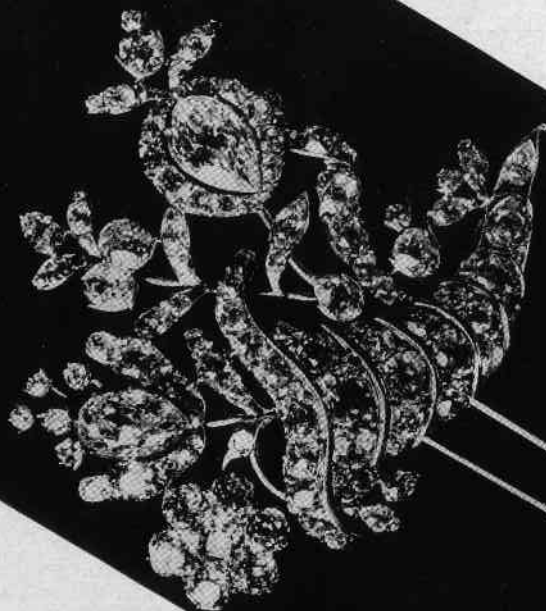


Gems and Gemology

SUMMER

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Diamond hair-pin in
the form of horn
of plenty (full size).

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers. Subscription price: \$3.50 a year.

Robert M. Shipley, Editor

VOLUME V SUMMER, 1947 NUMBER 10

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Cover: Figure 7 in "Jewels of the Russian Diamond Fund"; a diamond hair-pin in the form of a horn of plenty, described in Part II of the Fersman article (Spring Issue, Gems & Gemology). Reproduced from "Russia's Treasure of Diamonds and Precious Stones."

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(UNITED STATES AND CANADA)

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Los Angeles 5, California

"Gems & Gemology" Acquires an Editorial Board

Becomes "The Journal of the G.I.A."

"*Gems & Gemology*" is to have the expert advice of a new five-man Editorial Board, as approved by the G.I.A. Board of Governors at its annual meeting, held April 28, 1947. The action was taken in the belief that such a group could contribute much to the interest and authenticity of the publication by suggesting new authors, pointing out subject matter that should be included, and checking the accuracy of articles. Individual editors will be asked to examine, prior to publication, manuscripts relating to their own specialized fields, as well as assist in determining general editorial policies. Robert M. Shipley will continue as Editor of *Gems & Gemology* and will function as Chairman of the new Board.

Appointed as Associate Editors were the following:

Basil W. Anderson, Director, Precious Stone Laboratory of London Chamber of Commerce, London, England; lecturer on gemology at Chelsea Polytechnic, London; member of the G.I.A. Educational Advisory Board; author of many articles in English and American gemological publications.

Dr. Sydney H. Ball, of Rogers, Mayer & Ball, New York, N. Y.; geologist and authority on diamonds, diamond mining, precious stones; prolific author of reports and treatises; honorary member of G.I.A. Educational Advisory Board and

the Examinations Standards Board; member Examining Board.

Dr. W. F. Foshag, Curator of Minerals, Smithsonian Institution, Washington, D.C.; author of *Minerals from Earth and Sky*, *Gems and Gem Material* and numerous mineralogical papers and reports; member G.I.A. Educational Advisory Board.

Dr. Edward Gübelin, Lucerne, Switzerland; Certified Gemologist; founder of the Gemmological Institute of Switzerland; first G.I.A. Research Member; author of varied reports on original gemological research; Fellow of the Gemmological Association of Great Britain.

Dr. George Switzer, Washington, D. C.; associated with the U.S. Geological Survey; former instructor in mineralogy, Yale University; and former G.I.A. Director of Research.

Editorial Board members will be appointed by the executive committee (chairman, vice chairman and secretary-treasurer) of the Board of Governors, and will serve a one-year term, or until the next annual session of the Board of Governors, subject to reappointment. In general the Editorial Board will function under and in cooperation with the Board of Governors, who have expressed the desire that *Gems & Gemology* should become increasingly the "Journal of the Gemological Institute of America."

CONTRIBUTORS IN THIS ISSUE



Dr. Edward Gübelin, whose article, "Identification of Synthetic Gems," Part II, appears in this issue, is founder of the Gemmological Institute of Switzerland. Educated

at the University of Zurich, he became a certified gemologist of G.I.A. in 1939, and was the institute's first research member.

