tons of white arsenic. As noted in the section on Arsenic, this company employs 7,290 miners and operates with a capital of 193,700 contos. The output of this company in 1940 was 3,945 kilos which represented 85% of the total of Brazil.

The second largest mining company is the Cia. Minas de Passagem in the city of the same name in the state of Minas Gerais. It employs 2,000 miners and works with a capital of 2,900 contos. The output of this mine, which for an interval was showing increased production, declined perceptibly in recent years and in 1940 amounted to 405 kilos or 9% of the total.

The third largest company, the Cia. Minas de Timbotuva of the state of Paraná, operates in the Campo Largo district and has installed equipment which is capable of treating 150 tons of ore daily. Smaller installations of the company are situated in Curitiba. In 1940, this company produced 142 kilos or 3% of the domestic mined gold output.

The other primary deposits which are being worked at present are those at Santa Barbara, Cuiabá, Caeté and Mariana in the state of Minas Gerais. According to some reports there is the mining of gold in the state of Rio Grande do Sul at the municipality of Lavras.

As was mentioned, all gold produced in Brazil must be sold to the Bank of Brazil and as such, their purchases furnish a partial index to the output within the country. It must be noted however, that there is a portion of old gold included in these purchases, this in 1935 being as much as 3,200 kilograms but which in recent years has diminished to about 500 kilograms. Included also are the purchases from overseas which in 1939 totalled 1,167 kilograms and in 1940 amounted to 1,712 kilos. (Table 4).

GOLD

Table 4 PURCHASES OF BANCO DO BRASIL IN GRAMS

SOURCES	1935	1936	1937	1938	1939	1940
MINES	3.591.625	3.924.712	4.423.606	4.614.815	4.467.326	4.605.478
IMPORTS	—	—	—	—	1.166.694	1.712.286
OTHER SOURCES:						
Minas Gerais	710.973	604.968	318.372	358.402	915.398	1.025.300
Bala	441.210	406.493	293.061	371.565	759.928	803.240
Pará	459.912	391.697	550.506	569.132	675.361	672.135
Federal District	1.538.432	807.457	343.100	410.703	400.578	337.215
São Paulo	595.474	252.352	68.815	28.815	82.092	153.165
Espirito Santo	—	91.804	33.970	44.095	126.120	109.787
Amazonas	14.952	69.176	64.251	103.584	78.278	104.773
Estado do Rio	—	39.707	35.917	21.299	41.529	73.243
Rio Grande do Sul	227.014	87.506	58.261	51.497	58.065	70.080
Goiaz	—	3.522	2.062	14.388	53.580	61.127
Maranhão	183.070	95.309	50.784	41.643	52.343	45.983
Paraiba	—	—	—	—	—	41.848
Mato Grosso	—	24.435	19.391	18.505	29.694	23.787
Pernambuco	131.360	48.619	36.725	44.085	50.059	21.257
Santa Catarina	—	7.808	4.900	1.555	11.084	21.080
Ceará	53.269	33.896	9.103	18.247	23.048	11.739
Paraná	—	15.438	6.401	3.224	9.721	9.670
Alagoas	—	19.352	11.535	11.171	10.133	8.294
Rio Grande do Norte	—	2.221	156	539	6.163	5.487
Sergipe	—	19.748	3.454	11.274	4.120	1.964
Piauí	—	1.042	—	293	1.801	1.168
TOTAL	8.162.336	6.947.275	6.334.509	6.738.836	9.023.117	9.920.115

NOTE: The state totals have been rounded in the conversion of milligrams to grams and thus do not sum the total given.

In the twenty odd years since 1920, there were but four years in which there were exports of gold officially recorded, being those from 1930 to 1934. In 1930, the shipments totalled 3,230 kilograms while in the subsequent years they were 4,238 kilos, 3,862 kilos and 3,773 kilos. Imports in one form or another have continued and in the 1920-9 period, they averaged 31 kilos annually while in the 1930-4 period they totalled but 15 kilos, about one-half of that of the previous period. The 1935-9 average shows an increase being 25 kilograms. In 1940, the total was 197 kilograms. Imports of gold leaf and other manufactures of gold totalled 21 kilograms, that of the former being 7 kilos and the latter 14 kilos.

The prices of gold ore vary considerably some of the more important deposits receiving the following mine prices in 1940: Minas Gerais: Morro Velho — 104 milreis, Raposo — 80 milreis, Faria — 114 milreis, Bicalho — 88 milreis, Cuiaba — 88 milreis, Passagem — 44 milreis, Santana — 64 milreis, Juca Vieira — 40 milreis, Cutão — 20 milreis, Andaime — 24 milreis, Onça — 24 milreis, Brumado — 12 milreis, Paraná: Timbotuva — 32 milreis, Santo Inácio — 48 milreis, Ferraria — 80 milreis; Rio Grande do Sul: Boa Vista — 20 milreis, Cerro Rico — 96 milreis, Saraiva — 80 milreis, and Cerrito — 64 milreis.

The gold itself is valued at 8 milreis per gram per metric ton of ore while the official price of fine gold was set at 24.0 milreis and the comercial price 24.2 milreis in 1940. These market prices compare with official price of 23.9 milreis and the commercial price of 23.6 milreis in 1939. Imported gold averaged 19.9 milreis per gram (CIF Brazil) in 1940 while in 1939, this was 19.8 milreis.

13. IRON AND STEEL

According to a recent estimate of the iron ore reserves of the world the United States was noted as having ten and a half billion tons of reserves with a metal content varying from 35% to 50%, France is estimated as having 8 billion tons with a metal content of 25% to 30%, while England has less than 6 billion. Sweden and Russia possess a little more than 2 billions, India less than three a half billion and Cuba, more than three billions. It is interesting to note that the ore of India has a content which varies from 55% to 60%. Brazil possesses about 22% of the total known reserves of the world.

Studies of Luciano Jacques de Morais, Octavio Barbosa and Fernando Lacourt, place the total of the principal reserves of the state of Minas Gerais at 15,000,000,000 tons, the largest region of occurrence being that of Itatiaiussú which stretches to Pico Belo Horizonte and has more than 3,200,000,000 tons of reserves. The reserve in the Itambé-Morro do Pilar deposit is estimated to contain 3,000,000,000 tons while that of Santa Rita Durão and Pitanguí is said to have about 1,500,000,000 tons. Others of primary importance are São Vicente-São Gonçalo with 1,400,000,000 tons and Burnier-Ouro Preto, Mutuca-Morro Grande and Morro Agudo-Monlevade with 1,000,000,000 tons each.

The total noted above, classified according to metal content, reveals that there are one and a half billion tons of hematite with a minimum of 65% iron, three and a half billion tons of good itabirite with a metal content of 50% to 60% and 10 billion tons of a relatively poor ore which has a 30% to 50% iron content.

The region where the greater part of the deposits of iron ore of Minas Gerais is situated is 550 and 600 kilometers, respectively, from the ports of Vitoria in the state of Espirito Santo and from Rio de Janeiro. Railway service is carried out by the Estrada de Ferro Central do Brasil, E. F. de Vitoria a Minas and the Leopoldina Railway.

In Urucum of the state of Mato Grosso, there is a large deposit of hematite. Other deposits whose reserves have not been studied, as yet, are located in Santa Sé and Jequiá of the state of Baía, Catalão in the state of Goiaz, Morrette and Antonina of the state of Paraná, Itajaí of the state of Santa Catarina and Ipanema in the state of São Paulo.

The largest single deposit of Brazil is situated in Itabira do Mato Dentro which is owned by the Itabira Iron Co. The Cauê Heights alone, contains 111 million tons of compact hematite with 68% iron. The same company also owns the following deposits; Conceição with 44 million tons of compact hematite and 50 million tons of low content iron, Dois Corregos with 10 millions tons compact hematite with more than 65% iron, Rio do Peixe with ores of the same category, and Itabirussú, João Coelho, Girau, Onça, Borrachudo, Santana, Sumidouro, Sumidouro II, Sumidouro III and Campestre whose reserves have not been studied as yet. The deposits of the Brazilian Iron and Steel Co., an American company, are also located in Itabira in the districts of Esmeril, Camarinha, Chacrinha, etc. The reserves are smaller than those owned by the Itabira Iron Co.

The deposit of Andrade is the property of the Cia. Siderurgica Belgo Mineira and contains about 40 million tons of ore with 68% iron.

The Itabirito Heights deposit consists of 30 millions tons and is the property of the Cia. do Morro Velho. The deposit of the Fabrica de Ferro has 60 millions tons of ores with more than 60% iron. The deposits of Pires, Casa da Pedra and Jangada which are all in proximity to each other and have several million tons of ores.

The production of iron ore is practically all concentrated in the state of Minas Gerais. In 1937 the municipality of Conselheiro Lafayette was the largest supplier, her output being 300,000 tons of the total of 338,700 tons produced. That of the municipalities of Ouro Preto, Contagem and Belo Horizonte amounted to 24,000 tons, 16,000 and 3,200 tons respectively. In 1938, the state output had risen to 982,387 metric tons and decreased to 745,630 metric tons in 1939. The output of 1940 is estimated to have totalled 740,000 tons.

The states of São Paulo, Baía, Paraná, Santa Catarina and Rio Grande do Sul contain deposits of magnetite while those of Goiaz, Ceará, Mato Grosso and Minas Gerais are, in general, hematite.

Exports of iron ore in the ten years from 1920 to 1930 averaged 36,700 metric tons annually while from 1930 there has been almost an unbroken series of increases the average for the 1930-4 quinquennium rising to as much as 4,355 metric tons. Since 1935 the trend was as follows: 1935 — 47,000 metric tons; 1936 — 110,997; 1937 — 185,640; 1938 — 368,510 and 396,938 metric tons in 1939, the average for the five years being 221,853 metric tons, more than 50 times that of the previous period.

In the year 1939, Germany was the principal market, purchasing 151,600 metric tons while Dantzig was second with 137,660 metric tons. Poland and France follow in order of importance with 23,520 metric tons and 20,787 metric tons respectively. In 1938, Holland was the largest market importing 117,502 metric tons from this country while Dantzig was second with 67,226 metric tons.

In 1940, the upward trend in the exports of the ore was broken and amounted to but 225,548 metric tons or about 35% less than that of the previous year. This is due largely to the loss of the European market, in fact, the sole purchaser of the Continent being Great Britain which imported 70,230 metric tons of the Brazilian ore. This total compares with the Continental shipments of 365,595 metric tons of 1939, a decrease of 81%. Exports in 1940 were to the United States, Canada and Great Britain, the total of the former being 106,-055 metric tons while that of the second was 79,263 metric tons. The FOB price per metric ton in 1940 proved to be the highest in the history of iron ore exports in recent years, the trend since 1936 being the following: 1936 — 41 milreis per metric ton; 1937 — 42 milreis; 1938 — 54 milreis; 1939 — 48 milreis and 63 milreis in 1940. It may be noted that in 1940, the mine price of hematite and magnetite averaged 12 milreis while that of itabirite was 7 milreis.

The lack of transportation has created difficulties for the large scale exploitation of iron ore and has thus, also indirectly affected the exports of this commodity due to the fact that the iron ore center of the country is situated at a distance of 550 to 600 kilometers from the ports and is encircled by mountains.

* * *

It is interesting to note that the iron and steel industry was one of the first to develop in Brazil. In fact, it was created a little after the rise of the sugar industry, which thus, precedes that of gold and diamonds. Historians say that in 1597, iron was worked in the "capitania" of São Vicente (present state of São Paulo), but unfortunately, instead of developing, it completely disappeared.

In the Seventeenth and Eighteenth Centuries, no new attempts were made to restore this industry but in the Nineteenth Century, the industry was revived. In 1785, Portugal started a campaign for the destruction of the iron works which existed in order to concentrate the colonial activity in minerals, especially in gold. It was only in 1795 that Portugal permitted the renewed construction of an iron and steel industry in this country. In 1800, the iron works situated in Sorocaba was reopened. Since then few if any obstructions have

been placed in the natural development of the industry and today one finds 27 firms with a total capital of 330,778 contos and about 11,700 persons employed in this activity.

A factor which deserves particular mention with regard to the iron and steel industry is the lack of coking coals in the proximities of the deposits of iron which compels some Brazilian mills to depend on charcoal, the consumption of this type of fuel, in general, reaching substantial amounts due to its wide use. Coking coals are produced in the state of Santa Catarina far to the South, but involve railway shipments while that of the Federal District, although used, is small because of the limited quantities sold by the producer and its softness, the proper factory consumption being of considerable magnitude (72% of output).

In 1930, at the beginning of the Vargas Administration, the production of pig iron in Brazil totalled 35,305 metric tons, all of which was produced in the state of Minas Gerais. This state continued to be the sole producer until 1938 in which year São Paulo and Estado do Rio appear with outputs of 1,003 metric tons and 7,802 metric tons respectively. The total Brazilian output in that year thus totalled 122,352 metric tons or practically three and one-half times that of 1930. By 1940, output had risen to 185,548 metric tons which for the eleven years of the Vargas regime had elevated the production to more than five times its quantity in 1930.

Minas Gerais continued to be the leading producer with an output of 168,729 metric tons in 1940 thus accounting for 91% of the total. Estado do Rio is the second largest producer having an output of 13,616 metric tons and São Paulo with 3,203 metric tons is third. (Table 5).

PIG IRON

Table 5 PRODUCTION OF BRAZIL BY STATES IN METRIC TONS.

STATES		1935	1936	1937	1938	1939	1940
Minas Gerais		64,082	78,418	98,101	113,547	143,803	168,729
Estado do Rio		—	—	—	7,802	12,612	13,616
São Paulo		—	—	—	1,003	3,601	3,203
TOTAL:	Tons	64,082	78,418	90,101	122,352	160,016	185,548
	Contos	14,957	23,564	33,452	48,000	59,434	69,002

The Cia. Siderurgica Belgo-Mineira of Minas Gerais is the leading pig iron producer contributing with 84,655 metric tons or 46% of the total output while the Usina Queiroz Junior, also of Minas Gerais, is second with 27,621 metric tons or 15% of the total. Others of importance in 1940 were the Cia. Ferro Brasileira (Minas Gerais) and Cia. Brasileira de Usinas Metalurgicas (Minas Gerais) with respective outputs of 26,390 metric tons and 25,083 metric tons.

Pig iron exports have been sporadic those since 1940 being the 6,390 tons of 1931, 3,541 tons of 1932, 121 tons of 1937 and 2,328 tons of 1938. In

1939, the total was 23,413 metric tons, which, it may be noted, was 15% of the total national production. Of this, 17,863 metric tons or 76% of the total was shipped to Argentina while Belgium took 3,596 metric tons. The other markets were Sweden, Uruguay, United States and Norway. In 1940, the principal market was also Argentina, her purchases amounting to 20,165 metric tons of the total of 22,147 metric tons. Japan was the second largest, having purchased 1,313 metric tons of the total; this was the first sale of this product ever made to that country. Sweden and Uruguay were the other markets in this year.

* * *

In contrast to pig iron which was produced only in the state of Minas Gerais until 1938, laminated or rolled iron has been produced in three states since 1930, and thus reflects the use of not only domestic raw material but also the foreign. In that year, of the total output of 25,895 metric tons, 12,146 metric tons or 47% was produced in the state of Minas Gerais while 8,198 metric tons or 32% was from the state of São Paulo. All of the remaining 5,551 metric tons was that of Estado do Rio. Since then, each of the states have increased their outputs substantially, the Brazilian total having risen 93% in the decade. There has appeared, besides, a new producing state, Rio Grande do Sul. In 1940, Minas Gerais' contribution to the total output was 74,508 metric tons or 55% of the total, that of São Paulo, 37,847 metric tons or 28% and Estado do Rio 21,102 metric tons or 16% of the total. Rio Grande do Sul, the other producer, had an output or 1,836 tons or 1% of the total.

The Cia. Siderurgia Belgo-Mineira is the leading producer of Brazil and is also the sole producer in the state of Minas Gerais while the Cia. Brasileira de Usinas Metalurgicas of Estado do Rio is the second largest. The first produces 55% of the Brazilian total while the second accounts for 16%. The Cia. Brasileira de Mineração e Metalurgica of São Paulo is the third largest and contributes with an output equivalent to 15% of the total. There was a total of ten companies engaged in this industry in 1940 seven of which were in São Paulo and one each in Minas Gerais, Estado do Rio and Rio Grande do Sul.

ROLLED IRON

Table 6 PRODUCTION OF BRAZIL IN METRIC TONS BY STATES

STATES		1935	1936	1937	1938	1939	1940
Minas Gerais		23,023	28,886	30,054	35,125	40,787	74,508
São Paulo		14,747	16,210	22,544	31,109	38,253	37,847
Estado do Rio		14,586	17,850	18,821	19,035	19,487	21,102
Rio Grande do Sul ..		—	—	—	397	2,469	1,836
TOTAL:	Tons	52,358	62,946	71,419	85,666	100,996	135,293
	Contos	39,347	61,387	76,248	100,422	113,755	154,661

Since 1940, official export statistics have recorded rolled products separately, that of bars having totalled 3,882,088 kilograms valued at 4,452,987 milreis while that in sheets amounted to 4,539,191 kilograms valued at 4,748,-791 milreis. The principal market for the former was Argentina which

IRON AND STEEL

Table 7

PRINCIPAL CHARACTERISTICS OF THE PRODUCERS

FIRMS	LOCATION	Year of Establishment	Capital Contos	N.º Employed	PRODUCTION IN 1939 (Tons) Pig Iron	Steel	Rolled Iron
Cia. Siderurgica Belgo Mineira S. A.							
Usina Siderurgica	Sabará — Minas Gerais						
Usina Barbanson	João Monlevade — Minas Gerais	1921	150,000	2,461	72,452	59,155	40,787
Cia. Brasileira de Usinas Metalurgicas							
Usina de Morro Grande	Morro Grande — Minas Gerais	1925	35,000	681	27,405	745	—
Cia. Ferro Brasileiro	Caeté — Minas Gerais	1931	35,000	952	19,235	—	—
Cia. Brasileira de Usinas Metalurgicas							
Usina de Neves	Neves — Estado do Rio	1925	35,000	957	—	21,923	19,487
Cia. Metalurgica Barbará	Barra Mansa — Estado do Rio	1937	15,000	754	8,140	—	—
Cia. Brasileira de Mineração e Metalurgia	S. Caetano — São Paulo	1925	15,000	805	—	28,204	20,907
Cia. Nacional de Navegação Costeira	Ilha do Viana — Estado do Rio	1938 (1)	11,000	1,800 (2)	—	597	—
Usina Santa Olimpia Limitada	São Paulo — São Paulo	1925	5,000	247	—	720	7,167
Usina Siderurgica e Laminadora N. S. Aparecida	São Paulo — São Paulo	1938	5,000	201	—	—	4,712
Usinas Santa Luzia	S. Cristovam — Dist. Federal	1932	4,500	325	—	122	—
Laminação e Artefatos de Ferro S. A.	Recife — Pernambuco	1939	3,000	38	—	—	(3)
Comercio e Industria Souza Noschese S. A.	São Paulo — São Paulo	1938 (4)	2,400	643	2,457	—	—
Pirie, Vilares & Companhia Limitada	São Paulo — São Paulo	1939 (4)	2,000	500	1,144	—	—
Siderurgica Rio Grandense S. A.	Porto Alegre — R. G. do Sul	1938	1,700	134	—	—	2,469
S. A. Metalurgica Santo Antonio	Nova Lima — Minas Gerais	1931	1,600	430	2,816	—	—
Cia. Industrial de Ferro S. A.	Belo Horizonte — Minas Gerais	1937	1,500	145	2,436	—	—
Sociedade Paulista de Ferro Limitada	São Paulo — São Paulo	1936	1,500	90	—	95	—
Fabrica de Aço Paulista S. A.	São Paulo — São Paulo	1923	1,000	348	—	1,633	—
Usina Metalurgica Itaité S. A.	São Paulo — São Paulo	1938	1,000	78	—	—	829
Usina Queiroz Junior Limitada	Itabirito — Minas Gerais	1891	1,000	412	15,395	—	—
Usina Siderurgica de Gagé Limitada	Conselheiro Lafaiete — M. Gerais	1921	1,000	81	3,864	—	—
Siderurgica Barra Mansa S. A.	Barra Mansa — Estado do Rio	1937	800	84	4,673	—	—
Metalurgica Nestor de Goes Limitada	Santo André — São Paulo	1935	500	96	—	—	2,291
J. L. Aliperti & Irmãos	São Paulo — São Paulo	1928	428	168	—	360	2,347
Usina Siderurgica Capiruzinho (5)	Rio Branco — Paraná	1939	400	—	—	—	—
Eletro Aço Altona Limitada	Blumenau — Santa Catarina	1936	250	200	—	541	—
Laminação de Ferro Sacoman Ltda.	São Paulo — São Paulo	1939	200	14	—	—	—

NOTE: (1) — The Company was established on February 7th. 1891 but commenced operations as an enterprise under this classification on May 1938.
(2) — Total number employed in this company which includes some who work in other divisions not strictly within this classification.
(3) — For experimental purposs, 55 metric tons of iron products were produced.
(4) — The company was established on July 31st, 1920 but commenced operations as an enterprise under this classification on January 1938.
(5) — Under construction.

purchased 3,369,568 kilos; the other markets were Portugal which took 501,000 kilos and Bolivia which took 11,520 kilos. The overwhelming portion of the latter was also shipped to Argentina (4,534,000 kilos), the secondary markets being Uruguay (5,000 kilos) and Bolivia (191 kilos).

Exports of iron bars were priced (FOB Brazil) at 1,147 milreis per metric ton while that of the imported product (CIF Brazil) was 1,428 milreis in 1940. That of sheets was 1,046 milreis, the import price of the similar product being 1,638 milreis.

The exportation of ferro-alloys were recorded separately since 1939, there being shipments of 1,000 kilos each of ferro-manganese and ferro-silicon to Uruguay. In 1940, there were no exports of these two alloys there being, in their places, that of ferro-nickel which totalled 88,979 kilos valued at 237,839 milreis which was shipped to germany.

The unit prices of the ferro-silicon and ferro-manganese exports in 1939 were the same, i.e., 4,674 milreis per metric ton (FOB Brazil). There were no import prices with which a comparison might be made. That of ferro-nickel in 1940 amounted to 2,672 milreis per metric ton, the imports being priced at 6,879 milreis (CIF Brazil).

* * *

Brazilian output of steel in the 1930-1940 period rose from 20,985 metric tons to 141,076 metric tons, an increase of seven times during the Vargas Administration. The state of Minas Gerais which in 1930 produced 67% of the total, in 1940 accounted for 60% (Table 8). The state of São Paulo, the third largest in 1930 was the second largest in 1940 producing 21% of the total replacing Estado do Rio which in 1930 produced 32% and in 1940 contributed with but 18%.

In the domestic production of steel, the Cia. Belgo-Mineira is also the largest producer, the output being 85,332 metric tons, nearly three times that of the second (27,304 metric tons), Cia. Brasileira de Mineração e Metalurgia.

Third in importance was the Cia. Brasileira de Usinas Metalurgicas of Estado do Rio which had an output of 24,281 metric tons in 1940 and thus accounted for 17% of the domestic total.

STEEL

Table 8 PRODUCTION OF BRAZIL BY STATES IN METRIC TONS.

STATES		1935	1936	1937	1938	1939	1940
Minas Gerais		25,935	30,811	31,290	40,653	59,900	85,398
São Paulo		20,586	22,370	24,382	28,520	31,012	30,213
Estado do Rio		17,710	20,486	20,758	22,625	22,520	24,834
Santa Catarina		—	—	—	533	541	528
Federal District		—	—	—	91	122	103
TOTAL:	Tons.	64,231	73,667	76,430	92,420	114,095	141,076
	Contos	25,278	45,311	55,663	72,135	90,169	113,174

Pertinent to this branch of the iron and steel industry is that of electrical furnaces in the industry being of special interest to the defense and metallurgical industries. There are 23 such furnaces in Brazil, 19 of which are for refining and fusion and 4 for reduction. São Paulo has the largest number, nine, while the Federal District has the second largest, seven. In the latter district all furnaces are the property of official enterprises or organizations such as the Arsenal de Marinha (Navy Arsenal), Estrada de Ferro (R. R.) Central do Brasil, Fabrica de Projetis de Artilharia, etc. Pernambuco, Santa Catarina and Rio Grande do Sul possess one furnace each. The four reduction furnaces are located in Santos Dumont and Livramento in the state of Minas Gerais, there being the possibility that the former will transfer its installations to the Federal District after its incorporation into another firm engaged in this industry. The Santos Dumont plant had been handicapped in its operations from time to time due to the droughts which irregularly strike the area and thus reduce the available electrical current supply. In the Federal District, it will no doubt find ideal conditions for operations inasmuch as power rates are exceedingly cheap and plentiful. In Brazil, there is but one "bleeder" furnace. The Pernambuco plant will begin operations in the near future and will bring about the realization of a long awaited desire, that of supplying the Northeast region of Brazil with equipment and parts for the sugar industry.

Steel exports are recorded officially since 1940 in which they totalled 9,640 kilos, an infinitely small proportion of domestic production. The markets for the metal (bars) were Bolivia (7,906 kilos)and Argentina (1,734 kilos). In addition there was initiated the exportation of special spring steel which amounted to 119 kilos valued at 3,332 milreis. Against this shipment of 10 metric tons of steel bars is that of imports which attained 6,609 metric tons. There were, in addition, imports of steel strips and plates the former totalling 6,367 metric tons and the latter, 10,892 metric tons. The price of imported steel forms averaged 2,300 milreis per metric ton (CIF Brazil) while the export product was sold at 3,263 milreis (FOB Brazil). Steel of an unspecified nature produced in Brazil was valued at 802 milreis per metric ton in 1940.

The principal source of iron and steel crude and semi-manufactured forms during the 1937-9 period was Germany which accounted for 34% of the total while the second, the United States supplied 33%. With the full effects of the War under way, purchases from the former decreased to 0.2% of the total while that of the second represented 93% of the total. It may be noted that England, the third largest source in the 1937/9 period supplying 6%, last year (1940) provided but 3%.

It is of interest to note in passing the changes in the imports of manufactures and semi-manufactures of iron and steel which clearly demonstrate the transitions being made in the local metallurgical industry. In the 1920-9 period, the imports of semi-manufactures averaged 85,080 metric tons while that of the 1930-4 period fell to 48,070 metric tons. However that of the 1935-9 period had increased to 104,060 metric tons with the general expansion of industrial production. Contrasted to this movement is that of manufactures which in the

21 years since 1920 has varied as follows: 1920-9 average — 274,200 tons; 1930-4 average — 161,200 tons and 1935-9 average — 223,200 tons.

Construed in the light of the advantages of abundant high grade iron and electricity, large deposits of manganese and limestone, and a fairly large present day market and assuredly large future market, the importation of the iron and steel (300,000 tons) manifests in itself a challenge to local capital and initiative. The industry as it now operates with annual increases of 56,300 tons plays as important role in reducing these imports but there still remains the problems of variety on a large scale which can only be realized with an enormous expenditure of capital on a modern fully equipped, steel plant. Therein lies the basic reasons for the plan which resulted in the projected construction of a large scale works to be financed by the joint capital of the United States and Brazil, the share of the former being $20,000,000 and that of the latter, $25,000,000

Interest in the iron and steel problem originates in the earlier days of Brazilian economy but it may be said that a serious animated interest was only evident since 1930. The Administration named a commission of specialists to study the contract of the Itabira Iron Co., and came to the conclusion that it presented serious disadvantages. Since then, the iron problem has come under the direct orientation of the Government which organized a special commission composed of Messrs. Guilherme Guinle, Ari Torres, Adolfo Martins Noronha Torrezão and Col. Edmundo Macedo Soares e Silva to study the various aspects of this vital problem.

Various rectifications were made in the plans, the final, definite project being that organized by Col, Macedo Soares e Silva, the basic points of which were incorporated into the contract signed with authorities of the United States on September 26, 1940.

STEEL

Table 9 PROJECTED ANNUAL PRODUCTION OF CIA. SIDERURGICA NACIONAL

PRODUCTS	TONS	LITERS
Rails and accessories	90,000	—
Structural forms, medium and heavy	25,000	—
Rods, round and flat	50,000	—
Plates	60,000	—
Billets	20,000	—
Tinplate	50,000	—
Coke	50,000	—
Pig iron	50,000	—
Ammonium sulfate	4,000	—
Light oils	—	3,600,000
Toluene	—	200
Tar	—	9,000

The special Commission established a production scheme based on filling the need for 300,000 tons of semi-manufactures noted in Table 9. In the plan, there was included every provision for the production of all raw materials necessary in the manufacture of the required 300,000 tons of steel which de-

mands, 750,000 tons of iron ore, 225,000 tons of limestone and dolomite for pig iron production and 35,000 tons of the same for steel manufacture, 670,000 tons of coal for coke production and 100,000 tons for power generation.

Extensive studies were carried out in the establishment of the program, the principal factors taken into consideration being the utilization of domestic raw materials, which in the final analysis necessitated the location of the plant in a favorable point, advantageous both from the economic and strategical viewpoints, salubrity, the supply of water and the utilization of the existing means of transportation. The site finally selected was Volta Redonda situated in the Paraiba River valley, approximately midway on the railroad line connecting the two largest urban and manufacturing cities of Brazil, Rio de Janeiro and São Paulo. The Paraiba River is a perennial river with few if any overflows recorded in this century; the Estrada de Ferro Central do Brasil passes through this site as does the Oeste de Minas Railway (electrified); the climate is relatively mild due to the altitude and sufficient food supplies are near at hand bearing in mind that the production of technological and garden crops is the largest in the Union in the state of São Paulo and that the region itself is one of the largest if not the largest dairy center of Brazil.

As is well known, the iron ore of Minas Gerais, which is found on the Estrada de Ferro (R.R.) Central do Brasil (wide guage) is of high metal content and found in large quantities situated near the railway, the furthest being the deposit in Congonhas do Campo which is fourteen kilometers from the line. Many reserves are in operation while those not being worked at present are the Corrego do Feijão (Brumadinho), Mangabeira, Taqueril, Cercadinho and Lagoa Seca (Belo Horizonte). Those which have never been worked as yet are Espinheiro, Fabrica, Quilombo Doce, Olimpio Menezes (Brumadinho), Engenho Seco (Betim), Serra das Aguas Claras, Curral and Mutuca (Nova Lima).

The characteristics of the various types of ores vary from location to location. Differing from other regions where ores are considered rich when the ores have a metallic content in excess of 45%, that of Brazil is denominated as such only when is contains more than 55%. Another element, that of the phosphorus content, is of importance especially when steel is fabricated by the Bessemer and Thomas methods. Brazilian ores show low contents of phosphorus and in that respect leave little reason for concern with regard to this problem. The large problem is the augmenting of output to meet this enormous demand and still maintain the present level of exports. The present output of the state of Minas Gerais is, roughly speaking, sufficient to supply the Volta Redonda plant but consideration must be given to the necessities of the other enterprises engaged in the industry whose annual consumption is rapidly rising. In addition, there is the average annual export of about 300,000 tons which although need not be filled, is desirable.

The manganese ore will come from the Morro da Mina deposit in Minas Gerais which is described in greater detail in the section relative to that mineral.

Minas Gerais will also be the state to supply another important element for this steel plant, that of limestone. As was noted, the rocks of Herculano Pena and Pedra do Sino possess reserves of 12 million tons. As to dolomite which will also be necessary, this will be obtained in Crockatt de Sá (Minas Gerais), Taubaté (São Paulo) and possibly in Cantagalo in Estado do Rio.

An important element in this industry, coal, is found in the carboniferous basin of southern Santa Catarina whose reserves are estimated to reach 500 million tons and which, to date, have scarcely been touched when construed in the light of the fact that the annual production of that region is but 150,000 tons. As compared to Rio Grande do Sul, the output is small, the reasons for which are the lack of adequate railway transportation and port facilities. The railway difficulties will soon removed with the equipment of the Estrada de Ferro (R.R.) Teresa Cristina which will enable the more rapid distribution of the coal of the Lauro Muller, Rio Deserto and Cresciuma zones.

As to port facilities, Imbituba has possessed fairly satisfactory equipment for some time and with the improvements now being realized in the port of Laguna, it may be said there will be a complete guarantee of appropriate marine transportation. In the latter port, the breakwater projected by the Departamento de Portos e Navegação is progressing favorably.

The present projects and working plans of the mining companies will not attend the future needs. However, the Departamento Nacional de Produção Mineral of the Ministry of Agriculture has completed the requisite studies and will cooperate with the mine owners in order that the Cia. Siderurgica Nacional may have the required 2,300,000 tons of coal.

For coke production, it is estimated that 15% of the finer coal will be utilized. An analysis of experimental coke produced from the Santa Catarina mineral showed an ash content of 17.7% which proved to be the greatest disappointing factor but it is to be noted that this may be reduced with the installation of better equipment. A comparison with the coke used in the Tata Iron and Steel Company of India shows at least equal if not superior qualities on the part of the Brazilian product and for that reason leave little cause for anxiety in this field, the principal difficulty, as was noted, being that of transportation.

As will be noted in the section on Coke in the chapter on Fuels and Energy, coke is already being produced in Brazil, both from the imported coal and the domestic product. The quantities, however, are of low magnitude, the amount which is free to pass into interstate trade being from 300 to 500 tons only a larger part of which, however, is from Santa Catarina.

The Cia. Siderurgica Nacional held its first General Assembly on April 9th, 1940 under the presidency of Dr. Guilherme Guinle recently appointed to this position by President Vargas. Dr. Ari Torres was elected vice-president, Lt. Col. Edmundo de Macedo Soares e Silva, director of the Technical Section, Dr. Oscar Weinschenk, director of the Commercial Section and Mr. Alfredo de Sousa Reis Jr., director of the Secretariat.

The initial steps to be taken involve the organization of the technical division in New York and Cleveland in the United States by Lt. Col. Macedo Soares e Silva to draw up the plans, and select, control and ship the material while Drs. Oscar Weinschenk and Ari Torres are in charge of the construction of the plant, port installations and coal mining in Brazil.

The preferred stock of the company which represents 50% of the total was all subscribed by the Federal Savings Banks and the Institutos dos Industriarios, Comerciarios and Bancarios. The common stock will be sold to the general public through banks the Federal Government taking up the difference between the authorized capital and the immediate subscribed amount to later resell at par to those who may be unable to secure shares at the opening in view of the wide public interest manifested in this stock.

14. LEAD AND SILVER

LEAD

The principal uses of the metal are in storage batteries, white lead and litharge paint and in cable covering. It may be noted that the first and third uses provide recoverable lead while the second does not, thus providing considerable amounts in competition with the primary mined lead. Secondary uses for lead are in the automobile, ammunition and bearings industries. In Brazil, the principal use of lead is in its metallurgical application such as tubes, sheets, solder, etc., although it may be noted that the amounts entering the paint and printing industries are of some importance.

An attempt at international cooperation in this industry is evident in the form of the Lead Producers Association which was formed in September 1938 for the purpose of restricting output. It controls about 60 to 75% of the lead produced outside the United States. Successful manipulations are reported for the initial period of its operation which involved the 10% reduction of output but with the War, further information has become unavailable.

As is well known, the largest producers are the United States and Australia, which in 1939, produced 410,000 metric tons and 240,000 metric ton respectively. The former produces about 20% of the world total while the latter accounts for about 14% of the total. Other important producers are Mexico, Canada and Bermuda.

The largest exporter is Mexico which is followed by Australia, Canada, Yugoslavia and Burma, in order of decreasing importance. The leading importing country is England, followed by Australia, Canada, Yugoslavia and Burma, in order of decreasing importance. The leading importing country is England, followed in order by Germany, Belgium, France and Japan.

The production of lead in Brazil is still in a comparatively undeveloped state, the exploitation of the ore having been initiated only recently despite its occurrence in all states in Brazil except four, Amazonas, Maranhão, Territorio

do Acre and the Federal District. In a bulletin, *Chumbo e Prata no Brasil* (Lead and Silver in Brazil) by Othon Leonardos, the engineer catalogued no less than 120 occurrences of the ore, galena. However, only ten of these have been intensively studied so that the others remain within the realm of the problematical, ranging from mere surface indications to deposits of unknown magnitude.

Among the more important deposits, the most outstanding is Minas das Furnas in the southern part of the state of São Paulo between the towns of Iporanga and Apiaí. The mine is owned by the Sociedade Mineração das Furnas and contains the largest known reserves of lead and silver in Brazil. In the small section now being worked, there is an exposed reserve of about 50,000 metric tons of pure galena with an average content of 4 to 6 kilograms of silver per ton of lead ore. The local conditions indicate that the vein is extensive, both in length and depth, the amount of argentiferous galena being estimated to amount to considerable quantities.

