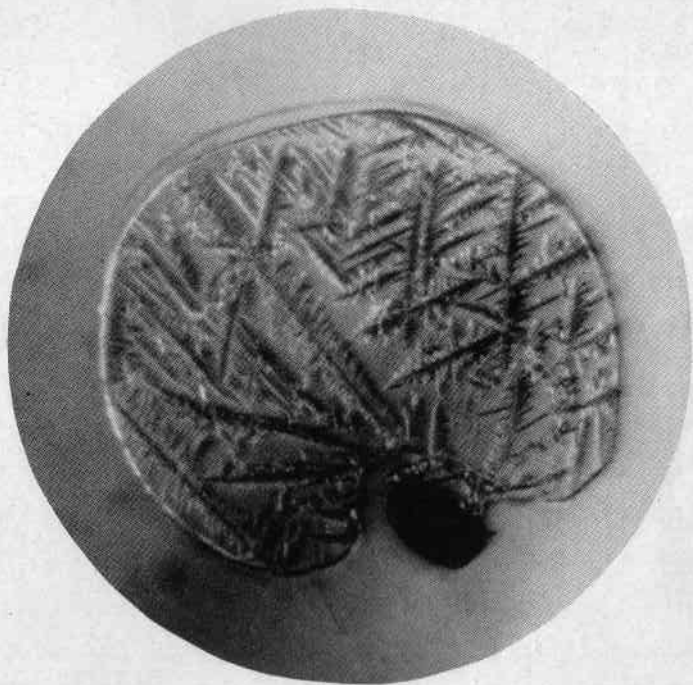


Gems and Gemology



Hidden beauty of a
Siam Sapphire revealed
through a microscope.

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Gems & Gemology

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Robert M. Shipley, Editor

VOLUME V

SPRING, 1947

NUMBER 9

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Cover: Interesting recrystallization in a liquid inclusion of a Siam sapphire. From photomicrograph by Dr. Edward Gübelin.

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(UNITED STATES AND CANADA)

Established 1931

541 South Alexandria Ave.



Los Angeles 5, California

Gemology in North America*

by

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University of Michigan

The people of the United States and of the world are today more mineral and gem conscious than ever before. In large measure, this is due to the enormous advances made in science and technology during the last half-century. The additions to our knowledge during the last fifty years are as great, yes, perhaps greater, than in all previous history. The production of minerals since 1900 exceeds that of all previous time. At present, minerals and gems loom large in national and international affairs.

In the textbooks on physics of the early nineties, one cannot find any reference to x-rays, radium, or radio. At that time, the term electron was associated with amber, because of its property of frictional electricity. In the dictionaries of that period, electron was also considered as being the same as electrum, an alloy of gold and silver. It was in 1897 that the electron, as we understand it today, was demonstrated by the English physicist, J. J. Thomson. Two years earlier, in 1895, Roentgen discovered x-rays at Wurzburg, Germany, where he was professor of physics. However, the real nature of x-rays was not well understood until seventeen years later, when, in 1912, Laue, Friedrich, and Knipping, at the University of Munich, passed x-rays

through oriented crystal plates. The results of this epoch-making experiment confirmed the theory of the lattice structure of crystals, which had been previously postulated on purely theoretical considerations. The Laue experiment led to many significant advances in physics, and subsequently to the development of modern x-ray analysis of crystal structure.

Radium, which was recovered from the mineral commonly known as pitchblende, was not discovered until 1898 by the Curies and Belmont. As early as 1887, the German physicist, Hertz, sent a feeble message without wires across a room. Ten years later, in 1897, Marconi sent a wireless message fifteen miles, and four years later, in 1901, he succeeded in transmitting one across the Atlantic Ocean.

New Uses Found for Minerals

These epoch-making discoveries and the large number of others which followed in due course opened many new fields of research, and have exerted a profound influence upon our civilization and way of life. They have caused minerals to be used in greatly increased quantities. Many new uses of minerals, long known to the mineralogist, were developed. Some of these minerals have varieties that are important as gems; for example, the diamond, now used in very large quantities for industrial purposes,

*Address given at the twelfth Conclave of the American Gem Society (United States and Canada) at Chicago on March 30, 1947.

and the rock crystal variety of quartz, which in the form of thin piezo-electric oscillating plates has become essential in radio communication and in the more precise timing of the clocks in some of the world's important observatories. Many other illustrations might be given of new uses of old minerals in our modern times.

Synthetic Materials Produced

During the last fifty years, many important developments have been made in crystal optics. The simple method for the determination of indices of refraction of crystals and minerals under the microscope was discovered by Becke in 1893. Since then, the method has been greatly refined and is now used extensively. The improvements which have been made on the polarizing or petrographic microscope during this period have been many, so that today the instrument is one of great precision and usefulness. Simple direct-reading refractometers, which are very helpful to the gemologist, have been developed, such as the Smith, Tully, Rayner, and the Erb and Gray. These and many other instruments, which include, for example, the diamondscope, polariscope, diamond colorimeter, diamolite, and many others developed at the Gemological Institute of America, are of vital importance in the study of gems and gem materials. The application of x-ray technique to gems is also a very important contribution of the Institute.

During the last fifty years, much progress has also been made in the production of synthetic gem materials. Thus, the Verneuil process, now used for the manufacture of synthetic rubies, sapphires, and spinels, was developed in France

about 1902. In 1908, Baekeland announced the production in this country of the phenol-formaldehyde resin known as bakelite. Today, there are many plastics on the market, some of which are used for personal adornment. Moreover, as the result of many experiments made during this period of fifty years, it has been repeatedly shown that no incontrovertible proof has been given that the diamond has ever been produced in the laboratory, as had been claimed by the French chemist, Moissan, in 1893, and by others since then.

Gemology Books Published

From the earliest times, man has always been interested in personal adornment. For this purpose, various minerals, for example, the diamond, ruby, and sapphire, rock crystal, and many others, found early use. However, early students of mineralogy did not usually stress the minerals that served as gems. It was during the latter part of the nineteenth century that professional mineralogists began to take greater interest in this phase of their subject, when several noted European authorities published texts on gem minerals. In 1883, Groth, professor of mineralogy at the University of Munich, and in 1893, Doelter, at the University of Vienna, published elementary texts. In 1896, Max Bauer, of the University of Marburg, issued his *Edelsteinkunde*, which was a monumental contribution and served as a most valuable reference work. After Bauer's death, the book was revised by Professor Schlossmacher, of the University of Königsberg, and issued in two volumes during the years 1928 to 1932.

In this country, G. F. Kunz published *Gems and Precious Stones of*

North America in 1890. Kunz followed, in 1908, with his *The Book of the Pearl*, in 1913 with the one on *The Curious Lore of Precious Stones*, in 1915 with *The Magic of Jewels and Charms*, and in 1916 with *Shakespeare and Precious Stones*. Although Kunz could not be ranked with Groth, Doelter, and Bauer, who were highly trained, scientific mineralogists, his influence in the field of gemology in the United States was very great. In 1903, O. C. Farrington, of the Field-Columbian Museum in Chicago, published *Gems and Gem Minerals*. In 1912, in England, the first edition of G. F. H. Smith's *Gem Stones and Their Characters* was issued. This book subsequently appeared in many editions, and in 1940 was revised and greatly enlarged. During the last thirty years, there has been a great increase in the number of books which are very useful in the field of gemology.

First Course on Gems

Shortly after the turn of the century, Dr. Alfred J. Moses, professor of mineralogy at Columbia University, introduced a short course on gems designed primarily for dealers. This course, which has been modified from time to time, has been continued. Also early in the century, Professor G. M. Butler gave, for a period, a somewhat similar course at the School of Mines at Golden, Colorado.

In the spring of 1916, I introduced at the University of Michigan a general cultural lecture course dealing with gems. The course was very well attended, and I continued to give it until 1933, when I was appointed Dean of the College of Literature, Science and the Arts, and devoted my entire time to administrative duties. Since 1934, the

course has been conducted by my very able colleague, Professor Chester B. Slawson. During the last two decades, similar credit courses have been organized at a number of colleges and universities in this country.

In 1916, the task of assembling material for a course on gems was not easy. The fundamentals of crystallography and mineralogy, as well as the description of gem minerals, offered no difficulty. But it was a real problem at that time to secure authoritative information concerning gem cutting, especially of the diamond, for very few mineralogists in this country or abroad had endeavored to make personal contacts with diamond cutters. Accordingly, such contacts were made, and very material assistance was early obtained from Milton Kadison, of New York and Henri Polak, president of the International Diamond Cutters' Union of Amsterdam; and later from S. H. Ball, Lazare Kaplan and his sons, Leo and George, of New York; Jack Levy, of Detroit; and Sal Asscher, of Amsterdam, and many others. Then, too, there was very little detailed information available concerning the preparation of synthetic rubies and sapphires, which were then becoming important. Moreover, when blue zircons began to appear on the market in large quantities, doubt was raised in my mind whether the color was actually natural.

With the assistance of my associate, the late Dr. Edward F. Holden, the lecture material appeared in 1925 in book form under the title, *Gems and Gem Materials*. During the last two decades, the book has been well received in this country and abroad. Since 1939, when the

third edition appeared, Professor Slawson has been the junior author.