Author of many reports on original gemological research in *Gems and Gemology*, Dr. Gübelin is a fellow of the Gemmological Association of Great Britain.

Prof. Alexander Fersman, distinguished Russian mineralogist and geochemist, died in the Spring of 1945. The third part of his article, "Jewels of the Russian Diamond Fund," appears here.

A prolific writer, his outstanding life of scientific service in the field of mineralogy included exploration, research and education. His authoritative work on pegmatites led into studies of gemstones, and this investigation resulted in his writing several books. Among these are four volumes, which he edited jointly, on the Romanoff crown jewels, and an elaborate work which he co-authored on the crystal morphology of the diamond.

Dr. William H. Barnes is Associate Professor of Chemistry at McGill University, Montreal, and associated with Mappin's, Ltd., Montreal, in a consultative capacity. His

article, "Pearl Identification by X-Ray Diffraction," appears in this issue. Dr. Barnes, who has done considerable research work in adiabatic calorimetry and X-ray crystallography, is at present working with Dr. J. M. Buerger under a Guggenheim fellowship at Massachusetts Institute of Technology.



William F. Foshag, author of "Present Status of Japanese Pearl Culture Industry," has been Curator of Mineralogy of the U.S. National Museum (Smithsonian Institution) since

1919. Co-author of a book entitled, "Minerals from Earth and Sky," he is an honorary member of Sociedad Geologica de Mexico; fellow of Geological Society of America and Mineralogical Society of America; member of American Geophysical Union and Washington Academy of Science.

He also serves on the Educational Advisory Board, G.I.A.

Alpheus Fuller Williams, whose personal diamond collection was photographed in color for this issue, was born in California but has spent most of his life in South Africa. Educated at Cornell University and the University of California, from which he received a B.S. degree in mining engineering in 1898, he followed his father to Kimberley, South Africa, and in

(Continued on Page 447)

Present Status of Japanese Pearl Culture Industry

by

WILLIAM F. FOSHAG, Ph.D.†

U. S. National Museum

The center of the Japanese pearl culture industry is in the area of Ago Bay, in the Shima district, Miye Prefecture, Honshu Island, the largest of the Japanese Islands. These small bays are inlets of the Pacific Ocean and with their small pine-clad islets yield a strikingly beautiful scenery. Within this area, about 100 "farms" are in operation. Some of these farms are small affairs, operated by a single family group; others like those of Kokichi Mikimoto are large plants with millions of oysters under cultivation. Many of the smaller farms are organized into cooperative societies for mutual aid in marketing and research.

The commercial cultivation of oysters for pearls was developed by Kokichi Mikimoto and his associates. In the first attempt, beads of mother-of-pearl shell were introduced into the oyster and left to develop a coating of nacre or pearl-forming material, a method known and used for centuries by the Chinese. In this method the nucleus or bead became attached to the shell and was covered by a growth of pearl nacre and yielded only half-round pearls. Researches by various persons had shown, however, that the mere presence of a nucleus alone was not sufficient to induce the formation of pearls in mollusks, but that cells of the mantle, or epithelium, must be present. It is the epithelium of the mollusk which

secretes and deposits the pearl shell material.

In the method developed, therefore, some of the epithelium tissue is introduced into the body of the oyster along with the nucleus. In the original method it was considered necessary for the nucleus to be completely encased in epithelium tissue to form the "pearl sac." This was accomplished by opening an oyster, placing the nucleus on the outside of the epithelium or mantle, then carefully dissecting this section of flesh from the body of the oyster. The small piece of living tissue so obtained was drawn over the mother-of-pearl bead, tied into a "pearl sac" and introduced into the body of the oyster, where it developed into a pearl-forming sac.

Present Method

It has recently been found, however, that such a complicated and time-consuming task is not necessary. The nucleus is now placed within the body of the oyster by means of a small tool, like a dentist's tool, and a small section of the epithelium tissue, cut from a living oyster, is placed in direct contact with the bead. In about a week's time this small section of epithelium grows completely around the nucleus to form the pearl sac, after which the successive layers of nacre begin to deposit upon the beads. For the nucleus, a small bead, about the size of buckshot, is used. These beads are cut from the shell of the fresh

water mussel of Arkansas, as this yields a pure white bead. The deposited layers of nacre are sufficiently translucent that the color of the nucleus will effect, in some degree, the appearance of the pearl. Attempts to use black nuclei to yield black pearls did not lead to satisfactory results.