Near this deposit, in the district of Macacos, there are many other occurrences of the same category also belonging to the Sociedade de Mineração de Furnas in quantities which are sufficient to keep the company supplied for more than a hundred years.

In the Fazenda do Espirito Santo on the banks of the Iporanga River, the Companhia Mineração Iporanga is working four deposits whose reserves are estimated to amount to 20,000 metric tons of galena with an average of 500 grams of silver per ton of lead ore. In the same district, in the locality known as Morro Chumbo (Lead Hill) or Serra dos Motas, there are also other deposits of varying magnitude.

About seven kilometers from Apiaí (Guapiara) there are other deposits of some importance belonging to the Companhia de Mineração e Metalurgia Brasil (Cobrazil). A sample of this mine analyzed in the Central Laboratory of the Departamento Nacional de Produção Mineral showed a lead content of 84.5% and 2.5% silver. Recent analyses made in American laboratories on two and a half metric tons of Brazilian ores showed 10% to 66% lead in the Furnas sample which when concentrated had 64% to 81% lead. Panelas de Brejauvas (Parana) ore tested with 56% lead and 81%. The other sample of ore, that of Braços da Pescaria had a 21% lead content while an analysis of its concentrates showed a 62% content.

In the state of Paraná, another company, the Plumbum S. A. has been working the deposits of Panelas de Brejauvas, with apparent success during the last two years. In 1939, this company exported 1,114 metric tons of lead ore to London, Antwerp and New York with a metallic content of about 63% and 2.1 kilograms of silver. In 1940, the production of the company had in all probability amounted to 2,000 metric tons.

Concentration, metallurgical and refining equipment, which operated at low cost by the State might permit the exploitation of the ores of the states of São Paulo and Paraná with profit, is at present a reality and is carried out by

the Usina (mill) de Chumbo e Prata. Under the former circumstances, the exports of the ore of lead and silver did not compensate the expenditure particularly due to the high transportation cost.

The Usina de Chumbo e Prata operated by the Instituto de Pesquizas Tecnologicas for the State Government of São Paulo was projected by a Brazilian engineer based on the studies and experiences in a recent trip to the United States and Canada. The mill is situated in the vicinity of Apiaí near the communication systems of the region and centered in the deposits of lead and silver which are situated in an area within a radius of 70 kilometers. It consists of the following units:

1) — Central hydroelectric power plant using the fall of the Salto do Calabouço of the Palmital River, the concession of which was granted by the state of São Paulo;

2) — Concentration mill with a capacity to treat 30 to 35 metric tons of ore per day;

3) — Metallurgical and refining mill using the Parkes process which permits the production of 10 metric tons of refined lead per day and the recovery of all the silver and gold contained in the ores. The production of silver varies from 15 to 70 kilograms per day depending on the quality of the concentrates treated.

The mill receives ores from all the national companies which work the deposits of the Ribeiro de Iguape Valley in the state of São Paulo as well as Paraná and transforms it into refined lead and silver, recovering all the by-products. Charges are made only for the cost of the concentration and refining, thus assuring the national companies of profits which enables them to divert the necessary capital to the development of the mines.

The building of this authorized mill through the action of the Government is not only a reflection of the desire to bring about the rapid development of the home mineral industry on a sound basis, but also the realization of the plan to place the industry on a well organized basis by the construction of a network of communication lines between the more important deposits and a system of highways in order to permit the easier exploitation and transportation of the ores to the mill. Simultaneously, prospects and geological and genetic studies of certain deposits of the region have been carried on by the Instituto Geografico e Geologico of the state of São Paulo with the cooperation of the Departamento de Produção Mineral. These studies and prospects are made for the purpose of directly and efficiently aiding private initiative supplying the national companies with necessary information which will justify the investment of capital in the development of the mines.

Exports in lead ore have showing irregular tendencies over the years having averaged 234 metric tons annually in the 1920-9 period, 628 tons in the 1930-4 quinquennium and 480 tons in the 1935-9 period, although it may be

pointed out that in the last five years there has been a distinct trend toward an increase reaching 947 tons in 1939. In that year the chief market for the product was Belgium which imported 583 metric tons of the ore while the United States was the other market purchasing 364 metric tons. In 1937 and 1938, England and Germany were other markets for the mineral but did not appear in the Brazilian market in 1939. In 1940, exports amounted to 296 tons, the principal outlets being Great Britain (150 tons) and the United States (143 tons). The other market was Argentina which purchased 3 metric tons.

The unit price of export lead ore in 1938 was 516 milreis per metric ton and that of 1939 — 416 milreis. The 1940 price rose to 454 milreis while that at the mine was 800 milreis (concentrated).

This country imports about 10,000 metric tons of crude lead annually valued at about 19,000 contos-de-reis, the industrial center of São Paulo alone consuming about 12,000 contos-de-reis of leads ingots.

Imports of the crude metal in the 1920-9 decade averaged 4,729 metric tons while in the succeeding five year period this rose to 5,600 metric tons. During the 1935-9 period, there was a sharp increase in the average to 9,270 metric tons which continued in 1940 in which the total was 9,358 metric tons. The United States and Canada were the principal sources of the crude lead in the latter year, imports from the former being 4,778 metric tons and that from the latter 3,351 metric tons. Chile was a secondary source supplying 697 metric tons. Lead sheet imports amounted to 93 metric tons in 1940, seventy tons while that for tubes in 1940, amounted to 25 metric tons, 18 tons of the latter being from Great Britain, 6 metric tons from the United States and a small amount from Sweden.

SILVER

As was mentioned, silver in Brazil, as in Australia, is found associated principally with lead.

The world production of silver showed a substantial increase with the discovery of America, which today, contributes to about 80% of the world total. However, even in the Colonial days when the idea prevailed that great riches in silver existed in the *sertões* (prairies) of Brazil and incited the interest of the Portuguese, Brazil was still among the smallest of producers in the American continent. It would thus lead to the conclusion that silver, in contrast to gold, has never exercised an appreciable influence on the national economy. And yet, there are few countries with conditions so favorable as those of Brazil for the production of large quantities. It is encountered in the various lead deposits of the states of São Paulo and Paraná where silver is obtained as a by-product of the working of that metal. It is interesting to note that the exploitation of the plumbiferous zone of these states, though still on a small scale and accomplished with difficulties in transportation, still has been able to operate due to the fact that the ores of the region contain high percentages of silver. The erection of

the state of São Paulo in September 1939 has added materially to the economic development of the ores of that region, especially those of silver and lead.

In Pandeiros which is 36 kilometers from the city of Januaria in the state of Minas Gerais, silver is found associated with zinc. It is an interesting vein of willmenite which is being worked by the Cia. Januarense de Explorações Ltda.

Various analyses of the mineral of Januaria have been made in Rio de Janeiro and in Belo Horizonte in the state of Minas Gerais and have showed varying metallic silver contents up to 32%.

The higher silver content ores are found only in the surface deposits while in the other deeper ores which have not been concentrated, the ratio of silver continues to remain from 0.5% to 1.5%, that is, 5 to 15 kilograms of silver per ton of ore.

SILVER

Table 10 PRODUCTION OF BRAZIL BY STATES IN GRAMS

STATES	1935	1936	1937	1938	1939	1940
Minas Gerais	644,724	724,903	744,676	770,323	833,970	739,021
Paraná	—	11,789	40,789	24,129	24,294	29,044
São Paulo	2,918	7,303	—	—	—	—
TOTAL: Grams	647,642	761,995	785,465	794,452	858,264	768,065
Contos	159,561	159,083	184,813	201,033	196,094	168,965

Production of this precious metal in Brazil has shown little if any progress until 1934, the output in that year amounting to 582 kilograms, to 648 kilograms in 1935, to 785 kilograms in 1937, to 794 kilograms in 1938, to 842 kilograms in 1939 and 768 kilograms in 1940.

Compared to the irregular production is that of importation which has varied still more sharply over the years manifesting an abnormal increase in the last three years, that of 1940 being 5,772 kilograms the highest in the import history of this metal. In the 1920-9 decade, imports of this metal averaged 519 kilograms annually and increased to 733 kilograms in the 1930-4 quinquennium: the average for the 1935-9 period was 1,645 kilograms. The principal source of this metal up to the War was England while the United States and Germany were secondarily important. In 1940, the principal source was the United States.

The import price of silver (CIF Brazil) has varied as follows: 1938 — 275 milreis per gram, 1939 — 272 milreis and 251 milreis in 1940. The average mine price in 1940 was 200 milreis.

15. MANGANESE

It is estimated that about 95% of the world production of manganese ore is absorbed by the iron and steel industry, principally in the manufacture of

ferro-manganese and spiegeleisen, the usual form in which the metal is applied in the steel industry. There are other metallurgical uses such as that in the non-ferrous metals which, however, is insignificant. Another use is in the manufacture of batteries (dry cells), there being required at least a 70% MnO_2 content and the absence of lead bearing particles and iron pyrite. Special uses are also found for this metallic ore in the chemical, ceramic and glass industries, specifications usually requiring an ore with about 85% MnO_2 and less than 1% iron. In Brazil, practically all the ore is used in the iron and steel industry with little if any diverted to the other industrial applications.

The production and exportation of Brazil has increased lately, particularly is this true of the trend since 1936, despite the competition of Russia which used to supply about 50% of the total world consumption before the World War. At that time India supplied 40% so that between these two countries, they furnished 90% of the total. With the end of the World War, Russian production practically ceased and the interested countries began to look for new supplies in the Gold Coast and Egypt. The mines of Brazil which were at that time inactive after a period of intensive operation, entered into the production field with renewed animation due in large part to the new demands from the United States. The latter, though one of the largest producers of steel in the world does not possess manganese in sufficient volume to meet her needs and for this reason is now taking an unusual interest in the Cuban deposits. Large amounts are also imported from Russia at present but these are the object of decreasing interest according to late reports which, indirectly, holds forth promises for the domestic product.

In Brazil, the largest and best known deposits of manganese ore are located in the states of Minas Gerais, Baia and Mato Grosso, there being some minor deposits in the states of São Paulo, Ceará, Maranhão and Paraná. From 1933 to 1939, however, the only producing state has been Minas Gerais, production having risen from 24,893 metric tons in the first mentioned year to 306,025 metric tons in 1938 only to fall again in 1939 to an estimated total of 250,000 tons thus placing this country in fifth place of importance among world producers. The preliminary estimate for 1940 is an output of 270,000 tons.

There are about 34 concerns engaged in the working of the manganese of this state and employ approximately 2,120 persons. More than 5,000 contos of capital are invested in the industry, the fifth largest in mining activity in the state.

The manganese of Brazil is encountered in two types of deposits, first, those associated with iron ore and limestone or that of chlorite schists in the regions which are classed under the general denomination of *Minas Series* and second, that which does not fall within this classification. The former is also known as the Burnier type and the latter, Lafayette, since the deposits of these regions are representative of the entire groups.

In various localities in the central zone of Minas Gerais, there are layers of manganese associated with those of limestone, itabirite and quartzite,

which are represented by the best known, the deposits of Miguel Burnier at the 503 Km. Post of the Estrada de Ferro Central do Brasil. Others of a similar nature are found in Ouro Preto and vicinity. The ore of Migual Burnier consists principally of a mixture of psilometane and pyrolusite having an average of 50% manganese, 1% silica and from 0.03% to 0.05% phosphorus.

The most important mine of the country, however, is in the Morro da Mina which is about 4 kilometers from the city of Conselheiro Lafayette which is linked to the Estrada de Ferro (R. R.) Central do Brasil by means of a branch line. The ore occurs in large layers which are nearly vertical and consist principally of psilometane with manganite and pyrolusite. The deposit is mined by open cuts and worked by hand although some sections must be developed by the gallery system. The mine is operated by the Companhia Meridional de Mineração, a subsidiary of the United States Steel Corp. which acquired the mine in 1920. The reserves are estimated to be about 10,000,000 tons, of which 3,200,000 tons have been extracted up to May 1935. The present reserves are calculated at about 3 million tons.

In Agua Preta, near the Morro da Mina, a similar type of ore is being worked and transported to the E. F. Central do Brasil, which is eight kilometers distant, by means of a cable-way. This deposit belongs to the A. Thun & Cia. which also owns a mine at Cocoruto which is 32 kilometers from the Lafayette station. The deposits there attain considerable magnitude and are being worked by means of galleries.

Other deposits of the Lafayette type are found in Estiva, Paiva, Sabino, Jurema and Micaela. All these occurrences are linked to the principal railway by means of branch lines with 60 centimeter and 1 meter gauges.

The mines of the Nazaré district of the state of Baía, which are situated near the coast are at present idle. The most important deposits of this state are those of Sapê, Pedras Pretas and Onha which were worked during the World War. Of those in the hinterland, there is only one worth mentioning that of Bomfim which is in Laranjal in the Jacobina district. In 1940, the state produced 7,590 metric tons, there being an exportation of 6,295 metric tons.

The reserves of the Urucum deposits in the municipality of Corumbá in state of Mato Grosso are estimated to contain about 30 million tons of which, at least, 15 million tons contain 43% manganese. The deposits which are government-owned are situated 9 kilometers from the Paraguay River and 20 kilometers to the south of Corumbá. A railway links it to the Paraguay River from whence it goes to the city of Rosario in Argentina, a water distance of about 2,000 kilometers. Ships of 4,000 tons can navigate to the Mato Grosso port from the Argentine city.

In general, the Brazilian manganese ore contains from 38% to 50% metal, that which is exported usually averaging 45 to 48%.

Analyses of the principal Brazilian ores show that the Burnier (Minas Gerais) mineral had a 54% manganese content, that of Morro da Mina

of Minas Gerais 51%, that of Laranjal of Baia 53% and the Urucum mineral of Mato Grosso 44%.

The United States is the principal market for the Brazilian product, the general average of shipments in the last five years being about 50% of the total domestic production. In America, Cuba is only competitor of Brazil. The Cuban ore is favored by tariff exemption in the United States while the Brazilian product enjoys a 50% reduction, in spite of which, however, the ore of this country is able to compete effectively due to the lower cost of production.

In 1939, the United States imported 134,963 metric tons of Brazilian ore while Germany, the second largest market bought 37,306 metric tons. Other secondary markets were Czecho-Slovakia, Hollanda, Belgium, Dantzig and France. This export quantity which was 38% larger than that of 1938 was made despite the difficulties encountered in the transportation of the ore to the ports founded largely upon the coal shortage which came with the War and reduced the movement of freight service. Another unexpected development was the higher evaluation of ores thereby increasing the tax payable on the exports. In 1940, the exports of this ore increased 17 percent to attain 222,713 metric tons of which 215,601 metric tons were shipped to the United States and 7,112 metric tons to Belgium.

MANGANESE

Table 11 EXPORTS OF BRAZIL

YEAR	TONS	MILREIS	YEAR	TONS	MILREIS
1920	453,737	39,829,000	1931	95,550	6,395,121
1921	275,694	22,917,000	1932	20,885	1,308,976
1922	340,706	22,269,000	1933	24,893	1,134,710
1923	235,831	26,784,000	1934	2,300	133,607
1924	159,229	18,258,000	1935	60,669	6,675,913
1925	311,882	31,476,000	1936	166,471	16,342,421
1926	319,825	25,304,119	1937	189,003	20,640,000
1927	241,823	21,225,344	1938	136,843	16,312,794
1928	361,829	37,043,974	1939	247,115	44,730,000
1929	293,318	28,579,096	1940	222,713	32,311,317
1930	192,122	14,486,477			

The price of the exported manganese ore was 119 milreis per metric ton in 1938, 109 milreis in 1939 and 145 milreis in 1940. Contrasted to this is the ore known as *extra* in the trade which contains 48% or more metal which was quoted at 80 milreis a metric ton in 1940. Another type rated as *exportavel* (exportable) which contains from 42% to 48% manganese was sold at 45 milreis per metric ton in the same year while the *baixo* (low) which contains 35% to 42% metal averaged 30 milreis during 1940.

Ferro-manganese (25 to 35%) was quoted at 15 milreis per metric ton.

16. MERCURY

The uses of this metal which remains a liquid at ordinary temperatures are manifold being divisible into two grand divisions, the military and the civil.

In the former, as a metal, is that as an amalgam, in storage batteries and in meters while as a salt, its use is principally as a fulminate and a drug. In the civilian field are those largely connected with the electrical industry (rectifiers, thermostats, batteries and diffusion lamps). The preparation of hatters felt also absorbs appreciable quantities of this metal.

Towards the middle of 1940, a deposit of cinnabar was discovered in the vicinity of Dom Bosco in the state of Minas Gerais which is on the Ouro Preto branch of the Estrada de Ferro Central do Brasil. For a long time, a deposit has been known to exist in Tres Cruzes of the Tripui district of the same region. An analysis of a sample of the ore of the first mine was made in the laboratories of the Departamento Nacional de Produção Mineral and showed a 79.45% mercury content.

There is a small occurrence of cinnabar at Aratuipe in the state of Baía but little importance is attached to it.

With the increasing industrial expansion, uses for mercury have augmented substantially as may be noted from its imports which in the quinquennium 1925-9 averaged 4,500 kilograms annually and rose to 5,330 kilograms in the succeeding five years. By the 1935-9 period, the yearly average had increased to 8,550 kilograms nearly double the amount of a decade previous. In addition to this demand is that which arises for medicinal uses which amounts to about 1,500 kilograms annually. The principal source of the first quality of mercury is England with varying amounts coming from Germany and the United States. The latter comes principally from England, Germany and Italy.

The 1940 imports of industrial mercury totalled 5,989 kilos, a decrease of 6% over 1939 in which year it amounted to 6,397 kilos. In 1940, the United States was the principal source with Mexico and Great Britain being of secondary importance.

17. MOLYBDENUM

The principal use of molybdenum is in the iron and steel industry as an alloy, especipally in combination with one or more other metals such as tungsten, chrome, vanadium, silicon, etc., although when used alone, it is not without its peculiar properties which render it useful in industry. Molybdenum high speed steel is being increasingly used and is providing one of the main outlets for this metal. Other non-metallurgical uses include those in the chemical and ceramic industries particularly in the salt form.

In Brazil, molybdenum is found in Morro do Baú near Vila Gaspar which is 42 kilometers from Itajaí and 13 kilometers from the Itajaí River in the state of Santa Catarina. This deposit is composed of two thin veins of quartz pyrites and molydenites, the mineral containing 20.083% sulfuret of molybdenum.

Other small occurrences of little economic significance are distributed in various region, the most important of which are in Baturité in the state of

Ceará, the Serra da Onça deposit in the southern part of the state of Baía, those in Caçapava, Encruzilhada and Cachoeira in the state of Rio Grande do Sul, that along the Capivari River in the state of Paraná and in Monção in the municipality of Campos in Estado do Rio.

Molybdenum wire imports are registered separately since 1937, the overseas purchases in 1937 being 256 kilograms. In 1938 this had increased to 259 kilograms, while in 1939, the total was 343 kilograms. The principal source of supply is these years was the United States. In 1940, the total had increased to 178 kilograms, all of which was from the United States.

Molybdenite was quoted at 15,000 milreis per metric ton at the mines in 1940.

18. NICKEL

Nickel, despite its wide application at the present, at one time was considered a nuisance and was even called "devil's copper" because its occurrence with copper, gave the impression that it was the latter and obstructed the extraction of that metal under the ordinary methods of reduction employed in that day.

The present day uses of nickel extended to many fields but the principal is in the steel industry in which it is employed as an alloy metal. Its properties of non-staining, non-corroding and resisting heat impart qualities to steel which make it valuable in the automobile, electrical, hardware, etc., industries. There are, besides, other alloys based strictly on nickel, the more important of which are nickel-copper, nickel-silver, Monel metal, Iconel metal and heat and electrical resistance alloys. In Brazil, the principal use for the metal is in the iron and steel industry. Small amounts are also employed in the plating industry.

World production of nickel has made notable increases in recent years, reaching a total of 115,000 metric tons (metal content of ore) in 1937. Canada, which for many years has been the leading producer, contributed to the total with 102,412 metric tons or about 90% of the world total. New Caledonia is the second largest producer while Russia is the third having increased its output substantially in recent years. Brazil was eleventh among world producers in that year.

In the world trade of nickel, Canada, New Caledonia, Norway, Greece and Brazil are the most important exporters while England, Germany, Norway, the United States and France are the leading importers.

The principal occurrences of nickel in Brazil are found in the São José do Tocantins region which is in the state of Goiaz and in the Livramento and Ipanema districts of the state of Minas Gerais. There are deposits of less importance in several regions of Minas Gerais as Bom Jesus do Galho, Jucuí, Aiuruoca, Cataguazes, etc. In Estado do Rio, there is the Areal deposit in the municipality of Paraíba do Sul.

The deposits of São José do Tocantins are found in the Serra (mountain) da Mantiqueira. These deposits are the richest in Brazil being incomparably superior to those of Livramento. The metal content is very high and its reserves are said to be larger than those of New Caledonia but less than those of the south of Ontario, Canada; the ore has a metal content of 12% to 13% nickel in certain localities while the total deposit may be said to have an average of 5% metal.

The major problem for the nickel of Goiaz is its inaccessability and hence transportation costs are relatively high. The transportation of ore at present is accomplished by means of the highway to Anapolis which is the terminal of the Estrada de Ferro Goiaz (Goiaz Railway) and from there is sent to the port of Santos, a distance of about 800 kilometers; there is little doubt that with the extension of highways, the nickel of Goiaz will occupy an important place in the production and export trade of Brazil. A solution to this problem seems to lie in the concentration of the ore or even the reduction of the ore at the spot. No information has been divulged as yet upon the results of an experiment to concentrate the ore. It is to be noted the sole source of fuel used is firewood and charcoal.

The deposits of Liberdade of the state of Minas Gerais are also large but have a metal content which approximates 2%, although there is a small quantity of ore which has a content which ranges from 4% to 5%. The mineral of Livramento which has a content in excess of 2.5% is exported in the ferro-nickel form through Angra dos Reis in Estado do Rio reaching this port by means of the Estrada de Ferro Oeste de Minas, a distance of 241 kilometers. These deposits are being worked by the Companhia de Niquel do Brasil which has so far invested about 6,500 contos in the enterprise. The equipment of the plant consists of a hydroelectric plant which supplies an electric furnace with a daily reduction capacity of 20 to 35 metric tons of ore. This company has been exporting the metal regularly but has ceased since 1938 in order to turn its efforts exclusively to the problem of metallurgy. At present, they produce from two to two and a half metric tons of ferro-nickel every 48 hours which contains 20% nickel. The plant employs 161 persons.

The largest producing municipality in the state of Minas Gerais is Aiuruoca in the south while Ipanema which is in the west is a secondary producer. The first mined 5,010 metric tons in 1937 while the latter's output was 4,100 tons. About 160 persons are employed in the mining of the ore in Aiuruoca. In 1938 the state production totalled 9,100 metric tons of ore while for 1939 and 1940 no official data is available.

It is to be observed that the exports of nickel ore have been irregular over the years and commenced in 1933 with a shipment of 310 metric tons and rose in 1934 to 387 metric tons. Since then the shipments have been as follows: 1935 — 55 metric tons, 1935 — 4,783 metric tons, 1937 — 4,171 metric tons and 1938 — one metric ton. The latest export (1938) of one ton was made to Japan. In 1937, the principal market was Germany which imported 4,161 tons of domestic ore. Japan was the other purchaser.

The mine price of the ore in 1940 was 100 milreis per metric ton.

The price per metric ton of a shipment of ferro-nickel of 88,979 kilograms in 1940 was 2,763 milreis the destination being Germany.

The principal nickel semi-manufactures imported are cubes and sheets, the average during the 1920-9 decade having been 11,030 kilograms annually while that during the five year period from 1930 to 1934 averaged 29,980 kilograms. The annual overseas purchases during the 1935-9 quinquennium which averaged 101,150 kilograms were the largest to date, the importation of 1938 being 156,625 kilograms, more than any single annual purchase in the last twenty odd years. In 1940, imports totalled 63,218 kilos, the principal sources being the United States and Great Britain.

The imports of nickel manufactures show the following changes: 1920-9 average — 6,910 kilograms, 1930-4 average — 1,040 kilograms and 1935-9 average — 9,280 kilograms. As compared to 1939 in which the imports totalled 31,370 kilograms, that of 1940 amounted to but 7,916 kilograms, a decrease of 75%. In 1940, the chief sources were the United States and England.

19. PLATINUM

A larger part of the platinum consumed is absorbed by the jewelry industry, its alloy with iridium being used extensively in rings and other types of jewelry. The second in importance is the chemical industry where it is used as a catalyst, vessel linings, hydrogenation of organic compounds, rayon spinnerets and laboratory equipment. The dental industry also uses considerable quantities in orthodontic work, in bridges and in bracings. The uses in the electrical field are largely in the field of contact points, resistances, voltage regulators and meters. In Brazil, a considerable portion is used in dental work and jewelry, the industrial uses being of an indefinite nature.

The rapid extension of uses for this metal have so increased consumption that despite the larger recovery of platinum from refining processes of nickel, copper and gold (17% in 1929 and 57% in 1938) production has not been able to create huge surplus stocks.

The discovery of platinum dates back to the beginning of the last Century. In 1801, the occurrence of this metal in the auriferous zone of the state of Minas Gerais was a known fact.

Platinum is found associated with gold and diamonds or isolated in the alluvium of the Abaeté River and in the ravines of the eastern flanks of the Serra do Espinhaço which commences at Morro do Pilar and goes on to Itambé do Serro in the state of Minas Gerais; in the auriferous ores of Itabira and Congo Soco and in the volcanic cones in Coromandel and Carmo do Parnaíba in the same state.

In the eastern Espinhaço region, platinum is found in the gravels of the Picão Ravine, the Lages Ravine, the Bomsuccesso Ravine and in Ribeirão das Pedras in the form of sheets, or in lumps the size of a bunch of grapes. The density of the platinum grains of the Lages Ravine varies from 18 to 20.5 and

an analysis reveals 85.5% platinum and varying quantities of osmiridium, iridium and palladium. The ore of the Fazenda do Condado has a density of 16.3 and from 73% to 74% platinum, 21.8% palladium and small quantities of iridium. The heavier minerals which accompany platinum are magnetite, hematite, rutile, xenotime, monazite, oligiste, zircon, gold, diamonds, martite, tourmalines, pyrites, disthene and columbite.

In the Abaeté River, platinum occurs in gravel and is associated with diamonds, gold, magnetite, perovakite, chromite, garnets, rutile, disthene, limonite, pyrites and phosphatic formations. They have a round, thin disk form, a density of 17.5, 82.8% platinum and traces of palladium.

The occurrences of platinum in the alluvium of Minas Gerais are of greater importance, the most significant being those in the volcanic soil and rock and basic rock of the Mata da Corda. In Patos, Coromandel and Carmo da Paranaiba, the former Serviço Geologico do Brasil carried out some prospects and tests with the following results:

1) — At the Fazenda Cascata in Patos, 0.6 grams of platinum per metric ton of volcanic soil and 1 gram per metric ton of diabasic olivine were found;
2) — in Coromandel, the average platinum content for a ton of volcanic rock was 0.81 grams and 0.42 grams for a ton of *filitos;*
3) — in Carmo da Parnaiba, two samples of volcanic soil tested 1.95 and 4.76 grams of platinum per metric ton.

Platinum also occurs in the northeastern section of the state of Minas Gerais in the alluvium of several rivers and ravines of the São Matheus and Suassuí Grande basins. Analyses made of hundreds of samples of the deposits there showed 0.35 grams of platinum per metric ton of gravel.

Imports of platinum bars, sheets, and wire have been irregular in recent years, the total in 1937 having been 19 kilos, 8 kilos in 1938, 14 kilos in 1939 and 3 kilos in 1940. Very recent imports are thus little different in quantity as compared to the average during the 1920-9 decade when they amounted to 10 kilograms but are considerably less than that of the 1930-4 quinquennium when they averaged 21 kilograms, it being worthy of note that the importation of 63 kilograms in 1934 was the largest in twenty odd years. The 1935-9 quantity was 24 kilograms. In 1939, the principal sources were the United States and Great Britain, 48% of the total being from the former and 47% from the latter. The other suppliers were Germany and France. In 1940, the total imports were from the United States.

In 1939, platinum semi-manufactures which were imported were priced at 22,209 milreis per kilogram (CIF Brazil) as compared to the 21,832 milreis of 1940.

Imports of platinum manufactures show a similar irregularity and from the 1.4 kilos of 1937, purchases rose to 3.2 kilos in 1938 and decreased to 0.6 kilos in 1939. The United States and Great Britain are also the principal sources of supply of these manufactures. In 1940, imports totalled 1.2 kilos, all of which was from the United States.

20. RADIO-ACTIVE MINERALS

Although the most widely known use of radium is in the field of medicine as a curative; its employment in the field of inspection of metals has increased to such an extent that it may be noted as being one of the more important newer uses. It is used in the verification of the soundness and fitness of casted and welded pieces. Radium activated materials are also commonly used in luminous paints.

Uranium, another radio-active metal, is used in its salt form in the ceramic industry to produce a golden glaze on pottery and to obtain yellow or orange colored glass.

The production of radio-active mineral, in Brazil, though still new, is worthy of mention. The principal radio-active elements in Brazil are radium, uranium, thorium and actinium.

Other radio-active minerals found in Brazil are polycrasite, aerodite, djalmaite, eschweigeite and fergussonite.

The most important deposit of radio-active minerals in Brazil is located in Divino, in the municipality of Ubá, in the state of Minas Gerais, where the minerals are found with samarskite and columbite.

There is another deposit of these minerals in Ribeirão de Santa Clara, near Pombas, in the state of Minas Gerais which includes polycrasite, blomstrandite and xenotite. The analysis of it by the Escola Nacional de Minas e Metalurgia in Ouro Preto, Minas Gerais, showed that one sample contained 22.7% yttrium, cerium and erbium, 10.25% uranium oxide and 1.0% thorium oxide. A second sample of the same tested with 28.3% of yttrium, cerium and erbium, 10.00% uranium oxide and 2.0% thorium oxide.

Cachoeira de Itapemirim in the state of Espirito Santo also contains deposits of these minerals.

In the deposit of Divino of the state of Minas Gerais, from 13% to 18% uranium oxide is obtained in the pegmatites exploited for mica, colored stone, tourmalines, beryls, etc. The deposits of Ubá contain 75% samarskite, 15% monazite and 10% columbite.

In 1940, there appeared for the first time, in official statistics, the importation of these minerals classified under "Radium and other radio-active products", which amounted to 181 milligrams with a value of 796 milreis per milligram (CIF Brazil).

21. TIN AND TUNGSTEN

TIN

The principal use of tin is in the tinplate industry while the second is that in solder. Babbitt and bronze also use considerable amounts of tin as do collapsible tubes, but not to the extent to which the metal is used in the first

two applications. In Brazil, considerable portions of the metal are used in tinning and solder.

Tin is one of the few metals which is under international production control. The International Tin Committee under whose jurisdiction, the setting of quotas is placed, establishes output limits in quarters of a year and also operates a Buffer Pool which has for its purpose the creation of extra supplies from which metal could be withdrawn until an upward quota change could be filled or which could purchase excess outputs and thus maintain price levels until production returned to a new lower level. The super-demands of the war however have difficulted not only the operation of the quota system itself but also the functioning of the Pool to the extent that quotas changed from 40% in the first quarter of 1939 to 120% in 1940 with severe intermediate changes within the quarters themselves. There are 7 countries in this control scheme producing 84% of the world output of ore.

Malaya is at present, the largest producer in the world, being followed in importance by Bolivia, the Dutch East Indies, Thai (Siam) and Nigeria.

The normal annual consumption of the United States is about 75,000 metric tons or approximately 15% of the world production. In 1938, when the world consumption compared to that of 1937 fell about 24%, the United States imported 51,738 metric tons. In the same year, the second largest importing market was England with 18,655 metric tons while Russia was third with 16,497 metric tons. Germany, Japan and France follow in order with 13,643 metric tons 11,182 metric tons and 9,229 metric tons respectively.

Among the principal suppliers of tin ore in 1938, Malaya was the leader with 44,000 metric tons; Bolivia, second with 25,993 metric tons; the Dutch East Indies third with 21,421 metric tons and Thai, fourth with 13,888 metric tons.

Cassiterite is found in the Picui-Parelhas zone of the states of Paraiba and Rio Grande do Norte but, although their metal content is high, it is believed the reserves are small since they are pegmatites and not alluvials. In the state of Baía, there are the deposits of Livramento, Minas do Rio das Contas and the upper reaches of the creeks and streams of the Brumado River basin which have been worked to some extent by rudimentary methods. The latter deposits are alluvials of little significance, are known as wood tin, and have a low metallic content. Cassiterite is noted in the exports of Baía for the first time in 1940, the total being 347 kilograms of which 237 kilos were shipped to New York and 110 kilos to Rio de Janeiro.

Occurrences of this mineral are found near Fortaleza and Salinas in the state of Minas Gerais but little is known of its characteristics. The sands of the Paraopeba near the State Capital, Belo Horizonte, also contain quantities of tin.

The deposits of the state of Rio Grande do Sul are the most important, have a high metal content and are the only ones worked on a large scale. The stanniferous zone is located in the municipalities of Encruzilhada and Pi-

ratini in the alluvials of the creeks and streams which flow into the Camaquan River. The most well known are those of Sanga Negra (alluvial), Campinas (primary and alluvial), Taboleiro (primary and alluvial), Cerro Branco (primary), Estreito (primary with discoveries of alluvials in 1938), Santa Barbara and Paulista (primary and alluvial) and Camaquam (alluvial). It is believed that the Camaquan River banks contains quantities of tin in the alluvial form since the creeks which empty into it pass over stanniferous regions.

The mining of the ore is carried out by crude methods, most of the miners using sluices. Production is naturally small and is usually sold to the smelters in Taboleiro and Figueira, there being but three furnaces in this region. Although late data are not available, the production of cassiterite concentrates in 1937 was estimated to have totalled 1,500 kilograms per month. Although quantity is lacking, quality is not and the smelters of the region receive good prices as well as find a continual market for their product.

In 1939, there were no recorded exports of tin products but in 1940 there is noted, under "Not specified", 261 kilos of manufactures valued at 8,802 milreis which was shipped to Mexico and Colombia.

Brazil's annual acquisitions of tin and tinned articles, including tinplate, in foreign countries, amounts to about 120,000 contos annually. Considering the fact that of the principal products exported by Brazil, only seven attain an equal amount, one obtains an idea of the magnitude and heavy drain exerted by this metal on foreign trade balances of this country abroad.

Imports of tin in the raw material form by Brazil increased greatly in the 1935-9 period when it averaged 909,960 kilograms annually as compared to a similar average in the 1930-4 period of 594,800 kilos and the 547,000 kilos of the 1920-9 decade. In 1939, the total was 1,280,096 kilograms, the highest figure yet recorded in the imports of this country.

In 1940, imports of the metal decreased to 916 metric tons due largely to the difficulties of receiving supplies, the principal sources in the 1937-9 period having been England, Holland and Argentina. In 1940, the principal sources were Malaya and England.

The absence of similarity in the articles produced and imported does not permit a comparison of values. The price of a metric ton of cassiterite in 1940 at the mine was quoted at 10,000 milreis in all Brazil although it is of interest to note that the export cassiterite of the state of Baía was sold at 7,192 milreis per metric ton; the import tin in 1939 was valued at 14,115 milreis per metric ton (CIF Brazil) while the price in 1940 for the similar metal was 23,028 milreis.

Imports of tin solder are becoming of increasing importance amounting to 47,125 kilos in 1939 and 73,161 kilos in 1940 as compared to the 37,672 kilos of 1938. The unit price of tin solder per metric ton was 12,074 milreis in 1940 (CIF Brazil).

TUNGSTEN

It is estimated that about 95% of the world output of tungsten is absorbed by the steel industry particularly in the manufacture of tools for metal cutting which include the highspeed tool steels and the cemented carbide dies and cutting edges. Other important uses are in filaments of electric lights, X-Ray and radio tubes. Tungsten salts find application in the chemical industry. In Brazil, the principal application for the metal is in the manufacture of filaments.

As tungsten ore occurs quite frequently associated with tin ores, China, Burma, Bolivia and Malaya, which are large producing countries of the latter, also have substantial outputs of the former.

China, whose production is about 42% of the world total, is also the principal exporting country. Another important exporter in that year was Burma; others of importance were Bolivia, Portugal and Malaya.

The principal consuming countries of tungsten in the world are Germany, England, the United States and Belgium.

Up to the present there are only two known deposits of tungsten in Brazil. The more important is in Encruzilhada in the state of Rio Grande do Sul and the other, in Mariana, in the state of Minas Gerais.