European Centers Visited

In 1926 and 1936, trips were made to Europe in order to secure first-hand authoritative information on the various phases of gem cutting, synthetics, blue zircons, and so forth. In 1926, I was particularly anxious to visit plants making synthetic rubies and sapphires. Prominent mineralogists in Germany upon whom I called could offer very little assistance. They knew there was a plant at Bitterfeld and that permission to visit it could not be obtained. The German mineralogists were, however, certain that synthetics were also produced in Switzerland, but they did not know where. Even the Swiss professor of mineralogy at the University of Berne did not know the location of the plants in his own country. But it was suggested by him that there probably was one at Biel. I went to Biel, and after much inquiring, ferreted out the location of the Jewel Works Company. As I approached the entrance of the plant, an up-standing man was leaving the office. He proved to be Mr. J. Telecki, the superintendent. Upon inquiry whether synthetic gems were manufactured there, I received an affirmative reply. I told him I was professor of mineralogy at the University of Michigan, and that I had lectured on synthetic rubies and sapphires and had published a book on gems, but that I had never seen synthetic rubies and sapphires made. When I asked whether I might see his plant and observe the process, he immediately replied, "Certainly—that's the way university professors usually do. They first lecture and

write about a subject and then afterwards try to obtain first-hand information. In fact, a noted European has just published a large book on synthetic gems, but he, likewise, has never seen them made. Sir, come right in."

Although it was then after working hours, a furnace was started up and the operation demonstrated. Telecki generously answered all the questions I asked. In fact, he subsequently sent me a long report giving detailed information about the various aspects of the process. This report has served as the basis of the description of the Verneuil process for the production of these synthetics in subsequent editions of *Gems and Gem Materials*. Ten years later, visits were made to the plant of the Swiss Jewel Company, at Locarno, Switzerland, and to the one at Bitterfeld, Germany. Mr. E. G. Sandmeier, manager of the Locarno plant, has for many years furnished much valuable information.

On both trips to Europe, visits were made to the old and very important gem-cutting center at Idar-Oberstein, Germany, where the industry has flourished since the latter part of the fifteenth century. Visits were also made to the plant of Asscher and Company in Amsterdam, where the famous Cullinan diamond was cut. The itineraries also included a trip to the so-called "amber coast" at Palmnicken on the Baltic Sea, and to Königsberg in East Prussia, where much amber is prepared for the market. Many universities, and mineralogical and gem collections were also visited in Germany, Austria, Czechoslovakia, Switzerland, Holland, France, and England.

(Continued on Page 402)

Pearl Identification By X-ray Diffraction

Mappin's Gemmological Laboratories, Montreal

by

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PART I†

Theory of X-ray Diffraction by Pearl

ABSTRACT

An experimental study of the application of X-ray diffraction methods to the identification of natural (oriental) and cultured pearls is described. A technique for the examination of pearls when the X-ray beam cannot be directed through the centre of the specimen is discussed. A few X-ray diffraction patterns obtained from conch and fresh-water pearls are included.

Introduction

The diffraction of X-rays by pearls when the X-ray beam passes through the geometric centre of the specimen has been the subject of a number of investigations (1).^{*} In some pieces of jewellery, however, pearls are keyed on their mounts so that it is inadvisable to attempt their removal. In such cases, although the size of the pearl and the type of setting may permit examination by X-ray diffraction methods, it is usually impossible to direct the X-ray beam through the centre of the pearl. The results of a detailed study of the X-ray diffraction effects from natural and cultured pearls under such asymmetric conditions are discussed in the present paper. In addition, an extensive examination of the X-ray diffraction patterns obtained from a cultured pearl under controlled variations of

orientation relative to an X-ray beam passing through its centre are described. A few X-ray diffraction patterns given by conch and fresh-water pearls also are included.

Apparatus

A Hilger all-steel gas-type X-ray tube (2) with tungsten target was employed throughout this investigation. The radiation was not filtered. Due to the relatively large absorption of radiation by the thickness of the specimens through which the X-ray beam must pass in the case of pearls of moderate size, the greater penetrating power (shorter wavelength) of tungsten radiation makes such a target preferable to one of molybdenum or copper for this work.

In most cases the pearl under examination was mounted on the goniometric arcs of a Cambridge Universal X-ray Photogoniometer (3).

The horizontal X-ray beam was defined by a pin-hole system of 0.5 mm. diameter and the diffraction pattern was recorded on flat film normal to the X-ray beam and about 4 cm. from the centre of the pearl. This instrument permits predetermined angular settings of the specimen over a range of 360° about a vertical axis, a limited range of angular positions on the arcs about two horizontal directions at right angles, a small range of vertical adjustments, and a small range of

†*Editor's Note:* The work described in the following pages was carried out for, and constitutes a contribution from, the Gemmological Laboratory of Mappin's Limited, Montreal. It was undertaken at the suggestion of Mr. H. R. Cox, F.G.A., and with the cooperation of Mr. K. G. Mappin, F.G.A., C.G., Director of the Laboratory.

^{*}Numeral refer to references at end of installment.

horizontal adjustments in two directions at right angles. By means of suitable vertical and horizontal movements of the film holder between exposures and by the use of appropriately cut masks of lead foil to protect the area of film outside each diffraction pattern during exposure, it was possible to obtain six photographs on a single film. During each exposure the undiffracted portion of the X-ray beam was absorbed in a lead button which was removed for a few seconds to permit registration of the main beam on the film without excessive fogging at the centre of the diffraction pattern. The shadow of this lead button appears as a clear disc enclosing the spot due to the undiffracted beam in each of the photographs.

For part of the work a less elaborate apparatus (4) was employed which permitted a vertical beam of X-radiation, defined by pin-holes, to pass through the centre of a pearl placed in a small hole in a metal disc. The flat film holder was normal to the X-ray beam and about 3.5 cm. from the centre of the specimen but no lead button was used to absorb the energy of the undiffracted beam during exposure. No adjustment of this film holder was possible but two patterns could be recorded on each film by placing the film in a light-tight envelope smaller than the film holder, opening the top of the latter between exposures and moving the film to another position in the holder.

During the course of the present investigation it was found that with tungsten radiation and Agfa Non-Screen X-ray film, at least three films can be placed one behind the other in the film holder and the diminution in the intensity of the

X-ray diffraction patterns on the second and third films is of no practical importance for pattern identification purposes. Such a procedure thus gives two or three original negatives, one or two of which may be filed in the X-ray laboratory while one may be attached to the report on the pearl under examination.

General Theory

It has already been established (1, b, d, e, f) that the X-ray diffraction patterns obtained from pearls are due to the presence of aragonite crystals. In the natural pearl, as well as in conch and in most freshwater specimens, these crystals are arranged radially with their pseudo-hexagonal axes¹ perpendicular (normal) to the spherical surface of the pearl. In mother-of-pearl, however, they occur in layers with their pseudo-hexagonal axes normal to the more or less plane parallel surfaces of the laminae. In the cultured pearl, the outer layer of nacre is so thin compared with the radius of the mother-of-pearl core that the observed diffraction effects are essentially those of mother-of-pearl. It is possible, of course, that a cultured pearl might contain a mother-of-pearl bead so small compared with the thickness of the outer covering of nacre that the latter would determine the type of diffraction pattern obtained. The probability of such specimens being in circulation, however, is not very great because of the prolonged time that would be required for their cultivation in the pearl farm. This conjecture receives support from the fact that a cultured pearl alleged to have been

¹Although aragonite is orthorhombic, its structure is such that the principal axis is one of almost hexagonal symmetry.

sixteen years under cultivation gave typical mother-of-pearl patterns. The diffraction effects characteristic of a natural pearl also would be expected from a cultured pearl having a seed-pearl as nucleus. Such pearls probably could be identified by radiographic methods of X-ray

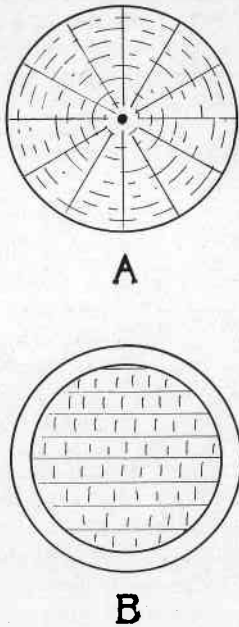


Figure 1

examination (i.e., X-ray "shadow" pictures such as those employed in medical and surgical diagnosis and industrially for the location of physical defects in structural materials, etc.) because of the relatively low density of the conchiolin layer that separates the outer nacre from the core. The present investigation, however, is concerned with the usual type of cultured pearl containing a mother-of-pearl core of sufficient size to determine the nature of the X-ray diffraction effects observed.

The manner in which the aragonite crystals are arranged in genuine and cultured pearls is shown schematically in Figure 1. Figure 1-a shows a genuine pearl to be composed of concentric layers of needle-like aragonite crystals from the centre of the pearl outward. Every crystal is oriented with its long, or pseudo-hexagonal axis perpendicular to the surface of the pearl, or in other words, along a radius of the pearl. In contrast to this, in Figure 1-b the aragonite crystals are seen to have an entirely different orientation in cultured pearl. Here, the axes of the crystals making up the mother-of-pearl core are essentially parallel, and perpendicular to the layered structure of the mother-of-pearl. The mother-of-pearl bead is surrounded by a thin layer of genuine pearl, but since most of its bulk is mother-of-pearl, a cultured pearl reacts to X-rays as though it were composed entirely of mother-of-pearl.

It is of particular importance now to consider the types of X-ray diffraction patterns which may be obtained as the X-ray beam is directed in various directions through a fibrous aggregate of aragonite crystals such as make up pearl. Patterns of two types may be obtained:

A. The X-ray beam is parallel to the long, or pseudo-hexagonal axes of the crystals of aragonite. The resultant pattern is of the hexagonal spot, spoke, or halo type, such as pictured in Fig. 2, P-5-3, P-5-4, P-46-2, P-46-3, P-46-4. Patterns of this type are obtained when X-rays pass through the centre of a genuine pearl in any direction. Similar patterns are obtained from a cultured pearl only if the X-ray beam is

passed through the pearl in a direction perpendicular to, or nearly perpendicular to, the parallel layers of the mother-of-pearl bead.