The pearl mollusk used in this culture is the small Japanese pearl oyster *Meleagrina martensi*, having an average size of about the palm of one's hand. While this mollusk is usually referred to as an "oyster" it has, in fact, no close relationship to our common bivalve, but is more nearly related to the pecten, scallop or fan-shell. It may be mentioned here that all mollusks, including the common oyster, can form pearls, but only those with iridescent shells (mother-of-pearl) can form iridescent or precious pearls, since the mollusk forms the pearls from identically the same material as its shells. The Japanese *Meleagrina* or "oyster" is indigenous or native to the waters of Ago and neighboring bays. It is reported that the earthquake of December 7, 1944, in this area has greatly depleted the reserve of native pearl oysters.

Pearl Farms

The Japanese pearl "farms" have a normal capacity of 30,000,000 oysters. To obtain such a huge number of mollusks, it is necessary to raise most of them from seed oysters or "spat." These are gathered from the rocks of the bottom of the bay or from bamboo poles driven in the sand, and are kept in wire cages until they have reached an age of 3 years. The supply of oysters raised from spat is supplemented by oysters gathered from the bottom of the bay by girl divers, called *amas*. When the oysters are 3 years old

they are inoculated with the nuclei as described above. The best years of the oysters' growth is during the next 3 or 4 years. Beyond this period it is not commercially practical to continue pearl growth, since any increase in the deposit of nacre is comparatively small and the quality falls off.

For the cheaper grades of culture pearls the period of growth may be reduced to two or even one year but the coating of nacre is thin and the pearls are of little value. In the best grades of pearls the nuclei remain in the oyster from 3 to 4 years before harvesting. It is stated that a single oyster may be inoculated with as many as seven nuclei, although at the time of our visit to the fisheries we saw only a single nucleus placed in each mollusk. Since large pearls are more valuable than small ones it would be desirable to use nuclei that are as large as are practical. The mortality of oysters inoculated with large nuclei, however, is large, which accounts for the scarcity of large-sized pearls.

Placed in Wire Cages

After inoculation, the oysters are placed in wire cages with seven shelves, each cage containing about 150 mollusks. These cages are suspended from bamboo poles on rafts by wire cables to permit the movement of the oysters from place to place, depending upon the favorable or unfavorable condition of the water and to avoid as far as possible the numerous enemies of the oyster. These enemies are principally starfish, octopus and the so-called red water, a coloration due to algae, which grow upon the oyster, and if not removed, will eventually smother it to death. From time to time the oysters are removed and cleaned of any accumulated algae, barnacles or

other obnoxious growths to keep the oyster in a healthy condition. Cold water (44°F) and fresh water, due to heavy rains, are also fatal to the mollusk.

After the growth period, the nuclei are covered with a thick coating of nacre, composed of alternating layers of aragonite (carbonate of lime) and conchiolin (an organic material). The color and luster of the pearl depends upon the original quality of the mother-of-pearl shell and the place where the nucleus eventually lodges in the oyster itself. The finest color and luster is found in the center of the shell. Black pearls develop near the edge of the shell where the mother-of-pearl is dark in color. It is not infrequent that natural pearls are encountered in the oyster at the harvest.

Harvested in November

The oysters are usually harvested in November. The oyster does not thrive in the cold water of the winter season. After the harvest, the oyster is opened and the pearl removed from the body of the animal. The pearls are placed in hydrogen peroxide and warmed, to bleach out any discoloration due to included organic matter, and then exposed to strong sunlight for a brief period, a treatment that improves their luster or "orient."

Pink pearls are in best demand in the United States. Silvery pearls are in better demand in Europe and golden pearls are considered best in the Orient. It is not an unusual practice to "pink" the pearls. In treating the pearls with hydrogen peroxide a slight shrinkage takes place in the contact of the nuclei with the nacre. When the pearls have been drilled this zone can absorb some pink oil, yielding a delicately tinted pink pearl. The surface of the pearl re-

mains unaffected, so that the coloration is reasonably permanent.