In the Mariana deposit, there is also found another tungsten ore, a very rare scheelite, which is present in the auriferous quartzes of this region. Several studies have been made and show that it could be worked for its gold, the tungsten being extracted as a by-product.

Analysis made of the stoltzite of Mariana showed 50.92% WO_3 while the wolframite of Encruzilhada contained 53.18% of the same.

The deposit of Encruzilhada is the only ore being worked at present and is located in the district known as Acampamento. The rock structure of the zone in general is composed of granite, the wolframite occuring in quartz veins. The veins in the region are of varying widths attaining a maximum of 60 cm. and are found in a nearly vertical position. The distance of the mine deposits vary from 30 to 35 kilometers from the Encruzilhada station and are covered by means of a road.

Recorded exports of tungsten ore from Brazil begin in 1937 with a shipment of 6,681 kilograms, 5,531 kilograms of which was sold to Belgium, and 1.150 kilograms to Holland. The 1938 exports totalled 2.090 kilos, the two markets in that year being Germany (1,090 kilos) and the United States (1,000 kilos). In 1939, Germany was the sole market and bought 7,900 kilograms of the ore. The shipments of 1940 proved to be the largest in recent years totalling 10,000 kilos. The lone market in this year was the United States.

The export price of the ore (FOB Brazil), which in 1937, had attained 9,682 milreis per metric ton, suffered a decline to 5,549 milreis in 1938 but since then has manifested rises, that of 1939 being 8,276 milreis and that of 1940 — 14,995 milreis. The mine price of wolframite in 1940 was 10,000 milreis per metric ton.

Imports of tungsten wire continue within the limits of 200 to 300 kilograms the major source of supply being Germany. It may be noted that the import price of this wire in 1940 was 2,362 milreis per kilogram (CIF Brazil) while that of the export product, tungsten wire for electric light filaments, the first registered from Brazil, was 26,206 milreis per kilogram, the total shipment being three kilograms valued at 93,399 milreis. In that year the market for the product was Uruguay.

22. TITANIUM

Titanium is found in almost all common rocks but its commercial ores, rutile and ilmenite, are found in limited areas in the world. As a metal, titanium finds wide use, its principal employment in former days being in ceramics and pigments while newer uses are as an alloy metal in the manufacture of steel, iron castings, ferro-alloys, and welding rods. An ultra-hard carbide useful in cutting tools and wearing surfaces, known as Kennametal, is a tungsten-titanium carbide. Minor uses for this element are in the smoke screen and aerial writing compounds, pyrotechnics, medicinal and toilet preparations and abrasives. In Brazil, its use in the traditional industries, paints and ceramics, still continues and is by far the predominant and possibly, only use.

Brazil is one of the principal producers and exporters of titanium in the form of rutile and ilmenite. In Europe, Norway is the only important country producing both titanium minerals. In the Americas, Canada and the United States are also important producers, the greater source of titanium being rutile and the second, ilmenite.

Brazil possesses important deposits of titanium, principally in the states of Goiaz, Minas Gerais and in deposits of monazitic sands along the coast. Export titanium, however, is practically limited to the first two-named states.

In the state of Goiaz, the titanium occurs in the form of rutile in the valleys of the Paranaiba, Tocantins and Araguaia Rivers. The titanium oxide content of rutile of these region ranges from 92% to 95%. The localities where the most mineral is found in this state are Pirenopolis, Corumbá, Anapolis, Bomfim, Ipamerí, Trindade, Caldas, Campo Formoso, Pouso Alto and Morrinhos.

In the state of Minas Gerais, the rutile is found in the vicinity of Aiuruóca, Bom Jardim, Andrelandia, Araxá and Lima Duarte. The rutile of these deposits although being inferior to those of the state of Goiaz, contain quantities of ilmenite, the percentage of TiO_2 varying between 66% and 80%. There is now an economic process in operation which concentrates these to the higher mineral contents demanded by the market.

Lima Duarte is the largest producer of rutile in the state, accounting for about 65% of the total. Andrelandia ordinarily has an output equivalent to about 30% of the total. Production of rutile in 1937 is reported to have totalled 133,000 kilograms while in 1938, this rose to 208,232 kilograms. In

1939 there was another increase to 317,800 kilograms while in 1940, it is estimated to have attained 320,000 kilograms.

Rutile exports are of recent origin and date back to 1936 in which year they amounted to 721 metric tons valued at 847 milreis. The principal market in that year was the United States, the second largest being England. In 1937 shipments had risen slightly to 768 metric tons only to fall in 1938 to 376 metric tons. In the three years the United States continued to be the principal market. In 1939, of the 489 metric tons exported 239 metric tons were shipped to England. In that year, Germany was the second most important market taking 147 metric tons while the United States was the third purchasing 90 metric tons. The 1940 shipments of this mineral, which totalled 499 metric tons, though larger than those of 1939, did not attain levels of the preceding years. It that year (1940), Great Britain proved to be the most important outlet, purchasing 255 metric tons while the second largest, the United States, bought 141 metric tons.

In 1938, the export price of rutile was 1,390 milreis per metric ton (FOB Brazil), that of 1939 — 2,655 milreis and the 1940 price — 2,822 milreis. Rutile has varying prices within the country, the representative being the Minas Gerais mineral which was quoted at 400 milreis per metric ton in 1940 and that of Goiaz which averaged exactly double the former.

Ilmenite export prices show exceedingly irregular variations which is without doubt traceable in large part to the mixed quality of the product. To cite examples, in 1933 the price was 610 milreis per kilogram; in 1935, it rose to 1,153 milreis only to fall in 1936 to 97 milreis. In 1937, the price was 1,704 milreis while in 1938 it fell to 167 milreis only to rise again in 1939 to 1,198 milreis and 1,645 milreis in 1940.

Although the production of titanium minerals has increased in Brazil, the participation of this country in the world market is still of small proportions. The high price of the rutile however promises a bright future for the Brazilian product and assures the possibility of shipment to distant markets, even at high freight rates, and still compete favorably overseas with the other producers.

There is a regular exportation of rutile from the state of Goiaz where production has been principally the by-product of diamond and gold mining. The rutile of these regions is red, very rare and the most valuable that can be obtained in Brazil.

The average exports during the 1920-9 decade were 1,336 metric tons while that of the 1930-4 quinquennium were 49 metric tons. In the 1935-9 period there were some indications that exports might improve but all proved erroneous and the average of 116 metric tons was but 9% of the 1920-9 average.

Exports of ilmenite have been made with regularity to England during the last five years, shipments in 1939 having amounted to 10,150 kilograms valued at 12,158 milreis. Those to the other countries since 1935 have terminated completely with the exception of shipments to France in 1937 and 1938, when they amounted to 100,000 kilograms and 150,000 kilograms respectively. Exports in 1935 totalled 280,767 kilograms valued at 146,596 milreis. England was the sole market for this product in 1939 while in 1940, there appeared five outlets

for this mineral. England however, continued to be the leading purchaser and bought 254,668 kilos. The United States was the second largest market for the mineral with 140,608 kilograms while the other buyers were, in order of importance, Japan, Germany and Sweden, the amounts being 50,900 kilos, 42,350 kilos and 10,063 kilos respectively.

The unit export price has risen steadily, being 1,145 milreis per metric ton in 1937 and increasing to 1,704 milreis in 1938, to 2,655 milreis in 1939 and 2,822 milreis in 1940, the latter being the highest in the export history of the product. The mine price of ilmenite in 1940 was 150 milreis per metric ton.

The only titanium product imported is the oxide (paint) which is recorded separately in official statistics since 1939, year in which the total amounted to 62,952 kilograms valued at 408,588 milreis. Imports in 1940 amounted to 76,743 kilograms and were valued at 508,844 milreis.

23. VANADIUM

Although quantities of vanadium are used as a catalyst in sulfuric acid manufacture and also in compound form in the glass, ceramic and miscellaneous industries, it is in the manufacture of steel and iron alloys that one finds the largest use for this metal, principally in the tool and constructional steels.

Strictly speaking, vanadium does not exist in the native state in Brazil but is found in combination in carnotite, roscolite, vanadite, etc. It is also encountered to some extent in ilmenite, oil shale, coal and oil.

Vanadite is associated with scheelite and stoltzite in Sumidouro in the municipality of Mariana in the state of Minas Gerais. It is also found in the Furnas Mine of Iporanga in the state of São Paulo.

A vanadium-bismuth ore is encountered in the workings of beryls and bismuth of São José da Brejauba in Minas Gerais. In treating this in the city of Rio de Janeiro, the bismuth was extracted but the more valuable vanadium was usually discarded. When used, it was limited to the preparation of pharmaceutical products.

Traces of vanadium are also recorded in the nickel ores of Barro Branco of Poços de Caldas (Minas Gerais) and the red earth of the state of São Paulo. Other discoveries of minor importance are noted in Hora and Santa Luzia do Sabugi in the state of Paraiba and Coromandel and Sete Lagoas in the state of Minas Gerais.

Exports and imports are not recorded separately in official statistics.

24. ZINC

Zinc enters into our everyday lives in many forms, probably the more important being in the manufacture of brass, galvanized sheets or wire, and as a paint (zinc white and lithopone). In the field of industry, its most important use is for die-castings, due to its clean and sharp shape when formed, which permits the low-cost production of metallic parts. Other industrial uses are in pho-

to-engraving sheets, boiler plate, brake lining, electro-chemical protection for iron and steel, etc. In Brazil, the main form of consumption is brass and galvanized sheets. Its use as a paint is also of some significance as is that in photo-engraving sheets.

Zinc occurs in the form of blende in many countries. Germany the sole producer until the middle of the past century, was surpassed by the United States in output in 1909 and now is the third largest producer, following Belgium. Canada and Poland make up the remainder of the five principal world producers of this metal in 1938.

World production reached an all-time high in 1937 with an output of 1,668,700 metric tons. The United States, besides being the largest producer (26% of the total), is also the largest consumer of metallic zinc, followed by Germany, England, Belgium and Japan. World production in 1939 was estimated to be 1,600,000 tons that of the United States being 450,000 tons and that of Germany 240,000 tons.

Mexico, Australia, Italy Sweden and Belgium, are the chief world exporters of this ore while Belgium, France, England, Germany and Poland are the principal importing countries. Brazil is also an importing country.

The main deposits of zinc ore in Brazil are in the municipality of Ipóranga in the state of São Paulo and Morro do Bule in Ouro Preto and Januaria, both in the state of Minas Gerais. The ore of the latter is a silicate with 30% zinc and 8% silver.

The deposits of Morro do Bule are the largest of the state of Minas Gerais and are found in the form of the blende with a zinc content of 62.16%. The deposit is situated near the Dom Bosco station of the Ouro Preto branch of the Estrada de Ferro Central do Brasil. The ore is found associated with small quantities of gold and silver.

The zinc zone of Iporanga in the state of São Paulo is the most important of Brazil. The ore there occurs as a blende and a calamine and contains from 31% to 36% zinc. The reserves in this region are estimated to be about 30,000 metric tons and are found near the well known lead and silver deposits of Apiaí which are the most important of the kind in the country. They include other ores such as antimony, copper, cadmium, arsenic and gold.

No zinc metal products are recorded separately in official export statistics. There are, however, the shipments of zinc white which commenced in 1937 with a shipment of 506,366 kilos valued at 277,249 milreis. In 1938, there were no exports but in 1939 they were renewed and amounted to 58 kilograms valued at 150 milreis while in 1940, the total was 200 kilos valued at 1,000 milreis. In the latter year, the principal market was Colombia. Imports in 1937 and 1938 are not recorded separately; that of 1939 was 3,428 metric tons and that of 1940 was 3,317 metric tons. In the former year, the largest source of the oxide was Belgium while in 1940, England was the leading supplier.

It is of interest to compare the FOB export prices in Brazil with those of the CIF import prices which in 1939 and 1940 were 2,586 milreis and 5,000

milreis respectively for the former while those of imports were 1,869 milreis and 2,785 milreis respectively.

The principal sources of zinc sheets are Belgium and Poland while England and Belgium are the principal suppliers of zinc bars and sheets for this country. Zinc plates come largely from Belgium and Germany while Poland and England are secondary sources.

With the continued reluctance in the exploitation of zinc in the country, the imports of both the raw materials and manufactures continue although it may be noted that the latter does not weigh on the national economy as heavily as the former. In the decade from 1920 to 1929, the imports of crude and semi-manufactures of this metal averaged 954 metric tons and increased slightly to 1,033 metric tons in the 1930-4 period. In the following five-year period, 1935-9, the average had risen to 2,250 metric tons. The 1940 imports of this metal totalled 2,262 metric tons, 2,041 metric tons of which consisted of bars, 84 metric tons of sheets and 137 metric tons of smelted metal.

Compared to the rising trend in semi-manufactures and crude metal imports is that of the manufactures which have been showing a contrary trend averaging 38 metric tons in the 1920-9 decade, 12 metric tons in the the 1930-4 period and 13 metric tons in the 1935-9 quinquennium. In 1940, the total was 12 metric tons 70% of which was from Belgium.

The blende ore of Brazil was quoted at 600 milreis per metric ton in 1940.

25. ZIRCONIUM

Though little known, zirconium is one of the most versatile and unusual minerals in industry. Due to its low linear thermal expansion, in fact, lower than the usual ceramic raw materials, it was used in refractory crucibles. Addition to vitreous porcelain bodies (30 to 70% zircon) gives the product a long firing range, considerable mechanical strength and heat shock resistance. The *Minerals Yearbook, 1940,* besides noting the above uses, points out the possibility that the glass industry may become the largest consumer of this mineral in the manufacture of heat-resisting glasses. Zirconium metal is used in radio transmitting tubes, flash bulbs for photography, ammunition primers, etc. The salts and oxide are used in the manufacture of the metal and also as a opacifier in vitreous enamels and ceramic glazes.

Brazil contains one of the largest if not the largest reserves of zirconium in the world. It is usually found in two forms, the oxide and the silicate.

The largest deposit in this country known to the present day is in Poços de Caldas near the station of Cascata, in the state of Minas Gerais. The deposits are located near the regions called Campo do Alemão and Ponte Alta which cover about 2,420,000 square meters and in Pocinhos, which has an area of 484,000 square meters. The reserves of zirconium in these deposits are estimated to amount to 2,000,000 metric tons. The mineral bearing rocks can be classified into two groups:

1) — Baddeleyite containing 85% to 95% zirconium in the dioxide form, ZrO_2, known locally as *favas de zirconio* (Zirconium beans);

2) — Colored ores (Caldasite) ranging from light brownish-gray to dark blue with a ZrO_2 content, generally from 65% to 80%.

In the states of Baía, Espirito Santo and Estado do Rio, zircon is found associated with monazitic sands. Tests of concentrates of this sand showed a 20.7% zirconite content and 61.4% monazite content.

The only recorded production available is that of the state of Minas Gerais which in 1937 totalled 850 metric tons, all of which was produced by one firm with a capital of 10 contos and employing three persons. In 1938, this had decreased to 410 metric tons while in the subsequent years, 1939 and 1940, there were increases to 750 and 850 metric tons respectively. The output of the first year, 1937, is that of the municipality of Andradas while that during 1939 is from three, that of Poços de Caldas being 500 metric tons, that of Andradas 150 metric tons and the Parreiras output 100 tons.

Exports in recent years have settled to about 1,500 tons, that of 1940 being 1,521 metric tons. In that year, the principal market for the mineral was the United States which purchased 1,500 metric tons. Norway was the second largest market buying 20 metric tons while the other was Japan which purchased 304 kilograms. Germany and Norway, important outlets in 1938 and 1939, did not take any Brazilian ore in 1940.

The FOB Brazil price of the zircon ore in 1937 was 565 milreis per metric ton which in 1939 had decreased to 443 milreis and to 334 milreis in 1940 The local price varies widely, the average being 200 milreis. Caldasite of the state of Minas Gerais was quoted at 300 milreis per metric ton.

NON-METALLIC MINERALS

(Excluding Building Materials and Fuels)

1. GENERAL SURVEY

In general, it may be said that the minerals classified under this group may be subdivided into two general categories, the stones and the non-stone minerals. Within the former group are first, the precious stones, such as, diamonds, emeralds, carbonados, etc., second, the semi-precious stones as garnets, topazes, beryls, tourmalines, etc., and third, rock crystals. In the latter group are included a great variety of non-metallic minerals which exclude the structural materials and fuels.

An outstanding characteristic of the stones is the fact that they are essentially export products due to the high overseas demand for Brazilian stones based on the favorable price differential in world markets, their relative abundance and the quality of the products.

Mining companies, in the true sense of the word, are few in this branch of the non-metallic mineral industry and it may be said that production is concentrated in the hands of *garimpeiros* who, in their searches and washings, work in scattered groups in the remote interior of the country. Their ignorance of changing prices, especially under the present conditions in which fluctuations are violent, is an accepted fact and thus they become easy prey to the commercial exporters. The very fact that they work in widely scattered groups also prevents a united, cohesive and coordinated action which would be to their benefit. It is principally because of this disorganized condition that Brazilian stones appear at low prices despite their relatively, higher quality. Welcome news in this field which should greatly remedy this exploitation, to a certain extent, is the recent decree-law concerning rock crystals which, as is noted in the section on this stone, will standardize the product and guarantee a minimum to the producer as well as assure the foreign buyer a sorted and classified product which should greatly facilitate and even foster its trade.

The relative abundance of the stones in Brazil is based on the favorable geological structure, particularly in the mountain ranges which traverse the states of Baía, Minas Gerais, Goiaz and Mato Grosso. It is in these four states that practically all stones of this nature are produced.

The quality of the stones of Brazil need be stressed but little, so well is it known, probably the greatest deficiency in this field being the mixture of qualities when exporting, particularly true in the case of rock crystals. However, there has been a conspicuous effort carried out to remedy this by private initiative, especially among the exporters but the greatest step was no doubt taken in the enactment of the above-mentioned decree-law strictly controlling price as well as quality.

Another feature of this industry is that of the lack of organization which was referred to lightly above but which merits further mention in that it is this factor which impedes the extension of financial help which would possibly place the activity on a sounder basis and lead to a greater output at more stable prices.

The advantages which arise from the existence of an industrial set-up which concentrates, smelts or refines any of the ores produced in the country in the country are self-evident. Equally true is this of the precious and semi-precious stone industry which in this case requiries a lapidating organization. At present, there are two such centers in Brazil, one being the city of Rio de Janeiro and the other the Capital of the state of Minas Gerais, Belo Horizonte, there being eight lapidaries in all Brazil. Recently new interests from the old centers, Antwerp and Hamburg, are reported to have invested capital in a huge enterprise in Rio de Janeiro. With the inclusion of the new firm, the gem stones industry will no doubt derive ample benefits and stability, elevating the prestige of the domestic export stones. A welcome step in further intensifying this activity is found in the recent measure adopted to establish a lapidating school in Petropolis in Estado do Rio, in order to increase the number of cutters and spread them throughout the mining states which again should bolster the industry greatly.

In the non-stone group of non-metallic minerals considered in this chapter, that group which might find use in the chemical industry is by far the more important and includes salt, pyrites, phosphatic rock (apatite) and barites. In the case of salt the huge demand of the foodstuffs industry not only as a table salt for human consumption, but the salting and pickling of meats as well as the feeding of the fourth to fifth largest herd of livestock and draft animals in the world, draws off considerable quantities which might eventually be consumed by the chemical industry. However, the small consumption of the latter is not affected by these demands at present. Nevertheless, it is necessary to point out in this connection that about 55,000 tons of products relying directly upon salt as a basic raw material are now being imported by Brazil whereas local production varies in the vicinity of 1,500 tons. News of the plan to establish a large scale caustic soda plant in the Southeast in view of the large present imports and the demands which will be increased with the installation of the woodpulp plant in the South and the repeated plans made to remodel the textile industry will no doubt bring new problems of supply to the fore in the salt industry. Another associated problem is that of providing sufficient shipping space in the coastwise movement of salt from the Northeast to the Southeast region where

the plant may be built, although in this connection it has been noted in some sections that there are sufficient areas for the concentration of brine in the Southeast and thus dispense with the necessity of such shipments.

Pyrite production is increasing but is insufficient to meet the domestic sulfuric acid industry needs which consequently results in the importation of huge quantities of sulfur. At present the acid industry is at a standstill as far as local demand is concerned, there being attained a production sufficient to meet these needs. However, the increased output of apatite in the state of São Paulo alone will create a large new demand and thus a new problem to pyrite mining. A solution recently suggested is that of using the sulfur content of the poorer coals of the South.

The oil paint industry is a product of the World War of 1914-18 when imports sources were reduced and necessitated the provision of supplies within the country. Progress in this industry, however, was exceedingly modest and in 1925 the output barely exceeded 700 tons. Today it is an industry with a production of nearly 10 thousand tons of which 76% of the total output was from the state of São Paulo. Fairly large amounts of barites, graphite and ochres are consumed in this industry and thus provide an appreciably large and certain market for these minerals.

In general, it may be said that with the exception of the sulfuric acid and, possibly, the new phosphates industry, those chemical industries which depend upon the non-metallic minerals included in this chapter as a raw material are not developed to the extent which might be desired and are, in a sense, a deterring factor to the development of the mineral extraction industry itself inasmuch as the absence of a national industry results in the importation a relatively large quantity of finished products, while on the other hand, a developed industry would increase the demand since the general tendency in all domestic industries is to give preference to the national raw material.

The domestic industrial demands for the remaining types of minerals are from the ceramic and electrical equipment industries. The former is of some importance, its output rising from 3,000 tons in 1925 to 10,300 tons in 1939 thus drawing off a considerable portion of the domestic minerals production. However, the domestic ceramic industry output is far from filling the demands of the nation and the annual imports are of some importance, that for chinaware amounting to as much as 1,400 tons per annum. It must be noted, however, that these imports are of the finer pieces and as such reflect on the technique rather than the raw material itself which thus points out the extent to which the mining aspect is prejudiced by the deficiency. Domestic imports of glass products total about 9,500 tons, the domestic production of such products amounting to about 47,000 tons. There are thus considerable possibilities for the domestic mining industry in this field alone in the sense that there is a potential demand but it must be noted, in addition, that there is no basic foundation in the window glass industry which accounts for the major portion of the imports.

The electrical equipment industry in Brazil has created new markets for the domestic mica which should benefit from the healthy growth of the former which is favored with the principal raw materials, i. e., rubber, cotton and copper, abundant labor and cheap power supplies. Exports of articles of mica commenced in 1940 and give a partial indication to the progress in this industry. Also, the imports of similar articles amounting to 1.3 tons indicate further possibilities for expansion in this industry but it is principally in the exports of ore that the largest market exists for this product.

Of the remaining miscellaneous non-metals such as diatomite, talc, asbestos, graphite, monazite, etc., it may be noted that other than the monazite, there are no regular exports of these products and that whatever production may exist is absorbed in large part by local industry. However, the continuation of imports of these minerals with the exception of diatomite leads to the conclusion that the production of these minerals is insufficient to meet local needs.

2. ASBESTOS

The principal uses of asbestos depend upon two distinct qualities of that mineral, that of being a silky fiber and its incombustibility. In general, the uses may be divided into that which is employed in the automobile industry, the building materials industry and general industrial uses. In the first, brake bands take up the major part while the second largest use is in clutch facings. In the building industry, it is used in shingles, wallboard and insulation or fire-proofing while in industry, in general, the principal use is as pipe covering and in gaskets. In Brazil, the use of asbestos is practically limited to the latter application, there being little use in the building industry due to the extensive use of the ordinary tile and brick in all possible cases, the latter being extraordinarily cheap in Brazil.

In world production, Canada is the largest and predominates the situation, the second largest being the U. S. S. R. and the third Southern Rhodesia. Production data of Brazil is not obtainable, the substitution of data of the state of Minas Gerais alone placing this country in 16th place among world producers.

The leading world exporters are Canada, Southern Rhodesia and the Union of South Africa while the importers are the United States, England, Germany and Japan. In either form of trade, the position of Brazil is of little world importance.

Asbestos is found in Brazil mainly in the states of Minas Gerais and Baía. The best-known deposits in the former are at Lima Duarte, Caeté, São Domingos do Prata, Piracicaba, Conceição do Rio Verde, Tocantins, near Ubá and in the vicinity of Juiz de Fora. There are other deposits at Itaberaba, Conquista and Campo Formoso, in the state of Baía; in Xililí, near Rio Branco, in the state of Pernambuco; in São Sepé, state of Rio Grande do Sul; in

the state of Rio Grande do Norte, near the locality called Santana do Matos; and in São João do Carirí, in Paraíba do Norte.

Until the discovery of the Poções deposit of the state of Baía, it may be said that all asbestos of Brazil was of the inferior short fibered quality, not sufficiently strong and long to be woven so that it was all used in boiler tube covering and heat insulation. A possible exception may be made with reference to a small deposit in Minas Gerais which is of the chrysotile variety. The chief difficulties encountered were, besides inferior quality, the smallness of the deposits, despite their large number, and transportation.

The important deposit recently discovered in Bom Jesus in the municipality of Poções in the state of Baía is one of the most promising in recent years being of the chrysotile variety which may be spun. The deposit is estimated to have 3,000,000 tons of mineral of which 70,000 contains the crysotile variety. It is being worked by the Sociedade de Mineração de Amianto, Ltda. which has equipment capable of producing 4 tons of the product daily. During 1938 and 1939, the output of this firm was destined to the São Paulo market and amounted to 18 metric tons in the first year and but three tons in the latter. In 1940, there was a considerable increase and shipments are recorded to both São Paulo and the Federal District, 127 metric tons of the total of 129 metric tons being to the former market and 2 metric tons to the latter.

In the state of Minas Gerais, the deposits of Lima Duarte, Ubá, São Domingos do Prata, São João do Carirí, São Sapé and others have all been worked sporadically on a varying scale. In 1937, the output of the state totalled 105,200 kilograms (partial returns) of which 75,200 kilograms were produced in the municipality of Lima Duarte in the southern part of the State. São Domingos do Prata produced the remaining 30,000 kilograms while that of Ubá did not supply information. In 1938, the state output had risen to more than double the 1937 quantity, that is, 314,280 kilos while that of 1939 was 608,610 kilos or nearly double that of 1938. The principal producing municipalities in that year were Conceição do Rio Verde (400,000 kilos), Santa Barbara (60,000 kilos), Baependi (30,000 kilos), Pomba (30,000 kilos), Presidente Vargas (25,000 kilos), Ubá (24,610 kilos), Cambuquira (20,000 kilos), Jacuí (10,000 kilos), Oliveira (5,000 kilos) and Nepomuceno (4,000 kilos). It will be noted none of the producing municipalities of 1937 appeared as producers in 1939. Estimates for 1940 place the total at a lower level, 500,000 kilograms.

In 1939, there were four establishments operating in this industry in Minas Gerais with a total capital of 115 contos and a working force of 25 persons.

In the last twenty years, there are only four in which there are exports recorded officially, that of 1924 which amounted to 308 kilograms, that of 1925 which totalled 334 kilograms, that of 1938 which was 1,840 kilograms and the shipment of 2,940 kilograms in 1940 which was the largest to date. The United States was the sole market for the 1940 shipment. In 1938, France and Belgium, the only two markets in that year, each imported 920 kilograms.

MINERALS INDUSTRY IN THE STATE OF MINAS GERAIS

Table 12

ORGANIZATION IN 1939

INDUSTRY	N.º of Establishments	CAPITAL AND RESERVES	EMPLOYERS			POWER	
		Milreis	Male	Female	Total	N.º of Electric Motors	Horsepower
Arsenic, white	2	(1)	—	—	(1)	—	(1)
Asbestos	4	115,000	24	—	24	1	20
Barite	5	55,000	36	—	38	—	—
Bauxite	5	513,000	208	—	208	16	260
Building sand, stones, gravel, etc.	117	1,522,800	952	20	972	30	431
Calcium carbide	1	2,880,000	310	—	310	41	10,000
Cement	1	12,000,000	195	—	195	37	1,206
Colombite	2	30,000	12	—	12	—	—
Dolomite	2	205,000	56	—	56	—	—
Ferro-nickel	1	200,000	159	2	161	9	2,090
Gold	18	227,849,324	9,900	336	10,236	910	41,730
Iron and teel:							
Iron ore	15	1,385,000	1,292	—	1,292	11	1,840
Iron and steel	10	254,438,319	5,721	—	5,721	1,100	50,661
Ferro-silicon	1	(2)	—	—	(2)	—	(2)
Kaolin	17	245,000	192	3	195	2	26
Lime and limestone	129	2,865,712	1,314	7	1,321	4	19
Manganese	38	6,376,200	3,094	15	3,109	32	845
Marble	6	2,565,000	275	—	275	15	294
Mica	37	1,173,000	643	158	801	—	—
Mineral waters	7	14,813,654	410	29	439	45	238
Ochres	14	398,000	125	—	125	5	37
Precious and semi-precious stones:							
Amethysts	1	5,000	2	—	2	—	—
Aquamarines and tourmalines	8	76,500	37	1	38	1	2
Diamonds	30	10,366,800	405	5	410	40	1,572
Total:	39	10,448,300	444	6	450	41	1,574
Pyrites	3	90,000	80	—	80	13	95
Rock crystals	1	41,000	12	—	12	—	—
Rutile	5	174,000	20	—	20	5	57
Silver	1	(1)	—	—	(1)	—	(1)
Talc	12	67,000	95	5	100	—	—
Zircon	1	10,000	3	—	3	—	—
TOTAL:	494	540,460,109	25,572	581	26,153	2,317	111,223

NOTE: (1) — Included in "Gold".
(2) — Included in "Calcium carbide".

Although price data based on trade statistics are not strictly comparable due to the consolidation of the trade figures for crude and prepared mineral, they offer documentary value. That of 1938 for exports (FOB Brazil) was 1,881 milreis per metric ton in 1938 while the same for imports was 2,818 milreis per metric ton (CIF Brazil). In 1940, the export price had fallen to 1,076 milreis as had that of the imports whose value was 2,364 milreis. It may be noted that the mine price of amphibole asbestos during 1940 averaged 100 milreis per metric ton while that of chrysotile was quoted at 200 milreis.

3. BARITE

Crude barite is used for the manufacture of ground barite, lithopone and the barium chemicals. In Brazil, practically all of the output is directed to the paints industry and to a very small extent in the metallurgical industry as a *fundente.*

Germany and the United States account for an overwhelming portion of world production, England and the U. S. S. R. being secondarily important. In the absence of complete Brazilian production data, the substitution of the output of the state of Minas Gerais places this country in eighteenth place among world producers.

The largest exporters are Germany and Greece while the principal world import markets are Belgium and England although at times the purchases of the United States reach substantial quantities placing her in second place.

In Brazil, barite is found in the Ouro Preto district and, in general, scattered throughout the Triangulo Mineiro district, in the state of Minas Gerais, in Juquiá of the state of São Paulo and in Bom Jesus dos Meiras, Minas do Rio de Contas and Camanú of the state of Baía.

An analysis of the Ouro Preto mineral shows a 60.04% BaO content, 33.56% SO_3, 0.62% Fe_2O_3 and 0.15% SiO_2. This district is the leading producer in the state of Minas Gerais and in 1937 mined 58% of the total of the state while the second largest, Araxá produced 42%. The other producing municipality was Mariana. In that year, the output had attained 676 tons while in the following year it was 668.5 tons. By 1939 the output had risen slightly to 690 tons but did not attain the high of 1936 in which year it was 800 tons. In 1939, the principal producer was the municipality of Araxá with 440 tons while the second largest was Ouro Preto with 243 tons. Mariana produced 7 metric tons.

The Araxá deposit is being worked by two paint factories, one in Rio de Janeiro and the other in São Paulo. The mineral in some districts is green as contrasted to the Ouro Preto material which is pure white. In the deposit of the Rio de Janeiro factory, there is installed a small plant for the selection of the material in order to reduce the transportation cost to Rio de Janeiro, the latter in recent years amounting to about 150 milreis per metric ton.

In general, it may be said that the industry is suffering from poor transportation facilities and the lack of capital, the working of all deposits being on a small scale. There are five firms engaged in the extracting branch of this industry and employ 36 persons. The invested capital amounts to but 55 contos.

There are no exports of the ore while its manufactures are not classified separately in official statistics to determine the extent to which these products are exported. The imports of barite itself are also omitted from the official classification list; the principal manufactures are the chlorate and the sulfate, that of the former in 1940 having amounted to 176 metric tons valued at 378 contos or 2,148 milreis per metric ton while the latter totalled 233 metric tons valued at 354 contos or 1,518 milreis per metric ton.

The price of barite at the mines in 1940 was 500 milreis per metric ton.

4. DIATOMITE

The applications of diatomite or kieselguhr are numerous, the principal of which formerly was as an absorber of nitro-glycerine to form dynamite; today, it is used extensively as a filter in the sugar and petroleum industries, in the abrasives industry for metal polishes and due to its resistance to heat, low moisture absorption, and chemical inertness, as a filler in electrical equipment.

In Brazil, the principal form of use is as a filter in the sugar industry although there must be noted the use of the mineral in the manufacture of light tiles which is commonplace in the Northeast of Brazil. To cite an example, the Capital of the state of Ceará, Fortaleza, is almost entirely roofed with light tiles made of diatomite, an ideal material for tropical climates. The use of the mineral for a cheap material rather than the more remunerative applications is based on the lack of the necessary capital and insufficient studies on the structure of the deposits, the available quantities and the chemical and botanical composition. There are few studies on its behavior in industrial applications also thus limiting its uses in this country. The consumption of this material for these reasons continues to be largely that for tiles, the annual amount of which is about 60,000,000 units, estimating on a conservative basis, or an annual production of about 100,000 tons.

Among world producers, Brazil is the leader while the United States is the second largest. Denmark and Japan are other producers of considerable importance. Algeria and Denmark are the principal exporting countries in the world while England and Germany are the predominating buyers, year after year.

Occurrences are known to exist in Estado do Rio, in the states of Pernambuco whose deposits are at present worked and exported, Ceará, Rio Grande do Norte where the largest deposits are located, Piauí, Maranhão and the Upper Rio Branco in the state of Amazonas whose SiO_2 content is exceptional.

The deposit in Estado do Rio is the first known in Brazil and is located in Lagoa de Cima, in the municipality of Campos. The deposit is extensive

but the material is mixed with gravel. However, this diatomite can be used to advantage in heat insulation and as a refractive.

The deposit in Recife in the state of Pernambuco is in a locality known as Dois Irmãos, about a 40 minute ride from the downtown district. It occupies an area of 52,000 square meters and has a volume of about 154,800 meters. The mineral contains 94% SiO_2 and finds wide application in the sugar industry as a filter and in the manufacture of insulating material.

The principal occurrences in the state of Ceará are located in Macejena which is about 18 kilometers from the Capital, Fortaleza. Deposits are also found in Euzebio which is near Macejena and has a volume calculated to attain 570,000 cubic meters, in the Maraponga and Soure districts near Fortaleza and in the São José and Macaíba municipalities.

The reserves of this state and of Rio Grande do Norte are very extensive and are said to exceed millions of tons.

In the state of Maranhão there are 45 lagoons which contain diatomite at the bottom in layers varying from 30 centimeters to 2 meters in thickness with an approximate reserve of 80,000 tons.

The general classification given to the algae structure of the various diatomaceous earths in Brazil are the following: Estado do Rio — *Melosira granulata,* Pernambuco — *Navicula, Eunotia, Pinnularia* and *Anomoeneis,* and Amazonas — *Eunotia.* Data with regard to that of the state of Maranhão is unavailable.

Exports of diatomaceous earth are recorded for the first time in 1940 the total being 60,920 kilograms valued at 64,798 milreis. The principal destination of the material was Argentina which purchased 52,860 kilos of the material. The other that imported from Brazil was Uruguay.

The mine price of diatomite of an unspecified quality is quoted at 50 milreis per metric ton in 1940. Contrasted to this is the export price of 1,064 milreis (FOB Brazil).

5. FELDSPAR

The principal use of feldspar is in the ceramics industry, within which the demand from the glass industry is the largest and that of pottery and enamelled ware are secondary. Other minor uses are in the field of soap and abrasive manufacture. In Brazil, although some factories specialize in the grinding of crude feldspar and sell the pulverized product, principally to cleansing compound and ceramic ware manufacturers, the major part of the work is done by the factories themselves.

The larger part of the world production is carried out in the United States with Sweden, China and Norway being the secondary producers. Brazil is annually in 8th or 9th place among world producers.

The mineral in Brazil is found in comparative abundance in the states of Minas Gerais, Estado do Rio and São Paulo. In the first mentioned state, the most worked is the archaeic zone which includes Carangola, Tiradentes, and Caparaó. In 1937, the total output of the state was 27 metric tons of

which the municipality of Tiradentes produced practically all, that of Carangola and Caparaó being very small. In 1938, the state output had risen to 40 tons while data for 1939 and 1940 have not been published as yet. The feldspar of this region as that of Estado do Rio is sufficiently pure to be used in the ceramic industry.