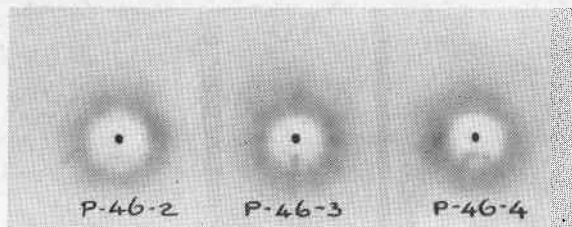
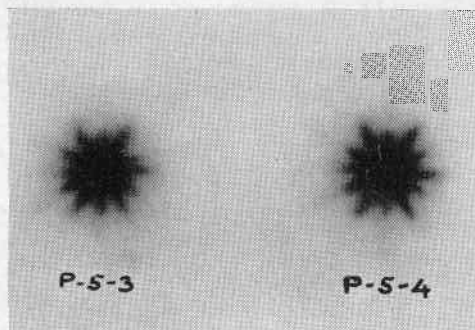


Figure 2

B. The X-ray beam is perpendicular to the long axes of the aragonite crystals. In this case rectangular diffraction patterns of the type shown in Figure 3 are obtained. Patterns of this type are not obtained from a genuine pearl regardless of direction of the X-ray beam, provided it passes through or near the centre of the pearl. Patterns of this type are obtained when the X-ray beam is perpendicular to the long axis of the aragonite crystals of the mother-of-pearl bead.

In both natural pearl and mother-of-pearl, although the pseudo-hexagonal axes of the individual crystals are all more or less normal to a spherical surface in the former and to a plane surface in the latter, the crystals may have any orientation with respect to one another

around the direction of the pseudo-hexagonal axes. The general structure, therefore, is similar to that of the mineral fibres such as asbestos, fibrous calcite and fibrous aragonite and to that of the textile fibres such as natural silk, ramie cellulose and stretched cotton (5). The diffraction of X-rays by a stationary fibre is analogous to that by a single crystal rotated continuously about an important crystallographic axis during exposure to the X-ray beam. The fact that the pseudo-hexagonal axes of the aragonite

crystals in pearl lie along a preferred direction, while individual crystals may have any orientation around this axis, is equivalent to rotating a single crystal of aragonite continuous-

ly about its pseudo-hexagonal axis. In pearl, however, individual crystals may diverge to a greater or lesser degree from perfect alignment of their pseudo-hexagonal axes and all possible angular positions about these axes may not be represented among the finite number of crystals in the path of the X-ray beam. Thus, whereas the diffracted rays from a single rotating crystal give sharply-defined spots on a photographic negative when the X-ray beam is at right angles to the axis of rotation and sharply-defined concentric circles when it coincides with the rotation axis, the spots are drawn out into streaks and the circles become arcs in the corresponding patterns obtained from stationary fibres.

When the X-ray beam is normal to the preferred direction of the

pseudo-hexagonal axes of the aragonite crystals in pearl, the diffraction pattern obtained on a flat film normal to the X-ray beam consists of a series of spots (drawn out more or less into streaks) on a "zero layer line" through the spot due to the undiffracted portion of the X-ray beam and on hyperbolic layer lines above and below the zero line. The pattern is symmetrical about lines, parallel and perpendicular, respectively, to the direction of the

direction of the pseudo-hexagonal axes. In most patterns, internal strain in the pearl causes the spots to appear as radial streaks and the haloes to broaden towards the centre of the pattern.

The hexagonal or halo pattern is obtained when the X-ray beam passes through the centre of a natural pearl in any direction but only when the direction of the beam is normal (or nearly so) to the layers of the mother-of-pearl core of a cultured pearl. If the beam makes an appreciable angle with the normal to these layers in a cultured pearl, the characteristic diagram of fibrous aragonite appears. Since one of the prominent features of this pattern (see Figure 3 for example) is a set of four spots (arising from the $\{111\}$ planes) at the corners of a rectangle enclosing the spot due to the undiffracted beam, this fibre diagram will be referred to as the "rectangular" pattern to differentiate it from those of the hexagonal or halo types. From its general appearance, Alexander (1, f) has compared the fibre diagram as a whole to a "Maltese cross."

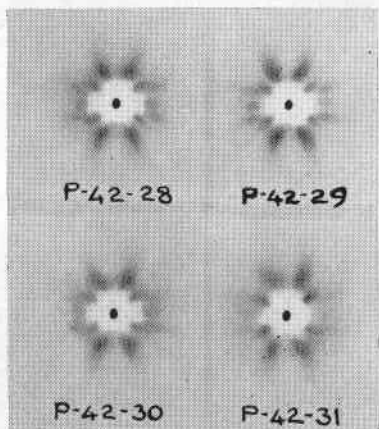


Figure 3

pseudo-hexagonal fibre axis. Thus, for example, in the patterns P-42-28 to P-42-31 reproduced in Figure 3, the pseudo-hexagonal axes of the crystals were vertical and the zero layer lines in the diagrams are horizontal. When the direction of the X-ray beam coincides with that of the pseudo-hexagonal axes, the diffraction pattern consists of a distribution of spots exhibiting hexagonal symmetry around a central spot due to the undiffracted portion of the X-ray beam or of a broken or unbroken halo, depending on the degree of perfection of random orientation of the crystals about the

(To Be Continued)

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Fluorescent Diamonds

by

GEORGE SWITZER, Ph.D.

Director of Research, Gemological Institute of America

Diamond is treasured and admired for its remarkable clearness, great brilliance, and constantly changing flashes of fire. These aspects of its appearance are well known to the millions who wear them. What is *not* commonly known is that diamonds sometimes exhibit even more spectacular effects than brilliance and fire; some diamonds glow like hot coals of many colors in ultraviolet light. The effect of this "black light" on some diamonds is very spectacular, as is shown by the accompanying color plate. The diamonds in this picture,* when viewed in ordinary light are unattractive, yellowish to brownish rough stones, looking completely uninteresting to the untrained eye. In a darkened room, however, under ultraviolet light, rather than being completely invisible, the diamonds glow vividly in a variety of colors.

This strange effect is known as **fluorescence**. Many different substances are known to **fluoresce** or glow when placed before a source of ultraviolet light in a darkened room, but none is more spectacular in its exhibition of a large range of colors of fluorescence than is diamond. The experiment may be carried a further step by turning off the ultraviolet lights after having viewed the fluorescence for a short time. It will be seen now that a few of the diamonds continue to glow

with a yellowish white light, even though they are no longer being exposed to ultraviolet rays. This continued emission of visible light is known as **phosphorescence**.

Possible Cause of Fluorescence

Now that this hitherto unsuspected beauty of diamonds has been observed, the question which naturally arises is why do these diamonds glow in the dark when irradiated by ultraviolet light? Before attempting to answer this question it will be necessary to first review briefly a theory commonly proposed to explain the phenomenon whereby any solid body emits light.

The atoms of which all materials are composed are made up of a heavy central **nucleus**, surrounded by a number of smaller, lighter **electrons**. These electrons rotate in fixed orbits about the nucleus much in the same manner as the planets rotate about the sun. Under normal conditions these electrons rotate always in particular orbits having fixed distances from their nucleus.

These various orbits are called **energy levels**. Now, if our atom receives energy from an outside source, such as heat, the electrons of any particular orbit are driven to an orbit farther out from the nucleus, in opposition to the attractive force of the nucleus, or to a **higher energy level**. They are now in an unstable position, having been driven there by absorption of energy. When these electrons return to their normal position they do so accom-

*The fluorescent diamonds shown in the color plate were obtained through the courtesy of Lazare Kaplan & Sons, Inc., New York.

panied by emission of energy, which may be in the form of light. This is the Bohr theory of the atom, which is now outmoded and has been replaced by a purely mathematical treatment known as the quantum theory. The Bohr theory, however, is easy to visualize and is still useful for elementary discussions.

The most common manner in which the electrons of an atom are driven to a higher energy level is by application of heat. When a solid is heated until it becomes red hot it is said to be **incandescent**. In such a case the heat energy has driven the electrons to a higher energy level, and as they return to their stable condition light is emitted. Visible light is emitted only when the frequency of motion of the electrons becomes rapid enough to propagate waves having a frequency in the range to which the human eye is sensitive.

Another manner in which the electrons of an atom may sometimes be driven to a higher energy level is by supplying energy in the form of ultraviolet light. If as the electrons return to a stable condition, light is emitted, the substance is said to be **fluorescent**.

Now that a theory of fluorescence has been proposed, our problem is to determine why in some substances the emission of visible light is brought about by excitation by ultraviolet light without application of heat. A commonly proposed theory to explain this phenomenon is to suppose that certain atoms present in the crystal as impurities do not fit well into the pattern assumed by the atoms of the material in question and thus cause the crystal to be in a condition of strain. In

this strained condition the crystal components are set into the necessary vibratory motion when radiated by ultraviolet light, and fluorescence results.

In the case of diamonds this above-discussed theory will not always offer a logical explanation because many fluorescent diamonds are exceedingly pure chemically. In the case of industrial diamonds, where the degree of chemical purity is considerably less, it might at first be supposed that there would be a relation between chemical impurities and fluorescence. However, at the present time there is no apparent correlation between chemical composition and fluorescence.