The cleaned pearls pass to girls whose task it is to spot with ink the place where the pearl is to be drilled. Any small imperfection, such as a spot or wart, can frequently be removed by drilling through it. Drilling is done by small motor driven drills. Girls who are well trained in distinguishing the slight variations in color and luster sort and arrange the pearls for stringing.

Present Production

The total capacity of the Japanese pearl culture industry is normally about 30,000,000 oysters. Of these Mikimoto controls about 30 per cent of total production, but with the outbreak of the Pacific War production was almost completely suspended. At the present time production is about 30 per cent of capacity due to shortages of manpower and wire for cages.

The present production as well as the accumulated reserve stocks is marketed entirely through the post exchanges of the U. S. Army of Occupation, which receive from the various producers a weekly quota of 3700 strands of all grades per week, as well as some loose pearls for ring or earring use. Although the open sale of pearls to Japanese nationals is forbidden, many strands, particularly of the finer quality, are purchased by them clandestinely, as a hedge against inflation. Fine, well-matched strands of pearls are now seldom seen offered for sale. The production of seed pearls for export to China, where they are valued as medicine, has been an important element in the trade. The baroque and other odd-shaped pearls are used for the same purpose.

In addition to the pearl culture about Ago Bay, on Honshu Island,

the cultivation of pearl oysters was carried on in Kyushu, the southern island of Japan. At the present time production in Kyushu is at a standstill, and the pearl farmers are without stocks of finished product and without necessary supplies. Some attempts are now being made to revive the industry there.

The culture of pearls was undertaken on the Island of Buton, in the Celebes, by the Mitsubishi interests, using the large *Margaritifera maxima* shell. About 20,000 to 30,000 oysters were under cultivation and the first commercial production began in about 1930. Pearls yielded by this shell were more heavily coated with nacre and were of better orient than those of Japan, but the venture was not particularly successful and is now extinct. Most of the production from this source was sold in Paris. Because of their superior quality and size these pearls commanded from four to five times the price of Japanese pearls.

A small production of culture pearls from "black lip" shells came from Palau in the Marianna Islands and from farms in the Ryukyu Islands. This venture was carried out by Mikimoto and is no longer in operation.

Attempts have also been made to cultivate the fresh water mussel *Unio* in the streams of Japan. Pearls were successfully produced but it proved difficult to recover the mussel, since the *Unio* lives in the sands of the stream bed and moves or is washed about by the currents.



Dr. Kraus Re-elected G.I.A. President

We are pleased to announce the re-election of Dr. Edward Kraus, Ph.D., Dean Emeritus of the College of Literature, Science and Arts, University of Michigan, as president of the Gemological Institute of America.

Dr. Kraus, author of many reference works on mineralogy and numerous mineralogical and gemological papers, was unanimously re-elected at last Spring's meeting of the G.I.A. Board of Governors in Los Angeles.

Other officers re-elected were Percy K. Loud, R.J., president of Wright, Kay & Co., Detroit, secretary-treasurer, and Robert M. Shipley, executive director.

Those appointed as officers for the Board of Governors were:

Leo J. Vogt, C.G., R.J., Hess & Culbertson, St. Louis, chairman; Paul S. Hardy, Hardy & Hayes Co., Pittsburgh, vice chairman; and O. C.

(Continued on Page 445)

†Curator of Geology and Mineralogy, Smithsonian Institution, and Member of the Educational Advisory Board, Gemological Institute of America.

Identification of Synthetic Gems

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

Part III—Synthetic Spinel & Emeralds

Synthetic Spinel

Synthetic spinel is encountered with increasing frequency in the trade. Inasmuch as the characteristics of synthetic spinel differ from those of synthetic corundum, special consideration of these features is essential.

Curved striae are never present, but fissures and gas bubbles are common features. The spherical gas bubbles which are seen through the microscope are definite characteristics of the synthetic spinel. They frequently deviate from the spherical form and when examined under the microscope sometimes appear rather like minute tubes or worms (Figure 6). They also may present a certain orientation which causes them to be mistaken for the liquid inclusions in natural gems. Occasionally, larger gas inclusions appear, elongated and in interesting shapes with sharp profiles (Figure 7). Generally, however, gas bubbles of spherical or any other shape occur rather rarely in synthetic spinel of any color. A determinative property of synthetic spinel is the irregular, patchy double refraction visible with crossed nicol prisms (dark position of the polariscope) and caused by internal strain due to an excess of alumina. This kind of refraction is called "anomalous double refraction by tension," and its presence in a suspected stone would confirm its synthetic origin. Such refraction is evident in pale blue synthetic spinel (erroneously termed "synthetic aquamarine") and in dark green, tourmaline-colored stones, though observable in synthetic spinels of whatever hue. It is always recognizable, although it appears in a variety of manifold and typical patterns (Figures 8 and 9).