The feldspar of Estado do Rio in the vicinity of the State Capital, Niteroi is formed by potassic and sodic varieties, intercrystallized. The chief deposits are in São Gonçalo and Maricá.

The local price of this mineral in 1937 was 76 milreis per metric ton while in 1938 it rose to 80 milreis. In 1940, the mine price had declined to 50 milreis per metric ton.

Official import and export statistics do not classify feldspar separately.

6. FLUORSPAR

The principal consumer of fluorspar is the steel industry while the hypofluoric acid and glass industries are of minor importance. Some fluorspar is used in enamels, paint pigments and abrasives.

The United States, Germany, Russia, France and England are the principal producers in the world. Nevertheless, the United States also figures as the principal importer in the world followed by Canada, Belgium and Yugoslavia. Korea, Germany, Newfoundland and France are the largest exporters.

There are occurrences of fluorite to be found in Belmonte in the state of Ceará. However, it is Minas Gerais where the largest number of deposits are encountered. The calcareous formations of Matias Cardoso. Sete Lagoas, Contria and other points in the valleys of the São Francisco and Velhas Rivers and the argentiferous zinc deposits of Januaria in the northern part of the same state are of some importance. The latter argentiferous deposit would be able to provide one ton of ore per month if worked liberally since the fluorite is free of gangue which is usually found in the veins cutting the calcareous formations of that mineral.

No data is available as to the working of fluorspar deposits on large scale. Despite the absence of production data, there is a reported mine price of 300 milreis per metric ton for fluorite in Brazil.

Data as to exports or imports of fluorite and its compounds are not discriminated separately in official statistics.

7. GRAPHITE

The principal use of graphite is in foundry facing, core wash, etc., while of secondary importance is that of lubricants and crucibles. Pencils, crayons, etc., and stove polish, paints, etc., are applications of minor significance. In Brazil, it is reported that the largest consumption of graphite is found in

lubrication and moulds. Paints and pencils account for the major part of the remainder.

The largest world producer is the U. S. S. R. Japan is second and Germany third. Placing the production of Brazil as that of the one state, Minas Gerais, one finds this country in fifteenth place among the world producers.

The principal exporting countries are Korea, Madagascar, Ceylon and Mexico and the leading importing markets, the United States, England and Japan.

Brazil possesses several deposits of graphite which until today have not been well studied. To all appearances, the deposits situated in Fortaleza, Arassuai and Jequitinhonha, in the state of Minas Gerais, contain the best quality mineral. In the Emparedado zone which is about 2 kilometers from the Jequitinhonha River, there are several veins from 50 centimeters to 1 meter thick which have a carbon content which varies from 50% to 85% usually associated with monazite, zircon, ilmenite, etc. Other deposits in the state of Minas Gerais are located in Itabira, Ouro Preto, Mariana and Santa Barbara.

There is graphite in São Fidelis, Estado do Rio, whose ore contains about 83% pure graphite; in Pindamonhangaba in the state of São Paulo where the first mill in the country using the floating process was installed and in São João do Caririí in the state of Paraiba.

Graphite is also found in Canindé and Cangati in the state of Ceará, in Alcobaça in the state of Baía and in Tubarão in the state of Santa Catarina. The latter has a mineral which is 75% pure.

Recently, extensive deposits of graphite were discovered in the densely populated district Formosa which is on the Goiaz-Minas Gerais frontier.

The deposits of São Fidelis, in Estado do Rio, Alcobaça in the state of Baía, Canindé and Cangati in the state of Ceará have the same formation as those observed in Ceylon, the United States and Canada.

In 1937, the state of Minas Gerais produced 27 metric tons of graphite, the lone producer being the municipality of Prados. In 1938, the output had risen to 115 metric tons. Production data in the subsequent years is unavailable.

Besides the above production, there is that of the state of Paraiba whose output in 1939 amounted to three metric tons. Data of previous or subsequent production in this state or any other states is not available.

Exports of this product from Brazil have been exceedingly irregular, the largest since 1920 having been in 1929 when it amounted to 15,130 kilos. Since then there was a shipment of 9,540 kilos in 1930, of 9,060 kilos in 1931, 600 kilograms in 1933 and 1,786 kilograms in 1935. The destination of the 1935 export was the United States while the market for the 1929 record shipment was Argentina.

The imports of graphite have only been recorded separately since 1938 in which year they amounted to 66,657 kilograms. In 1939, there was a slight

increase to 79,189 kilograms only to fall again in 1940 to 72,151 kilograms, the sources in the latter year being the United States, Great Britain and Swit-

The mine price of graphite during 1940 was quoted at 500 milreis per metric ton while that of imports was 3,866 milreis (CIF Brazil).

8. KAOLIN

Kaolin is a white clay whose coarser fractions are used in the ceramic industries and as a refractive while the finer finds use in paper-coating, paper-filling, and rubber filling. In order to be white burning, it is necessary that the iron and titanium content be small. In Brazil, the principal use is in the ceramic industry although substantial qualities are consumed by the textile industry in the Federal District.

Among world producers, China is the most important followed by England, Germany, the United States and Japan. Complete production data for Brazil is unavailable but that of the state of Minas Gerais alone, places this country in 16th place.

The world export market is dominated by England and Czecho-Slovakia, Brazil being the 13th most important. Germany and the United States are by far the largest world importers with France, Belgium and Canada being secondarily important outlets.

In Brazil, kaolin is found in various states, the principal being Baía, Minas Gerais, São Paulo, Rio Grande do Sul, and Estado do Rio.

In Baía, the deposits are situated in Bom Jardim and Carinhanha with other less important occurrences being found scattered throughout the state.

In the northern part of Minas Gerais there are quality deposits at Salinas, Fortaleza, Itamarandiba and Teofilo Otoni.

The best deposits of Brazil are those of the Mata Zone of the southern part of the state of Minas Gerais, which includes that of Buenopolis, Ouro Preto and Tiradentes. That of the Caeté district contains 56.3% silica and 25.2% alumina while the Morro Grande deposit of the Buenopolis group tested as follows: SiO_2 — 78.86%; Fe_2O_3 — 1.75%; Al_2O_3 — 16.06%; MgO — 0.37%; and slight traces of CaO. This latter with that of Riachão and Mariana form a continuous bank of clay calculated to have 75,000 tons of material. In Riachão, the layer is of sedimentary origin and is about 11 meters thick, being white and pure with visible films of iron hydroxide at times. This deposit is estimated to contain about 25,000 tons and is mined by open cuts and transported 9 kilometers to the Estrada de Ferro Central do Brasil at Buenopolis. A recent report on this deposit notes that the construction of a concentration plant at the site is difficult due to the scarcity of sufficiently clean water.

Some significantly important deposits are found in Bicas, Mar de Espanha, Carandai, Tiradentes, Carangola, Ouro Preto and Juiz de Fora in the

state of Minas Gerais the output of the first in 1937 having been 1,330 metric tons while that of the second mentioned was 720 metric tons in the same year. The total for the state was 3,701 metric tons in 1937 and rose to 17,395 metric tons in 1938. Output in 1939 was 18,496 metric tons while it is estimated that the 1940 total exceeded 15,000 tons. In 1939, Bicas and São João del Rei were the largest producing municipalities with outputs of 7,000 and 4,300 tons respectively.

The industry in this state employs 195 persons and is composed of 17 firms with a total invested capital of 245 contos.

In Estado do Rio, there is a fairly large deposit in Vassouras with other scattered deposits along the mountain range which includes Petropolis and Terezopolis, two important summer resorts. Others in the state are those of São Gonçalo and Niteroi although these are of no great commercial importance as yet.

Kaolin exports have only been recorded separately since 1937. Argentina has been the sole market for the domestic kaolin and in 1937 acquired 30 metric tons valued at seven contos as compared to 15 metric tons valued at 21 contos in 1938. In 1939, this same country purchased 20 metric tons worth only nine contos. The unit price, as will be observed, has suffered drastic changes, that of 1937 being 247 milreis per metric ton, that of 1938 being 1,400 milreis and that of 1939 falling to 464. The 1940 shipments of this clay totalled 197 metric tons with a total value of 69 contos and a unit price of 350 milreis. This compares with the local price changes of 200 milreis in 1937, 300 milreis in 1938, 300 milreis again in 1939 and 300 milreis in 1940.

9. MICA

The insulating and dielectric properties as well as those of transparency, resistance to high temperatures and low heat conductivity are the basis of the applications of mica in industry. Thus the larger part of the mica is used in the electric industry as an insulator. The mechanical uses are in diaphragms, peep-holes, eye-protectors, etc., where transparency and thinness are essential qualities.

The United States is the largest producer of this non-metal in the world, the second largest being the U. S .S. R. India is the third most important and the Union of South Africa the fourth. It is with the substitution of the data of the state of Minas Gerais alone that Brazil is in fifth place.

The principal world exporter is India and the second largest, the United States. Canada, Madagascar and Brazil are the others of some importance. The largest import markets are the United States, England, Germany and Switzerland.

Mica is so abundant in some portions of Minas Gerais that its brilliance and sparkle is evident in the streets of some villages where it composes part of the pavement. The deposits are largely composed of veins of pegmatite

which cut through not only archean rock (granites and gneiss) but also the schists of the *Minas Series.*

Mica appears in the form of books and packages intercalated or associated with kaolin, beryls, tourmalines and feldspar and only in feldspar and kaolin when the deposits are in zones of intense superficial decomposition. The states in which the deposits are located are Goiaz, Minas Gerais, Estado do Rio and Baía.

In Estado do Rio, the mines are located in Campos, São Fidelis and Paquequer, the latter locality having some plates two meters thick.

The deposits of Goiaz are in the southeastern part of the state in the zones known as Arraias, Annicus and Curralinha. The larger part of the mineral of this state is of better quality than that of Minas Gerais but is not exploited to the extent that the latter is due to the difficulties in transportation and lack of sufficient capital.

In the state of Minas Gerais, there are 22 municipalities which have at one time or another produced mica in recent years. The principal, year after year, has been Carangola producing about 35% of the state total while the second largest in these last few years has been Figueira which produces about 26% of the total. Others of importance are Peçanha, Arassuaí and Bicas. In 1937, the state output totalled 568,200 kilograms and increased to 874,600 kilograms in 1938. There was another increase in production in 1939 to 998,400 kilos; the total for 1940 is estimated to have augmented again to 1,200,000 kilos.

With regard to the state of Minas Gerais, it may be noted that the principal problem lies in those which have come to the fore with the so-called *mica rush* which took place several years ago in the sparsely populated regions and resulted in the unorderly hit-or-miss system of galleries which greatly handicap mining today. So great was the *rush* in some sections that the columbite was discarded in favor of the mica. Today the latter is being worked to some advantage.

In general, the mica is cut in rectangular forms and selected in the locality of the mine in order to reduce transportation costs of undesirable portions. The India cut is the principal cutting system applied.

Recent data on the industrial organization of the mining of mica is unavailable; that of 1939 shows that in Minas Gerais there were 37 firms engaged in the industry with a total capital of 1,173 contos and employing 800 persons.

The exports of mica have shown a distinct tendency to increase in the last 20 years, the 1920-9 average being 56 tons, the 1930-4 average 46 tons, the 1935-9 average 327 tons and in 1940, reached the highest level in the export history. The total of 1,117 metric tons in 1940, was more than double that of 1938 the largest to the present time. Since 1936, the shipments have developed as follows: 1935 — 110 metric tons; 1936 — 237 metric tons; 1937 — 330 metric tons; 1938 — 521 metric tons and 1939 — 435 metric tons.

Until 1937, the principal market was the the United States but since then, the leading outlet has been Japan, basing the criterion on value, although in years, there were larger shipments made to the United States. It may be noted that the total to Japan in 1940 amounted to 624 metric tons valued at 6,699 contos which in itself was larger than the total Brazilian shipments made in any one year. The second largest outlet was the United States which purchased 316 metric tons of the Brazilian product. Third in importance was England with purchases of 55 metric tons. It is worth observation that mica is also exported to India, the third largest producer in the world. According to reports, it is possible to increase production and exports more than 100% through financial aid and technical assistance.

There are no recorded imports of mica in the crude or semi-manufactured form while that of manufactures is classified separately since 1940 being 1,250 kilos valued at 68 contos.

Mica was quoted at an average of 10,000 milreis per metric ton at the mine during 1940.

10. MINERAL FERTILIZERS

GENERAL SURVEY

Considering the fact that the virgen lands are gradually being reduced, that farming has become more intensive, that the fertility of the soil has been depleted despite the unusual strength of the *terra roxa* for which Brazil and especially the state of São Paulo is noted, and that the change from a monoculture to a polyculture agriculture has made new demands on the soil, it is but natural that the consumption of fertilizers should increase considerably.

For Brazil, the principal source of fertilizers in the past was the strength of the soil itself, and organic fertilizers, the use of chemical mixtures being limited to about 10,000 tons annually in the decade from 1920 to 1929. In the five-year period, 1930-4, the utilization of chemical fertilizers increased slightly and amounted to 10,400 tons. In this period, the production of crushed oilseed which in part was turned to fertilizer amounted to about 90,000 tons. Although the quantity of organic animal fertilizer production is unavailable, it may be noted that cattle slaughterings amounted to an annual average of 3,670,000 heads. In the 1935-9 period, the annual chemical fertilizer consumption had increased to more than four and a half times that of the previous period for an annual average of 45,100 tons, the production of crushed oilseed 330,000 tons and the number of slaughterings to 4,610,000 heads. In addition, it may be noted that the practice of fallowing, planting legumes, particularly in tree or bush crop regions and rotation which all aid in the maintenance of fertility, are new elements which have appeared with intense following in rural regions only after 1934, particularly with the institution of the seed experimental stations, the cooperative fields and agrarian education and propaganda.

Diminishing the available supply of fertilizers within the country are the exports of these products which for Brazil consist solely of the organic. The annual exports of animal fertilizers in the 1920-9 period averaged 5,200 tons while that of vegetable origin (oilseed cakes and meals) fertilizer exports had risen to 12,700 tons. That of oilseed cakes and meals had also increased being 51,000 tons. The 1935-9 average follows that of production and one finds that the exports of animal fertilizers had increased to 19,200 tons while that of vegetable origin also augmented being 207,900 tons in that period.

The imports of fertilizers are limited to the chemical variety and averaged 9,900 tons in the 1920-9 period, 10,200 tons in the 1930-4 period and 45,100 tons in the 1935-9 quinquennium. In this group, the nitrates are the most important accounting for 47% of the total while the phosphoric acid group represents 40%. The potash group is of relatively little importance being but 7% of the total while unspecified types make up the remaining 6%.

Today, the trend in fertilizers in Brazil is to stress the organic group for the nitrates and to diminish the phosphoric acid group with the increased output of apatite in the state of São Paulo as well as, some day, call on the phosphatic bauxite of the North. Fixation of the nitrogen of the air on a large scale is always discussed and could be realized with the utilization of the water-power sources which are the sixth largest in the world and are concentrated in two general regions, the larger of which is in the Southeast where the principal technological agricultural activity is carried out. Small but significant steps in the solution of this problem are evident in the experiments being carried out officially and by private parties in the variation of the degree of pulverization of organic materials to substitute mineral fertilizers and that of using marine vegetation to fill the potassic fertilizer needs.

NITRATES (Natural)

Of the mineral fertilizers, salitre is, by far, the first to be used in Brazil. However, salitre at the time was employed for less peaceful ends and was exploited at first in the *sertão* of the state of Ceará in the Northeast and along the São Francisco River to be shipped to Portugal for the manufacture of gunpowder.

Towards the end of the 18th Century, João da Silva Feijó worked the deposits of the *sertão* of Quixeramobim and later those of the Serra da Ibiapaba but all with unremunerative results. The first was located at a place known as Tatajuba and in slightly less than a year, only two tons were extracted. In the second, the workings were concentrated in a place called Pindoba near the city of Viçosa. In either case, the process consisted of the leaching of the soil containing nitrates and with the aid of wood ash, convert calcium nitrate into potassium nitrate. The total output did not exceed 6 tons at the time. Later calculations show that 100 tons of firewood are necessary for 1 ton of nitrates since the wood forms but 2% ashes and this in turn but 20% K_2O.

Other estimates place the amount of firewood necessary for the production of one ton of KNO_3 at 500 tons.

In the Northeast of Brazil, the most promising deposits are found in the state of Piauí, the principal being those of Valença and São Raimundo Nonato. In the former, samples show 2.8% nitrogen and 8.9% K_2O. Other samples, from a location not too easily reached show 37.3% soluble material which consists of 12.6% K and 20.7% NO_3. Two hundred and thirty-six samples from the Pimenteiras region showed a soluble content ranging from 0.5% to 2.4%. In general, the outcrops, usually chocolate-colored, show a high content of soluble material while the gravelly deep red-colored material below shows successively lower quantities with greater depths.

About 120 kilometers from Urussuí, the inhabitants of the land make gunpowder from the salitre, which, as a matter of fact, is a common practice in the remote interior in regions where salitre is available.

There is a type of calcareous material found in the soils of *grutas* (caverns) which is of some importance in the salitre industry in the Northeast. It is believed to be nitrogeneous organic (animal) material which has reacted with the limestone. However, the material is only found is small deposits and does not contain the chlorates, perchlorates and iodates as the Chilean material. The regions with numerous *grutas* contain from one to two tons of salitre per *gruta* (contents usually 1% to 2% salitre).

Besides the deposits of the state of Piauí, there are those of the states of Ceará and Baía, the principal ones of the former being those of Ipú which are carbonates of potassium and sodium and of Tauá which is a continuation of the Valença deposit. The Baian deposits are in the Chapada Diamantina (mountain tableland Diamantina) which contains deposits spread throughout an area of 12,500 square kilometers, and in Geremoabo which is the principal one of the state.

The Minas Gerais deposits are a continuation of the Baian deposits and in early days were worked with those of the latter but due to the limited reserves known at that time, were forced to stop operations. In reality, the nitrates of that region consist of broken deposits which stretch from the caverns of the Rio das Velhas valley northward to Baía. The major part of the mineral is nitrate of lime.

Early records of the gold rush to the state of Goiaz point out the existence of salitre in that province, particularly in the zone now known as Natividade and the village of Cavalcante. The largest producing regions are Santa Luzia, Burití and Santa Rita do Parnaiba. Refined samples of some of these deposits show 95.95% nitrate of potassium. However, a study of the possibility of using the material in the armaments industry during 1939 proved that no to great importance could be attached to these deposits for that purpose.

Salitre occurs in the Jauru region of the state of Mato Grosso and also in small deposits in the state of São Paulo.

Despite the presence of these salitre deposits within Brazil, it may be noted that there is little production and that it is necessary to resort to imports.

During the 1920-9 decade, the annual average imports amounted to 3,290 metric tons which in the 1930-4 quinquennium fell to 2,480 metric tons due to the increased use of other nitrogenous materials. For the 1935-9 five-year period, there is a decided increase to 10,220 metric tons and is not only the result of the rise in demand due to the "tiring" of the soil in the intensively worked lands which plant annual crops and demand this type of fertilizer but also the result of the agrarian educational program which has brought about a general extensive use of the salt.

The price per metric ton of the imported product (CIF Brazil) in 1938 was 535 milreis, that of 1939 — 599 milreis and that of 1940 — 651 milreis.

In the last four years, the imports of nitrates have been irregular depending largely upon the changes of salitre imports which account for the major part of the total. In 1937 and 1938, salitre was 58% of the total while in 1939, it accounted for 76%. In 1940, it represented 93% of the total thus showing the tendency towards this nitrate in preference to the others. It may be mentioned in this connection that the larger part of the non-salitre imports comes from Germany while the salitre is from Chile. This change to salitre is based to a large extent upon price, the import prices (CIF Brazil) of the nitrogen compounds in 1940 being, 1,126 milreis per metric ton for calcium cianamide, 1,146 milreis for ammonium sulfate, 1,076 milreis for impure potassium nitrate and only 651 milreis for salitre, as noted above.

PHOSPHATES

Phosphorus, another valuable fertilizing element, has come to make its presence desired with the transformation of agriculture from extensive cultivation to that of intensive. It is possible that with a sudden opening of a highly developed transportation system, this scarcity will be overcome but such prospects still remain within the realm of wishful thinking.

During the 19th Century, the principal sources of phosphates were the guano of some islands off the coast of Brazil, principally the Rata Island which forms part of the Fernando de Noronha group. This, despite its relative importance, never succeeded in giving satisfactory results due to the distance, the low magnitude of the deposits and the difficulties of mining.

Another source of phosphorus, basic slag, is of some importance but in Brazil, despite the existence of iron production, no mention has ever been made with reference to the use of the slag for fertilizer.

A third possible source of phosphorus is a type of phosphate of aluminum and iron which is found in the Trauira Island at the mouth of the Maracassumé River on the coast of the state of Maranhão. It is a replica of those found in the French Guianas and in Nauru Island in the South Seas. It is explained as being the result of the action of guano on a *diabasio* which has

been greatly altered with methasomatic action. A disadvantage, or possibly a blessing in disguise, is the composition of the product, that is, its being a phosphate of aluminum instead of calcium as is more common. Some suggestions point to the possible extraction of aluminum by electric furnaces and the conversion of the anhydrous phosphorus into phosphates.

A fourth source of phosphorus is apatite which is found in the states of Alagôas and Baía, being encountered in Arapiraca in the former and in Camisão in the latter. Transportation difficulties prevent the large scale utilization of the mineral of these regions although there are some small firms working in the Baía deposit. The largest and most important in Brazil, however, is in the state of São Paulo near the region now known as Ipanema.

The working of the Ipanema deposit may be said to be a splendid example of the chance discovery of an important element through the failure to find another. The original purpose of working the Ipanema region was for the iron that the region contained, an interesting point in this connection being that this was the first iron ore deposit discovered in Brazil. However, the high phosphorus and titanium content of the ore prevented the extraction of iron as did the expenses connected with transportation.

When the product was first utilized for the phosphorus content, it was ground fine without taking measures for the solution of the phosphorus and was distributed as such to the consuming public resulting in a certain feeling of doubt as to its qualities.

Actual large scale working of this deposit was commenced in 1939 with serious studies based on numerous drillings and measurements begun in 1937. Tests of some samples showed that the P_2O_5 content averaged 16% in unspecified localities while the Fe_2O_3 content was about 20%, the latter being of some concern to experts since the iron impurities (oxide) are in the colloidal state. It was found, however, that with concentration, it was possible to raise the apatite content of the crude product from 30% to 90% with the coincident reduction of the ferric oxide and alumina soluble in sulfuric acid to a maximum of 2%, the limit established by the buyers of concentrated phosphates.

The Mina Nova zone was the first to be studied by means of galleries, trenches and drillings and showed that in general the P_2O_5 content ranged from 10 to 18% but suffers inasmuch as it is intercalated with thick layers of sterile matter which in some cases seriously prejudices the working of the deposit. In compensation, there were other sections which showed highly favorable combinations of ore structure. However, the location with respect to transportation and the possible larger quantities of the deposits favored the Cotiara and Cascavel zones for immediate exploitation, the first samples showing that they contained the average quality for industrial use. Later tests demonstrated the plausibility of using the Cascavel mine since it contained in the limited area prospected, 400,000 tons of mineral with more than 10% P_2O_5. This mine with that of Cotiara is expected to serve the newly constructed concentration plant for a reasonable industrial period. With regard to these deposits, there

must be noted also that these optimistic conclusions are offset to some extent by the fact that there are irregular masses of sterile matter intercalated with the apatite. With reasonably careful selection of the mineral at the mines, it is has been demonstrated that a 15% content mineral is available.

The other deposits are of unknown magnitude and have not been studied intensively due to the distance from railway lines.

The extraction of the mineral was first carried out by manual labor with the homogeneous blocks being extracted by blasting. It was found that with selection at the mine, the price of the ore at the shipping point amounted to 10 milreis per ton. Since mechanical means are of greater utility, plans were lain for the installation of mechanical equipment.

Several problems arose as to the feasibility of installing the concentration plant at Ipanema near the mines and the superphosphate plant in the vicinity of the city of São Paulo. Supporters of the plan noted that it would benefit from the large supply of skilled labor, the numerous wide stretches of level land which are not available at the mine, and the proximity of the consuming markets. Other important factors were that the cost of the sulfuric acid in the city of São Paulo was one-half of that at the mine and that the shipment of concentrates could be made in open cars to the city of São Paulo while the shipment of sulfuric acid to the plant and the subsequent transportation of the finished product to the consumers would have to be done in closed box cars thereby raising freight costs.

Laboratory tests for the production of the phosphates at the mine also showed some advantages but involve the production of rophosphates instead of superphosphates since the latter requires 50% sulfuric acid and 50% phosphate while the former needs but 33% acid and the remainder phosphates. Favoring the latter also is the fact that the state of São Paulo with its *terra roxa* (in other words, soil containing iron) precludes the excessive use of superphosphates while the other may be used in unlimited quantities. Based on a price of 500 milreis for a metric ton of sulfuric acid and 200 milreis per metric ton of concentrates it was calculated that the superphosphate would require 250 milreis of acid and 100 milreis of phosphates for a cost of 350 milreis, the percentage of total cost of acid being 71% and the mineral 29%. In contrast, the manufacture of rophosphate would mean 165 milreis of acid or 55% of the total and 134 milreis of phosphates or 45% for a total cost of 299 milreis.

The imports of phosphates in general have been distinctly downward, that of 1937 being 31,159 metric tons, 23,630 tons in 1938, a rise to 24,212 tons in 1939 and 16,700 metric tons in 1940. Of the total, superphosphates account for the major portion, that of the natural phosphates which requires further industralization being relatively small. The price differential in favor of the natural phosphates is small, the latter being 499 milreis per metric ton in 1940 as compared to the 519 milreis for the super-phosphates. The principal sources of the latter are Germany, Holland and Belgium.

POTASH

There are no known deposits of the potash minerals, kainite, sylvinite carnallite, etc., the major portion of the consumption being furnished by imports and other forms of local potash compounds.

Imports of potash compounds have decreased perceptibly in recent years, the trend being expressed in the following figures: 1937 — 8,388 metric tons; 1938 — 6,376 metric tons; 1939 — 4,549 metric tons and 1940 — 2,800 metric tons.

The principal potash import is the chloride while the sulfate is the second. Germany is the largest supplier of both products.

The chloride was priced (CIF Brazil) at 951 milreis per metric ton in 1940 while the sulfate was quoted at an average of 1,229 milreis.

11. MINERAL WATERS

The mineral water industry which naturally divides itself into two distinct branches, that is, the beverage industry and that connected with water-spas, is probably one of the, if not the most extensive of mineral industries in Brazil today. The probable exceptions are gold mining and lime manufacture.

With regard to the first, that is, the beverage industry, it may be noted that the drinking of mineral water in Brazil is based little if any on the medicinal properties that the water may contain, the principal objective being the carbonated action of its contents. The magnitude of this demand may be more fully realized when considering the fact that soft-drinks have not the stronghold they have, for example, in the United States, and thereby favors this industry, while in addition, there is the other factor of greater importance, the fact that 80% of Brazil is included within the tropics or sub-tropics which encourages the partaking of such waters to a greater extent, either pure or mixed. The large demand has not failed, however, to create so large a market that today artificial mineral waters have greatly extended their outlets accounting for more than two-and-a-half times the output of the natural waters.

There is, however, a tendency among bottlers to adopt the name of the locale for their products and thereby conserve the distinctive character of their waters which greatly aids the continuation of sales of their goods. Also, inasmuch as few bulk shipments are made, the practice being to bottle in the vicinity of the spring, the production of natural mineral waters becomes a true state product. It is not strange to find, therefore, the state of Minas Gerais leading in national production, being the state with famous springs resorts as Lambarí, Caxambú, São Lourenço, etc., words which are on the tips of the tongues of tourists as well as drinkers. This state offers variety as well as quantity and thus dominates the industry accounting for 40% of the total output which in 1939 attained 17,622,000 liters. Transportation facilities constantly improved by the influx of tourist trade enables local manufacturers to make a smooth distribution of their goods and thus assures the state continuing domi-

nance in the industry, it being of interest to note that in 1936, the output totalled 5,945,000 liters, which in 1937 registered a gain, rising to 6,292,000 liters. Output in 1938 was 6,386,000 liters and in 1939 had increased again to 6,872,000 liters. There are 14 enterprises with a capital of 17,616 contos employing 490 persons in this state.

Despite the importance of the state of Minas Gerais, it must be noted that its leadership, though predominant, is declining relatively with the rise of new centers and constant injection of new capital into the industries of the other states. The strength of São Paulo is based to a greater extent on the latter factor and finds this state increasing its production in the following manner to rise from 18% of the total in 1936 to 21% in 1939: 1936 — 2,503,000 liters; 1937 — 2,722,000 liters; 1938 — 2,898,000 liters and 1939 — 3,650,000 liters. The principal sources of São Paulo's water are Lindoia, Prata and Platina with São Pedro being a promising new center. In this state there are 24 firms engaged in this industry employing 160 persons and working with an invested capital of 6,414 contos.

The fame of the Federal District and Estado do Rio which are the third and fourth respectively in this industry, lies in the waters of Federal, São Gonçalo, Salutaris, etc., and because of their proximity, are partly for this reason found in the Capital at lower prices than competing brands. They, however, have suffered proportionate declines, the Federal District which in 1936 accounted for 16% of the total with an output of 2,200,000 liters produced 2,665,000 liters in 1939 to represent but 15% of the total while the corresponding changes of Estado do Rio were from 2,244,000 liters to 2,521,000 liters to decline from 16% of the total to 14%. There are 4 firms in the Federal District employing 106 persons while in Estado do Rio there are 13 firms employing 125 persons. The capital invested in the former amounted to 610 contos in 1939; in Estado do Rio the total invested amount was 3,716 contos.

In all there are twelve states now producing mineral water, the newest to enter this industry being the states of Espirito Santo and Paraíba. The production of the remaining, in order of importance, are Paraná, Rio Grande do Sul, Santa Catarina, Pernambuco, Ceará, Baia, Paraíba and Espirito Santo. Goiaz, which at one time produced, has not recorded outputs since 1938.

There are a total of 80 firms engaged in this industry in Brazil with a total capital of 30,431 contos. The number of employed approximates 1,070

Exports have shown little variation over more than twenty odd years, the annual average during the 1920-9 decade having been 1,204 liters as compared to the 1,556 liters of the 1930-4 quinquennium and the 1,450 liters of the 1935-9 period. In 1939, there was an export of 425 liters of mineral water of an unspecified nature to Bolivia. The 1940 shipments of 2,578 liters were made to Bolivia and Colombia, the former taking 2,338 liters and the latter 240 liters.

It may be noted that the unit export price during 1939 was 1,265 milreis per 1,000 liters while that for 1940 was 1,286 milreis (FOB Brazil). Foun-

tain prices of the natural mineral waters vary greatly, a fair average being 1,200 milreis per 1,000 liters.

Eighteen states have springs which have been analyzed and their properties recognized and show a great range in mineralization and temperature. With regard to the former, there may be denoted ten fairly distinct classifications which are given in the accompanying table noting the location of the principal waters.

MINERAL WATERS

Table 13 LOCATION OF WATERS ACCORDING TO COMPOSITION

ALKALINE SULPHIDRIC:

Poços de Caldas	M. Gerais
Pocinhos	" "

FERROUS ACIDULOUS:

Lambari	M. Gerais
Cambuquira	" "

SULPHIDRIC SULFATED ALKALINE:

Araxá	M. Gerais
Patrocinio	" "
Carapatós	Pernambuco
Fazenda Nova	"
São Pedro	S. Paulo
Iraí	R. G. do Sul
Prado	" " " "
Volta Redonda	" " " "
Arenal	" " " "

CARBONIC DIOXIDE:

Caxambú	M. Gerais
S. Lourenço	" "
Lambari	" "
Cambuquira	" "

COMPLEX ALKALINE:

Caxambú	M. Gerais
São Lourenço	" "
Fervedouro	" "
Caldas do Rosario	Sergipe
Salgado	"

CHLORIDRIC BICARBONATED:

Brejo das Freiras	Paraíba
Olho d'Agua do Milho	R. G. do Norte

CHLORIDRIC:

Caldas do Cipó	Baía
Moriçoca	"
Mosquete	"
Fervente	"

FERROUS ACIDULOUS ALKALINE:

Caxambú	M. Gerais
Marinheiro	" "

OLIGO-MINERAL:

Santa Clara	M. Gerais
Jacu	" "
Candoi	" "
N. S. de Lourdes	" "
Sabá	Pernambuco
Lindoia	S. Paulo
Serra Negra	" "
S. Sebt. do Paraizo	M. Gerais
Caldas Novas	Goiaz
Caldas Velhas	"

SODIUM BICARBONATE:

Prata	S. Paulo
Platina	" "
Pedras Salgadas	" "
Olho d'Agua do Milho	R. G. do Norte
Salgadinho	Pernambuco

The different waters rated according to mineralization show that that of Araxá of Minas Gerais (sulphur) contains the highest having 4.3355 grams per liter. Prata of the state of São Paulo is the second largest having 3.9868 grams per liter while Caldas do Cipó of Baía, Caxambú of the state of Minas Gerais, Poços de Caldas also of Minas Gerais, Araxá (radio-active) of Minas

Gerais and Lindoia of the state of São Paulo follow in order with quantities varying from 0.1028 from to 1.6850 grams per liter.

The temperatures of the principal thermal springs in Minas Gerais are as follows: Pocinhos do Rio Verde — 24° C., Araxá — 34° C., Patrocinio — 23° C. and Poços de Caldas —45° C.

The radio-activity rating of the Lagôa spring of the Araxá spa is 88.5 units, that of the alkaline-sulfur spring in the same locality 44.2 units and that of Caxambú 43.3. The others, such as Pocinhos do Rio Verde, Cambuquira, and Araxá (radio-active spring) of the state of Minas Gerais, Caldas da Imperatriz of Santa Catarina, Santa Clara of Paraná and Prata of São Paulo have from 11.09 to 28.04 units.

The spas of Brazil, principally those of the states of São Paulo and Minas Gerais have not been publicized abroad as much as might be wished and naturally give the impression that accomodations as well as transportation facilities are insufficient to meet the exacting demands of tourists. It might be mentioned, however, that in all aspects, these points compare favorably to others well-known in Europe. The additional factor of a reasonable cost of living plus the high therapeutic qualities add greatly to their value.

The total production in 1936 was 13,723,900 liters which in 1937 rose to 14,687,700 liters a gain of 7%. There was another rise registered in 1938, the total being 16,194,600 liters while in 1939, this trend was continued being 17,622,200 liters. It may be noted that the gain in the 1937 to 1938 period was 10% and that from the 1938 to 1939 period 9%. It is of interest to compare this with that of artificial mineral water production which varied as follows: 1936 — 31,359,000 liters; 1937 — 32,205,000 liters; 1938 — 34,881,000 liters and 1939 — 42,759,000 liters. The percentage, increases of this product were 3%, 8% and 23% respectively in the three periods.

12. MONAZITE

Monazite is essentially a cerium phosphate and thus lead to the belief that with the increased use of flint for lighters there would be a revived demand for this mineral but commercially it is principally for the thorium which accompanies it that the product is applied in industry. Thus, monazite is consumed largely by gas-mantles. Minor uses are in the manufacture of flaming-arc carbons and heat-ray lamps.

Monazite is encountered in various forms from pebbles to fine grains of sand, the usual type in Brazil being the sands although in the interior, along river courses it is not uncommon to find some which resembles gravel.

The coastal deposits are located within the stretch of coast between São José da Barra in the state of Estado do Rio to Barra do Jequitinhonha in the state of Baía further to the North. In this area, the monazite is found in mixtures with other minerals such as ilmenite, zircon, garnets and quartz. The

principal sources of monazite, however, are Espirito Santo and Baía. Several bags of the sand of the state of Espirito Santo analyzed as follows: Ilmenite — 71.6%; Monazite — 6.0%; Magnetite — 0.2%; Zircon — 13.0%; Quartz — 6.0% and the remainder, mixed products. Testing the monazite separately, it was found that the average thorium oxide content in six samples amounted to 6.2% while that of cerium, lanthanium and didymium oxide totalled 60.7%. It is the practice to separate the quartz from the sands by means of washing while the ilmenite, monazite and zircon are later extracted by means of an electro-magnet.

The sands of Comoxatiba of the municipality of Prado in the state of Baía contain 5.75% thorium while those of Bandeira de Melo have as much as 10.5%. The sands of Mucurí vary greatly having a minimum of 5 and a maximum of 6%. The state average however, is low, ten samples testing with only 3.33% thorium oxide.