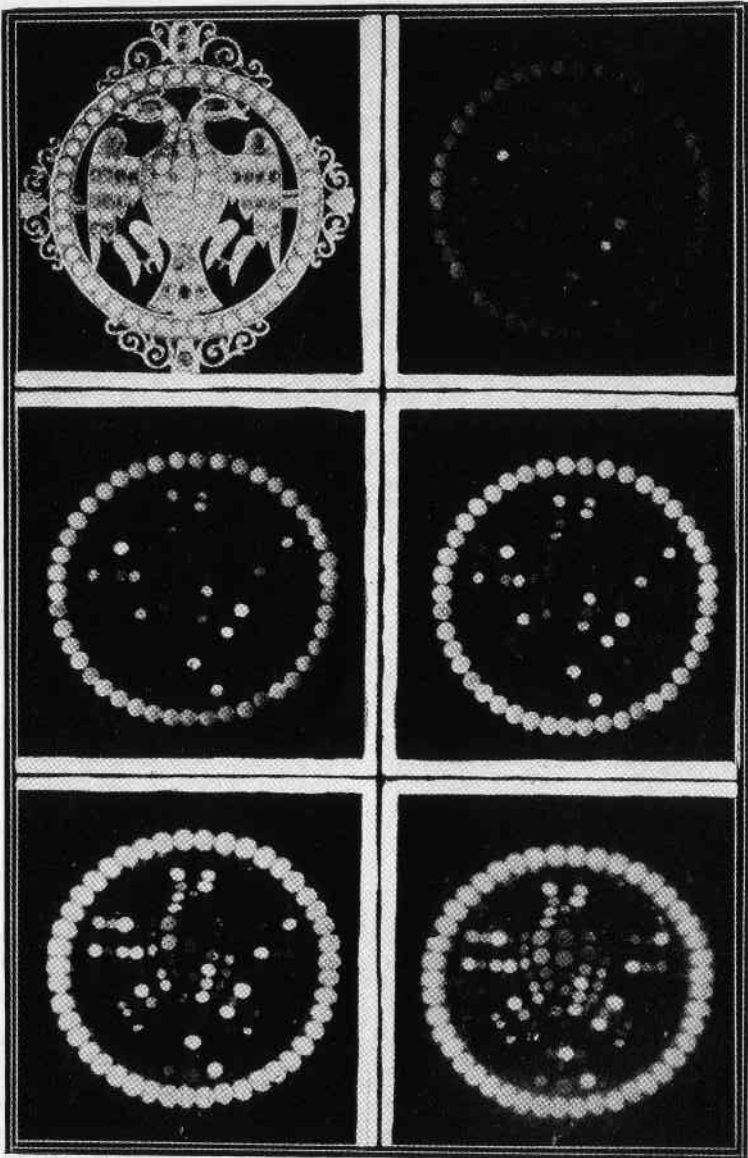
Theories of Diamond Structure

Recent studies into the atomic structure of diamond have led to a proposal by Sir C. V. Raman of the Indian Institute of Science, Bangalore, India,¹ that the fluorescence of diamond may be related to atomic structure. Raman and his associates have proposed that there are actually four different types of diamonds, differing slightly from one another in the manner in which the atoms are arranged in space. Two of the four proposed structures are thought to be of tetrahedral symmetry and the other two to be octahedral.

Raman summarizes his results by stating that the blue fluorescence is caused by an intergrowth of the positive and negative tetrahedral structures. The interpenetration of the tetrahedral and octahedral structures gives rise to the yellow fluorescence.

(Continued on Page 398)

¹Proceedings of the Indian Academy of Sciences, Vol. XIX, No. 5, pp. 199-215 (May, 1944).



(Photograph from *Proceedings of the Indian Academy of Sciences, A*, vol. XIX, Pl. III, May, 1944)

Fluorescence of South African Diamonds

Top left: Photographed in daylight.

Others: Photographed in ultraviolet light with increasing exposure time.

Figure 1

Notes on the Abundance and Color of Fluorescent Diamonds

by

ROBERT M. SHIPLEY

Founder, Gemological Institute of America

Data collected over a period of five years in the Godfrey Eacret laboratory of the Gemological Institute of America have revealed that a much greater proportion of diamonds is fluorescent than is commonly supposed. It has been observed that approximately 65% of gem quality diamonds fluoresce with enough intensity to make the phenomenon noticeable to the eye when viewed under an arc light with a Woods filter.¹ A recent check on 409 carats (made up of 350 individual crystals) of gem quality rough at the Institute showed 47 per cent to be fluorescent when viewed under a G.I.A. Fluorescent Unit² at a distance of six to twelve inches. To arrive at an exact evaluation of the percentage of all gem diamonds that are fluorescent is difficult because factors such as strength of the source of ultraviolet radiation, and sensitiveness of the observer's eyes, enter into the problem. Raman² found, for example, that in a piece of jewelry containing 88 diamonds a cursory examination indicated that only 10 or 12 were fluorescent. However, a visual examination of each diamond in detail under a very strong source of ultraviolet, revealed that all but three or four

were fluorescent to some degree. (See Figure 1.)

The percentage of diamonds that are fluorescent also depends to a certain extent upon the body color of the diamond. It has been observed in the Godfrey Eacret laboratory of the Gemological Institute of America that fully 95 per cent of all diamonds having complete absence of body color are noticeably fluorescent; whereas, taking the whole color range of colorless to yellow gem quality diamonds, the figure is approximately 65 per cent.

The dominant color of fluorescence of these gem quality diamonds is blue. Out of over 500 stones examined in the Gemological Institute of America all but a few were blue (or less often, violetish blue). Four exhibited greenish blue fluorescence when observed; three showed pink fluorescence and one showed yellow under ultraviolet light.

Industrial diamonds also show a large variety of colors of fluorescence, as is shown in the color plate. In industrial diamonds, however, yellow seems to be the dominant color, followed in abundance by blue, red, and green. In sorting the industrial diamonds shown in the photograph³, it was found that it was not possible to segregate them into definite groups of pure colors, so great was the variation.

¹Produces ultraviolet radiation having a wave length of 3600 Angstrom units, the wave length which has been found in the G.I.A. laboratory to produce the greatest fluorescence in diamond.

²Proceedings of the Indian Academy of Sciences. Vol. XIX No. 5, pp. 199-215 (May, 1944).

³Diamonds by courtesy of Lazare Kaplan & Sons, Inc., New York.

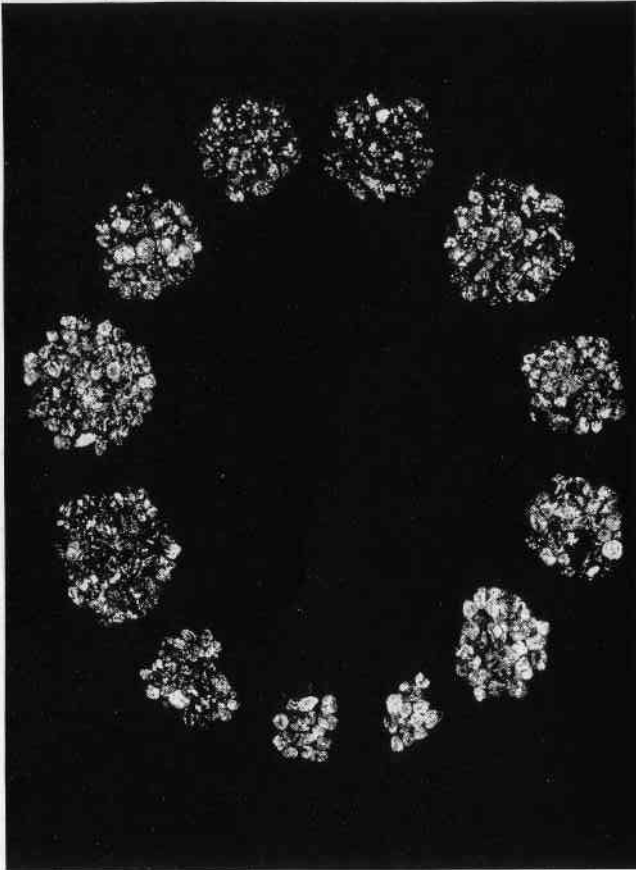


Photo by G. Switzer. Copyright, Gemological Institute of America.

Fluorescent Diamonds

Diamonds photographed in ordinary light. The same diamonds shown in the color plate on the opposite page were photographed under ultraviolet light.

Figure 2

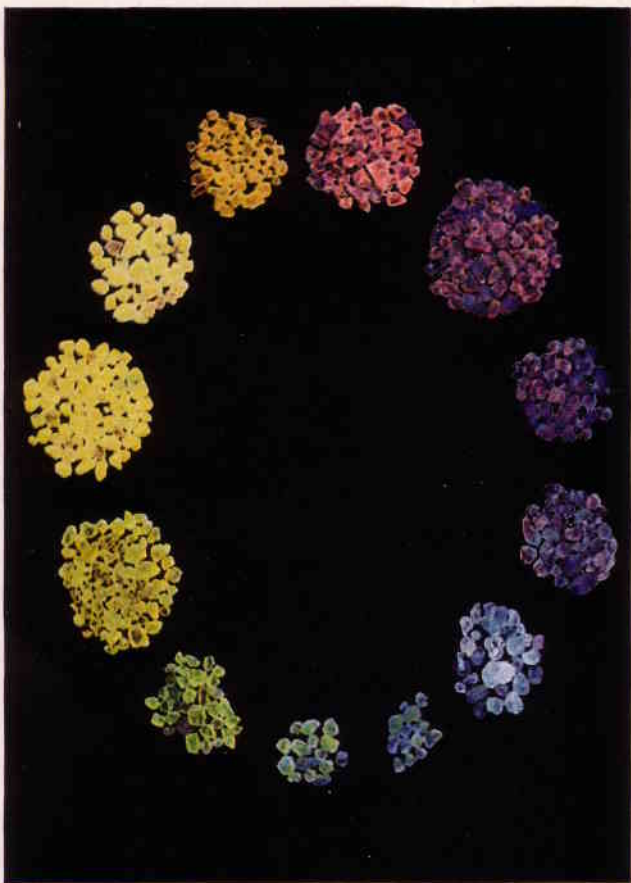


Photo by G. Switzer. Copyright, Gemological Institute of America.

Fluorescent Diamonds

Groups of rough diamonds arranged as to their
color under ultraviolet light.