Natural spinels may also present this anomalous double refraction due to strain. In this case, however, the texture is rather "blotchy" and very different from the cloudy, fibrous or feathery pattern observed in the man-made stone. It appears faintly, and the borders between the bright and dark fields or the curved bands are not very distinct. This property, by the way, also distinguishes natural spinel from garnet, the anomalous double refraction of the latter showing a more "chequered" structure. Moreover, natural spinels with anomalous double refraction nearly always contain solid or liquid inclusions which seem to cause the anomaly.

Synthetic Emeralds

Synthetic emeralds are produced by a totally different process; their growth is a slow crystallization from a mother liquor, and any striae that may be observed are rigorously straight or may even form the same kind of zonal structure, with a hexagonal pattern, as is occasionally found in natural emerald. Nor do their physical features, as a rule, differ greatly from those of the natural gems. Nevertheless, though single deviations may not suffice to give convicting evidence, taken all together they enable the gemologist

to make an accurate and reliable diagnosis. Generally the physical properties, such as refractive index, density and birefringence, are slightly smaller with synthetic emeralds because their unit cell is chemically purer and therefore infinitesimally smaller.

The only drawback is that such a determination requires elaborate instruments which the average jeweler rarely possesses. He will therefore find it more practical to rely on typical impurities, such as cracks, flaws and feathers, observed through a magnifying instrument, in order to discriminate between natural emeralds and their synthetic counterparts.

Synthetic emeralds may contain solid, liquid and gaseous inclusions. The solid impurities are tiny specks "sprinkled" more or less evenly throughout the whole stone (Figure 10). Through a microscope they appear black, whereas they have a green color when viewed through the Diamondscope. Their nature is uncertain, but I believe them to consist of minute particles of coloring agent (Cr_2O_3).

When observed along the optic axis, the configuration of the liquid inclusions has the form of undulate feathers or wisps whose curled shapes and wavy arrangements are of absolute diagnostic value (Figure 11). Viewed under a powerful microscope they are seen to consist of swarms of little lenticular drops each containing a tiny gas bubble (Figure 12). They do not form any particular pattern and their presence has been noted in all synthetic emeralds (American as well as German-made ones) hitherto examined. Individual liquid-filled cavities and cracks are also a feature of synthetic emeralds. These cavities have strange shapes and are not found in natural stones (Figure 13). Another distinguishing feature of synthetic emeralds is a pronounced anomalous double refraction similar to that observed in synthetic spinel. Complete extinction is not obtained when the stage of the polariscope is rotated between crossed nicols. The anomaly is due to internal strain, probably caused by the method of growth and not, as in spinel, by an excess of one chemical component (Figure 14).

Fluorescence may be used to positively identify synthetic emerald, but this paper has been limited to magnification methods.

Methods of Magnification

Any type of magnifying instrument may be used for observing these internal features of synthetic stones. Gas bubbles and the wisp-like feathers in synthetic emeralds are best studied with the G.I.A. Diamondscope. Occasionally, however, the curved striae in synthetic sapphires, and even more markedly in synthetic rubies, are not discernible with this instrument. In such cases the stone should be viewed against the white background on the reverse of the dark field of the baffle. But a polarizing microscope, even of the simplest type, is far more satisfactory for this purpose. By immersing the stone in a highly refractive liquid and viewing it with diaphragm almost shut and nicol prisms crossed, the curved structure lines are distinguished with ease and certainty. The Shipley immersion stage will be found invaluable in examining suspect stones.

Microscopic examination permits a reliable diagnosis in most cases. If that is insufficient, the use of the spectroscope or a study of luminescence under different types of radiation offer additional means of distinguishing precious stones from their synthetic substitutes.