Samples of the mineral of the state of Estado do Rio show that the sands contain 5.87% thorium oxide.

In the state of Minas Gerais, monazite is found generally in river beds. No tests of this mineral are available.

In more than 20 years of the export history of this product, the largest shipment was that of 1920, year in which the total was 1,153 metric tons. Since then shipments have been exceedingly irregular averaging 221 metric tons in the 1920-9 decade, 144 metric tons in the 1930-4 quinquennium and 158 metric tons in the 1935-9 period the largest since 1920 being that of 1937 in which exports of monazitic sands amounted to 417 metric tons, Germany being the sole market for the mineral. In 1938, there was a decrease to 323 metric tons, the chief market in that year being France which purchased 223 tons. The United States was the only market in 1939, year in which the total was but 48 metric tons. A slight increase was evidenced in 1940, the total of 180 metric tons being shipped to the United States.

The unit price of the exports in 1937 was 197 milreis per metric ton, that of 1938 being the same and that of 1939 — 199 milreis thus being one of the most stable minerals in price in the export trade. In 1940, however, there was an abrupt rise to 743 milreis. It may be noted in this connection that the mine price in the same year was 500 milreis.

There are no imports of products based on monazite or its derivatives which are classified separately to permit a study of their prices.

13. PRECIOUS STONES

GENERAL SURVEY

Due to the sporadic nature of production of all gems other than diamonds and carbonados, it is difficult to place the actual production of Brazil. Suffice it to say, however, in this connection, that the exports of diamonds and

carbonados approximates the total in practically all years and thus furnishe an index as to the trends in the industry.

Annual exports of precious stones in the 1920-9 decade averaged 15,945 contos while in the 1930-4 quinquennium, there was a drastic decline to 1,669 contos and in the 1935-9 five-year period, they increased again to average 16,351 contos. In the first mentioned period, carbonado exports were larger than that of diamonds accounting for 40% of the total while that of diamonds amounted to 31%. Other gemstones represented 29% of the total. In the following five-year period, carbonados accounted for a larger percentage share amounting to 55% while the diamonds represented 41%. It is only in the 1935-9 period that there is a distinct domination of the trade by diamonds (94% of the total) due largely to the extraordinarily large shipments of 1939. Carbonados in this period represented but 2% of the total. It may be noted that in 1940, the total exports of this nature consisted of diamonds and carbonados only, that of the former being 81,403 contos while the latter amounted to 1,180 contos.

From the above trends, to all appearances, the importance of carbonados has declined to new levels despite the perceptible increase in the last few years. One significant reason for this change is evident in the growing use of borts and the smaller diamonds in the place of carbonados. According to the *Minerals Yearbook, 1940,* smaller stones are said to be sounder and harder than the larger. There is the additional discovery of a new cast-setting metal of beryllium-copper which permits the use of small diamonds and which will no doubt greatly affect the trade in carbonados.

Imports of precious stones vary but slightly although there is a noticeable decline in the five years from 1930 to 1935 in which they averaged 840 contos as compared to the 1,400 contos of the previous decade and 1,600 contos for the quinquennium 1935-9. In 1940, the imports amounted to 499 contos.

DIAMONDS

The uses of diamonds are divided between the industrial applications and that for ornament. However with the fears of contingencies arising from the "unexpected", diamonds have lately served another purpose, such as that as an investment for capital.

The discovery of diamonds in Brazil dates back to 1729 and their exploitation from that date in the state of Minas Gerais became one of the most important activities of Colonial Brazil.

This country soon became the world's principal producer of diamonds. The stones acquired an excellent reputation for their unequalled clearness and brilliancy and competed on even terms with the diamonds of Hyderabad, India whose mines at Golconda served as a standard for Brazil. It may be said that the world-wide popularization of this gem was due to its discovery in Brazil;

until that time diamonds were a monopoly of the Orient and their use restricted to the aristocratic class.

Brazil and India which were the principal diamond fields in the Eighteenth and Nineteenth Centuries, later ceded their position of leading importance to Africa which subsequently became the Diamond Continent with the discovery of the precious gems in the Cape Colony, Transvaal and in the Orange Free State.

In 1870, with the discovery of large diamond reserves in primary deposits, the Union of South Africa commenced to exert an enormous influence on the diamond market. From that time on, diamond regions dependent on alluvial production dropped to a secondary position. Included in the latter group is Brazil which, since that time, has never been able to regain her former position as leader. In Hyderabad, India, diamond mining has declined almost to the point of disappearing.

The best-known alluvial diamonds zones in Brazil are distributed among the following states: Minas Gerais, Baía, Mato Grosso, Goiaz, Amazonas, Paraná and São Paulo.

In the state of Minas Gerais the principal diamond alluvials are found in Diamantina, Grão Mogol, São José da Chapada, Serra do Cabral, Abaeté, Coromandel and Estrela do Sul.

The town of Tijuco, today Diamantina, was the principal diamond-mining center in Colonial times, and today is the center of a scientific research to determine the development or genesis of Brazil's diamond deposits.

The region of São João da Chapada, well-known for the primary deposits of precious stones, possesses several occurrences that of Campos do Sampaio being the most important. Its production averages 100 carats a month and has been in continual operation over a long period.

In the diamond field of Estrela do Sul, there was discovered in 1854, the celebrated diamond of 254.40 carats which is known under the name of the place of origin.

Lately, production in the state of Minas Gerais has been more intense in the regions of Tiros, Patos and Coromandel. In 1938, there was found in Coromandel the largest diamond ever to appear in Brazil. It weighed 726.60 carats and was named the *Presidente Vargas*. In the same regions the *Coromandel* diamond weighing 400.65 carats and the *Darcy Vargas* of 460 carats were found, the latter being the second largest diamond ever found in Brazil.

The discovery of the first diamonds in the vicinity of Mocugê in the state of Baía, in 1844, caused a rush in which the prospectors established themselves permanently so that even to this day it is still one of the most important diamond districts of Brazil. Its population of 20,000 persons increased, between 1844 and 1848 to 50,000. It was a rush in no way inferior to those for the search of gold in California and in Australia.

One of the most productive areas of Baía, is that between Sincorá in the south and Morro do Chapeu in the north. This fact is attributed to the richness of the fields and to the abundance of water.

Other diamond zones in the state of Baía are the following: Camassari, slightly to the north of the State Capital; Rio Itapicurú, principally the districts of Santa Luzia and Barracão; municipality of Canavieiras, along the Rio Salobro, a tributary of the Rio Pardo and Lavras Diamantina, the most important of which includes the municipalities of Sincorá, Mocugê, Andarái, Lenções, Campestre, Palmeiras, Assuruá, Brotas and Morro do Chapeu.

The principal diamond districts of the state of Mato Grosso are the district of Coxim which is along the banks of the Rio Juruema and its tributaries and that of the Rio das Garças. Besides these two there is the alluvium of the Rio Aquidaüna which has proven a constant source of supply and has assured the success of the mining operations undertaken in that region.

In the state of Goiaz, as in Mato Grosso, diamond prospecting has been effected on a large scale only in recent years. The most important diamond districts of this state are those of Verissimo and of the rivers, Corumbá, Caiapó, Araguai and their tributaries.

Other Brazilian diamond zones are located along the rivers Tibagí, Peixe, Paranapanema, Canoas and Verde in the state of São Paulo; the rivers of Iapó, Pitanguí and Cinzas in the state of Paraná; the River Seco, tributary of the Tocantins River in the state of Maranhão and the Quinô and Irengmutã, in the state of Amazonas. The basin of the Rio Branco has furnished some stones and all indications seem to point to the possibility of operations as important as those of the Guianas.

The four largest diamonds in the world were discovered in South Africa. The *Culiman,* found in 1905 in the Premier Mine is the largest known to date. Uncut, it weighed 3,025.75 carats. The *Excelsior,* found in 1893, weighing 1,969 carats, is the second largest, followed by the diamond known as the *1,649 Carat* (weight) and the *Jubilee* of 971.75 carats. The fifth largest diamond is the famous *Great Mogul,* discovered in 1550 near Golconda, India. It weighed 793 carats.

The *President Vargas,* found in Brazil in 1938 and weighing 726.60 carats, is the sixth largest in size among the world's diamonds. The seventh place goes to the *Jonkers* which weighs 726 carats and was discovered in South Africa in 1935 while the eighth is the *Darcy Vargas,* a Brazilian stone of 460 carats.

Among other large diamonds found in Brazil there are the famous *Estrela do Sul* of 254.50 carats, discovered in 1853; the *Coromandel* of 400.65 carats, discovered in 1939 and the *Cruzeiro do Sul* of 118.50 carats, discovered in 1935.

The production of diamonds in Brazil is slightly more than 3% of the total world production and one-half of one percent of the total value of Brazil's exports. Estimates of output by states are unreliable because of the con-

stant travelling of the buyers from zone to zone who organize the lots to be sold in the cities of Baía and Rio de Janeiro, the two principal export centers.

The total national production however, may be estimated to have totalled 197,088 carats in 1937. In that year, Mato Grosso produced 75,000 carats and was the leader according to amount but in value (6,600 contos) was the third largest thus bearing out the low unit price of the stones from that state. Minas Gerais with an output of 53,000 carats was the second largest producer but first in value (10,800 contos) while Baía the third most important had an output of 48,000 carats with a value of 6,700 contos. Other producing states in that year were Goiaz, Amazonas and Paraná.

The domestic total in 1938 fell to 114,205 carats a decline of 32% over 1937 and was valued at 16,535 contos. It is to be noted that production in all states declined with the exception of Amazonas. The industry developed in the sense that São Paulo and Pará appeared as new producers but their output was of little consequence.

The 1939 output had increased to 208,244 carats valued at 28,224 contos, Mato Grosso continuing to be the leading producer with an output of 76,600 carats or 36% of the total while the value was but 7,400 contos, the third largest in the country. As in 1937, Minas Gerais was the second largest in quantity and first in value, the corresponding values being 52,500 carats and 9,000 contos while Baía was third with 48,000 carats and second in value with 8,000 contos.

As is apparent in Table 1 there is a tendency for the exports of diamonds to increase in recent years after an appreciable decline in the 1930-4 period. In the 1920-9 period, the annual average was 4,927 contos; in 1930-4 period this had fallen to 689 contos while in the 1935-9 quinquennium, it had more than tripled the amount of the first period being 15,427 contos. The 1939 exports were the largest in the recent history of diamond exports but was surpassed in 1940 when the value more than doubled.

In 1937, the leading market for the stone was England with Belgium and Holland being of secondary importance. In 1938, Holland was the leading outlet while England and Belgium followed in importance. The United States which for some years had imported varying quantities of the Brazilian stone was the principal market in 1939 according to value accounting for 50% of the total. England and Belgium were second and third respectively with purchases of 9,397 carats and 7,513 carats respectively. In that year, Germany, Japan and Switzerland were other markets of some importance. The 1940 shipments were 25% larger than those of 1939 in quantity and as mentioned above, more than twice the value.

Due to to the wide variations in value attached each cut of stone, it is meaningless to compare a list of prices by year although for purposes of interest it may be mentioned that in 1940, the export price for diamonds was 1,600 milreis per carat while the mine price was 100 milreis. The export price of carbonados averaged 512 milreis per carat during the year and obtained an average mine price of 50 milreis.

CARBONADOS

The carbonado, a dark variety of the diamond, is opaque, without a clear-cut crystalline form, nearly always a yellow, dark gray or black and is of great utility because of its extreme hardness. Although found in Baía as early as 1842, no special importance was attached to these carbonados until 1860, when Leschot discovered their utility in tipping rock drills.

Up to the present, carbonados have been found in economically favorable conditions only in Brazilian fields. The carbonados coming from Piranhas, in the municipality of Andaraí in the state of Baía generally obtain the best prices and have become the principal world source for this stone.

The United States is an important market for this industrial product. American capitalists have organized an enterprise known as the Companhia Brasileira de Exportação Diamantina, a subsidiary of the Baía Corporation, to exploit this stone. This company is the only one which works carbonado deposits on a large scale with machinery for extraction, washing and sorting.

In 1895 the largest carbonado in the world was discovered in Chapada Diamantina. Its weight, according to some, was 2,078 carats and according to others 3,167 carats. A model of it in iron is in the National Museum in Rio de Janeiro. The carbonado in question was broken up into stones for sounding equipment and played an important part in the development of the mining district of Mesabi in the United States.

Production of carbonados in Brazil approximates the exports of the state of Baía inasmuch is it is the only producing zone in Brazil and in the world and very little direct use is made of the stone locally. The total exports of Baía in 1937 totalled 2,605,285 grams 12.7% of which was shipped to Rio de Janeiro and 87.3% overseas. In 1938, the total had decreased to 1,370 grams the percentage shipped overseas in this year being 69% and that to Rio de Janeiro 31%. The 1939 shipments increased to 3,163 grams, 2,202 grams of which were shipped to Rio de Janeiro and 961 grams directly overseas the larger part of which was to London. The 1940 shipments amounted to 2,762 grams, 2,263 grams being shipped to Brazilian markets and the remainder to the United States and England.

Carbonado exports have never reached the levels of the 1920-9 decade in which they amounted to an average of 6,386 contos. Since 1936, there were indices that the industry was on the way to recovering its former importance and in 1940 totalled 1,180 contos after being at the low of 62 contos in 1936. In 1937, England acquired 103 contos of the total of 165 contos that Brazil exported in that year. In 1938, and 1939, Germany proved to be the largest market of these diamonds by purchasing 275 contos of the total of 509 contos in the former year and 378 contos of the 1,021 contos in 1939. Belgium was the second largest market for carbonados in 1938 purchasing 102 contos of this stone but in 1939, the United States was second, her total being 374 contos. In 1940, the United States was the principal market by accounting for 691 con-

tos of the total of 1,180 contos. The other outlets of importance were Belgium, Sweden, and Japan, the respective amounts of their purchases being 220, 74 and 69 contos.

EMERALDS

The extremely rare Oriental Emerald, a designation now in disuse, is a green corundum. The Beryl Emerald is found in South America and is the variety which made famous the Muso mines in Colombia which today are closed. In all cases the coloring matter is chromium.

The discovery of corundum emeralds has been reported in the state of Goiaz but no further details are available.

The emerald occurs in association with basic rock (talcum schist) in Itaberaí in the Serra das Lages in the state of Goiaz. The alluviums of this region have an extension of several kilometers.

The emerald appears in the state of Minas Gerais in the regions of Conceição, Itabira and Ferro where it is found in mica schist cut by pegmatite veins.

Two regions in the state of Baía at present produce emeralds, Vila Nova in the municipality of Conquista, near the Rio Gavião, and Serra das Eguas in the municipality of Brumado. In these localities they are found in veins of magnesite, constituted of large rhombohedrons of the magnesite itself and of quartz, emerald, tourmaline, topaz, etc. This type of occurrence is very similar to that found in Colombia, the leading producing district of which at present in Chivor.

In the Serra das Eguas there are alluviums with emerald deposits covering an area of 2,000 meters by 200 meters. The present operations however are limited to a zone of only 200 meters by 300 meters, partly in the veins, but for the most part in the alluvial deposits. It is possible to prospect these deposits by means of a line of shafts following the maximum declivity. Excellent gems were discovered in this manner at Brumado in the state of Baía.

Ordinary Brazilian emeralds range from 50 milreis to 200 milreis a gram while cut stones vary from 50 milreis to 500 milreis a carat. Eppler however mentions prices up to 10,000 milreis a carat for some stones.

CORUNDUM

Corundum is an anhydrous aluminum with a hardness of 9, density of 4, and a refraction index of 1.765. It occurs in short bipyramidal prisms. The blue variety is known as sapphire or "engineers' stone" the coloring of which is due to the presence of iron and titanium, while the red stone is the ruby or "lawyers' stone", the coloring of which is attributed to the chromium element.

In Brazil, there are no deposits in the strict sense of the word, but corundum gems are nevertheless occasionally found at rare intervals in the process of washing diamond gravel.

Corundum stones have been produced in India for many centuries the sapphire fetching prices from 100 milreis to 7,500 milreis a carat, while the value of the ruby varies between 250 milreis and 40,000 milreis a carat. The Australian sapphire which contains green or yellow hues and is at times too opaque, brings lower prices, ranging from 15 milreis to 250 milreis a carat.

The sapphire occurs in Brazil as a satellite of diamond in Diamantina in the state of Minas Gerais; in Salobro in the Minas do Rio das Contas and Recreio in the state of Baía; Jaurú and Quilombo in the state of Mato Grosso; Cachoeira das Escadinhas in the state of Espirito Santo and Serra do Itaqui, Rio Canoas, Rio Sapucí and Rio Santa Barbara in the state of São Paulo.

Rubies have been found at Abaeté, Abadia dos Dourados, and Agua Suja in the state of Minas Gerais; at Rio Paraguassú, Rio Camassarí, Jequié and Andrade in the state of Baía; at Rio Piuma in Espirito Santo State and in the Coxim and Jauru Rivers in the state of Mato Grosso.

14. PYRITES

The importance of pyrites lies in the sulfur it contains which eventually is utilized principally in the manufacture of sulfuric acid. To this application, may be added that in other chemicals, that for fertilizer and insecticides, pulp and paper, explosives, dyes, rubber, etc. In Brazil, the larger part enters into the manufacture of sulfuric acid, insecticides, rubber and explosives.

In Brazil, there are no known occurrences or deposits of brimstones. Thus, the only local source of sulfur is pyrite, a sulfide of iron which is often confused with gold. Among world producers, Brazil is of insignificance in the production of this mineral, being in 25th place with the admission that the total output of Brazil is that of the state of Minas Gerais alone. The absence of data from other producing states does not permit the correct collocation of this country. Spain, Japan and Norway are the principal world producers. The leading world producers of native sulfur are the United States, Italy and Japan.

Pyrites are found in nearly all parts of the country in small quantities but veritable deposits are encontered in but few places. And even as such, the greater quantity is found containing gold, especially those which occur in veins associated with arsenified minerals. The presence of the latter and gold thus gives rise to the extraction of gold and arsenic and the sacrificing of the sulfur content. As such, there are only two deposits being worked strictly for the sulfur, that of the Ouro Preto district in the state of Minas Gerais and the Rio Claro deposit in Estado do Rio.

The Ouro Preto mineral is formed in layers containing small crystals of nearly pure pyrite, there being little or no arsenic which is undesirable in the manufacture of sulfuric acid. The sulfur content is 42.40% and is refined

by means of vibrating tables. It is estimated that the reserves of the deposit are sufficient to supply at least 13 million tons of pyrites.

In 1937, the production totalled 3,000 metric tons valued at 600 contos. This, in 1938 had decreased to 2,526 metric tons while in 1939, the total was 2,000 tons. The total for 1940 is estimated to be 2,500 tons. The extraction of the mineral is carried out by 20 to 30 persons and is done by three firms with a capital of 48 contos.

Nearly all of the output of the Ouro Preto district is absorbed by a sulfuric acid plant operated by the Ministry of War.

The pyrites of the Rio Claro region in Estado do Rio are associated with quartzite intercalated with the gniess of the Serra do Mar (Coast Range) and has been worked since 1931. The sulfur content is 40.5% and is thus slightly inferior to the Minas Gerais mineral. Arsenic is completely absent but some galena and blende accompany the mineral. In spots, thalium is also encountered with the pyrite. According to a survey, its production capacity is two tons per day under present working conditions. The reserves are large enough to supply the domestic sulfuric acid industry as conditions exist at present but with the increased production of apatite and hence superphosphate fertilizers in Ipanema in the state of São Paulo, there arises doubts as to this point as does the possible consumption of the woodpulp industry which is to be established in the state of Paraná, both of which will be large consumers of sulfur in one form or another.

Near the Rio Claro deposits, there are two others, one in Tres Corregos and the other in Volta Branca which consist of pyritic rock.

According to a recent publication *Minerais Estrategicos* by Dr. Luciano Jacques de Morais, another source of pyrites is that of the coal of the South (Rio Grande do Sul and Santa Catarina) which in some regions contains substantial sulfur contents in the mineral. With the advancement of industry in that region, it is expected that this source will provide the largest quantities of sulfur in the country surpassing that of the pyritic rock of Minas Gerais and Estado do Rio. This supply, on casual estimates, runs into tens of millions of tons.

Still another source, is that of the deposits of lead and zinc in the Ribeira do Iguape of the state of São Paulo which contain high percentages of pyrites besides the enormous quantities of SO_2 which could be obtained with the treatment of those metallic ores.

No exports of pyrites are recorded and are not possible under the present circumstances due to the heavy demand from the domestic sulfuric acid plants which number five (only large scale) according to a recent survey.

Pyrites were priced at an average of 80 milreis per metric ton at the mine during the year 1940.

There are no imports of pyrites, the total being native sulfur in powder and bar form. The average imports during the 1920-9 period was 5,930 tons per annum while in the 1930-4 quinquennium it was 7,370 metric tons. In the following five-year period, the average had risen 120% to attain 16,260

metric tons, the importation of 23,224 metric tons of 1939 having been the largest up to that time. In that year, the principal source of the sulfur was the United States which supplied 47% of the total. The second largest supplier was Chile which furnished 30%. In 1940 there was another increase to 24,100 metric tons, the record high to date, the leading sources being Chile (54%) and the United States (38%).

In connection with the increasing sulfur imports, it is of passing interest to note that the imports of sulfuric acid had decreased to an annual average of 130 tons in the 1930-4 period as compared to the average of 400 tons during the 1920-9 decade. In the 1935-9 period there was still a further decrease to 20 metric tons while in 1939 it was no longer recorded in official statistics due to its insignificance.

15. ROCK CRYSTALS

Rock crystals were formerly used for moderate-priced jewelry, to some extent in optical instruments and in some countries, principally Japan, for the manufacture of seals. At the time, quality was a factor of little importance as compared to today and the stone was quoted on the market in tons. With the development in radiotelegraphy and radiotelephony, short wave broadcasts, sound films and television, crystals have come to play an important role in industry, particularly as an oscillator. Prices were then quoted in *arrobas* (15 kilograms) and now in kilograms, so greatly has risen the value attached to them.

World producers of rock crystals are limited, the principal being Brazil which has an annual output of 2,600 metric tons. Madagascar, Japan, Kenya, and South West Africa (Rose quartz) are of some importance.

Exports from Brazil are by far the largest in the world due to the factor of quality and exceeded that of the second largest exporter Madagascar by approximately 673 metric tons in 1939.

In the state of Minas Gerais, there are deposits in Diamantina, Sete Lagoas, Buenopolis, in the valley of the Jequitinhonha (rose quartz), Bocaiuva, Grão Mogol, Itanhomi and to some extent in scattered regions throughout the state. In 1937, Diamantina was the largest producer accounting for 83,000 kilograms of the total of 206,640 kilograms. Second in importance was Sete Lagoas with an output of 65,000 kilos. In 1938, the state output totalled 368,850 kilograms an increase of 79% over the previous year. The 1939 output was 583,525 kilos and that for 1940 estimated to be 650,000 kilograms, gains of 58% and 11% respectively.

During 1939, the principal producing municipalities in the state of Minas Gerais were Curvelo and Sete Lagoas with 160,000 kilograms each, Diamantina with 76,500 kilograms and Montes Claros with 58,000 kilograms. Of secondary importance were Santa Maria do Suassi with 25,000 kilograms, Teofilo Otoni with 22,360 kilograms and Bocaiuva with 20,000 kilograms.

Due to the unique characteristic of this industry, that of the distribution of this crystal being largely in the hands of export houses in the urban centers who buy directly from the independent *garimpeiros*, there are no detailed statistics as to the number of firms, capital, number employed, etc.

The deposits of Baía are in the vicinity of Conquista and various scattered regions thoughout the *sertão*. The quartz of this state is known for its sizes, stones over 300 kilograms each being found with frequency. Although, production data is unavailable, there is little regional utilization of the stone and the quantities approximate, fairly closely, the amount exported. In 1938 the total shipments to other states (coastwise) and overseas totalled 81,162 kilograms. In 1938, this had risen to 344,722 kilograms while in 1939 it was 429,099 kilograms. In 1940, the shipments totalled 444,005 kilograms.

With the more exacting demands placed on crystals, the state of Goiaz has come to the fore because of the general quality average. The usual density is 2.5 to 2.8 and the hardness rating — 7. It is estimated that the output of the state is 1,500,000 kilograms, based on exports, thus placing it as the largest producer in Brazil. The deposits of Cristalina, although the most important from the standpoint of reserves, are not, however, the largest producers. They have been worked for over a hundred years but lack the necessary modern equipment and sums of capital which are imperative for their development. Actually, the largest output comes from the Santana deposits; others of commercial importance are Cavalcanti, Garimpão, Raizania, Peixe, Pequizero, Veadeiros, Santissimo, Bom Jardim, Alagoas, Arraias and Paciencia.

The overseas exports average in the 1920-9 decade was 192 metric tons annually while that for the five years, 1930-4 amounted to 367 metric tons. In the 1935-9 quinquennium, there was a rise of 19% to 436. The total in 1939 was 678 metric tons of which Japan purchased 382 metric tons valued at 8,839 contos. England was the second largest market, taking 163 metric tons valued at 5,364 contos while the United States was the third largest having purchased 28 metric tons worth 2,308 contos. Germany's purchases exceeded that of the United States with regard to quantity being 93 metric tons while the value was but 2,279 contos due to the low unit price.

It may be noted in this connection that the smaller stones, usually less than 1 kilogram in weight go to Japan, although this country does purchase the larger sizes and cuts them. The United States market prefers the stones weighing more than one kilogram.

The 1940 shipments, the largest in the export history of this mineral, totalled 1,103 metric tons valued at 27,863 contos of which 447 metric tons (41% of total) valued at 12,224 contos (44% of total) were shipped to Japan. The United States purchased 61 metric tons in Brazil priced at 6,034 contos and was the third largest with regard to quantity and value. Great Britain was the largest according to quantity purchasing 522 metric tons which was valued at but 8,703 contos, the second largest.

The price (FOB Brazil) per metric ton of the exported product has been registering the following changes: 1937 — 13,111 milreis, 1938 — 20,059

milreis, 1939 — 28,124 milreis and 25,361 milreis in 1940. Quartz at the mine was priced at 2,000 milreis per metric ton in the state of Goiaz while in Minas Gerais it was 1,550 milreis. The cheapest was that of the state of Baía which was valued at 1,000 milreis per metric ton.

In order to establish stability in the industry, classifications and price limits were provided for under Decree-Law N.° 3,067 thus encouraging production and faciliting export as well as guaranteeing the buyer abroad a standardized article.

The principal contents of the decree-law are the following:

1) — Export must be made by a classification and evaluation form issued by the Departamento Nacional da Produção Mineral of the Ministry of Agriculture.
2) — Rock crystals shall be classified into a) — "cristal" (crystal) and b) — "lasca" (fragments).
3) — The term "cristal" will cover three classes, "A" being the hyaline crystal, colorless, light and with a uniform appearance, 60% of which must be utilizable, "B" which is also hyaline, colorless or lightly colored, 60% utilizable and with simple needles, few, sparse and hazy bubbles being tolerated, and "C", also hyaline, colorless or colored with more than 40% gemination.
4) — The term "lasca" refers to fragments weighing less than 200 grams and are divided into the following types: "Primeira" (first) that which does not present crystalline faces, spots, bubbles, and blue streaks; "Segunda" (second) that which contains crystalline faces, spots, bubbles and blue streaks and "Mistas" (mixed) that which presents mixed characteristics.
5) — The minimum prices for the classes and types are fixed as follows until further rectification:

"CRYSTAL"

CLASS	PER KILOGRAM
Less than 100 grams	1 milreis
100 to 200 "	5 "
200 to 300 "	20 "
300 to 500 "	40 "
500 to 700 "	80 "
700 to 1,000 "	120 "
1 to 1.5 kilograms	150 "
1.5 to 2 "	200 "
2 to 3 "	270 "
3 to 4 "	350 "
4 to 5 "	450 "
5 to 7 "	600 "
7 to 10 "	750 "

Above 10 kilograms — 25% increase for each kilo
CLASS B: 30% discount on "A"
CLASS C: 40% " " "B"

"LASCA"

	PER KILOGRAM
"Primeira when optically pure and without defects	4 milreis
"Segunda" when not optically pure and with defects; each stone may weigh more than 200 grams	1 "
"Mista"	3 "

6) — All crystals of classes "A", "B" and "C" destined for export must be packed in wooden cases with a capacity of 45 to 50 kilograms those crystals in excess of one kilogram, being marked individually with labels or tickets which denote the weight, class, the names of the exporters, consignees and the number of the order.

7) — The classification and evaluation form for each lot must contain the number of cases which form the lot, the number and classification of the crystals and names of exporter and consignee.

8) — "Lascas" may be shipped in wooden cases or appropriate bags. Each classification and evaluation form for "lascas" must contain the quantity of bags or cases, types of "lasca" in each case or bag, export value, source of product and the names of exporter and consignee.

9) — The exports of rock crystal will only be permitted through the ports of Rio de Janeiro and Salvador (state of Baía).

16. SALT

The uses of salt are manifold and reach numerous industries in one form or another but the principal may be considered to be the food and the chemical alkali industries. In Brazil, by far the largest use is in the former, within which there are myriad uses. The use in human alimentation is well known. However, there is another which may well be classified in this group, that of the preservation of foods which is carried out to a relatively larger degree in Brazil than, for example, in the United States where freezing is the customary method. Dried beef (xarque) takes up large amounts of salt and is a carryover from former days when it was the most practical method of conserving and transporting meat. Pickling in brine is also quite common.

Salt as a food for animals is another application for this mineral and in Brazil, it is estimated that one head of cattle requires a normal ration of 60 grams daily which for the total herd of Brazil approximates 750,000 tons annually. For purposes of fattening the ideal daily consumption rate is established as being 80 to 150 grams per cattle. Hogs normally require 30 to 60 grams, horses and mules 30 grams and sheep 1.5 to 2 grams.

Among world producers, Brazil occupies tenth place in importance. The United States is the largest producer and is followed by Russia and Germany. In fourth place is China. The exports of Brazil are still of a small magnitude as compared to the leaders Germany, China and Manchukuo and in

world standings is of insignificance as yet. The largest world importer is Japan, her imports being nearly four times that of the second largest Belgium.

For over a decade, the Brazilian production of salt varied within the limits of 280,000 tons and 500,000 tons beginning in 1925 and ending in 1936. From 1937 however, there is a noticeable trend towards an increase and from the average of 358,900 tons up to that year, there is a 115% increase to 770,403 metric tons in the following year and another in 1938 to 788,218 metric tons. During 1939, there was a decided fall in output evidenced due to the adoption of control by the Instituto Nacional do Sal which fixed quotas. In 1939, the output fell to 502,202 metric tons, nearly 38% less than that of the previous year.

Salt is found in nearly all states of the Union, either as rocksalt or the evaporated product. In many regions, particularly in the Northeast along the river banks, it is not uncommon to find protruding lumps of rocksalt which are known locally as *lambedores* and upon which animals feed.

Production of salt, however, is limited to 11 states, all of which lie long the coast. Of these, Rio Grande do Norte produces 63% of the total while second in importance is Estado do Rio which contributes with 17% of the total. Sergipe, Ceará, Maranhão and Baía are of secondary importance as will be noted in Table 14 and represent 7%, 7%, 3% and 2% of the total respectively.

SALT

Table 14 PRODUCTION OF BRAZIL BY STATES IN METRIC TONS.

STATES		1931-1935	1936	1937	1938	1939
R. G. do Norte		305,209	306,640	510,593	549,494	336,826
Estado do Rio		33,714	120,517	47,498	82,793	75,585
Ceará		12,882	22,500	48,031	42,756	34,915
Sergipe		19,642	29,772	63,030	38,262	25,208
Maranhão		6,781	7,968	15,786	18,145	11,733
Baia		5,917	2,955	10,068	9,458	7,705
Pernambuco		60	300	2,366	4,757	2,965
Piaui		—	—	6,091	5,000	4,138
Paraiba		279	2,518	4,044	3,057	2,212
Alagoas		84	949	1,206	1,086	800
Espirito Santo		—	—	—	63	115
TOTAL:	Tons	384,568	494,119	708,714	754,871	502,202
	Contos	5,453	10,871	15,592	49,861	32,890

It will be observed that the Northeast of Brazil produces about 80% of the total which is explained by the constant winds which blow over the region, the low rainfall period of four months and the small capital outlay necessary in this enterprise. Within this semi-arid belt, the rainfall in the stretch of coast which extends from Aracatí in the state of Ceará to Macau in Rio Grande do Norte is the lowest in all Brazil. This zone produces 51% of the total of the country. These localities, in addition, are favored by the highly indented seaboard which actually is a low lying coast with a tidal river system concentrating

on the Mossoro, Piranhas and the Jaguaribe Rivers which at their lower course dry up a larger part of the year.

The salt industry in Estado do Rio is concentrated about the Araruama Lagoon which is on the leeward side (to the prevailing winds) of the mountains to the North. With regard to topography the fact that it is a lagoon is self-explanatory, it being of interest to note in this connection there are no rivers of heavy discharge or of any exceptional length emptying into this lagoon. The production of this area amounts to 17% of the total, or in other words, amounts to the total of Estado do Rio.

The other producing zones are of slight importance and with the exception of Camocim in the state of Ceará (14,000 tons) and Socorro (near Aracajú) in the state of Sergipe (13,000 tons), production is less than 10,000 metric tons in the others.

The salt pans in the state of Rio Grande do Norte alone cover an area of about 4,800,000 square meters, an area capable of producing 720,000 metric tons annually which is about 200,000 tons more than the average consumption of this country. The capacity of Araruama Lagoon in Estado do Rio is estimated to be 140,000 metric tons, the crystallization area of Cabo Frio being 9,830,000 square meters, that of Araruama 6,170,000 and the São Pedro da Aldeia pans about 2,530,000 square meters.

There is considerable coastwise trade in this product the total being about 70% of the total national output, the larger part of which moves from the semi-arid Northeast to the densely populated regions of the Southeast and the pastoral states in the South.

Salt exports from Brazil reached their all-time high in 1934 when they totalled 10,199 metric tons or 3% of the total production. The average for the decade from 1920 to 1929 was 55 metric tons as compared to the 1930-4 quinquennium when it was it was 2,910 metric tons.

It may be mentioned that exports in these fifteen years have been exceedingly irregular while in the 1935-9 five year period, there is noticeable a relative steadying of shipments but nevertheless a distinct trend towards an increase, the average having been 208 metric tons, rising from the 23 metric tons of 1935 to the 447 metric tons of 1939. Shipments in 1940 totalled 433 metric tons a decrease of 2% over the previous year. Coinciding with this movement is the consolidation of the market to two countries, Bolivia and Colombia, the latter purchasing larger amounts in the earlier years (except 1936) and the former being the leading markets in 1939 and 1940. In the latter year, Bolivia purchased 350 metric tons of the total while Colombia took the remaining 83 metric tons. The respective amounts in 1939 were 391 metric tons and 56 metric tons.

The largest imports into Brazil were in 1925 when they amounted to 126,041 metric tons there being an irregular tapering off of imports to 48,611 metric tons until 1930 and a sudden drop to 10,000 metric tons in the next two years. Since then the imports have never exceeded 2,783 metric tons (1936).

The average during the 1920-9 period was 65,700 metric tons, that of the 1930-4 period 22,870 metric tons and the 1935-9 period, 1,040 metric tons. In 1940, the imports totalled 67 metric tons 37 metric tons of which was salt for industrial applications while 30 metric tons was table salt. In the previous year, the former amounted to 95 metric tons and the latter 46 metric tons.

Pertinent to these changes are the export and import prices of the various types of salt. The export price (FOB Brazil) in 1939 was 452 milreis per metric ton while the import price (CIF Brazil) of the industrial salt was 366 milreis and that of table salt 1,038 milreis. In 1940, the corresponding prices were 394 milreis, 593 milreis and 1,178 milreis.

Although it is difficult to completely trace down the imports of products made from salt, it is of interest to point out two of some importance, soda ash and caustic soda, the first because it comprises the largest mineral salt import and the latter because of the presence of one plant in Brazil, the plans to construct another and the large annual demand in Brazil which continues to be filled from overseas sources in preference to its manufacture domestically despite the presence of abundant raw material. In 1940, the imports of soda ash amounted to 23,378 metric tons valued at 17,736 contos while that of caustic soda amounted to 31,515 metric tons valued at 48,007 contos. Domestic production of the latter amounts approximately to 1,500 tons annually.

17. SEMI-PRECIOUS STONES

GENERAL SURVEY

The use of semi-precious stones dates back to the days of Babylon, their most important use at the time being for the manufacture of seals. Some by their appearance were credited with having medicinal or magic powers. Today, practically the only use is for adornment and ornamentation.