PLATE II

Fluorescence of diamonds is of considerable practical importance to the jeweler due to the fact that direct sunlight contains a very much higher content of ultraviolet light than does ordinary interior lighting from tungsten filament lamps or fluorescent tubes.

The more yellowish tinge possessed by a diamond the less desirable it is in the jewelry industry; the more nearly colorless or bluish, the more desirable. As a result of the high ultraviolet content of direct sunlight, a diamond which fluoresces blue will look less yellowish or more bluish in daylight than in artificial light. Conversely, a stone which apparently has "good" color in daylight may look very yellow in artificial light. Therefore, given two stones of equal body color in artificial light, if one of them fluoresces bluish and the other does not, the fluorescent one will have a much better color in daylight.

On the other hand, if the fluorescent stone had yellow fluorescence, its color would be more yellowish in daylight. Fortunately, gem quality diamonds which fluoresce yellow seem to be very rare, although such diamonds are abundant among industrial stones.

Since the content of ultraviolet in daylight is considerably reduced when it passes through most ordinary window glass, a diamond which fluoresces bluish will appear much more bluish or less yellowish in direct sunlight than indoors. On a sunny day near an open door or window such a diamond will appear more bluish or less yellowish than within a room or store. It is for this reason that many jewelers like to show diamonds to customers near an open door or outdoors. This,

however, is seldom done with intention to deceive, because to most jewelers the phenomenon of fluorescence is unknown, except in the type known to many jewelers as "Premier" quality. This type of fluorescent diamond has a characteristic oily body appearance, and a strong fluorescence.

It may be seen as a result of the foregoing discussion that it would be most ethical business practice to show diamonds to a customer under artificial light. Then upon removal to daylight the color will either remain the same, or become better, depending upon whether the stone is non-fluorescent or bluish fluorescent. On the other hand, if a diamond which strongly fluoresces bluish is sold in daylight, it will, upon removal to artificial light, appear more yellowish, with the probability of a dissatisfied customer as the result.

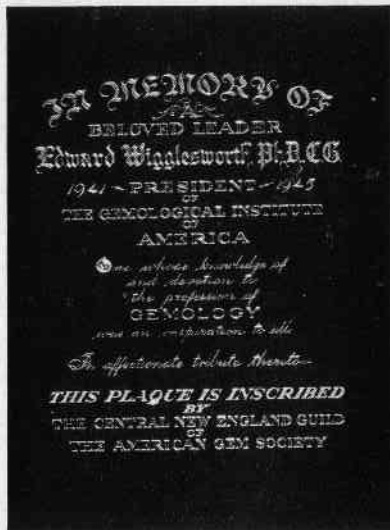
A selling practice which would be as ethical and at the same time more efficient from a sales standpoint would be to show fluorescent diamonds first under artificial light and then under sunlight or under an ultraviolet light source. It was for this purpose that the new Standard Diamolite was developed in the Gemological Institute laboratory. The Standard Diamolite contains a built-in fluorescent lamp⁴ which produces ultraviolet light having a wave length of 3600 Angstrom

(Continued on Next Page)

⁴The ordinary type of fluorescent lights now in common use for interior lighting contains practically no ultraviolet rays and should not be confused with a fluorescent lamp, which is used primarily as an intense source of ultraviolet radiation. In the wave length range 3200-3800 Angstrom units the white fluorescent tubes contain 0.24% and the daylight tubes 0.85% of the total lamp watts output.

Former President Honored

Next to the Eacret memorial plaque on the wall of the laboratory of the Gemological Institute of America now hangs another engraved silver plaque, in memory of Edward Wigglesworth, Ph.D., C.G., President of the Institute from 1941 to 1945.



(Continued from Page 397)

units, the wave length which had been found in this laboratory to produce the strongest fluorescence in diamond. In the Standard Diamolite it is possible to use artificial light alone, ultraviolet light alone, or both together, this latter combination being a very close approximation to daylight.

It is important to stress the fact that fluorescence in diamonds is not a defect or an unfavorable quality. On the contrary, it is distinctly favorable. This is because in a paper of diamonds purchased by a jeweler in artificial light, which is the more reliable light for buying diamonds, the bluish fluorescent diamonds are the most desirable, since they are of superior quality in daylight and especially so in sunlight or near sunlight. Similarly the layman who buys a (bluish) fluorescent diamond obtains one which has the same superior quality, and also a diamond which has a distinctive quality not possessed by every diamond.

Fluorescent Diamonds

(Continued from Page 393)

On the other hand, an equally qualified physicist, Dr. Kathleen Lonsdale,² of the Royal Institution, London, England, disputes Raman's theory of the four diamond structures. She believes there are only two structures, and that there is no correlation between structural type and fluorescence.

The fluorescence of diamonds is a matter of unusual interest from several points of view. The practical jeweler should be aware of the advantages in selling fluorescent stones. Purely from the standpoint of beauty, fluorescent diamonds are remarkable in their display of a wide range of brilliant colors. To the gemologist the fact that the exact cause of the fluorescence of diamond is unknown presents a challenging problem in research.

²Personal communication, March, 1947.

Identification of Synthetic Gems

Part II

by

EDWARD GÜBELIN, Ph.D., C.G.

We now come to a second "birth-mark" of synthetic stones, which, however, improvements in the process of production are gradually eliminating.

Practically all synthetic stones present gaseous bubbles, spherical or elongated, as shown in Figure 1.* This is a specific sign, typical of all synthetics produced by the Verneuil process. Sometimes these bubbles are very numerous; occasionally a stratified concentration corresponding to the different growth layers can be observed. Sometimes, synthetics are almost without flaw. Nevertheless, on carefully examining a stone of any size in all directions, one nearly always finds a bubble here and there, or a group of very small ones segregated in one area (Figure 2). The bubbles provide an absolutely reliable indication.

As a rule, the bubbles are black; only in larger ones can we observe a transparent nucleus in transmitted light of the polarizing microscope. They must not be confused with the liquid or other inclusions frequent in natural stones. Through the

Diamondscope they appear to consist of two concentric bright rings (Figure 3). When these bubbles are very numerous, their presence can reduce the specific gravity of the whole stone. The better a stone is, the fewer bubbles it contains. The size of the gas filled spheres also tends to diminish with the improvement of methods of production. Figure 4 shows a ruby produced during the first years after the process was introduced. This photograph presents the ordinary type of a gaseous inclusion, in addition to curved striae.

Many authors quote as a distinguishing symptom of synthetic origin the cracklike markings which frequently develop just below the surface of synthetic corundums during cutting and polishing (Figure 5). These marks do not, however, afford conclusive proof that the stone is synthetic, for they also occur in natural corundum. They are merely a feature of stones of the corundum species that have been polished too rapidly.

[Part I by R. T. Liddicoat. Parts II, III and IV by Dr. Gübelin.]

*Figures shown on following pages.

(To Be Continued)



Photo by Dr. Gübelin

Figure 1
synthetic sapphire
Dense cloud of minute spherical gas bubbles, some elongated wormlike gaseous inclusions and one very large gas bubble.

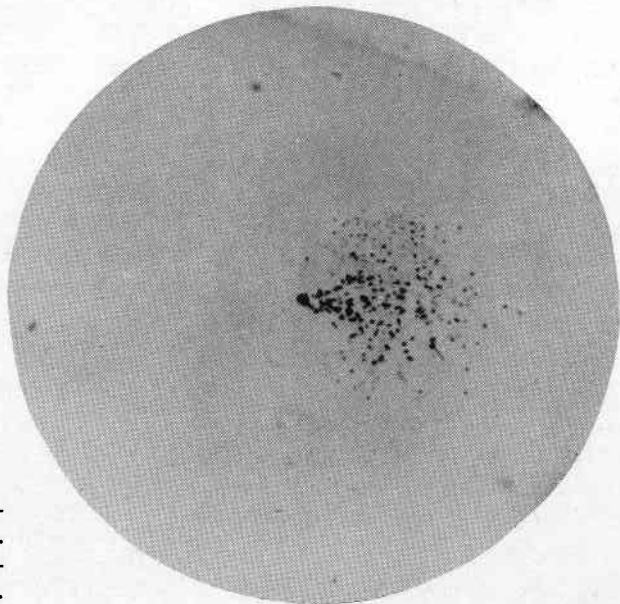


Photo by Dr. Gübelin

Figure 2
synthetic ruby, recent production.
Small cloud of minute gas bubbles.