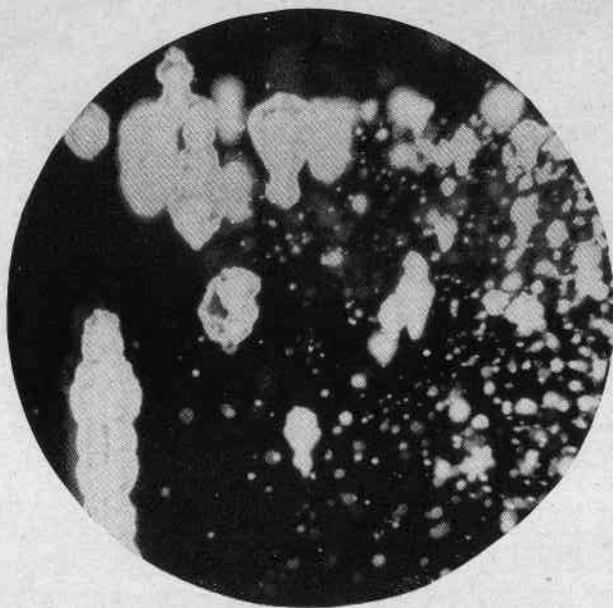


Photo by Dr. Gübelin

Figure 6
Worm or tube-like inclusions with the more common spherical bubbles in synthetic spinel, as seen in dark-field illumination.

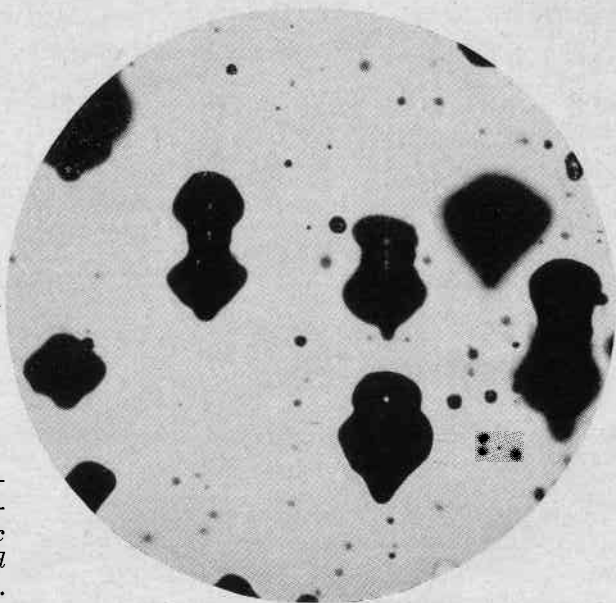


Photo by Dr. Gübelin

Figure 7
Elongated gas bubbles with sharp profiles in synthetic spinel photographed in transmitted light.