The characteristics of a gem are: beauty or splendor, durability (depending principally on the hardness of the stone), rarity, fashion (temporary and variable) and portability.

The first of these qualities is brought out by cutting which may be faceted, or by engraving, which may be in cameo, or carved or curvette. The principal lapidary center for colored gems is Idar-Oberstein, Germany. In Brazil colored stones are lapidated in Belo Horizonte (Minas Gerais) and in Rio de Janeiro.

No satisfactory studies have been made on this subject, the interested parties limiting themselves only to rudimentary and superficial workings of the deposits. Gems are sometimes discovered accidentally in the search for other useful minerals. During the past two centuries, Brazil has produced a number of colored stones, principally beryls and tourmalines, the production of which though not very significant, still continues.

The gem trade operated, until a few years ago, under complete freedom and for this reason, no statistical data as to turnover or production are

available. Lately control has been extended over this industry, both in the industrial and commercial aspects.

The *Casa da Moeda* estimates the production of uncut semi-precious stones as having totalled 641,412 grams in 1937 with a value of 1,795 contos while that for 1938 decreased to 577,928 grams valued at 3,614 contos. It is only in 1939 that there is data available as to output of the other types of stones, that of uncut semi-precious stones being 1,563,833 grams in this year, nearly 170% more than that of 1938 but only 83% of the value. The production of lapidated semi-precious stones is noted as being 4,874 grams during 1939 with a total value of 107 contos. Agate production totalled 1,473 grams and was valued at 9 contos de reis. The least important, that of rose quartz, totalled but 300 grams and a value of 3 contos.

Exports of semi-precious stones as noted in Table 1 amounted to 3,431 contos in 1938, and decreased in 1939 to 2,007 contos. It may be noted that in 1939, the principal markets for aquamarines which was the most important export product of this group (1,663 contos) was Germany, the United States being secondarily important. The 170 contos of tourmalines shipped abroad were sold principally in the German market. Amethyst shipments valued at 129 contos were exported principally to Germany and the United States the former taking 124 contos and the latter 5 contos.

In 1940, the shipments of these stones increased to more than seven times that of the previous year totalling 15,453 contos. Of this total, aquamarines accounted for 13,469 contos or 87%, the principal market being Germany which purchased 12,766 contos of this total. Tourmaline was again the second largest amounting to 1,281 contos. The markets for this stone were Germany, the United States, Switzerland and Peru. Contrary to other years, the third largest in 1940 was topaz which in total amounted to 197 contos while the fourth was amethyst which totalled 195 contos. Topazes are shipped chiefly to Germany while the latter, amethysts, are sold principally to Japan, Germany and the United States.

There are no recorded imports of semi-precious stones.

GARNETS

The garnets are silicates of aluminum, iron, calcium, magnesium, manganese, and chromium. Their hardness ranges from 6.5 to 7.5, their density, from 3.15 to 4.30 and the index of refraction, between 1.70 and 1.94. It occurs in crystals in the form of rhomboids. decahedrons or tetragonal trioctahedrons. The color varies from ruby-red to blood-red, from light brown to almost black, from a honey color to gray-brown and may appear in various shades of green. The most common varieties found in Brazil are almandite (Al and Fe), pyrope (Mg and Al), spessartite (Al and Mn) and grossularite

(Al and Ca). The Brazilian garnet is very rarely used as a gem. Certain regions in the southern part of Minas Gerais, in the Northeast (Paraíba and Rio Grande do Norte) and along the coast of Baía and Espirito Santo, have sold almandite for use as abrasives.

Almandite appears generally in mica schists and gneisses and in their alluviums. Pyropes are found in the alluviums of the Triangulo Mineiro (western Minas Gerais). Spessarite is found in the region of Lafayete in Minas Gerais.

TOPAZES

This is a fluorine aluminum silicate of hardness 8, density of 3.4 to 3.6 and average index of refraction of 1.162. It occurs principally in prisms and is colorless or wine-yellow, blue or pink.

The most valuable is the topazine colored stone and at times, is priced from 10 milreis to 300 milreis a carat. In Brazil it is found in Ouro Preto, Rodrigo Silva, Dom Bosco and in Salinas all in the state of Minas Gerais.

Minas Novas, also in the state of Minas Gerais produces blue topazes, as does Teofilo Otoni. Salinas and Teofilo Otoni produce hyaline or transparent topazes. Blue or rose topazes vary between 10 milreis and 400 milreis a carat in price, and the hyaline, between 10 and 25 milreis.

In Serra das Eguas and Ituassú (Baía) the topaz is found sporadically associated with the emerald.

TOURMALINES

This is another stone which has brought fame to the northeastern part of Minas Gerais. It is an aluminum borosilicate of green, red, black or sapphire blue color. Its hardness varies from 7.0 to 7.5 and its density from 2.98 to 3.25. The average refraction index is 1.63. It occurs in short or elongated prisms, sometimes of two colors, red in the center and green outside.

In Minas Gerais, the tourmaline is found in Salinas, Arassuaí, Teofilo Otoni, Itamarandiba, Minas Novas, Lajão, etc., associated with quartz in veins of pegmatite. In other states it is found in the same places as beryls but is rarely fit to be used as a gem.

In 1940, tourmalines were priced at 3,000 milreis per kilogram.

BERYLS

This stone has been included in the section relative to *Berryllium* in the chapter on *Metallic Minerals.*

SEMI-PRECIOUS STONES

Table 15 CHARACTERISTICS AND LOCATION OF BRAZILIAN STONES

STONE	COLOR	Hardness	Specific Gravity	Refraction Index	LOCATION
Agate	varied	—	—	—	All states from Goiaz to Rio Grande do Sul. Triangle Mineiro and Paranaiba Basin (Minas Gerais). Livramento, Passo Fundo, Tres Cruzes, Caxias, Alegrete, Don Pedrito, Quaraim, Rio Pardo, Santa Maria, São Borja, São Gabriel, Soledade, Uruguaiana, Rio Taquarí and Camaquan (Rio Grande do Sul).
Amazonite	Emerald-green	6	2.6	1.525	Ferros, Serro, Itabira, Rio Piracicaba and São Domingos do Prata (Minas Gerais).
Amethyst	purple	—	—	—	Arassuaí, Minas Novas, Grão Mogol, Teofilo Otoni, Diamantina, Salinas, Lafaiete, Mar de Espanha, Rio Preto, Andrelandia, Aiuruoca and Rio Pardo (Minas Gerais). Caitité, Mundo Novo, Condeubas, Brejo Grande, Ituassú, Serra do Trombador, Umburanas, Duas Barras, Riacho de Santana, Macaubas, Minas do Rio das Contas, Morro do Chapéu, Monte Alto, Jacobina, Conquista, Brumado, Urubú and São Francisco River (Baía). Taquarí River, Livramento, Quaraim, São Borja, Soledade and São Gabriel, (Rio Grande do Sul). Itabapoana Matilde, Soturno and vicinity of Vitoria (Espirito Santo). Cristalina (Goiaz). Barbalha and Canindé (Ceará). Coimbra, Cuiabá River, Corpó River, tributary of Manso River (Mato Grosso).
"Anatasio"	yellow blue grayish-brown	5.5-6.0	3.8-3.95	2.5	Found with diamonds in Minas Gerais, Baía, Goiaz and Mato Grosso.
Andalusite	gray green greenish-yellow grayish-brown pink red violet	7.0-7.5	3.1-3.2	1.64	Minas Novas, Diamantina. Arassuai and Teofilo Otoni (Minas Gerais). Botucatú, Iguape, Serra do Itaquí and Pedro Cubas São Paulo). Parelhas (Rio Grande do Norte).
Chalcedony:					
Bloodstone	dark green with red stains	7	2.6	1.533	Amargosa (Baía). Santa Luzia (Paraíba)

SEMI-PRECIOUS STONES — (Continuation)

STONE	COLOR	Hardness	Specific Gravity	Refraction Index	LOCATION
Chalcedony: (cont.)					
Chrysoprase	white gray brown or blue	7	2.6	1.533	Found in all states
Chalcedony	apple-green	7	2.6	1.533	Found in all states
Jasper	opaque red brown dark red grayish-blue	7	2.6	1.533	Livramento and Santa Luzia (Minas Gerais). Santa Luzia, Paraíba do Norte and Petropolis (E. do Rio). Paranaíba, Araguaia and Grande Rivers. States of Rio Grande do Sul, Santa Catarina and Paraná.
Onyx	parallel streaks of varied colors	7	2.6	1.533	—
Plasma	clear to dark green	7	2.6	1.533	—
Touchstone	velvety black	7	2.6	1.533	—
Chrysoberyl	yellowish-green	8.5	3.65-3.78	1.75	Minas Novas, Arassuaí, Teófilo Otoni, Suassuí, Serro and Cuieté (Minas Gerais). Colatina (Espírito Santo). Sapucaí (São Paulo). Bandeira de Mélo, Lençóis and Camassarí (Baía). Rio Claro (Goiaz). Rio Coxim (Mato Grosso).
"Crisocola"	blue	2-4	2-2.2	1.50	States of Baía and Piauí.
Cyanite	light blue	4-7	3.6	1.721	Andrélandia, Diamantina - (Minas Gerais). Minas de Rio das Contas (Baía).
Danburite	—	7	3	1.63	Serra das Eguas (Baía).
Euclase	colorless pale green blue	7.5	3.1	1.65	Ouro Preto (Minas Gerais). Lençóis (Baía).
Hematite	blood red	6	5	High	States of Minas Gerais, Baía, Goiaz, Paraíba and Mato Grosso.
Lazulite	azure-blue	5.5-6	3	1.63	Diamantina, Serro, Santa Rita and Burití do Claudio (Minas Gerais).
Malachite	emerald green	3.5	3.7-4	1.81	States of Rio Grande do Sul, Minas Gerais, Baía, Paraiba and Ceará.
Nephrite (Jade)	green	6-6.5	3	1.62	Basins of the tributaries of the Rio Branco and others of the Amazon River. Olinda (Pernambuco). Amargosa, Campo Formoso, Conquista and Lençóis - (Baía). Ouro Preto (Minas Gerais). Cabo Frio (Estado do Rio).

SEMI-PRECIOUS STONES — (Continuation)

STONE	COLOR	Hardness	Specific Gravity	Refraction Index	LOCATION
Olivine	yellow	6.5-7	3.2-3.4	1.57	Minas Novas and Conceição (Minas Gerais).
Opal	blue gray green black yellow orange red	5.5-6.5	1.95-2.3	1.45	States of Goiaz, Rio Grande do Sul, Paraná, Minas Gerais, Espírito Santo, Baía and Mato Grosso.
Phenacite	pale blue pink	8	3	1.66	São Miguel de Piracicaba (Minas Gerais).
Quartz:					
Citrine ..... ("False Topaz") ("Baía Topaz")	yellow	7	2.65	1.55	Cristalina (Goiaz). Salinas and Sete Lagoas - (Minas Gerais). Saiobro (Baía). Afonso Claudio (Espírito Santo).
Green (Prase)	green	—	—	—	Picuí and Soledade (Paraíba). Rio Grande do Norte. Joazeiro, Queimados and Brejão (Baía). Bom Despacho (Minas Gerais).
Rose	rose	—	—	—	Joiama, S. Miguel do Jequitinhonha, Arassuaí, Teófilo Otoni, Rio Pardo, Serro and Peçanha (Minas Gerais). Castro Alves, Rio Pardo, Jaguararí, Bomfim and Minas do Rio das Contas (Baía). Picuí, Soledade and Pedra Lavrada (Paraíba). Crateus (Ceará). Itajaí (Santa Catarina).
Smoky	smoky to dark yellow	—	—	—	Northeastern section of Minas Gerais. With rock crystal in Goiaz, Baía and Minas Gerais. Quilombo River (Mato Grosso). Pedra Branca (Espírito Santo).
Rhodonite	pale red	5.5-6.5	3.6	1.73	Morro de Minas (Minas Gerais).
Scapolite (Wernerite)	yellow	6-6.5	2.7	1.56	Itaguassú (Espírito Santo). Patos (Paraíba). States of Rio Grande do Norte and Ceará.
Serpentine	green	2.5-4	2.5-2.8	1.50-1.55	Jacuí, Bom Sucesso, Serro and S. Domingos do Prata (Minas Gerais). Brejo dos Santos and São Francisco (Ceará).
Spinel	red gree yel	8	3.5-4.1	1.72	Faria Lemos, and Minas Novas (Minas Gerais). Rio Paraguassú (Baía). Sacramento (São Paulo). Encruzilhada (Rio Grande do Sul).

SEMI-PRECIOUS STONES (Continuation)

STONE	COLOR	Hardness	Specific Gravity	Refraction Index	LOCATION
Spodumene:					
Hiddenite and Kunzite	yellow green emerald green pink	6-7	3.1-3.2	1.67	Minas Novas, Teófilo Otoni, Arassauí, Bôa Vista, Jequitinhonha, Peçanha, Cuieté, Alto Rio Doce, Lajão and Governador Valadares (Minas Gerais). Paraguassú River (Baía). State of Espírito Santo.
Staurolite	dark brown	7-7.5	3.4-3.8	1.74	In mica schists of S. Paulo, Minas Gerais, Goiaz, Baía, Paraíba and Ceará.
Rutile	transparent	6-6.5	4.2-4.3	2.6-2.9	Andrelandia, Bom Jardim, Livramento, São Tomé das Letras, Aiuruoca, Caxambú and Araxá (Minas Gerais). Pirenopolis, Corumbá, Anapolis, Bomfim, Ipameri, Caldas, Campo Formoso, Pouso Alto and Morrinhos (Goiaz). Iguape (São Paulo). Iguatú (Ceará). States of Mato Grosso and Baía.
Turquoise	blue	6	2.7	1.63	Joazeiro (Baía). Juquiá (São Paulo).
Zircon	blue brown yellow green	7.5	4-4.8	1.92-1.97	Coast of the states of Baía and Espírito Santo. Poços de Caldas and the northeast zone of the state of Minas Gerais. Tibagí River (Paraná). Patrocínio do Sapucaí (São Paulo). Diamond sands and gravels of Baía, Minas Gerais, Goiaz and Mato Grosso.

18. TALC AND SOAPSTONE

TALC

Talc is used principally in the paint industry while the ceramics industry also absorbs relatively large quantities. Other minor applications are in the rubber, roofing paper and toilet preparations industry. In Brazil, the main uses are in the paint and toilet preparations industries.

The leading world producer of this mineral is the United States. France and China are also important producers as is Italy. Due to the absence of complete figures as to the production of Brazil, the insertion of the output of the state of Minas Gerais in world data places Brazil as the 14th most important in the world.

Manchukuo and Norway are the principal world exporters while Japan, England and the United States are the leading importers.

It is common to find talc in the rocks of the *Minas Series* in the state of Minas Gerais, the producing municipalities being Pará de Minas and Ouro Preto.

In 1937, Minas Gerais produced 1,730 metric tons of talc of which the municipality of Pará de Minas accounted for 1,500 tons. The second largest was Ouro Preto which produced 230 metric tons. There were nine firms engaged in the industry, seven in Ouro Preto and two in Pará de Minas, employing 37 persons and operating with a capital investment of 40 contos.[1] The output for 1938 declined to 1.130 metric tons while that for 1939 rose 26% attain 1,428 metric tons. The 1940 output is estimated at 1,500 metric tons.

There is a deposit in Rezende in Estado do Rio which is found associated with kaolin. It has been worked for some years and contains a refining and pulverizing plant. The product was formerly sold in the state of Rio Grande do Sul for the polishing of rice. In some regions of this section, there are talc deposits with small sheets of mica which make it unfit for use in the manufacture of talcum powder.

Talc exports have been exceedingly irregular and infrequent the largest in the last twenty odd years being that of 1920 which totalled 1,000 kilograms. The next shipment was made in 1924 and amounted to 124 kilograms being followed in the succeeding year by an export of 158 kilograms. It is only in 1936 that the next shipment is recorded having been for 101 kilograms. The following export was in 1939 and amounted to but 50 kilograms. There were no shipments in 1940.

Despite the domestic production and exports, talc imports continue and are recorded separately in official statistics since 1937 in which year they amounted to 541,621 kilograms, the principal sources being China, Japan and Italy. The 1938 overseas purchases totalled 394,563 kilograms while that for 1939 was 475,665 kilograms. In 1940, the imports declined to 301,185 kilograms the principal source in this year being Japan.

The mine price of talc in 1940 was 100 milreis per metric ton while that of imports was 825 milreis CIF Brazil.

SOAPSTONE

The principal application of soapstone is in the ceramic and structural materials industries.

In Brazil, there are a variety of uses, one of the earliest being of interest because of its peculiarity that in the construction of small furnaces for iron. However, its present day uses are in structural work in the interior of buildings, tombs, etc., and more recently in the textile industry as a finisher.

Production data on this mineral is unavailable although it is known that there is a considerable amount produced in Pará de Minas which is near the State Capital and which is sold in Rio de Janeiro. Some samples of this

mineral which is known locally as *agalmatolito* were sent to Germany for tests and aroused great interest, inasmuch as its property of insulation under humid conditions could make it applicable for special uses in the electrical field. There are some occurrences at Oliveira in the western section of Minas Gerais also.

Other soapstone occurrences of some importance are known to exist in the states of Goiaz, Baía and Ceará.

No exports or imports of this mineral are recorded in official statistics.

The mine price of the mineral in 1940 was 100 milreis per metric ton.

MINERALS OF THE STATE OF MINAS GERAIS

Table 16 PRODUCTION, VALUE AND UNIT PRICE FROM 1936 TO 1940

MINERALS	UNIT	YEARS	QUANTITY	MILREIS	
				Per Unit	TOTAL
Arsenic, white	Kgs.	1936	731,806	2.5	1,824,223
		1937	716,971	2.5	1,792,428
		1938	519,403	2.3	1,177,701
		1939	712,925	2.4	1,693,281
		1940	1,080,000	2.4	2,611,200
Asbestos	Kgs.	1936	190,000	0.4	76,000
		1937	105,200	0.6	63,120
		1938	314,280	0.6	188,568
		1939	608,610	0.6	365,166
		1940	500,000	0.6	300,000
Barite	Kgs.	1936	800,000	0.2	160,000
		1937	676,000	0.2	135,200
		1938	668,500	0.3	218,690
		1939	690,000	0.5	345,000
		1940	700,000	0.5	350,000
Bauxite	Tons.	1936	4,000	200.0	800,000
		1937	7,000	200.0	1,400,000
		1938	14,374	80.0	1,149,920
		1939	9,012	80.0	721,360
		1940	10,000	80.0	800,000
Beryllium (ore)	Tons.	1936	10	300.0	3,000
		1937	25	300.0	7,500
		1938	25	300.0	7,500
		1939	...	...	...
		1940	...	...	...
Building sand, stones, gravel, etc.	Tons.	1936	890,000	10.5	9,350,000
		1937	1,088,436	11.1	12,105,702
		1938	1,104,575	13.3	14,730,700
		1939	1,193,978	13.3	16,163,960
		1940	1,200,000	13.3	15,960,000
Calcium carbide	Kgs.	1936	3,924,000	0.9	3,531,600
		1937	5,937,363	1.0	5,879,989
		1938	5,800,300	0.7	4,060,210
		1939	3,477,850	0.7	2,434,950
		1940	3,500,000	0.7	2,450,000
Cement	Kgs.	1939	37,944,379	0.2	7,874,421
		1940	40,000,000	0.2	8,400,000
Clay, refractory	Kgs.	1936	3,200,000	0.1	160,000
		1937	3,500,000	0.1	175,000
		1938	3,600,000	0.1	360,000
		1939	...	...	...
		1940	...	...	...
Columbite	Kgs.	1937	8,200	20.0	164,000
		1938	210,518	15.5	3,258,618
		1939	4,982	16.8	83,676
		1940	5,000	17.0	85,000

MINERALS OF THE STATE OF MINAS GERAIS (Continuation)

MINERALS	UNIT	YEARS	QUANTITY	MILREIS Per Unit	MILREIS TOTAL
Dolomite	Tons.	1937	900	70.0	63,000
		1938	860	100.0	86,000
		1939	...	...	...
		1940	...	...	...
Feldspar	Tons.	1936	200	76.0	15,200
		1937	27	76.0	2,052
		1938	40	80.0	3,200
		1939	...	...	...
		1940	...	...	...
Ferro-nickel	Tons.	1937	10	2.400.0	24,000
		1938	10	2.400.0	24,000
		1939	9	2.400.0	21,600
		1940	10	2.400.0	24,000
Gold	Grams	1936	4,816,789	18.6	89,835,285
		1937	5,380,797	19.0	102,235,143
		1938	5,657,253	21.5	121,457,712
		1939	6,024,476	22.7	136,939,328
		1940	6,100,000	22.7	138,600,000
Graphite	Kgs.	1936	4,800,000	0.2	960,000
		1937	27,300	0.2	5,460
		1938	115,000	0.1	14,950
		1939	...	...	...
		1940	...	...	...
Iron and steel:					
Iron ore	Tons.	1936	154,900	40.0	6,196,000
		1937	338,700	60.0	20,322,000
		1938	982,387	30.1	29,548,110
		1939	745,630	30.0	22,368,900
		1940	740,000	30.0	22,500,000
Ferro-manganese	Tons.	1939	1,060	900.0	954,000
		1940	1,500	900.0	1,350,000
Ferro-silicon	Kgs.	1936	—	—	—
		1937	55,360	2.5	138,400
		1938	676,210	0.8	540,968
		1939	159,350	0.8	127,480
		1940	160,000	0.8	128,000
Pigs	Tons.	1936	78,986	300.5	23,734,661
		1937	98,107	400.2	39,262,800
		1938	113,478	400.0	45,391,200
		1939	143,604	373.5	53,636,715
		1940	160,006	373.6	59,776,000
Rolled	Tons.	1936	28,886	928.7	26,840,000
		1937	30,339	1.160.0	35,193,240
		1938	35,125	1.173.0	41,201,625
		1939	40,787	1.180.0	48,128,660
		1940	50,000	1.150.0	57,500,000
Steel	Tons.	1936	30,811	664.5	20,473,000
		1937	31,005	780.0	24,183,900
		1938	40,702	780.0	31,747,560
		1939	59,901	807.4	48,363,150
		1940	65,000	963.8	62,650,000
Kaolin	Kgs.	1936	3,770,000	0.2	754,000
		1937	3,701,000	0.2	740,200
		1938	17,395,130	0.3	5,218,539
		1939	18,496,200	0.3	5,548,860
		1940	15,000,000	0.3	4,500,000
Lime and limestone	Kgs.	1936	114,160,500	0.1	11,418,050
		1937	175,534,000	0.1	20,763,200
		1938	173,159,400	0.1	20,582,684
		1939	150,685,400	0.1	20,379,335
		1940	155,000,000	0.1	23,250,000

MINERALS OF THE STATE OF MINAS GERAIS (Continuation)

MINERALS	UNIT	YEARS	QUANTITY	MILREIS	
				Per Unit	TOTAL
Manganese (ore)	Tons.	1936	216,472	80.0	17,317,760
		1937	262,409	100.0	26,240,900
		1938	306,025	100.0	30,602,500
		1939	255,147	100.0	25,514,700
		1940	260,000	100.0	26,000,000
Marble	Tons.	1936	20,450	120.0	2,454,000
		1937	10,940	125.0	1,367,500
		1938	7,400	160.0	1,184,000
		1939	6,760	160.0	1,081,600
		1940	7,000	160.0	1,120,000
Mica	Kgs.	1936	368,100	15.0	5,521,500
		1937	568,176	20.0	11,363,520
		1938	874,622	20.0	17,492,440
		1939	998,415	20.0	19,968,300
		1940	1,200,000	20.0	24,000,000
Mineral waters	Cases	1936	247,695	32.4	8,036,647
		1937	262,164	32.2	8,443,412
		1938	266,139	34.6	9,198,295
		1939	286,317	38.4	10,999,429
		1940	290,000	38.5	11,165,000
Nickel (ore)	Tons.	1936	3,950	74.0	292,300
		1937	9,100	100.0	910,000
		1938	9,100	100.0	910,000
		1939	...	...	...
		1940	...	...	...
Ochres	Kgs.	1936	2,827,300	0.3	925,480
		1937	5,005,650	0.3	1,501,695
		1938	4,427,500	0.3	1,328,250
		1939	6,128,400	0.3	1,838,520
		1940	6,200,000	0.3	1,860,000
Precious and semi-precious stones:					
Amethyst	Grams	1936	60,000	2.0	120,000
		1937	9,000	2.0	18,000
		1938	5,024	2.0	10,048
		1939	10,000	2.0	20,000
		1940	12,000	2.0	24,000
Aquamarines and tourmalines	Grams	1936	1,447,100	5.6	8,064,200
		1937	775,050	7.5	5,848,200
		1938	674,000	7.2	4,831,000
		1939	790,700	10.0	7,907,000
		1940	1,000,000	15.0	15,000,000
Diamonds	Grams	1936	24,367	1.209.9	29,240,400
		1937	25,330	1.500.0	37,995,000
		1938	23,814	1.456.0	34,696,500
		1939	29,887	1.500.0	44,830,500
		1940	30,000	1.500.0	45,000,000
Not specified	Grams	1936	60,800	5.0	304,000
		1937	23,100	5.0	415.500
		1938	8,099	1.4	11,578
		1939	9,560	1.5	14,340
		1940	10,000	1.5	15,000
Pyrites	Tons.	1936	2,500	150.0	375,000
		1937	3,000	200.0	600,000
		1938	2,526	200.0	505,200
		1939	2,000	200.0	400,000
		1940	2,500	200.0	500,000
Rock crystal	Kgs.	1936	196,400	10.0	1,964,000
		1937	206,640	10.0	2,066,400
		1938	368,850	16.9	6,218,440
		1939	583,525	45.0	26,256,625
		1940	650,000	45.0	29,250,000

MINERALS OF THE STATE OF MINAS GERAIS (Continuation)

MINERALS	UNIT	YEARS	QUANTITY	MILREIS	
				Per Unit	TOTAL
Rutile	Kgs.	1936	...	...	...
		1937	133,000	1.0	133,000
		1938	208,232	1.0	208,232
		1939	317,800	1.0	317,800
		1940	320,000	1.0	320,000
Silver	Grams	1936	742,903	0.2	155,055
		1937	744,676	0.2	175,002
		1938	770,323	0.2	194,892
		1939	833,970	0.2	190,505
		1940	840,000	0.2	193,200
Talc	Kgs.	1936	980,000	0.1	98,000
		1937	1,730,000	0.1	173,000
		1938	1,130,000	0.1	113,000
		1939	1,428,000	0.1	142,800
		1940	1,500,000	0.1	150,000
Zircon	Kgs.	1936	177,110	0.2	35,422
		1937	850,000	0.2	170,000
		1938	410,000	0.2	82,000
		1939	750,000	0.2	150,000
		1940	...	...	2,000,000
Others	—	1936	—	—	2,240,000
		1937	—	—	2,530,219
		1938	—	—	1,776,800
		1939	—	—	1,850,000
		1940	—	—	2,000,000
TOTAL:	—	1936	—	—	273,322,783
		1937	—	—	364,704,982
		1938	—	—	430,472,830
		1939	—	—	507,784,551
		1940	—	—	558,164,400

NOTE: The above statistics are those furnished by the Departamento Estadual de Estatistica of the State of Minas Gerais and do not in all cases conform with those furnished by the Ministry of Agriculture of the Federal Government.

BUILDING MATERIALS

1. GENERAL SURVEY

Activity in the building materials industry as it pertains to mining depends almost wholly upon domestic construction trends since exports represent an infinitesmal portion of the output. It is also the one branch of the minerals industry in which Brazil has reached, practically speaking, self-sufficiency as to supplies, the few imports remaining being capable of substitution with domestic products which have been unutilized as yet or are worked on a small scale.

In 1913, the imports of building materials totalled over 540,000 tons while in contrast, in 1940, they amounted to but 29,900 tons a decrease of about 94% while in addition there was a slight but significant increase in exports from 60 to 1,100 tons.

However, the attainment of a state of self-sufficiency with demand at a standstill would be practically meaningless. In Brazil, the increase was accomplished despite the extensive public works, the construction of roadways, and the building activity particularly evident after the initiation of the Vargas Administration. Less apparent is the increasing use of ornamental tiles and marble which has opened new fields for domestic industry and made heavy demands upon the refractory clay industries and the quarriers of marble. With regard to the latter product, it may be noted that production during the last three years has increased sensibly over previous years.

There are many conditional elements which govern the demand for the group of minerals which necessitates a light survey of the building conditions in the country. The first is the fact that about 80% of the country is within the tropical or sub-tropical zones and thus demands a differing building construction. Clay, brick or their combinations, and lately, stucco buildings are preferred over the wooden structures. Humble or presumptious as they may be, houses are usually constructed of these materials in preferenc to wood. It will also be noted that white is a predominating color due to the lower heat absorp-

tion factor of the color giving rise to the extensive use of kalsomine in the interior regions.

The traveller will also observe the widespread use of stone walls and the decorative mosaic walks constructed of black and white stone known the world over for their beauty of design and intricate combinations which to the responsible governments represents considerable savings in the frequent pipe-layings which may be necessary after the construction of the walk due to the fact that it merely requires the unloosening and subsequent replacing of the same small cubes of stone.

Red clay roofs are commonplace while roofing materials such as asphaltic cement and asbestos tile, are conspicuous by their absence.

Building interiors vary little in their historical evolution as compared to other progressive countries although, to some extent, the colonial glazed tiles retain their traditional importance in some of the newer structures. As is true of the homes and buildings; the construction of which dates back decades, the present structures may be said to also favor the use of window glass to a greater degree than is common in the Northern Hemisphere, particularly is this true of the multiple story buildings.

Asphalt, macadam and cement roads are common in the urban centers while the cobblestone pavement is gradually disappearing. In the rural centers, improved packed dirt roads are the rule while the practice is to favor the construction of cement highways in the important newly established connecting links. Public works are concentrated on two significant programs one of which is in the semi-arid Northeast and involves principally the construction of dams or irrigation projects and the second, the Baixada (lowlands) Fluminense which is a sanitation and drainage project. Bridge-building across the many rivers in Brazil which form part of the extensive highway construction program is another highlight in this industry.

Supplying these domestic needs are first, the cement industry which, as noted in the section on this product, has, practically speaking, reached the stage of self-sufficiency. There is in the second place the gypsum industry which must rely on imports to some extent, this being particularly true of the alabasters, plasters and chalks.

The production of tiles and bricks in Brazil is a traditional industry and is a characteristic feature of any compact population group, large or small, due to the abundance of red clay and firewood from the densely wooded groves which are common in most all parts of Brazil and, also due to the suitability of this material for Brazilian structures. Production exceeds domestic demands and exports amount to nearly 700 tons annually the only imports being that of decorative tile which amounted to 70 tons in 1940.

The lime industry, as mentioned in the chapter devoted to that product, is nation-wide in scope and supplies a large part of the domestic demand. The same may be said of the marble industry which despite the imports which are due to the peculiarities of the industry rather than any particular lack of

output, that is to say, combinations of colors, is one of the newer and important activities, principally with the rapidly increasing trends toward multiple story structures in the urban centers. Granite is supplied by the abundant domestic sources.

Probably the weakest element in the building materials industry is that of window glass. This is borne out by the continued large imports without an appreciable increase in domestic production. Despite the production of finer glass for the manufacture of ampoules, technical and laboratory equipment, glassware, etc., there is but little attention given over to that of window glass. This is said to be based on the fact that the enormous capital outlay necessary and the complementary chemical raw materials and abundant supplies of the proper type are lacking, although it is not uncommon to find foreign technicians studying the sands of the Southeast for exportation for the subsequent production of window glass.

2. ASPHALT

The principal use for asphalt is for paving roads while others of some importance are in roofing manufacture, pipe coating, moulding compounds, etc. In Brazil, the most extensive use of this material is in road construction, particularly in the urban centers.

In general, there are three sources of asphalt, that is, natural asphalt, asphalt rock and petroleum or manufactured asphalt. Trinidad is by far the predominating producer of the natural asphalt while the United States is the second largest. Leading in the world output of asphalt rock is the United States; Italy and Germany are the next largest. Although the total national production of the product is unavailable, that of one company in Brazil places this country in seventh place among world producers. Exact world data for manufactured asphalt production is difficult to obtain.

In São Paulo there are deposits at Anhembí, near Botucatu' which are being worked by the Asfalto Paulista Betumita S. A., while those of Guareí near Itapetininga are being exploited by the Cia. Itatig. The former has an estimated reserve of 775,000 tons while that of the latter is known to amount to several million tons. Production by the former company in 1936 totalled 550 metric tons, which in 1937 increased to 4,557 metric tons, fell in 1938 to 1,371 metric tons and rose again in 1939 to 2,138 metric tons. However, with the renovation and modernization of the equipment, the Asfalto Paulista Betumita Company has raised its capacity enormously and although producing an average of 500 metric tons per month now after completion of the established program, output will be increased to 3,000 metric tons per month. In addition, the Cia. Itatig is now operating and in 1940 the Brazilian output had increased to 5,489 metric tons.

The asphalt of Guareí is rich despite its abundance. There is an average of 13% bitumen with a density of 2.0 consisting of sandy silicates with 70% rounded grains which are extremely resistant. The Cia. Itatig which is

working the deposit has constructed at Ozasco, in the suburbs of São Paulo, a factory which has recently initiated operations and which will in a short time be producing about 400 metric tons of various types of these products daily.

The larger part of the deposits of the state of Baía are located in Maraú, near the city of Ilheus, and in the Santo Amaro Island in Reconcavo. It may be noted that operations for the exploitation of one of the deposits has already commenced, the exports of the product amounting to 10,000 kilograms in 1940. The shipment was made to Rio de Janeiro.

Tests of the Brazilian product, both the cold and the mastic types show that they may be applied with facility, support any type of traffic to be found within the country, are cheaper and more resistant and durable than any imported manufactured asphalt. Recently, demonstrations were given on roads in the cities of Rio de Janeiro, São Paulo and Belo Horizonte which conclusively proved the excellent qualities of this asphalt, withstanding, as it did, some of the heaviest traffic in the country.

Despite the production of asphalt within the country, imports still continue and after having reached a record high of 24,400 metric tons in 1928, overseas purchases decreased to 1,600 tons in 1932. Since that year, however, imports have once again shown a distinct tendency to increase and in 1938 rose to 11,500 tons, the highest in this decade. In 1939, there was a slight decrease to 11,000 tons while in 1940 the total was 9,700 tons. It may be noted that the average imports during the 1920-9 decade amounted to 8,100 metric tons while during the following five year period, the average decreased to 4,500 metric tons. In the 1935-9 period, the average was 10,100 metric tons. The larger part of the imports come from the United States while Trinidad which for some time was the second largest source was the third in 1940, the second being Argentina. The amounts imported from the three countries were, the United States 8,747 metric tons, Argentina 590 metric tons and Trinidad 210 metric tons. Cuba has also been of some importance as a supply center but in recent years has not shipped to this market. The constant favorable balance for Brazil in the trade with Cuba has brought about studies for the development of this trade and a suggested solution lies in the increased imports of asphalt from this source.

The price of the imported asphalt (CIF Brazil) in 1939 was 464 milreis per metric tons as compared to the local price of 99 milreis. The corresponding 1940 prices were 544 milreis for the former and 141 milreis for the latter.

3. CEMENT

The many uses of cement may be divided conveniently into five general classes, paving, housing, farm, building and construction and public works. Although there are no complete statistics on the Brazilian consumption according to these classes, it would be safe to assume that the quantitity for construction work, that is, for multiple story buildings, bridges, railways, etc., and that for public work are the largest. Paving work, though important, does not attain

the magnitudes of these two classes inasmuch as the tendency is to limit such work to urban centers while the long highways remain improved dirt roads, the problem at present being to stress quantity rather than quality in the effort to compensate the rapidly increasing needs of production throughout the country.

In 1892, there was erected, in the state of Paraíba, the first mill in Brazil which failed as did another in São Paulo in 1897 which had an annual capacity of 25,000 tons. The underlying reason for the difficulties encountered at that time were basically the cheaper price of the imported product, and the insufficient supplies of limestone with less than the critical amount of magnesia. This was also true of another mill which was established in the state of Espirito Santo just prior to the War of 1914-8.

The successful phase of this industry begins in May 1926 with the erection of the Cia. Brasileira Cimento Portland of São Paulo. The meager but significant initial output of 13,382 metric tons provided but 3% of the total domestic consumption at that time, the imports having been 396,300 metric tons. In the 15 years since that time, production has shown, with the exception of one year, an unbroken series of increased outputs to attain 743,635 metric tons in 1940. Imports over the same period, although not regularly, have shown a distinctly downward trend and in the past year totalled but 22,785 metric tons while exports in the meantime have been started since 1938 (six metric tons) and in 1940 totalled 402 metric tons. Thus, although domestic consumption is not completely filled by the national product, there is a clear trend toward that state of affairs. The principal reason for the continuation of imports is based on three factors, the need for special types of cement, the high coastwise freight rates which prohibit the competition of the domestic product in some distant non-producing states with the product imported from overseas and the large public works program which creates more-than-usual demands.