Photo by Dr. Gübelin

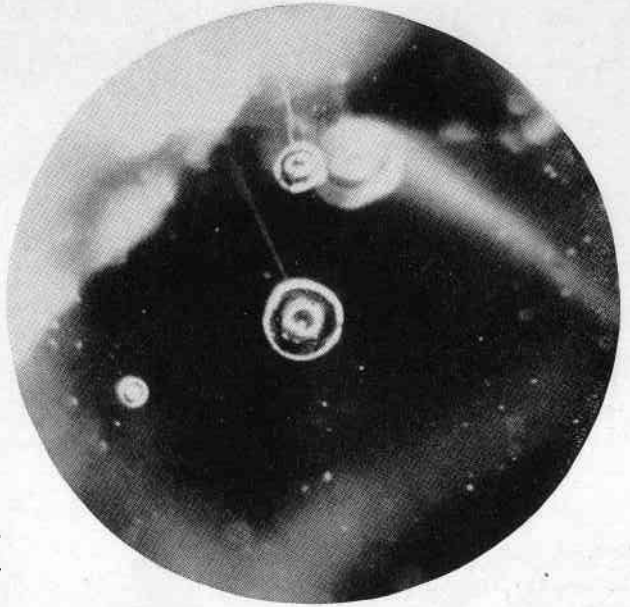


Figure 3
synthetic ruby
*Large gas bubbles
as seen through
Diamondscope.*



Photo by Dr. Gübelin

Figure 4
synthetic ruby of
early production.
*Strongly curved and
well-marked stria-
tions and dense
cloud of gas bubbles
placed along striae.*

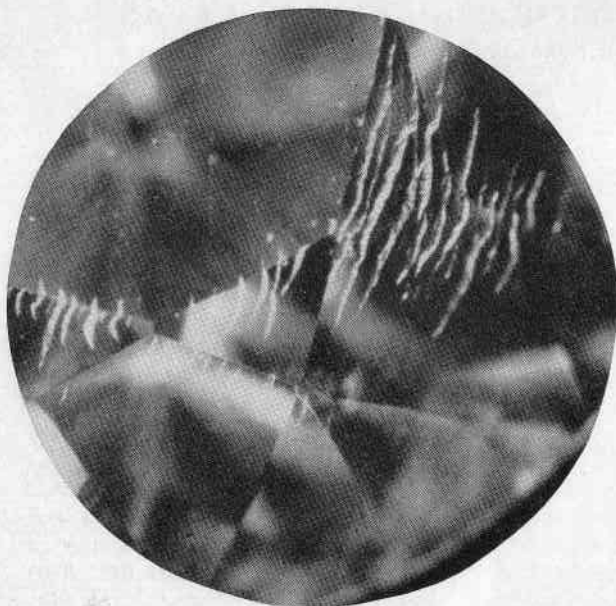


Photo by Dr. Gübelin

Figure 5
synthetic sapphire
 Surface cracks
 caused by the heat
 of rapid polishing
 along the edges of
 the facets.

Gemology in North America

(Continued from Page 386)

In England, in 1908, the need for a wider dissemination of authoritative information about gems was recognized by the National Association of Goldsmiths. At their meeting, held that year in Manchester, a resolution was adopted advocating the initiation of the teaching of courses and the giving of examinations in gemology. Steady progress was made with this project, and in 1913, the conducting of examinations was begun with G. F. Herbert Smith as the principal examiner. In 1931, the Gemmological Association was organized, and in 1938, the present title, Gemmological Association of Great Britain, was adopted. From 1932 to 1937, the Association

had as its president the distinguished mineralogist and educator, Sir Henry A. Miers, and from 1937 to 1942, Sir William H. Bragg, the noted physicist and Nobel Prize winner for his work on x-rays and crystal structure. Since 1942, Dr. G. F. H. Smith has served as president. For many years, the Association published as its official organ the *Journal of Gemmology*, which appeared as a section of the monthly publication known as the *Watch-Maker, Jeweller, and Silversmith*. Beginning with the January, 1947, number, it now appears as a separate journal. The first number of sixty-four pages makes a very favorable impression.

(Continued on Page 407)

Jewels of the Russian Diamond Fund

By ALEXANDER E. FERSMAN†

PART II

"Not less beautiful than these colored stones are pearls. The Russian court always appreciated Burmit [Burman] and Kafir [Portuguese East Africa] pearls. There are many thousands of carats of pearls in strands, and among them are stones of rare beauty. Here is a magnificent bud, delicate, brilliant, of regular form, and weighing 52 carats; here is a very large pink pearl, weighing 77 carats. . . .

"I am ending the description of the precious stones in the Diamond Fund, but the list is not complete. There are many other stones of the most brilliant hues. Here is a pink topaz from the sands of Brazil; dark green alexandrit (chrysoberyl) from Ceylon (at night it has blood-red fire in it); beautiful aquamarines and beryls from Brazil—stones of deep blue water; small golden heliotropes from Trans-Baikal, mined in 1886 for the tzarina; remarkable chrysolites, those olive-green stones, which are almost unknown in the present day market; here are turquoise in jewels of 1885; old German chrysoptase; smoky topaz; clear amethyst from the Urals; English agate.

"In a different style is the famous riviere. It is a collier consisting of 36 large diamonds, total weight almost 476 carats. It is a matching of the largest solitaires, freely connected by silk threads. These 36 remarkable stones, each of exceptional value, form two rows; the upper row has 21 of the largest solitaires and it forms the basic riviere, the remaining 15, in com-

ination with a small number of others, less valuable stones, form a row of freely hanging pendules. Undoubtedly, this riviere is the only one of its kind in the whole world, and is tremendously impressive.*

"Remarkable are several small pieces of jewelry: a diamond hair-pin made in the shape of a horn of plenty—signed work of the famous St. Petersburg jeweler Duval (Duval and son in 1796 took monopoly for manufacturing of precious things for the tzar's court); diamond brooch in the shape of the rose with leaves, an interesting example of utilizing of yellow diamonds. This was made by Petersburg's firm, Farberge. Especially interesting is an aigrette made in the shape of a fountain, the cut and the placing of diamonds representing falling water, in combination with large blue sapphires which tremble with the least motion of the aigrette and give one the impression of a real fountain in the corner of the park. . . .

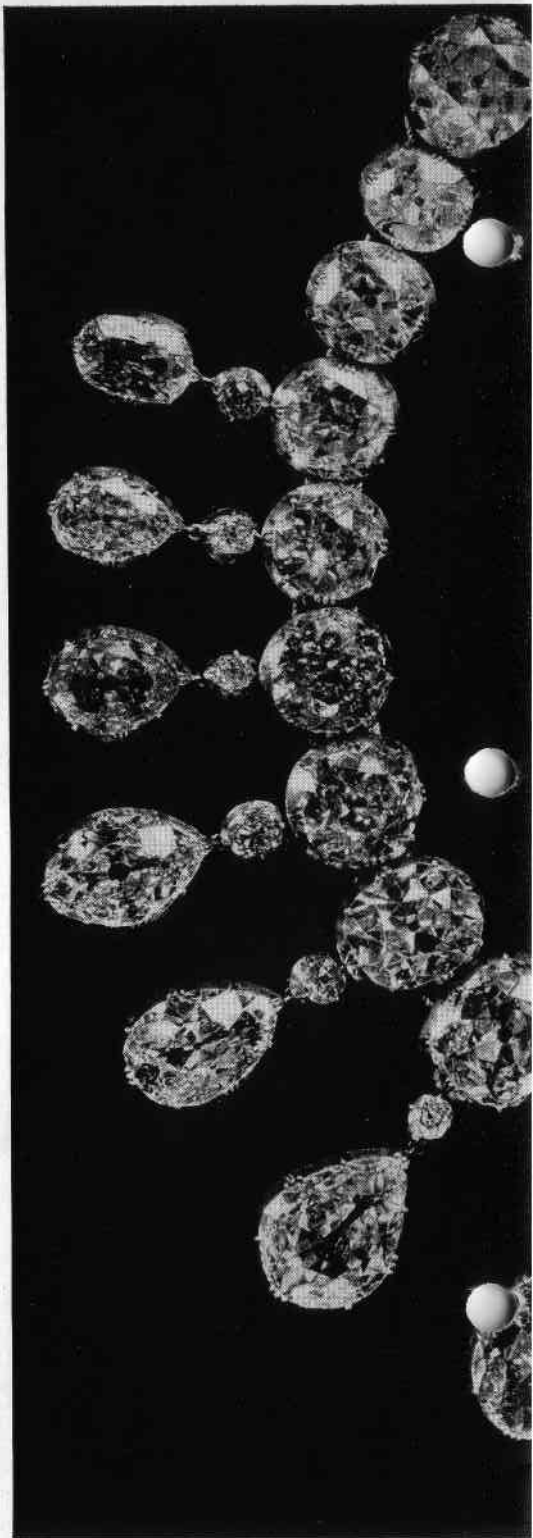
"Doubtless the most remarkable piece of jewelry of the middle of the XVIIIth century is the famous bouquet of narcissi. In technique, composition and exceptional simplicity of the plot, it is the best piece of jewelry of the whole collection. The flowers are movable and the stems flexible, just as if real flowers; the petals are studded with white diamonds, the middle of the flower of bright yellow diamonds set in gold. . . . The jewelers of the XVIIIth century knew how to use stones of little value, or even defective stones." (*To Be Continued*)