Photo by Dr. Gübelin

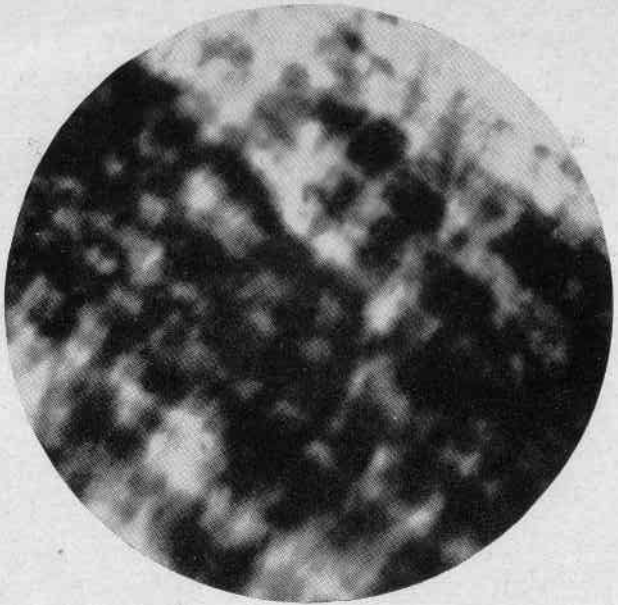


Figure 8
Typical "cross hatched" appearance between crossed Nicols caused by

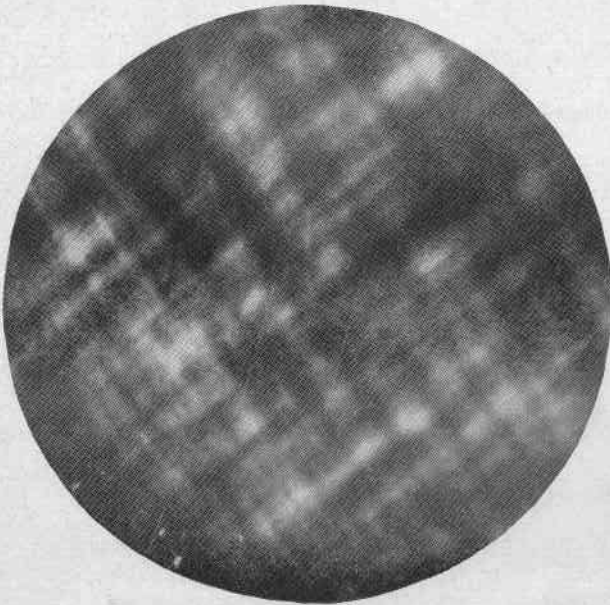


Photo by Dr. Gübelin

Figure 9
anomalous double refraction in synthetic spinel shown in both figures on this page.

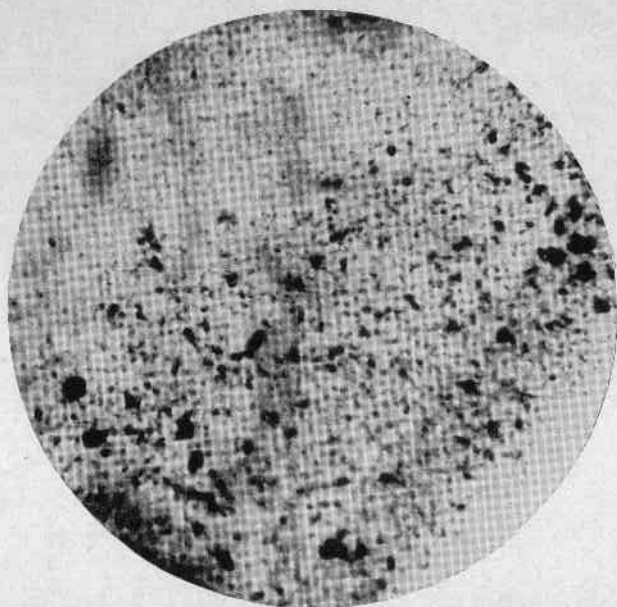


Photo by Dr. Gübelin

Figure 10
Minute particles of
foreign matter
"sprinkled" through-
out a synthetic emer-
ald.

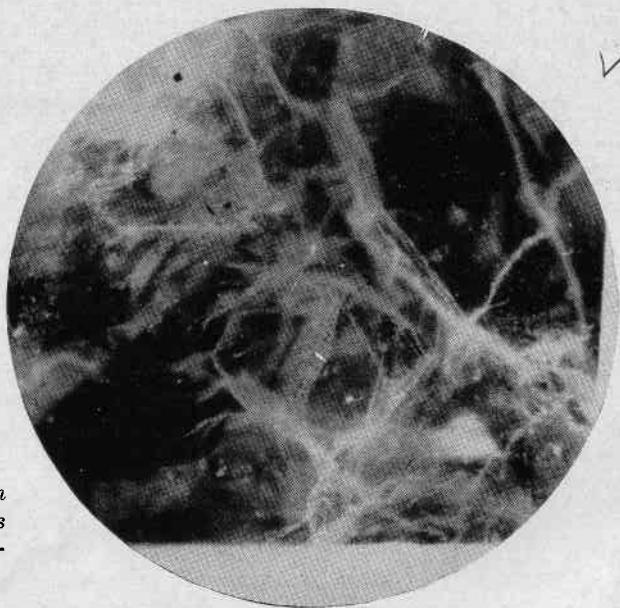


Photo by Dr. Gübelin

Figure 11
Dense accumulation
of wisp-like feathers
in a synthetic emer-
ald.