CEMENT

Table 17 PRODUCTION OF BRAZIL BY STATES IN METRIC TONS.

STATES		1935	1936	1937	1938	1939	1940
São Paulo		199,756	235,538	286,600	314,792	340,570	367,474
Estado do Rio		164,071	223,644	239,785	250,937	269,817	279,011
Minas Gerais		—	—	—	—	37,944	49,004
Paraiba		2,434	23,841	35,914	41,507	36,829	36,801
Espirito Santo		—	2,041	9,153	10,660	12,633	11,345
TOTAL:	Tons	366,261	485,064	571,452	617,896	697,795	743,635
	Contos*	75,328	105,829	125,342	138,306	159,302	183,422

As will be noted in Table 17, production has been increasing steadily in recent years, the state of São Paulo accounting for 49% of the total output in 1940 while Estado do Rio was second with 38%. Production in the latter state began in 1933 while that of the third largest producer, Minas Gerais, is relatively new having commenced operations in 1939 with an output of 37,944 metric tons. In 1940, this state produced 49,004 metric tons or 6% of the total

while the two other states, Paraíba and Espirito Santo, had outputs of 36,801 and 11,345 metric tons respectively which represented 5% and 2% of the total. The total output in 1940 was 84% of the total productive capacity.

There are six mills in the country while the seventh is expected to begin operations in the latter part of this year. There are 170,000 contos invested in this industry which employs 2,952 workers and has an annual production capacity of 879,000 tons. The same data, broken down into the component parts according to states, shows São Paulo with two mills, one with a capital of 25,000 contos and the other with 20,000 contos. In the former there are 800 employees while in the latter there are 506. The annual capacity of the former is 200,000 tons and that of the latter 168,000 tons. The state thus operated at full production capacity in 1940. The second largest producing state has but one mill as is true of the remainder. The Estado do Rio plant, situated at Guaxindiba has an invested capital of 80,000 contos, the largest of any individual plant, employs 785 workers and has a production capacity of 306,000 tons, the output of 1940 being 91% of the total possible. Minas Gerais has one plant in operation in Passos and one under construction in Ouro Preto, the former having a capital of 12,000 contos and the latter, 20,000. There are 188 employees in the former while the output capacity is 45,000 tons as compared to the 40,000 tons of the new mill. The Paraíba mill is at João Pessoa and has a capital of 12,000 contos, employs 518 persons and has a productive capacity of 90,000 tons which is practically 2-1/2 times the output in 1940. The Espirito Santo mill located at Cachoeiro de Itapemirim has the smallest invested capital (1,000 contos), the smallest working force (155) and the lowest production capacity (20,000 tons).

The total consumption of limestone in the São Paulo mills in 1937 was 440,000 tons while that of gypsum was 9,100 tons, the source of the latter being São Sebastião of the state of Rio Grande do Norte. One plant in this state also employs gravel as raw material the consumption of which totalled 21,000 tons. The total consumption of fuel oil was 46,300 tons while that of electricity was 35,300,000 kWH. The Estado do Rio plant besides using limestone, the consumption of which totalled 362,000 tons in 1937, uses gypsum, of which 6,800 tons were consumed in that year. Oil consumption totalled 38,500 tons and that of electricity 28,200,000 kWH. The Paraiba mill uses gypsum of Mossoró and Macau of Rio Grande do Norte, the consumption in 1937 being 960 tons. Limestone and gravel consumption totalled 43,200 tons and 6,200 tons respectively while in the place of oil, coal is used there being 6,000 tons of this utilized in that year. Electricity consumption amounted to 3,420,000 kWH. There is thus a total consumption of approximately 17,000 tons of gypsum in that year while that of limestone was about 843,000 and that of gravel 28,000 tons. This is the approximate quantity required for the production of 570,000 tons.

In 1938, the first recorded shipment of cement was made from Brazil being 6,460 kilograms valued at 3,717 milreis. This was made to Bolivia at a unit price (FOB Brazil) of 575 milreis per metric ton while the average price within the country was 223 milreis. Imported cement was priced at 193 milreis per

milreis per metric ton (CIF Brazil) in that year. In 1939, Colombia was the principal outlet having purchased 8,500 kilograms while the other markets, Peru and Bolivia acquired 4,400 kilograms and 2,307 kilograms respectively. In this year, the export price per metric ton was 469 milreis as compared to the internal price of 228 milreis and the import cost of 212 milreis.

The 1940 exports have proven to be the largest in this short three year export history, the total being 402,229 kilograms of which 396,444 kilograms were exported to Bolivia and 5,785 kilograms to Colombia. The unit export price was 738 milreis while the domestic and import prices were 247 and 246 milreis respectively.

It is worth noting that the imports of cement are composed of Portland, white, magnesium, *ferro* (iron) and unspecified types, the quantities of these overseas purchases being 14,896 tons, 4,341 tons, 57 tons, 1 ton and 3,491 tons respectively in 1940 while in 1939 they were 34,834 tons, 6,146 tons, 119 tons, nil and 0.2 tons respectively. The principal source of the first is England, the second the United States and the last, Yugoslavia.

During the 1920-9 decade, the average annual imports amounted to 1,153,000 tons while in the succeeding five years, the average decreased 85% to 179,800 tons. It may be noted as a point of interest that the production of cement in the latter quinquennium averaged 190,650 tons annually. During the 1935-9 five-year period, the imports continued to decline and amounted to 74,570 tons while that of production had increased substantially to attain an average of 547,690 tons.

4. GYPSUM

The principal use for uncalcined gypsum is in the Portland cement industry while minor outlets for this mineral are in agriculture, as a filler and in the paint industry. The bulk of the calcined product is employed in the manufacture of plasters and lath while wallboard and tile manufactures also consume appreciable amounts. It is also used to some extent in plate glass, pottery, art works, plaster of Paris, medicinal plaster and casting or moulding. In Brazil, the larger part of the production is destined to the manufacture of Portland cement.

The principal world producers of this mineral are the United States, Germany and France while the largest exporters are Canada, France and Latvia. Although the United States is the largest producer, it is also the world's largest importer and is followed in second place by England. Belgium and Sweden are other important buyers in the international market.

Among the world producers, Brazil is in 22nd place. The gypsum of Brazil is obtained from a mineral known locally as *gypsita*, the principal commercial deposits being in the state of Rio Grande do Norte in São Sebastião on the banks of the Tapuyo River in the municipality of Mossoró and in the

municipality of Macau. The crude product of this region is pure crystalline with a nearly perfect composition. The SO_3 content is 46.68%, that of CaO 29.50%, MgO neglible and SiO_2 0.21%. That of Assú shows practically identical characteristics, the SO_3 content being 45.18% and the CaO 30.14%. The layers in São Sebastião deposit are about 0.8 meters thick. At present this deposit is being worked by the Cia. (Co.) Gesso Nacional Tapuyo, the annual output being about 45,000 tons.

The other deposits of somewhat a similar nature are in southern part of the state of Ceará on the slopes of the Araripe Mountains while others of some importance in the same state are those of Santana do Cariri, Crato, Barbalha and Missão Velha. Those of the Araripe Mountains, although of satisfactory quality and being worked on small scale, present the great disadvantage of being more than 600 kilometers from the coast. The Assaré mineral shows, by analysis, 19.80% CaO, 36.41% SO_3, 17.18% SiO_2 and 0.82% MgO, while the Barbalha deposit contains 31.75% CaO, 45.77% SO_3, 1.05% SiO_2 and 0.30% MgO. The Barbalho and Crato deposits average approximately three meters in thickness and are also worked by the Cia. Gesso Nacional Tapuyo. The daily production here ranges from 10 to 20 tons daily giving an annual output of about 3,000 tons to 6,000 tons.

In the state of Maranhão, there are some deposits which appear to be of considerable size, those of Barra do Corda and Grajau being the more important. There are also deposits of varying magnitude along the Mearim, Gragau, Balsas and Manoel Alves Grande Rivers but inasmuch as all are in the interior of the state and therefore distant from the seacoast and any railway connections, their economic value at present is of little significance. Although located near rivers, all are unnavigable for transportation purposes. It is reported that the Minerios do Brasil Co. is working the Maranhão deposits. The Barra da Corda deposit tested 29.95% SO_3, 0.72% SiO_2 and 0.21% MgO.

In the northeastern part of the state of Mato Grosso, there are also deposits which according to some estimates reach billions of tons but here again, inaccessibility is the chief disadvantage.

The location of the cement industry in the South has naturally urged exploration of the South for gypsum sources, particularly in the states of São Paulo, Minas Gerais, Espirito Santo and Estado do Rio. Apparently, the only success obtained has been in Estado do Rio in the district known as Bôa Vista, near Campos. It is estimated that it contains about 215,000 tons of *gypsita* which is distributed over 16 deposits. This latter mineral tested as follows: 33.2% CaO, 43.32% SO_3, 1.35% SiO_2 and 0.20% MgO.

There is another deposit in the state of Rio Grande do Sul but no data on it is available.

There are, thus, 26 deposits of this mineral in the country, duly registered in the Departmento Nacional de Produção Mineral, 14 being in the state of Ceará, 7 in Rio Grande do Norte, 3 in Maranhão, one in Estado do Rio and another in Rio Grande do Sul.

No exports of this product are recorded while annual imports tend to stay within the limits of 3 to 4,000 tons annually, that of 1940 being 2,705 tons.

5. LIME AND LIMESTONE

Lime finds a wide variety of uses which in general may be classed into the agricultural, structural, refractory and industrial. Of these, by far the largest application of lime is found in the latter in which the metallurgy, paper and glass industries absorb large quantities. Another important use in this category is that of water purification. The structural industries also consume quantities of lime in masonry work and finishing. In agriculture, the mineral in the form of hydrated lime or quicklime is used to combat acidity in the soil. Lime and dolomite are important elements in the iron and steel industry as refractive material.

In Brazil, there are no exact consumption statistics but a rough estimate would place about 70% to 80% of the total consumed as destined to the building category. Lime in agriculture is of little significance, according to experts in this activity in São Paulo, the principal region where the technological crops are grown and hence the region where the largest amount of scientific agriculture would be practiced, because the soils of the state, generally speaking, are alkaline. Reports from the state of Minas Gerais, however, indicate that the use of lime in agriculture is of considerable importance. The consumption of limestone in the cement industry amounted to 842,700 tons in 1937 while in 1940 it is estimated to have totalled 1,100,000 tons. The iron and steel industry used 19,540 tons in 1937 for fluxing purposes while estimates for 1940 place this at 36,000 tons. In the former year, the same industry consumed 5,300 tons of dolomite. It may be noted in this connection that calcium carbide production in 1937 totalled 5,937 metric tons in the state of Minas Gerais, the sole producer, while in 1940 this had decreased to 3,500 tons.

Calcareous rocks are found in practically all inhabited regions of Brazil and in all geological formations, from the old archaeic to the latest quarternary. However, the greater quantities are disseminated throughout what are commonly referred to in Brazil as the *Minas Series, Bambuí Series, São Roque Series* and *Araripe Series*. Oyster and other seashells also form important sources but not to the extent that is true of the limestone.

The principal analyses of the composition of calcareous rocks in Brazil have been carried out mainly for the benefit of the cement companies inasmuch as they are one of the most requiring users of certain types of limestone, their requisites, until a short time ago, lying in a mineral with less than 5% magnesium oxide. Of a series of 120 analyses made by the Serviço Geologico e Mineralogico, 21.4% of the total showed less than 1% magnesium oxide while 52.5% had from 1% to 17.2% and, 25.8% more than this amount.

The manufacture of lime, however, does not place exacting demands upon composition and it may be said that nearly all populated regions of Bra-

zil have limestone or seashells of industrial value. Exception would possibly have to be made with regard to the chemical and sugar industries but their requirements have been filled satisfactorily. Isolated reports show that the calcareous rocks of the *Minas Series* in regions are magnesites or true dolomites and some because of their uniform character are of great use in the lining of furnaces. The calcareous rocks of the Paraiba Valley (crystalline and intercalated with gneiss) contain comparatively large percentages of magnesium. Two grayish-black samples of the *Minas Series* showed a lime content of 48% to 55%, traces to 6% magnesium oxide, and 43% ignition loss. The silica and alumina (and ferric oxide) contents were 0.6 to 1.3%, and 1.4 to 2.0% respectively. In the *Bambui Series* two samples showed 51.8% to 52.8% lime, 2.3 to 3.8% magnesia, 0. 5 to 1.1% silica, 0.6 to 0.8% alumina and ferric oxide and 42.7 to 42.9% ignition loss. Nine samples of the vicinity of Vacacai in the state of Rio Grande do Sul analysed as follows: lime 52.08%, magnesia 0.81%, silica 5.48%, alumina and ferric oxide 0.16% and ignition loss 41.44%.

According to an official inquiry made recently on the lime manufacturers of the country, there are 1,582 units within the country, 244 or 15% of which are in the state of Minas Gerais. The second largest number is found in the state of Ceará. the total being 173 or 11% of the total. Third in importance is the state of Baía with 140 or 9% while the fourth is Pernambuco with 119 establishments. Rio Grande do Norte has 110 and Paraíba 101. The remaining states possess less than 100 units each. It will be observed that 40.4% of the total of the country is located in the Northeastern states. It was found that 452 municipalities produce lime; 1,122 have no recorded output; 151 municipalities have only one establishment while those having 2 units number 84. There are 140 municipalities with 3 to 5 units and 77 with more than five.

The interest in production in the Northeast is based on the abundant raw material, the fact that the industry involves a small capital investment and the common practice of kalsomining instead of painting houses, barns, etc., since the pure white color offers greater protection against solar heating than any paint.

The principal problem in the industry is that of fuel. In Rio Grande do Sul, it was found that in order to produce 11 tons of lime (70% yield) in kilns operating continuously, it was necessary to use 32 cubic meters of firewood. Labor costs are relatively cheap.

Exports formerly were of appreciable magnitude averaging 25 metric tons in the decade from 1920 to 1929. However in the following years, they fell considerably and averaged but seven tons during the five years from 1930 to 1934, and 4 metric tons in the 1935-9 period. In very recent years, there is another trend towards an increase apparent, the amount in 1937 being 2 metric tons, that of 1938 three metric tons, that of 1939 four metric tons and the 1940 shipments 12 metric tons. The principal ports of shipment in the earlier years

were those of the North with the principal outlets being the northern countries of South America. In 1940 Guajará-mirim was the principal exporting port and the markets, Bolivia (11,100 kilos), Colombia (580 kilos), and Peru (400 kilos).

The reason for the small shipments of the southern producers lies in the larger demands within the region by they that of the cement factories or the other industries.

It may be noted that there continue imports of lime, the principal source until the War being Germany and the importing ports, Santos (São Paulo) and Rio de Janeiro (Federal District). This again bears out the point relative to the insufficient supplies in the South as does the fact that the coastwise trade in this mineral also attains quantities in excess of 1,000 tons, the movement again being from the North to the South.

As compared to the trend towards a decrease in exports until recent years in which there is a slight gain registered, that of imports shows that in the 1920-9 decade, the average overseas purchases amounted to 569 metric tons and fell to less than one-tenth of their former value in the five years from 1930 to 1934, amounting to 47 metric tons. Since 1935, the imports have shown an irregular trend and averaged 41 metric tons, slightly less than that of the previous period. Overseas purchases of this mineral in 1937 amounted to 39 metric tons while in 1939 they had decreased to 26 metric tons. In 1940, the total was 45 metric tons. The predominating source of lime prior to the War was Germany as mentioned above with the United States and England supplying insignificant proportions. In 1940, the principal supplier was the United States.

As to the prices of the lime, in 1937, that of the state of Minas Gerais, the largest producer, was 118 milreis per metric ton, 135 milreis in 1939 and 150 in 1940 (the mine price of limestone was 10 milreis per metric ton in 1940). Compared to this is the 340 milreis of the imported product (CIF Brazil) in 1937, the 1,377 milreis in 1939 and 995 milreis in 1940. Export prices in the respective years, that is, 1937, 1939 and 1940 were the following: 530 milreis, 885 milreis and a decrease to 712 milreis in 1940.

Lime is the only export product (except the carbide which is discussed later) while that consisting of calcium in imports are the chloride, the quantity in 1937 being 432 metric tons, 312 metric tons in 1939 and 566 metric tons in 1940; the hypochloride in 1937 totalling 765 metric tons, 636 metric tons in 1939 and 1,206 metric tons in 1940; the superphosphates (fertilizer) which amounted to 6,779 metric tons in 1937, to 21,381 metric tons in 1939 and 15,807 metric tons in 1940; and the cyanimide amounting to 96 metric tons in 1937, to 623 metric tons in 1939 and 258 metric tons in 1940.

The production of calcium carbide is carried out in only one state, Minas Gerais, by a firm employing 213 persons with capital and reserves amounting to 2,880 contos. Production in 1937 totalled 5,937 tons while that for the succeeding years was as follows: 1938 — 5,800 metric tons; 1939 — 3,487 metric tons and 3,500 metric tons in 1940. The principal use for the product in Brazil is illumination in the regions far from power sources and

thus with the advance of the latter, there has been a gradual decreasing use for the product. Exports of the product have been exceedingly irregular, the shipments during 1939 and 1940 having been 100 metric tons. The principal market has been Argentina.

Imports of the calcium carbide totalled 18 metric tons in 1937; imports for subsequent years are not recorded separately in official statistics.

Comparing the production, export and import price, one finds that in 1937, the former was 990 milreis per metric ton. No exports are recorded in that year; that of 1936 was 653 milreis (FOB Brazil). The import price (CIF Brazil) was 193 milreis. Comparing the production and export prices in the succeeding years, that of production was about 700 milreis in all years while that of export (FOB Brazil) was 1,297 milreis in 1939 and 1,510 milreis in 1940.

6. MAGNESITE

Magnesite is an important element in the steel industry as well as the cement industry, serving principally in stucco, flooring and wallboard. Metallic magnesium is used increasingly in alloys because of its lightness and strength, indispensable factors in aircraft manufacture. No statistics as to consumption of magnesium or magnesium compounds in Brazil are available although it is believed the largest type consumed is the dolomite in the iron and steel industry.

The U. S. S. R. is the largest producer of magnesite in the world and is followed in order of importance by Germany, Manchukuo and the United States. In the world export trade, Manchukuo and Germany are the principal suppliers with Greece and the former Czechoslovakia of secondary importance. The principal importing countries are the United States, England and France.

The known deposits of magnesite in Brazil are found in the state of Goiaz where it is encountered with dolomite and some serpentine rock. In the state of Rio Grande do Sul, the magnesite is known as *pedra moura* (moorish rock), *marmore amarelo* (yellow marble) and *olho de boi branco* (white cattle's eye) and occurs, in large units, near the Capivari and Pardo Rivers. However, the principal deposits in Brazil are those in Brumado in the state of Baía. The studies realized recently in connection with the utilization of the magnesite for industrial purposes revealed that their value not only as an abundant source of refractive material for the smelting furnaces which will soon be installed in Brazil but also for the production of metallic magnesium and various chemical products is of appreciable proportions. The working of the deposits which total several tens of millions of tons, a quantity sufficient to fill the domestic demand and still leave surpluses for export, depends largely upon the solution of the transportation problem.

The price of magnesite at the mine during 1940 averaged 200 milreis per metric ton.

7. MARBLE

Brazil possesses an extraordinary variety of marble which is not only of exceptional beauty but also of high resistance competing, as such, with the famous stones of Carrera in Italy and Parros in Greece which are the two largest producing centers of the world.

This product is found in several states of Brazil but, among these, special mention must be made of the black marble of Corumbá in the state of Mato Grosso; the streaked marble of Gandarela whose reserves are estimated to be 800 million cubic meters of a fine mineral with various colors as, blue, white and red; the white marble of Ouro Preto; the red of Rodrigo Silva; the grays of Arco-Verde and the white statuary marble of Mar de Espanha in the state of Minas Gerais. Equally important and appreciated are the yellow, red and blue-black located in the state of Baía and the high quality stone found near Patí do Alferes in Estado do Rio. In São Roque on the Estrada de Ferro Sorocabana in the state of São Paulo, there is some black marble. In the state of Paraná, the green and red varieties are found in Lapa, the blacks in Bocaiuva and the snow-white in Areias.

In the state of Rio Grande do Sul there are some white and blue marbles.

Several years, ago, the commercial exploitation of the building marble was started. The most widely demanded are those of the state of Santa Catarina which are known commercially as *Aurora Veiado* and *Gran-Bleu;* the white marbles of Monção in the Estado do Rio and *Aurora Vermelho* and *Aurora Perola* of Dom Bosco of the state of Minas Gerais.

There are eight states quarrying marble in Brazil, the principal being Minas Gerais which in 1937 produced 10,940 metric tons, 7,400 metric tons in 1938 and 6,760 metric tons in 1939. The municipality of Sete Lagoas is the largest producer of that state accounting for 45% of the state total while Mar de Espanha is the second largest. Estado do Rio was the second largest producing state, the output in the 1937-9 period being 2,822 metric tons, 4,116 metric tons and 3,631 metric tons respectively while that of the third largest, Santa Catarina was 875 metric tons, 1,252 metric tons and 1,367 metric tons respectively. Others of lesser importance were Paraná (170 metric tons in 1937, 314 metric tons in 1938 and 1,088 metric tons in 1939), Paraíba (nil in 1937, 70 metric tons in 1938 and 680 metric tons in 1939), São Paulo (nil in 1937 and 1938 and 600 metric tons in 1939), Espirito Santo (21 metric tons in 1937, 24 metric tons in 1938 and 19 metric tons in 1939) and Pernambuco (42 metric tons in 1937 and nil in 1938 and 1939).

The total output in 1937 was 14,870 metric tons and that for 1938 13,176 metric tons. Of the total production of 14,145 metric tons in 1939, only 79 metric tons or 0.6% was exported, 77 metric tons of which were sold to Argentina. England, Canada and the United States provided the outlets for the remaining 2 metric tons. In 1940, however, overseas shipments had increased to 270 metric tons or practically three and a half times that of 1939, the prin-

cipal market in this year being Chile (according to value) which purchased 71 metric tons of the Brazilian product. Great Britain was the largest market based on quantity taking 103 metric tons of the stone. Peru, Argentina, Colombia and Venezuela were the other markets during the year.

It may be noted that the domestic prices of marble averaged 133 milreis per metric ton in 1937, 169 milreis in 1938 and 168 milreis in 1939 while that of exports show the following changes over the same years: 1937 — 620 milreis, 1938 (no exports) and 682 milreis in 1939. The 1940 export price was 967 milreis per metric ton, the highest in recent years.

Despite the exportation of the product, imports are also made, that of 1940 being 4,503 metric tons. The sources in that year were Italy with 2,196 metric tons, Portugal with 2,026 metric tons, Belgium with 219 metric tons and Argentina with 62 metric tons. In 1939, imports had totalled 11,648 metric tons. Basing data on 1939, it may be said that the apparent consumption of marble in Brazil is about 25,800 metric tons.

As contrasted to the export marble, that of imports has a relatively low unit price being 516 milreis per metric ton in 1939 and 536 milreis in 1940.

The difficulties of importation and the coincident increased demand due to the feverish construction of multiple story buildings has led to an unprecedented demand for the stone, a type of demand which the local marble industry has been awaiting for some time.

The greatest problems encountered in this industry are transportation and equipment. With regard to the former, it may be noted that, consisting as it does of voluminous sizes and great weight, the ordinary means are taxed beyond their usual capacities and create difficulties while, in addition, the distances from quarry to market are usually of considerable magnitude. In no small number of cases, the numerous rivers, bearing in mind that the larger part of the quarrying is carried out in the rainy South, instead of being of invaluable assistance, present obstacles, some of which go to the extent of requiring the abandonment of the discovered deposit due to this one element alone. As to the second factor, that of equipment, it must be noted that few quarrying companies possess complete sets of equipment which include cutting equipment (wire), compressed air drills and mechanical hoists. In some deposits, the installation of compressed air equipment alone would bring considerable benefits inasmuch as transportation difficulties are little significance. However, the basic solution in the great majority of cases seems to lie in the installation of completely modernized equipment at the quarry and overcoming transportation hardships by trucks.

8. OCHRES (Colored earths)

The principal deposits of colored earth in Brazil are found in the state of Minas Gerais, in the district of Ouro Preto, where the main types are Sienna, Paris Green, Chrome, Yellow, Red Ochre and other greens,

browns, reds, mauves and blacks. The main deposits are located in Veloso, Serra da Brigida, Saramenha, Ojó and Botafogo, all of which are in the Ouro Preto District.

There are earths also found in the Serra de Antonio Pereira and Mata Machado in the state of Minas Gerais, in Anchieta and Cachoeira in the state of Espirito Santo, in the state of Alagoas and to a small extent throughout all Brazil.

Ouro Preto produces about 60% of the total output of the state of Minas Gerais which in 1937 totalled 5,006 metric tons. The municipality of Conselheiro Lafayette, the second largest producer, had an output of 1,700 metric tons while the third largest, Santa Barbara, mined over 250 metric tons. The other six municipalities which are producing at present are Contagem, Lagoa Dourada, Montes Claros, Paraisopolis, Pedra Branca and Tiradentes. Production in 1938 declined to 4,428 metric tons while what for the succeeding year manifested an appreciable increase being 6,128 metric tons. The output for 1940 is estimated to have attained 6,200 metric tons.

The industry engaged strictly in the working of ochres employs about 80 to 90 persons in Minas Gerais.

The exports of Brazil, which in 1937, reached 121 metric tons, in 1938 fell to 22 metric tons and rose slightly to 29 metric tons in 1939, shipments to Uruguay and Colombia amounting to 29,020 kilograms and 140 kilograms respectively. The value of the exports in 1939 was 12,436 milreis.

Exports of 1940 were made to only one market, Uruguay, the total being 17,000 kilograms valued at 14,518 milreis. It may be noted that exports represent but 0.3% of the production (state of Minas Gerais only).

The prices of the product have varied as follows during recent years: 1937 — 824 milreis per metric ton, 1938 — 429 milreis, 1939 — 426 milreis and 1940 — 854 milreis. The general price of the crude product in 1940 at the mine was 100 milreis.

Consisting at it does of a product with many varieties, those unavailable within the country are imported. It may be noted, however, that there is a distinct tendency towards a decrease in such purchases as is expressed in the following data: in 1937, the total imported was 115,249 kilograms while in 1938 it was 78,192 kilos and 42,211 kilos in 1939, the principal sources in those years being Uruguay, Argentina and Great Britain. In 1940, there were 37,004 kilos imported, the chief sources in this year being Great Britain and the United States. Prices (CIF Brazil) of the imported product, in general, have varied little, that of 1939 being 2,312 milreis per metric ton and that of 1940 being 2,440 milreis.

FUELS AND ENERGY

1. GENERAL SURVEY

In taking stock of what Brazil has and what she does not have in fuel sources and energy, one finds that as for the former, there is in the South, varying quantities and qualities of coal which range from isolated deposits to seams which run through two and three states and contain from the ashy, sulfurous (some suggest it for the exploitation of the pyritic sulfur in place of coal) to the Santa Catarina mineral which will supply the new $45,000,000 steel plant with its complete coke supply. There are, in addition, the deposits of lignite in the state of Minas Gerais which are used for the production of briquettes and the Estado do Rio peat which is also used for that product. Going further north, to the Northeast region of the country, there are the petroleum deposits which flank the seaboard from the state of Baía in the south to Sergipe in the north. Further north, in the state of Piauí, there is said to be an immense basin of coal which still remains within the realm of "unstudied deposits" and as such, offers no reassuring concrete solution to any fuel problem which might arise. There are, however, in the same region, immense groves of babassu palms which provide coal and could supply coke and distilled petroleum products upon a rationalized production program.

There is, thus, the coal of the South which is a certain source of fuel while the remaining are probabilities, however, probabilities in the sense that they actually exist but are not being used to advantage on a large scale as yet.

Turning to energy, Brazil is in a fortunate position possessing, as she does, the sixth largest water power sources in the world.

There is, in addition, another element in fuel supplies of which one must not lose sight when considering sources — that of wood. The mere statement of the fact that Brazil is a tropical and sub-tropical country with a density of population of five persons per square kilometer brings to light a train of thought which suggests the use of wood on a large scale in substituting many of the classical uses for coal and petroleum of other regions where the clearing of land for the extensive culture of crops is a curiosity and not a problem as in Brazil. The florestal exhuberance under the mentioned climatic factors and the ne-

cessity of clearing lands in order to accomodate a rapidly growing and spreading population releases large supplies of firewood and charcoal on the market which play an important role in Brazilian economy. No visitor can fail to perceive this encroachment on the realm of coal and petroleum in the everyday industrial and social life of the country.

However, despite the abundance of wood, and the supplies of coal and electricity, there still remains the problem of supplying the higher calorific power-fuels, coal and petroleum, on a larger scale to industrial Brazil which has increased her manufacturing output from 4,700,000 contos in 1930 to 25,000,000 contos in recent years.

Herein lies, it may be said, the reasons for the intense efforts to increase domestic coal production, for the mixing of alcohol with gasoline to reduce the aggregate consumption of the latter, the increasing preference for electrical traction over those based on coal or petroleum, and for the appearance of the new word in Brazilian literature *gasogenio*. It also explains, for example, the thoroughly studied, scientifically "discovered" oil field of Reconcavo in the state of Baía, why drillings are made in the sub-Andine petroliferous zone of the Territory of Acre, the most remote zone of Brazil being 38 travelling days from the Federal Capital by boat, why 2 oil tankers were included in the recent purchase of 18 ships and why the Trans-South American Railway "should" pass through the Bolivian oil fields.

Theoretical solutions of problems must however look to the practical obstructions and for coal the mere increased output was not sufficient to solve the question. There was the necessity of arranging a market inasmuch as the qualities of the national coal were competing with the best of England, Germany and the United States. The price differential in favor of the domestic coal was thus lost in some cases to the calorific cost. Two steps have been taken to overcome this problem but because of their newness, it is early to judge upon their merits. One involves the adoption of boilers to the qualities of the domestic coal, principally in the newly constructed units since the expense involved in the conversion of the old types is of considerable proportions. The second step is the improvement of the coal itself which naturally includes increased care in washing, briquetting and carbonization. Another problem was that of maritime transportation for the coal. In cases, freight accounted for 35% to 40% of the final price principally because the port facilities did not permit the anchoring of large vessels. The port projects adopted by the Department of Ports and Navigation include in their program, the improvement of the ports of Imbituba and those in Rio Grande do Sul which should be of great assistance in the satisfaction of this aspect of the problem.

For the above there are supplementary aids in the enlargment of the local market for an increased production of coal. One of the principal is that of the obligation of direct use. This is found in the regulation obliging the railways to use 20% national coal in their total consumption, their total absorption being about one-half of the national total of all types of coal at present.

The mixing of alcohol with gasoline for a motor carburant requires little further explanation except that it is in reality a program which "kills two birds with one stone" inasmuch as it helps to solve the fuel problem while at the same time providing a solution to that of overproduction of sugar for Brazil. It is of interest to note, in this connection, that the output of sugar in Brazil is the sixth largest in the world.

Electrical traction has been adopted in several lines with success but the problem lies less in providing a supply of electricity and more in the huge capital outlays which must be realized. Nevertheless, the program continues and it is to be noted the problem of electrification on steep slopes, the latter being quite common in Brazil, is adequately solved on the one stretch between São Paulo city and the port of Santos.

The new *gasogenio* motors which use charcoal or coal instead of gasoline is still in the experimental stage being tested by both the Ministry of Agriculture and by the Brazilian Traction and Power Co. To all appearances, the tests of the latter have shown reason to believe there is some justification for an increased use of this fuel generator inasmuch as they have recently equipped a large fleet of heavy duty trucks with this type of motor.

Although it impossible to judge to what extent the recent program of reducing the imports of fuels has been effective, the fact that in 1930, the total imports were 2,722,000 metric tons, that in 1935 it had risen to 2,958,000 metric tons and that since the full impact of the program got under way, the imports in 1939 fell to 2,691,000 metric tons and to 2,496,000 metric tons in 1940, proves that despite the increased consumption of those fuels there was accomplished, to some extent, the objective desired.

2. COAL, COKE, LIGNITE AND PEAT

COAL

The uses of coal are largely as a source of energy in transportation, power generation and coke production. Strict consumption data as to its use in Brazil is unavailable although the total for the country is estimated to be about 2,500,000 tons annually with a tendency towards an increase in recent years.

The consumption of the railroads amounts to about 1,200,000 tons or slightly less than one-half of the total. Also of importance is that given over to power generation for which there is no data available but which is no doubt of appreciable magnitude judging from the imports of the states using thermo-electric power. That given over to coke production is limited in view of the low coke production in Brazil, the large imports and the widespread use of charcoal and firewood.

In Brazil, the occurrences of coal with 30% to 35% ash are found in the states of São Paulo, Paraná, Santa Catarina and Rio Grande do Sul. In

the latter state, the principal basins are located in the Arroio dos Ratos, the mines being known as the Butiá and São Jeronymo.

The Butiá mine is 20 kilometers from São Jeronymo and is on the banks of the Jacuí River. A conservative calculated reserve, according to the latest data, is 3,000,000 tons, with a fair estimate placing the total at a figure several times larger. The better part of the deposit has a calorific power of 5,550 to 6,000 calories.

The São Jeronymo mines are equipped with three shafts, 50 meters deep and with many galleries. When washed, the coal of São Jeronymo can be graded into two qualities, the first, which includes about 35% of the haul contains about 25% ash and 0.6% sulfur while the second, which accounts for about 42% of the total, presents a 29% ash content and an exceedingly low percentage of sulfur. Estimates of this reserve place the total at about 6,000,000 tons.

In the Rio Negro Basin, also in the state of Rio Grande do Sul, there is a deposit with a minimum coal reserve of about 3,000,000 tons.

The carboniferous basin of the state of Santa Catarina runs in a North-South direction passing through the localities known as Cresciuma, Treviso, Rio Bonito and Urussanga, as far as Tubarão. In contrast to the coal seams of the state of Rio Grande do Sul which are about 50 meters below the surface, those of the state of Santa Catarina are mined by open cuts only thus reducing costs of production to a great extent. The deposits, however, are about 100 kilometers from the ports of Laguna and Imbituba which, unfortunately, do not take deep draft vessels. The advantages which thus do exist, are to some extent annulled with the problem of insufficient port facilities and the long distances from the mine. The probable reserves attain 500 million tons.

The coal basin of the state of Paraná commences in the Rio Negro and follows a northwest direction through all fields crossing the Estrada de Ferro São Paulo-Rio Grande at the Texeira Soares station which is located 80 kilometers south of Ponta Grossa, and continuing through Imbituba and Cedro, reaching Marçal and the Rio Tibagí basin in the valleys of the Cinzas and Peixe Rivers.

In the state of São Paulo, there are narrow seams between Rio Feio and Tatuí and also near Cerquilho and the Estrada de Ferro (R. R.) Sorocabana.

The known reserves of the states of Paraná and São Paulo are small, each of them being not much more than a million tons.

The characteristics of some of the principal coals are as follows:

URUSSANGA — This coal gives a very good yield of tar and satisfactory percentages of sulfate of ammonia and benzol; with a reduced ash and sulfur content, it would be quite suitable for carbonization. The coke is fairly hard, but lacks the well defined and close-grained structure which is characteristic of a good grade. This may, however, be improved by compression. Apart from the drawbacks of high ash and sulfur percentage, it might be termed a fairly satisfactory coke.

GRAVATAI — This coal is of inferior quality and useless for coking purposes. The best use to which it could be put is as a fuel. The coke is very friable and granular, and for all purposes may be regarded as non-coking.

BUTIA — Being non-coking, this coal can only be utilized for heating purposes.

TUBARÃO — This coal is similar to that from Urussanga, but slightly more homogeneous in structure, though not so dense. The coal has a tendency to swell and must be compressed for making coke when practicable. Apart from this deficiency, a fairly satisfactory coke could be obtained.

CRESCIUMA — This coal is very low grade and although it still makes a coke, it is unmarketable unless some reduction of the ash coefficient could be effected. The coke has a high density, quite different in this aspect from that of Urussanga and Tubarão. The quality of the coke is marred by the large amount of ash it contains, and due to the high specific gravity of the coal, it is very doubtful whether any improvement could be effected by washing.