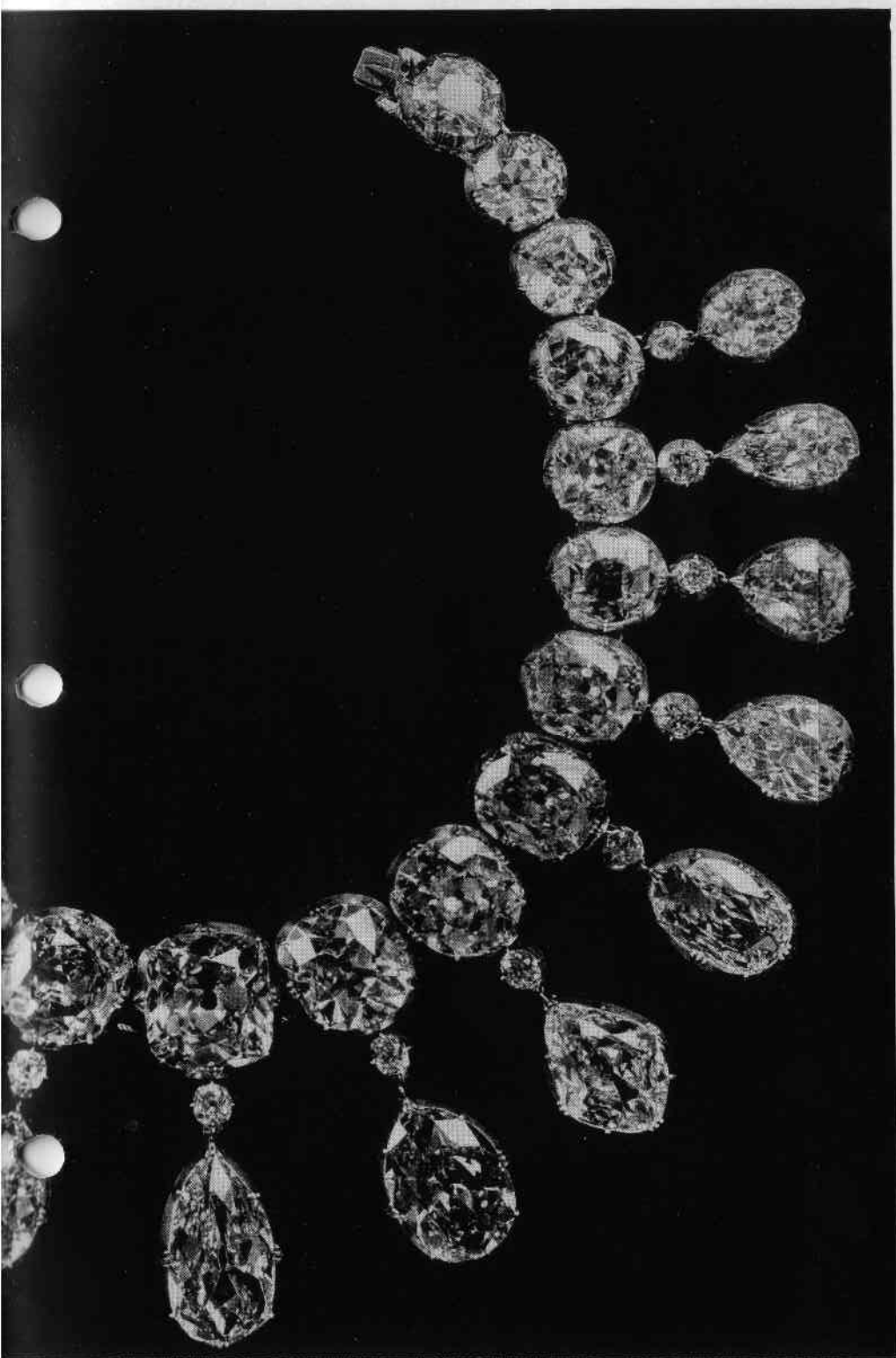
†Translated by Marie Pavlovna Warner.

*See Figure 6 on next page.

Figure 6
Famous Russian riviere—
a collier consisting of 36
large diamonds with a
total weight almost 476
carats. Photograph shows
actual size of the riviere.

Reproduced from
"Russia's Treasure of
Diamonds and Precious
Stones."





GEMOLOGICAL DIGESTS

X-ray Experiments on Color Changes of Gems

This paper by Frederick H. Pough and T. H. Rogers (*American Mineralogist*, vol. 32, pages 31-43, Jan.-Feb., 1947) records some color changes observed by bombarding various gem minerals with x-rays produced by a new, high-powered tube recently developed by the Machlett Laboratories, Inc. The most interesting color changes were produced in spodumene (changed from colorless or lilac to green), corundum (changed from colorless or pale blue to amber yellow), scapolite (white cat's-eye changed to deep violet), topaz (colorless or pink became smoky brown), and zircon (heat-treated blue stones turned brown, naturally brown stones unaffected). Very minor color changes were produced in beryl, tourmaline, quartz, diamond, spinel and a few others. No change at all was recorded for opal, simpsonite, diopase, brown zircon, and chrysoberyl.

It is especially important to note that in practically every case the color change produced was temporary. Most specimens reverted to their original color when exposed to sunlight or heat, but some appeared to retain their color indefinitely if kept in the dark. In the case of sapphire it was very difficult to remove the last trace of color without application of heat. It is also noteworthy that the color change was restricted to a thin surface zone, in general not over 1 mm. in thickness.

Treatment of these same gem

species by submitting them to irradiation from a Machlett Thermax tube (a conventional type widely used in medicine and industry) produced in the case of kunzite and colorless sapphire (the only two reported) very similar results except that the color produced with this latter type tube was deeper in color, more uniformly distributed, and penetrated to a greater depth.

It would seem then, that the only advantage in using the new type tube is that some reduction in exposure time is effected.

The color changes in most cases were not in a direction of improvement of the color qualities for commerce. The only possible exception to this was the production of yellow sapphire from colorless or pale yellow sapphire, and smoky brown topaz from colorless or pink topaz. However, in no case is the color change permanent, although in the case of the artificially colored yellow sapphire, the last trace of color was removed with great difficulty. The only possible way in which an unscrupulous person could make use of this information in an attempt to defraud, would be to treat the stones and keep them from prolonged exposure to sunlight until after their disposal.

By withholding payment for stones of these particular colors until they had been exposed for many hours to sunlight, or to a Westinghouse Mazda—Type R S 275 W sun lamp, or equivalent, a jeweler may protect himself from such fraudulent practices.

—G.S.

Gemology in North America

(Continued from Page 402)

This educational work in gemology initiated by the British attracted attention not only in Great Britain, but also in North America. In the late twenties, largely upon the advice of Frank B. Wade of Indianapolis, Robert M. Shipley, Sr., an experienced jeweler, went to Europe and familiarized himself with the educational activities in gemology in Great Britain and with other phases of the subject in continental Europe. After his return, Shipley was invited by the California Jewelers' Association to give a night course for jewelers, which he did in 1930 and 1931. The success of this instruction led to the founding of the Gemological Institute of America in 1931, with Shipley as its director, and subsequently to the American Gem Society in 1934. By 1936, many Canadian jewelers had enrolled as students, and the name of the society was changed to the American Gem Society (United States and Canada).

It was during this development period that Shipley visited the University of Michigan and discussed his ideas with me. He stressed the great lack of authoritative information on the part of jewelers and gem dealers. This lack I had long recognized, and accordingly, Shipley was at once assured of my cooperation. The success of his undertaking is well known to you all.

The courses of instruction now given by the Institute are diversified, well organized, and conducted on a very high level. All of them are supervised by a thoroughly competent staff. It is very gratifying that Shipley has been able to enlist

the services of trained men not only to conduct the instruction at the headquarters at Los Angeles, but also to take charge of the various regional groups in New York, Boston, Philadelphia, Cleveland, Detroit, Chicago, Minneapolis, and St. Louis. At the headquarters, Richard T. Liddicoat serves as Director of Education and Dr. George Switzer as Director of Research. The various regional groups are conducted by Professors R. J. Holmes of Columbia University, C. S. Hurlbut of Harvard University, C. W. Wolfe of Boston University, H. F. Donner of Western Reserve University, W. D. Shipton of Washington University, C. B. Slawson of the University of Michigan, J. W. Gruner of the University of Minnesota, and Samuel Gordon of the Philadelphia Academy of Science. Moreover, the list of persons serving on the various boards and committees, both in advisory and active capacities, is very impressive.

At present, about 2500 students are pursuing courses. Of these, 900 are veterans who are enrolled under the G.I. Bill of Rights. The Gemological Institute of America has recently broadened the scope of its study in residence by developing a series of three four-week courses which include both theory and identification practice. These courses are given twice a year at the headquarters in Los Angeles. The first of this series of three courses is also scheduled this summer for New York, Chicago, and Atlanta. The geographical distribution of the students is very wide—Brazil, Canada, Dutch West Indies, Panama, Italy, Singa-

pore, South Africa, and Sweden being represented. Examinations have been passed by residents of Canada, Ceylon, England, Finland, Mexico, the Philippines, and Switzerland. Through this educational work and the publications of the Institute and of the Society, notably *Gems and Gemology*, *Guilds*, and various books, significant contributions have been made to gemology and to the development of high professional standards.

World Association Suggested

The influence exerted by the gemological associations of Great Britain and North America is very great. It has led to the founding of similar organizations in Switzerland and Australia. Recently, it has been suggested that a World Federation of Gemological Associations be organized in order to bring about close cooperation between the various groups.

The large attendance at this conclave is proof positive that a remarkable change has taken place in the last two decades in the attitude of those interested in supplying the public with gems. It was not so long ago that members of reliable firms in many communities were not well informed concerning the properties and characteristics of the gem materials they sold, and therefore were often unable to answer intelligently pertinent questions asked by inquiring prospective purchasers. This situation has been changed greatly due in large measure to the activities of the Institute and Society. Today, there are many stores

with personnel well informed on the scientific aspects of gems and adequately supplied with instruments, such as refractometers, dichroscopes, polariscopes, specific gravity balances, diamondsopes, and sometimes even with polarizing microscopes, which you know are essential for the accurate determination of physical and optical properties. It is now possible to ask about specific gravity, hardness, index of refraction, dichroism, optical character—whether the stone is isotropic or anisotropic, uniaxial or biaxial, positive or negative—and receive intelligent answers. This is exceedingly gratifying to those of us who for many years have labored consistently to disseminate authoritative gemological information.

Public More Informed

It was imperative that this change should be made, for the establishment of many mineralogical clubs, the publication of numerous mineralogical journals and texts on gemology, and the development of thousands of amateur lapidaries in this country in recent years have also been very important factors in making the public better informed and more mineral and gem conscious than ever before.

Although much has been accomplished by the wider dissemination of authoritative gemological information and the adoption of high ethical and professional standards by those who serve the public, greater advances may be confidently expected through the continued activities of the organizations which sponsor this conclave.

DIAMOND GLOSSARY

(Continued from Page 380 of last issue)

Regent Diamond (Cont'd)

In 1717 it was sold to the Duke of Orleans, then Regent of France, for about \$650,000, and from that time on has been known as the Regent Diamond. It was set in the crown of Louis XV. Later stolen during the French Revolution, later recovered, worn in Napoleon's coronation sword, and finally placed on display in the Louvre Museum. Also known as Pitt Diamond or Millionaire Diamond.