In the 1925-9 quinquennium, the production of coal in Brazil averaged 357,589 metric tons, rising 57% to 559,684 metric tons in the 1930-4 period. During this period there were three producing states, Rio Grande do Sul accounting for 85%, Santa Catarina 14% and Paraná 1%. In the 1935-9 period, the average output increased 51% and was 843,854 tons of which Rio Grande do Sul now produced 82%, Santa Catarina 18% and Paraná nil. It may be noted that the output in Paraná was paralyzed since 1935 and continued operating in 1938 to open with an output of 264 metric tons against the final production of 4,861 metric tons in 1934.

COAL

Table 18 PRODUCTION OF BRAZIL BY STATES IN METRIC TONS.

STATES		1935	1936	1937	1938	1939	1940
Rio Grande do Sul ..		689.200	525.023	656.711	735.950	841.026	1,065 488
Santa Catarina		150,888	137,167	106,978	171.010	204.181	265 638
Paraná		—	—	—	264	1,768	2.773
São Paulo		—	—	—	—	—	2 402
TOTAL:	Tons	840.088	662 196	762 789	907.224	1,046 975	1,336,301
	Contos	40,474	32,902	40,054	48,297	54,288	72,473

Official statistics for the production of coal in 1940 place the total output at 1,336,301 metric tons valued at 72,473 contos-de-reis, an increase of 28% over 1939, of 47% over 1938 and 76% over 1937. Rio Grande do Sul continued to lead the other states with an output of 1,065,488 metric tons or 80% of the total, while the second, Santa Catarina produced 265,638 metric tons or 20% of the total, and the other two, Paraná and São Paulo, of comparative insignificance, had outputs of 2,773 metric tons and 2,102 metric tons respectively.

There are 42 mining companies engaged in this industry 32 of which are in Santa Catarina, seven in Rio Grande do Sul, two in São Paulo, and one in Paraná. The leading producing company is the Cia. Carbonifera Rio Grandense of Rio Grande do Sul which produces about 41% of the total; the second is the Cia. Estrada de Ferro (R. R.) e Minas São Jeronymo also of the state of Rio Grande do Sul which accounts for about 38% of the total.. Third in importance is the Cia. do Carvão do Barro Branco of the state of Santa Catarina, whose output represents approximately 7% of the national total. It may be noted that excluding the output of the Cia. Brasileira Carbonifera de Ararangua of the state of Santa Catarina, which amounted 3% of the total, all the remaining companies produced less than 24,000 tons. Thus, 86% of the total domestic production is concentrated in the hands of three companies.

Exports of Brazilian coal are exceedingly irregular. The general annual average for the 1920-9 decade was 233 metric tons, that of the 1930-4 period 28 metric tons and the 1935-9 period 16 metric tons. Shipments in 1940 totalled 6,900 metric tons, all of which was shipped to Argentina and which proved to be the largest to this time being more than four times that of 1926 (1,612 metric tons) which was the largest to date. Recent reports point to the inability to fill a contract for the supplying of 15,000 tons per month due to lack of shipping space the final contract being for 5,000 tons monthly which will no doubt raise exports substantially during 1941.

It may be noted that the official efforts have recently been directed towards the attainment of self-sufficiency in coal by various methods among which one may count as the most important, that of increasing production which as was noted, is on a favorable trend and the reduction of imports by the use of domestic coal and domestic substitutes principally babassu, electricity and domestic petroleum. With regard to the reduction of imports, it is of interest to observe that in the 1920-9 period, purchases overseas averaged 1,573,000 metric tons, that of the following five-year period being 1,253,000 metric tons and that in the 1935-9 period 1,365,000 metric tons. In this connection, the trend since 1937 is of interest being 1,381,000 tons in 1937, 1,516,000 in 1938, 1,200,000 tons in 1939 and 1,150,000 tons in 1940. A significant factor in this plan is the program in the railways to use increasingly smaller amounts of foreign coal in preference to domestic coal. In 1937, the consumption of coal by the railroads amounted to 1,238,000 tons of which 73% was foreign coal, this latter amount being equal to 66% of the total imports of coal in that year. In 1938, the amount of foreign coal was 790,586 metric tons or 68% of the total which in turn was 52% of the total imports. The 1939 total was 754,364 metric tons, this amount being 63% of the total coal consumption and 63% of the imports of that year. Further to the point of substitution is the perceptible increase noted in the consumption of firewood (Brazil has the second largest forest area in the world) the 1937 total being 8,061,000 m^3, that of 1938 over 8,929,000 m^3 and the 1939 amount 9,028,000 m^3.

For purposes of comparison, it is of interest to note the prices of the coal in trade, that of imports (CIF Brazil) in 1938 being 217 milreis per metric ton, that of 1939 being 165 milreis and the 1940 amount 234 milreis. Export prices (FOB Brazil) in comparison showed the following price movement: 1938 — 100 milreis, 1939 — 950 milreis and 1940 — 119 milreis. The 1940 mine price was 25 milreis per ton.

A different type of coal is that produced from babassu, the principal producers being the states of Piauí and Maranhão. Total production data is not known, the sole information with respect to it being the exports of Maranhão which in 1938 amounted to 0.4 metric tons and which in 1939 increased to 2 metric tons. According to official statistics, the 1939 production amounted to 5.5 tons in that State.

COKE

The amount of coke produced within the country is unknown some estimates placing it at 130,000 tons. It is known however, that one company in Rio de Janeiro produced 73,400 metric tons of coke in 1938 which was largely used in the plant, the portion sold being 21,400 tons. Coke of this plant is made from imported English and American coal and is light and little resistant thus making it unfit for metallurgical purpose but useful in furnaces, forges, heaters, etc. There is some production carried out in the state of Santa Catarina but the amount is not known.

There are no exports of coke; the annual imports amount to considerable, sums, the 1920-9 annual average being 18,186 metric tons, that of the 1930-4 quinquennium being 22,270 tons and that for the 1934-9 period averaging 39,500 tons. In 1940, the total was 23,338 metric tons, 59% of which was imported England and 38% from the United States. Previous to the War, 85% came from Germany but in 1940, this dropped to 3% of the total.

Briquette imports averaged 110,300 metric tons in the 1934-9 period and in 1940 declined abruptly to 36,360 metric tons.

LIGNITE

Brazil possesses various deposits of lignite, two of which are found in the Serras de Fonseca and the Serra de Gandarela of the municipalities of Alvinopolis and Santa Barbara, respectively, in the state of Minas Gerais. The reserves of the latter are estimated to be 1.7 million tons with a fixed carbon content of 43% and calorific power of about 6,000 to 7,000 calories. In passing, it may be noted that there is an enormous deposit of fine marble, manganese and iron surrounding this lignite.

In the municipality of Caçapava in the state of São Paulo, there is another deposit of lignite, the only one being worked at present. It reserves are estimated to reach two million tons. After a period of inactivity it was reopened by the Cia. Norte Paulista de Combustivel who transform the product

into briquettes, which are widely used by the industry of the state and the Estrada de Ferro (R. R.) Central do Brasil.

Other deposits of lignite are found in the states of Amazonas, Pernambuco and Baía. In the latter, in the region of Camamú, are encountered the best known in Brazil. The product contains only 12% ash.

PEAT

According to studies made of the João Branco deposit in Maraú in the state of Baía it is estimated that the commercial reserve is about 256,000 tons and that the crude oil content of the peat is 25%. As such there is a theoretical content of 64,000 tons of oil.

Another deposit of peat is found near Rezende in Estado do Rio whose product is known commercially as Floriano Peat. Its reserve is estimated to be 334,000 tons which corresponds to 150,000 tons dry peat. The cost of the plant at the Floriano Station which is 11 kilometers from the deposit, is 3.6 milreis per metric ton.

The International Machinery Co., of the United States organized a flow-sheet which showed the possibilities of making briquettes from the Floriano peat with a basic production of 50 metric tons per day. This would roughly amount to an immediate export capacity of 15,000 metric tons annually.

At Bom Jardim on the Estrada de Ferro (R. R.) Sul Mineira in Minas Gerais, there is a deposit of peat which is being worked with apparent success which is capable of furnishing a product with a 60% to 70% carbon content. The layers of peat are intercalated with fine layers of the white kaolin 20 centimeters thick. Recently, a deposit of *olioca* which is capable of producing 40% oil, was studied at Jucú near Vila Velha in the state of Espirito Santo by the Departamento da Produção Mineral and was estimated to have a reserve of 6,400 metric tons.

3. PETROLEUM AND MOTOR ALCOHOL

PETROLEUM

The earliest studies carried out with respect to petroleum in Brazil date back to 1919 but the lack of technical equipment, the discontinuity of the services initiated, the inadequacy of materials and various other factors contributed to the delay in the discovery and exploitation of Brazilian deposits for more than twenty years. Under the direction of the former Serviço Geologico e Mineralogico, attention was concentrated on the permotriassic formations of the south, the cretaceous formation of the coast of the state of Baía, the Alagoas coastal zone and the paleozoic area in the lower Amazon. Although results were far from successful, they served to establish the probable structure of the underground formation in these areas. Soundings in the states of São Paulo and Pará created unusual interest but remained only as such due to the restrictions placed by the economic conditions prevalent at that time.

It was on January 23, 1939 that the Lobato deposit on the coast of the state of Baía gave this country her first oil producing well. Tests of the oil analyzed as follows: specific gravity, 0.81, very fluid and pure, paraffine base, sulfur absent, and distillation temperature of 60°. Upon distillation, 20% petroleum with 5% ether, 10% kerosene, 20% diesel fuel, 25% lubricating oil, 20% heavy oils and paraffine greases and 5% coke and waste were obtained. As such, the oil of this region compares with that of Pennsylvania of the United States.

Prospecting in the Lobato field was carried out by the Conselho Nacional de Petroleo which, under the provision of Decree-Law N.° 395 of April 29, 1938, is authorized to install refineries and deposits, establish the minimum stock limits, regulate and control the importation, exportation, transport and trade of petroleum and its by-products, and carry out and authorize official studies on this product.

The Conselho Nacional do Petroleo, equipped with a highly trained staff, has been energetically continuing prospects in the Baía-Alagoas region, three drillings having struck two distinct new levels at shallow depths that are of substantial economic value. At present, the work of commercially utilizing these discoveries is being undertaken.

In the Alagoas Series, a shaft has been sunk to 6,000 feet, passing through several layers of oil-bearing sands and soil.

In the Territory of Acre, the C. N. P. has made soundings in the extreme western section, a part of the petroliferous zone known as sub-Andine, which is producing in Peru and Bolivia near the Brazilian frontier.

The sources of domestic gasoline and petroleum derivatives are imports and that which comes from domestic refineries. At present there are four refineries in Brazil, two in the state of São Paulo and two in Rio Grande do Sul, there being plans to increase this number as soon as the production of domestic petroleum fields justify such steps. In 1940, these distilleries produced about 27,900,000 liters of gazoline, 9 million liters of kerosene, about 6,000,000 liters of fuel oil, 985,000 liters of lubricating oils and 626,000 liters of solvent. Other products were 9,600,000 liters of diesel oil, 188,800 liters of pitch and 200 kilos of grease. Imports of crude oil for these refineries in that year amounted to 49,266 metric tons which is a decided increase over 1939 when it amounted to but 42,293 metric tons.

Although strictly comparative proportions are difficult to establish, the adoption of fairly accurate arbitrary conversion factors show that the production of gasoline in Brazil in 1940 amounted to 6% of the total consumption, that of kerosene 7%, that of lubricating oils 2% and diesel oils 7%. The corresponding percentages for the other products were 1% for fuel oil, 33% for grease and a negligible ratio for the non-classified products.

In the 1920-9 period, the average annual imports of petroleum products amounted to 509,700 metric tons while that of the five years from 1930 to 1934 increased to 748,100. In the 1935-9 quinquennium there is a further increase

evidenced, rising to 1,026,300 metric tons, the imports of 1939 being the highest in the history of the purchases of these products with a total of 1,295,000 tons. In 1940, there was a slight decrease to 1,276,400 tons but a distinct rise in value due to the increased unit price. For purposes of illustration, the following price (CIF Brazil) changes of the largest import products may be noted: Crude oil in 1939 — 339 milreis per metric ton and 444 milreis in 1940; gasoline in 1939 — 433 milreis and 526 milreis in 1940 and fuel oil in 1939 — 154 milreis and 222 milreis in 1940.

It may be noted that there are but two export products which exceed in value the amount of imports of these petroleum products. As will be observed in Table 2, gasoline is largest petroleum product imported accounting for 40% of the total while fuel oil is the second representing 26% of the total. Lubricating oil, kerosene and diesel oil were of secondary significance and consisted of 13%, 10% and 9% of the total. This compares with the data of 1930 in which gasoline accounted for 55% ot the total, fuel oil and diesel oil 16%, kerosene 18% and lubricating oil 11%. The lower percentage of kerosene in recent years is explained to some extent by the rapid encroachment of the electricity in rural illumination in the remoter parts of Brazil.

In 1939, the largest consumer of gasoline was the state of São Paulo which had 35% of the total motor cars in the country but which nevertheless accounted for 41% of the total consumption. The second largest was the Federal District whose consumption amounted to 118 million liters or 20% of the total.

The consumption of gasoline in 1940 totalled 585,100.000 liters (154,456,790 gallons) the largest consuming state being São Paulo, the industrial center, with an aggregate of 245,500,000 liters or 42% of the total, the Federal District, second with 113,200,000 liters or 19% and Rio Grande do Sul third with 51,100,000 liters, or 9%. It may be noted that the consumption of gasoline per vehicle in 1939 amounted to 5,380 liters while in 1940 this fell to 4,540 liters.

Consumption of aviation gasoline in 1939 totalled 15,600,000 liters while the same for 1940 had risen 11% to 17,400,000 liters. In both years, the the largest consuming federated unit was the Federal District which is the aviation center of the country. Her total of 5,500,000 liters in 1939 represented 35% of the total while the 6,700,000 liters of 1940 accounted for 39%. The second largest in both years was São Paulo which in 1939 consumed 2,300,000 liters or 15% of the the total; in 1940, the total was 2,800,000 liters or 16% of the total. Pará, in the northern extremity of the country, is the third largest consumer in both 1939 and 1940, the quantity in the former year being 1,700,000 liters or 11% of the total while in the latter year it had risen to 2,500,000 liters to represent 14% of the total. Other fairly important consuming states of some significance in 1940 were Rio Grande do Sul, Baía, Pernambuco and Mato Grosso.

REFINED PETROLEUM PRODUCTS

PRODUCTION AND IMPORTS OF BRAZIL

Table 19

PRODUCTS	UNIT	1938	1939	1940					
				TOTAL	Matarazzo	Ref. Brasileira	Ipiranga	Distilaria Riograndense	IMPORTS (1)
Gasoline	liters	18,712.5	26,511.0	26,443.0	16,283.4	731.5	7,096.9	2,331.2	
" aviation	"	—	0.9	1.1	—	—	1.1	—	368.4
" solvent	"	—	449.3	1,477.5	1,405.0	—	72.5	—	
Kerosene	"	9,052.7	11,426.0	9,136.1	4,701.6	525.4	2,794.3	1,114.8	101.6
Lubricating oils	"	517.3	9,207.7	985.3	99.7	—	879.8	5.8	43.1
Diesel "	kilos	11,200.3	7,404.1	9,598.6	2,431.1	29.7	5,549.8	1,597.0	127.7
Fuel "	"	11,972.1	1,420.7	6,129.4	901.4	60.8	3,622.8	1,544.4	566.4
Mineral oil solvent	liters	—	1,038.0	626.1	626.1	—	—	—	—
Turpentine	"	5.4	150.1	188.8	—	—	183.4	5.4	—
Grease	kilos	—	—	0.2	—	—	0.2	—	0.4
Residues	"	—	7.4	—	—	—	—	—	—
Others	"	—	36.2	—	—	—	—	—	1,276.4

NOTE: (1) — Metric tons.

São Paulo was also the largest market for kerosene in 1939 having consumed 29 million liters of the total while the second most important market, Rio Grande do Sul, accounted for 16 million liters of the total demand. Pernambuco was the third largest consumer with 14 million liters.

Whereas the consumption of all other types of petroleum derivatives show an increase in 1940 over 1939, that of kerosene alone manifests a decline, slight as it may have been, being from the 142,400,000 liters of 1939 to the 142,300,000 liters of 1940. In the latter year, São Paulo was again the leading consumer with 29 million liters or 20% of the total while Rio Grande do Sul was the second largest with 16 million liters or 11%. There was but a slight difference among the next three largest consumers, that of the largest, Pernambuco, being 12.8 million liters, that of the second largest, Baía, being 12.5 million liters and the third largest, Minas Gerais, 12.4 million liters.

The consumption of both fuel oil and diesel and gas oil, which are to some extent, indices to industrial progress, showed the largest increases of all the petroleum derivatives, that of the former being from 641.2 to 830.9 million liters or 30% and that of the latter from 146.7 to 171.7 million liters or 17%. The largest consumers of fuel oil are the state of São Paulo and the Federal District, the quantity of the former in 1939 being 260.0 million liters and 254.0 million liters in 1940 while that of the latter manifested, an opposite trend, rising from the 215.3 million liters of 1939 to the 281.5 million liters of 1940. Of interest is the increase of the third largest state, Pernambuco, which in 1939 consumed but 97.6 million liters while in 1940, this had increased to 195.1 million liters. As to diesel and gas oil, the leading consumer is the Federal District while the second largest is the state of São Paulo, that of the former in 1939 being 68.2 million liters and 78.0 million liters in 1940 an increase of 14%. The latter consumed 29.3 million liters in 1939 and 41.3 million liters in 1940 for an increment of 14% also.

MOTOR ALCOHOL

The onerous burden of imports of petroleum and its derivatives are apparent from the above, particularly is this true of gasoline which, as was noted, accounts for 40% of this type of imports. Since 1931, a series of measures have been put in practice with the ultimate objective of reducing the purchases of gasoline. The first act of the Administration (Decree-Law N.° 19,718) obliged the importer to mix a minimum of 5% alcohol, produced domestically, in the gasoline sold. Until July 1932, the inclusion of alcohol of 96% was permitted but since then only anhydrous alcohol is allowed. The resultant carburant is known as *alcool-motor* (motor alcohol) locally. Decree-Law N.° 22,152 of November 28, 1932 established the norms of production which at the time were concerned with the utilization of sugar, an industry which was suffering the effects of serious overproduction difficulties. However, the complexity of the problem itself, the almost unlimited possibilities for industrial alcohol, and the need to centralize the production aspects of alcohol

and sugar in order to secure the requisite coordination necessitated the creation of the Instituto do Açucar e do Alcool on July 1, 1933.

To insure the success of the production of anhydrous alcohol, *aguardente* (brandy) and the alcohol given over to the manufacture of anhydrous alcohol and carburant were exempted from the payment of taxes.

As contrasted to the North European and Asiatic countries where potatoes in general furnish the principal raw material, that of Brazil depends almost completely on sugar cane. Strictly speaking, cane is not widely used as is the molasses that is obtained in the manufacture of sugar. One ton of crushed cane yields 64 liters of alcohol while two bags of 60 kilos each of brown sugar (equivalent to 1.2 tons of cane) yields an equal amount of alcohol as does 200 kilograms of molasses. Manioc is utilized in the state of Minas Gerais with apparent success there being the tendency to use second year growths of the root in the place of the first year root because of the higher alcohol yield.

At present there are 175 distilleries of which thirty with a total daily capacity of 427,000 liters produce anhydrous alcohol and 145 others with a capacity of 513,575 liters manufacture potable alcohol. Pernambuco, the sugar cane center, with 58 distilleries has the largest daily capacity (343,395 liters) and is followed by Estado do Rio with 26 units which have an output of 231,400 liters. The state of São Paulo has 31 distilleries with a total capacity of 221,280 liters. Production by states is noted in Table 20 from which it will be observed that the domestic output has risen 86% within the short space of four years. Brazil is now the eighth largest producer of alcohol in the world.

ALCOHOL

Table 20 PRODUCTION OF BRAZIL BY STATES IN METRIC TONS.

STATES	1931-5	1937	1938	1939	1940 ALL TYPES	1940 ANHYDROUS
Pernambuco	19.752	18.155	28.023	30.493	43.500	21.000
Estado do Rio	15.686	15.975	21.951	25.044	24.500	16.500
São Paulo	9.704	15.393	21.709	29.481	28.000	8.000
Alagôas	3.413	4.715	5.386	7.113	8.000	5.000
Minas Gerais	992	2.745	2.142	2.289	2.500	500
Espírito Santo	935	324	195	377	500	300
Santa Catarina	154	763	493	291	500	—
Sergipe	243	528	419	610	500	—
Paraíba	353	109	378	726	1.000	—
Mato Grosso	196	288	238	153	300	—
Baía	1.842	38	68	18	100	—
Pará	83	31	22	28	50	—
Rio Grande do Norte	—	—	—	92	350	—
Rio Grande do Sul	126	82	—	74	—	—
Goiaz	26	—	—	—	—	—
Acre	4	—	—	—	—	—
TOTAL: Tons	53.509	59.146	81.024	96.715	109.800	51.300
TOTAL: Contos	38.092	44.328	59.649	72.596	...	...

Pernambuco produced 21,000,000 liters or 41% of the total anhydrous alcohol in Brazil in 1940 and thus continued to maintain its lead in this industry. It may be noted in this connection that this state is also the largest producer of sugar cane in this country having an annual output in excess of 4,200,000 metric tons or 21% of the national total. Estado do Rio, the second in importance grows 15% of the total cane and produces 32% of the total anhydrous alcohol. The corresponding ratios for the state of São Paulo are 14% of cane and 16% of anhydrous alcohol while those of Alagoas are 8% and 10% respectively. These four states possess 96% of the total capacity, produce 58% of the total cane and 99% of the total anhydrous alcohol.

MOTOR — ALCOHOL

Table 21 PRODUCTION AND SAVINGS EFFECTED BY ITS USE

YEARS	PRODUCTION MOTOR - ALCOHOL (liters)	ALCOHOL UTILIZED (liters)	% INCREASE IN ANHYDROUS ALCOHOL Year to Year (%)	% INCREASE IN ANHYDROUS ALCOHOL Over 1932 (%)	FOB. VALUE OF GASOLINE SAVED BY USE OF ALCOHOL (contos)
1932	19,265,909	12,147,957	—	—	3,329
1933	14,630,854	12,963,002	+ 6.70	+ 6.70	3,020
1934	27,285,269	14,115,963	+ 8.89	+ 16.20	3,374
1935	47,524,474	16,741,945	+ 18.60	+ 37.82	5,876
1936	138,611,595	24,340,393	+ 45.39	+ 100.37	8,519
1937	112,342,593	18,446,646	— 24.21	+ 51.85	6,991
1938	213,477,743	32,689,879	+ 77.21	+ 169.10	11,409
1939	312,683,596	49,065,372	+ 50.09	+ 303.90	21,540
1940	299,216,620	44,834,030	— 4.31	+ 269.07	18,696
TOTAL .	1,185,038,653	225,345,187	—	—	82,754

Production of anhydrous alcohol began in 1933 with an output of 100,000 liters in São Paulo. In the following year, the total was 911,900 liters, there being five producing states in that year. By 1940, it is estimated that the total output had attained 51,300,000 liters which amounts to 47% of the total output of alcohol in the country. In the intermittent years the production trend was as follows: 1935 — 3,256,000 libers, 1936 — 7,740,000 liters, 1937 — 14,076,000 liters. 1938 — 20,617,000 and 1939 — 36,506,000. In 1939, there were 49,650,000 liters of alcohol mixed with 263,614,000 liters of gasoline and 2,900 liters of kerosene to make a total of 312,684,000 liters of motor-alcohol. The relative percentages of the total were thus, alcohol 16%, gasoline 84% and kerosene nil. During the eight year period 1932-9, the corresponding percentages were 20%, 80% and nil respectively, which in itself would tend to statistically refute the value of the motor-alcohol policy but which when considered with the data noted in Table 20 will serve to demonstrate that the output and hence, consumption of motor-alcohol increased 150 times from a very low minimum while the corresponding increase in alcohol was but four times from a relatively high initial point. In 1940, there was a total of 299,216,620 liters of motor-alcohol produced which included 44,834,030 liters of alcohol, 254,382,328 liters of gasoline and 262 liters of kerosene, the ratios of the respective component parts being 15% for alcohol, 85% for gasoline and nil for kerosene. It may

be noted in this connection that with the adoption of the policy under the direction of the Instituto do Alcool e do Açucar, the savings in gasoline made since 1932 amounted to 82,754 contos which is about two-fifths of the annual imports in recent years; the saving of 18,696 contos in 1940 represented 9% of the total imports of gasoline in that year.

A decidedly different aspect to this problem is found in the efforts given over to the practical application of the gasogene motor which utilizes charcoal and coal as fuels. As is true of sugar cane and manioc, Brazil is also the second largest in the world with regard to timber standings and as such provides unlimited sources of this raw material for charcoal production. Although data relative to production is unavailable, it is known that it is manufactured throughout Brazil, there being a surplus which is exported.

4. ELECTRICITY

An inventory of the possible sources of electricity in Brazil shows the overwhelming advantages which would come from the use of the available water-power potentials which is the sixth largest in the world. The abundant rainfall, the topography crossed by numerous mountain ranges which lie beside lightly undulated and extensive plains compose a complex oro-hydrographic system which is ideal for the formation of cataracts and water gradients.

Yet, there are regions where it is more advantageous to resort to thermo-electric power. The principal of these is the semi-arid Northeast composed of seven states which combined possess but 8% of the total available water potential and even as such, have this amount due to the presence of a large percentage (6%) of this in the remote interior of one of the border states. In this region, the Inspetoria de Obras Contra as Secas is constructing dams, principally for irrigation purposes, but with the installation of hydroelectric stations in some of the more suitable, it is expected that this will alleviate the problem to some extent. The recent discovery of petroleum in the coastal region of Baía and Alagôas also brings rays of hope to this industry but it must be borne in mind that, at least for the near future, there will not be sufficient quantities available to competely solve the problem in this region which thus suggests the possible continuation of the heavy annual imports of coal and diesel oil in this region for some time to come.

In the South, there is the coal producing state, Rio Grande do Sul which possesses but 1% of the total available national water-power sources and this also in the remote interior section so that with the cheap coal at hand, there is the great dependence on, and preference for, thermo-electric power.

The Northern states, Piauí and Maranhão also suffer from the lack of an available potential and not too infrequently there has risen the suggestion that in the place of the importation of great quantities of coal, there be used for the manufacture of coke, thè babassu nuts which grow in veritable forests and is at present wasted.

The remaining regions of Brazil may be said to be favored with water-power sources sufficient for their uses. The state of Minas Gerais possesses 30% of the total while the second largest are São Paulo and Paraná with 13% each, all three states mentioned deriving their favored position on the existence of the Paraná Basin which has a total of 7,300,000 kW or 50% of the national total. Mato Grosso and Pará are also well favored due to the Amazon Basin, the former having 11% of the total and the latter 10%. The Amazon Basin is the second largest in Brazil and accounts for 23% of the total available water-power. The third largest basin is that known as the East and represents 14% of the total while fourth in importance is the São Francisco Basin with 8%.

Yet this enormous potential which places this country as the sixth largest in the world after the Belgian Congo, Russia, the French Congo, India and the United States, has not been utilized to the extent which might be wished despite the great progress realized in this industry since 1920.

ELECTRICITY

Table 22. INSTALLED CAPACITY AND HYDRAULIC POTENTIAL IN KILOWATTS

	INSTALLED CAPACITY			1940		HYDRAULIC
	1938	1939	1940	THERMO.	HYDRO.	POTENTIAL
São Paulo	499.988	501,837	564,456	15.300	549.156	1,940,800
Estado do Rio	232,845	231,406	257,427	11,472	245,955	405,200
Minas Gerais	110,436	111,715	130,509	7,820	122,689	4,346,900
Rio Grande do Sul ...	40,774	40,873	58.016	48.432	9,584	183.000
Pernambuco	27.195	28,039	32,293	33,045	4.248	34,300
Baía	23,702	23,820	22,758	7,216	15,542	912.400
Paraná	16,808	16,073	16,325	1,644	14,681	1,934,000
Santa Catarina	14,642	15,092	15,383	1,740	13,643	146,700
Pará	14,416	14,440	14.527	14.527	—	300
Federal District	12,487	12,487	13,187	12,812	375	300
TOTAL (inc. others)	1,040,445	1,044,738	1,186,882	193,140	993,742	14,561,200

The electrical industry in Brazil began in 1883 with the erection of a thermo-electric plant whose capacity did not exceed 50 kW. In 1889 there were three generating plants, one of them being a hydroelectric unit installed in the city of Juiz de Fora in the state of Minas Gerais. In 1900, even though the number of hydro-electric plants equalled that of thermo-electric plants, i. e., six, the generating capacity of the latter was 6,385 kW, while that of the former was only 3,791 kW. The year 1920, marks the point in which there was the initiation of an accentuated development in the exploitation of the hydroelectric sources; at this date, there were 306 enterprises with 134 thermo-electric generating plants, 204 hydroelectric plants and five of mixed origin distributed throughout 431 localities. The total thermoelectric capacity was 78,880 kW. while that of hydraulic origin amounted to 276,100 kW., making a total of 354,980 kW., for all Brazil. The impetus given the industry continued for twenty years and in 1939, there were 1,176 enterprises engaged in this industry with 637 thermo-electric plants, 738 hydro-electric plants and 15 with mixed generating equipment.

The total installed capacity was 1,044,738 kW., of which 160,168 kW. was thermoelectric and the remaining 884,570 kW., or 84.7W was hydro-electric.

In 1940, there were 1,312 enterprises or 136 more than 1939 supplying electric power to 2,331 localities. The number of thermoelectric plants operated by these enterprises totalled 740 an increase of 103 over 1939 while the number of hydroelectric units was 732. Twenty-seven plants had mixed equipment while there were 64 which had hydroelectric equipment for private use. The increment in both energy supplying and private hydroelectric plants increased by 58 over the previous year.

It may be noted as a point of interest that the total hydroelectric installed capacity of 993,742 kW in 1940 was equivalent to 84% of the total installed capacity which on the other hand represented only 7% of the total hydraulic potential of the country. The apparent reluctance to develop the possibilities which exist in the country may be partially explained by the fact that there are few but extremely high potentials available in the regions which are inaccessible and remote from the industrial or urban centers which prevents their utilization. Three striking examples are found in Paraná River system which in Paraná contains the Sete Quédas Falls and in Minas Gerais and São Paulo is concentrated along the state boundaries.

The Usina de Cubatão (hydroelectric) located in the Coast Range near the port of Santos has the largest installed capacity in Brazil and is the eighth largest in the world. This plant (280,000 kW.) serves the port city as well as the city of São Paulo, the largest industrial center in Brazil. The second in size is the Usina de Ilha dos Pombos of Estado do Rio and has an installed capacity of 117,040 kW while the third largest, the Usina de Ribeirão das Lages, also of Estado do Rio has a generating capacity of 67,647 kW. These plants serve the Federal Capital, Rio de Janeiro.

The largest thermoelectric plant is in Recife in the state of Pernambuco and has an installed capacity of 22,500 kW. while the second largest of this type is that of Porto Alegre of the state of Rio Grande do Sul. Although the other large units are in the Southeast, the major portion of the capacity is in Rio Grande do Sul and the Northeast, that of the first being based on the large deposits of coal that are found in that state and that of the Northeast because the region is one of droughts and cannot depend regularly upon suficient rainfall thus necessitating the use of coal and thermoelectric equipment.

The prime movers of the thermoelectric generating plants may be classified into the following: reciprocating, steam turbines, *gas pobre* (poor gas), and diesel, the relative percentages of each in the total generating capacity being 40% for the first, 40% for the second, 11% for the third and 9% for the last. The first two are based on steam generation and account in some measure for the large coal and oil consumption in the country. The largest installations with reciprocating engines for prime movers are in the states of Pernambuco (35% of total), Pará (18% of the total) and Paraná (8% of the total). Rio Grande do Sul possesses 41% of the total using steam turbine prime movers while the Federal District is second with 24%. Baía and Rio Grande do Sul

are the largest users of *gas pobre* prime movers while the largest for diesel motors are São Paulo, Rio Grande do Sul and Estado do Rio.

A study of the generating equipment in the country recently revealed that the majority of central power stations are equipped with AC current generators, the DC generators being almost completely equipment installed for private or factory use only. Of the total of 874,753 kW. of installed capacity registered in this survey, 859,483 kW. was for AC current (818 central stations) and 16,170 for DC (372 central stations). The former serves approximately 12,6 million inhabitants or factories while that of the latter amounts to 1.9 million. The states with the largest DC installations are Rio Grande do Sul and Amazonas. The largest AC current equipments is found in the state of São Paulo. Estado do Rio (to supply the city of Rio de Janeiro) is the second largest while Minas Gerais is the third.

One of the principal problems connected with the supply of electrical energy is that of uniformizing the frequency of the current. Particularly is this true when construed in the light of the fact that a substantial proportion of the water gradients fit for the generation of hydroelectric power exists in the interior of the country, in no small number of cases, closer to the neighboring South American countries than the seaboard cities of Brazil and thus suggests the possibility of selling electricity which brings with it a natural prerequisite — uniformity of current frequency. Another important advantage is that which arises from the standardization of generating equipment.

Steps have already been taken in Brazil to bring about a realization of this standardization, the principal of which was the Decree-Law N° 852 of Nov. 11, 1938, under which the concessionaire was obliged to adopt a frequency of 50 cycles after the termination of the "useful life" of the generating equipment. All generating equipment is to terminate its "useful life" by the end of 1946.

Viewing the generating equipment from the standpoint of frequency of the generated power, practically all of which is three-phase, one finds that 407,622 kW. is 50 cycle generators, 315,800 kW. of which is hydroelectric and 91,882 kW. of thermoelectric serving 7,600,000 inhabitants and, 439,127 kW. of 60 cycles of which 407,735 kW. is hydroelectric and 31,392 kW. is thermoelectric serving 5,000,000 inhabitants. There are 11,834 kW. of generating capacity of other frequencies. Practically 48% of the total 50 cycle frequency equipment is in Estado do Rio. The second largest, Minas Gerais, has 14% of the total while São Paulo is third with 8%. With the change to 50 cycles, the most seriously affected state is São Paulo which accounts for 74% of the total of the 60 cycle group, the second largest being Minas Gerais which has 13% of the total. Estado do Rio, Baía and Paraná follow in the order named.

Data as to the consumption of electricity in Brazil is not available, the only elements at hand being the consumption of the two largest urban centers of Brazil, Rio de Janeiro and São Paulo, and that of electricity supplied by the two largest power companies in Brazil.

Focusing attention, first, on that of the energy provided in 1938 by the two largest power concerns in Brazil, that of the Brazilian Traction Light and Power Company, commonly referred to as "Light" locally, amounted to 1,462,587,000 kWH. while that of another, the Empresas Electricas Brasileiras, S. A. totalled 458,877,800 kWH. the two supplying a total of 1,920,000,000 kWH. The two in that year possessed 69% of the total installed generating capacity in Brazil the former having 561,860 kW. and the latter 157,390 kW. In 1939 "Light" furnished 1,760,048,160 kWH. of electricity while the Empresas Electricas Brasileiras concern provided 452,775,000 kWH. In that year, the combined generating capacity totalled 933,079 kWH. or 70% of the Brazilian total. Data for 1940 show that "Light" increased its sales to 1,710,312,700 kWH; that of the second company was 499,533,000. kWH. In that year the former was operating with an installed capacity of 642,608 kW. while that of the latter was 170,212 kW., or 54% and 14% of the national total respectively. It must be out that any estimated based on a correlation of partial installed generating capacities to its total and that of partial kWH. sold to the total kWH. sold does not hold true in view of the fact that the two companies serve the most heavily populated regions of Brazil and in general, operate on a higher efficiency rating than do the others.

Partial data also shows that the consumption of electricity in the city of Rio de Janeiro was 452,752,000 kWH. in 1940 a compared to the 471,461,000 kWH. of 1937. In the latter year, 46% of the total was used for power, 29% for illumination and traction 25%. The relatively high percentage for illumination is accounted in large part by the extensive shore-line lighting system for which the city has become famous among tourists and earned the name of "Cidade Maravilhosa" (marvelous city). Public illumination represents 30% of the total of that category.

Data of the largest supplier of the Northeast region of Brazil show that 37% of the total energy is used for traction purposes while 32% is employed for industrial ends. A classification denoted "comercial services" is the third largest consumer consisting of 19% of the total. It is interesting to note that the portion for residences amounts to but 10%.

The same company which also supplies a large part of the total of the South diverted 22% of its total to traction purposes, and 25% for industrial uses. The amounts supplied to "commercial services" and residences, in this region, were equal as contrasted to the Northeast in which the former was larger.

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