Regent of Portugal Diamond. A round brilliant having a weight variously stated as 215 carats and 220.7 mc. Its history is very obscure. Probably found in the year 1775 near the Rio Plata, Brazil. Smith states that it may be topaz. Now presumably in possession of the Royal Family of Portugal.

Reitz Diamond. Now known as the Jubilee Diamond.

rejection chips. Term used at the DeBeers, Kimberley, and Dutoitspan mines to designate small misshapen stones, or broken pieces of inferior quality.

rejection cleavage. A term used at the mine to designate a third classification grade. Contain numerous inclusions and must be cleaved for cutting.

rejection, diamond. Stones in a parcel of diamonds that are not suitable for the purpose for which they were purchased.

rejections, diamond. Diamonds rejected at a diamond mine because too imperfect to be used as any-

thing but the poorest quality of cut stones.

rejection stones. A term used at the DeBeers, Kimberley, and Dutoitspan mines to designate stones inferior in quality to spotted stones in that they contain more inclusions.

repeated twinning. A laminated structure due to intergrowth of three, four, five or more individual crystals in twin position to one another.

"Rhine diamond." Colorless beryl.

Rhodes, Rt. Hon. Cecil John (July 5, 1853-Mar. 26, 1902). Empire builder, philanthropist and founder of DeBeers Mining Co. Born at Bishop Stortford, England, the son of an Anglican clergyman. Because of a tubercular tendency, young Rhodes was sent to Natal in 1871 to join his brother Herbert. A few months later he entered Oriel College, Oxford, but lung trouble again sent him to Africa late in 1871 where Herbert had a claim in Kimberley (New Rush), which Cecil took over and later sold. He then took over claims in Old DeBeers.

Over-production, falls of reefs in the mines, wasteful expenditure and general lack of control in the '70s caused a great slump in the price of rough diamonds that resulted in the amalgamation of the mine claims and the founding of the DeBeers Mining Co. (1880) with Rhodes as the master mind before Barney Barnato consolidated the claim holders in the

Kimberley Mine. In 1888 the two concerns were combined into the DeBeers Consolidated Mines, Limited.

Rhodes was elected a member of the Cape Legislative Council (representative for constituency of Barkly West). Intensely interested in politics, Rhodes was sent in 1881 to examine the position of the two Dutch Republics in Bechuanaland (Stellaland and Goshen), which he reported a "hindrance to Northward progress."

Gold was discovered in Witwatersrand, and Johannesburg founded in 1886. Rhodes, in 1889, was granted an administrative charter over Lobengula, King of Matabele; and the British South African Co. was called the Chartered Co. He was Prime Minister of Cape Colony from 1890-1894.

Rhodes' greatest work was in Mashonaland and Matabeleland, now known as Rhodesia, where he devoted his talents and wealth toward acquiring and settlement of that country as a legacy to his beloved British Empire; and as another step on his way to Egypt, he planned railroads through all British territory in Africa.

Rhodes resigned as Prime Minister of the Cape and managing director of the Chartered Co. as a result of Jameson's unfortunate raid in Dec., 1895, but was restored to his position with the Chartered Co. in 1898. In the same year he headed the newly formed Progressive ("Jingo") Party in his last election at the Cape.

In 1899 Rhodes was honored with a D.C.L. at Oxford. Boer War (1899-1902) ended with the Transvaal and Orange Free States proclaimed British.

Rhodes died March 26, 1902, at Muizenberg, near Cape Town, and was buried near Moselikatze in the Matopos, "The World's View," Rhodesia. Among many other legacies, Rhodes scholarships are the feature of his sixth and last will.

Rhodesia. An African diamond locality of minor importance. Total production to December 31, 1944, was 15,582.25 carats. For a number of years production has been practically nil.

rhombic dodecahedron. A crystal form of the cubic (isometric) system. Consists of 12 similar rhombus-shaped faces. A common crystal form of diamond.

Riccia Diamond. A rose-colored 15-carat diamond belonging to the Prince de la Riccia.

"right angle" illumination. Method of illuminating diamonds with strong light from the side against a black background (dark field illumination). Causes inclusions and imperfections to stand out clearly, reduces confusing surface reflections.

ripe diamond. True diamond (obsolete term).

River. A term used in the U.S. to designate finest color grade of diamonds. Sometimes used to describe *Jagers* or *Top Wesseltons*. An extraordinarily fine colorless diamond. Diamonds from the rivers or alluvial mines of Africa.

river bort. Industrial quality diamond from alluvial deposits.

river diggings. Diamond mines operating in river beds.

Rivers. See *River*.

riviere. A diamond necklace.

(To Be Continued)

New Members Added To G.I.A. Boards

Educational Advisory Board

Two outstanding scientific men who have recently been added to the Educational Advisory Board of the Gemological Institute of America are: Wm. H. Barnes, Ph.D., Associate Professor of Chemistry at McGill University, Montreal, and Cornelius S. Hurlbut, Ph.D., Associate Professor in the Department of Mineralogy and Petrography at Harvard University.

A Massachusetts man, Dr. Hurlbut received his A.M. degree in 1932 and his Ph.D. in 1933 from Harvard University, where he has taught since 1931. He is giving lectures at the evening classes of the Gemological Institute now being held in Boston. Dr. Hurlbut is secretary of the Mineralogical Society of America, a Fellow of the Geological Society, and a member of the Mineralogical Society of Great Britain.

Dr. Barnes, whose article on "Pearl Identification by X-ray Diffraction" appears in this issue, is already known to readers of *Gems & Gemology*, since the last issue briefly reviews his experience. Dr. Barnes is a Canadian member of the Educational Advisory Board, although he is at present working with Dr. M. J. Buerger under a Guggenheim fellowship at the Massachusetts Institute of Technology.

Board of Governors

When the Board of Governors of the Gemological Institute of America holds its annual meeting on April 27 at the Los Angeles headquarters for the first time since its organization in 1932, three new members will be welcomed to the group. They are:

James D. Dougherty, J. B. Hudson Co., Minneapolis; George Carter Jessop, J. Jessop & Sons, San Diego; and Chas. D. Peacock III, C. D. Peacock Inc., Chicago.

Other representative members of the jewelry trade who were re-elected by the Institute member firms to serve on the governing body for the ensuing year are: Nolte C. Ament, Geiger & Ament, Louisville; Henry G. Birks, Henry Birks & Sons, Ltd., Montreal; Carleton G. Broer, The Broer-Freeman Co., Toledo; Myron Everts, Arthur A. Everts Co., Dallas; Paul Hardy, Hardy & Hayes Co., Inc., Pittsburgh; Edward F. Herschede, The Frank Herschede Co., Cincinnati; O. C. Homann, The C. B. Brown Co., Omaha; C. I. Josephson, C. I. Josephson Jewelers, Moline; H. Paul Juergens, Juergens & Anderson, Chicago; John S. Kennard, Kennard & Co., Inc., Boston; P. K. Loud, Wright, Kay & Co., Detroit; Wm. H. Schwanke, Schwanke-Kasten Co., Milwaukee; F. B. Thurber, Tilden Thurber Corp., Providence; Leo J. Vogt, Hess & Culbertson Jewelry Co., St. Louis; and Jerome B. Wiss, Wiss Sons, Inc., Newark.

The Board of Governors will elect their own officers at the coming meeting which is the first one held in the West, all previous meetings having occurred in eastern U.S.A. or Canada. The present officers are: Leo J. Vogt, chairman; C. I. Josephson, vice-chairman; and O. C. Homann, secretary. Some Board members have served for 16 years and seen the G.I.A. staff grow from three to forty-six members.

Color Reproductions of Gems in Future 'Gems and Gemology'

For some time the laboratory staff of the Institute has been experimenting with various methods of producing color prints of gemstones. Early research was mostly with kodachrome transparencies and prints made from them. None of the results, however, obtained from kodachrome, resulted in either prints or transparencies which have met the standard of the Institute, principally due to the fact that the color perception of kodachrome is inferior to that of the human eye. At present the Institute staff is meeting with greater success with combinations of hand-drawn and painted reproductions based upon kodachrome photographs. Until colored photography is much further advanced, the Institute believes that, while such photography will make attractive pictures of gems, it cannot reproduce with sufficient accuracy either color differences between various specimens of a given gem species, or important nuances of color quality.

The color print of opal, which appeared in the Winter issue, was one of the experiments made with kodachrome. While this opal color print was superior to the result obtained when attempting, for instance, to obtain the accurate colors of a group of thirty-five different colored zircons from the Institute's collections, still some of the opals were accurately reproduced and others were not. In order to reproduce the true color of Lightning Ridge, White Cliffs and Amberooka opals, it was impossible to obtain at

the same time the correct color of the Coober Pedy opals. The reproduction did not do justice to the dark blue color and the brilliant red pin points of fire of the Coober Pedy opal. Similarly the reproduction of the White Cliffs and Lightning Ridge opals failed to show the numerous pin points of red fire which are actually present.

This Spring issue includes a color print reproduced from a retouched kodachrome transparency. This accurately represents as to color twelve groups of diamonds, each group fluorescing in a different color.

Beginning with the Summer number it is planned to reproduce for a series of 12 or more issues, at least two color prints in each number. They will include:

Amber, apatite, axinite, beryl, chlorastrolite, chrysoberyl, chrysocolla, diamond, emerald, euclase, feldspars, fluorite, garnet, iolite, jade, lapis lazuli, lazulite, malachite, opal, peridot, quartz including amethyst, rhodolite, ruby, sapphire, satin spar, scapolite, serpentine, sodalite, sphene, spinel, spodumene, steatite, topaz, tourmaline, turquoise, zircon; also crystals typical of each of the crystal systems.

This series will constitute a collection of every species of gemstone which has gemological importance, as well as many important though less well-known ornamental stones; each print suitable for framing.