✓
Photo by Dr. Gübelin

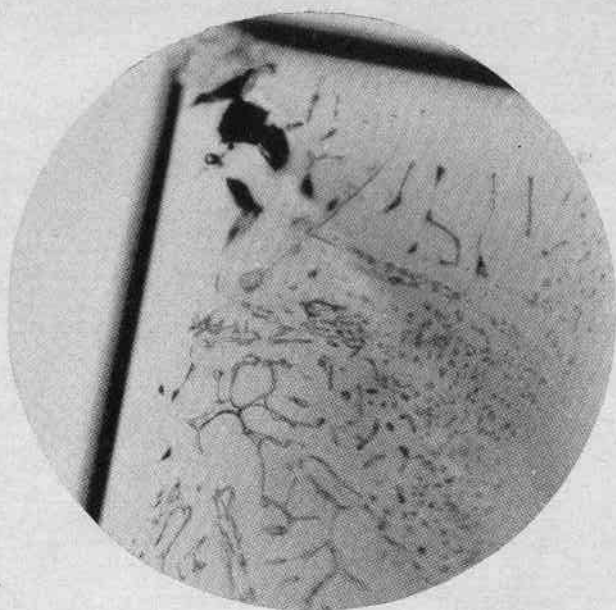


Figure 12

The broad side of a wisp-like liquid feather in a synthetic emerald. Notice the genuine-like pattern of the singular drops.



Photo by Dr. Gübelin

Figure 13

Large individual liquid inclusions in a synthetic emerald.



Photo by Dr. Gübelin

Figure 14
Blotchy extinction in a synthetic emerald caused by anomalous double refraction by tension.

SURVEY OF SOUTHERN CALIFORNIA GEM DEPOSITS

A detailed survey is being completed in the famous Pala district of San Diego County, California, it has been announced by Richard J. Jahns, Associate Professor of Geology at the California Institute of Technology and Geologist for the United States Geological Survey.

The Pala gem mines are noted for their substantial past production of fine gem tourmaline, spodumene, beryl and quartz crystals. Conducted under the joint auspices of the United States Geological Survey and the California State Division of Mines, the current studies have been in progress for the past nine months.

Activities have included the detailed mapping of several mines and gem producing pegmatites, and examination of all mines and prospects in the area. Collaborating with Mr. Jahns in this work is Lauren A. Wright.

In addition, the quadrangle in which the mines are situated is being mapped geologically by John B. Hanley of the Geological Survey.

A report of these studies will be published soon by the California State Division of Mines. Similar work is scheduled for extension into the gem bearing areas of Mesa Grande and Ramona.

Pearl Identification by X-Ray Diffraction

Mappin's Gemmological Laboratories, Montreal

by

WILLIAM H. BARNES, M.Sc., Ph.D.
Associate Professor of Chemistry, McGill University

Part II—Results

Cultured Pearl

The cultured pearl employed for most of the present study is shown in Figure 4. It was almost perfectly spherical with a diameter of about 8 mm., a weight of 17.17 pearl-grains and had not been drilled.

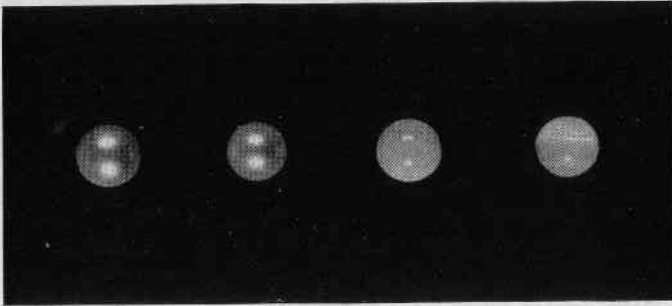


Figure 4

From left to right: *Natural (Oriental) Pearl, Cultured Pearl, Conch Pearl, Mother-of-Pearl Bead*

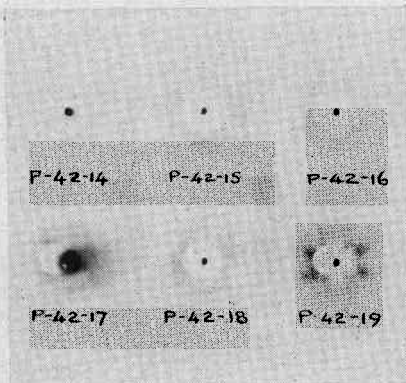


Figure 5

By means of preliminary X-ray diffraction photographs the direction of the pseudo-hexagonal axes of the aragonite crystals in the mother-of-pearl core was determined and the setting of the pearl on the photogoniometer was adjusted

so that the X-ray beam passed through the centre of the pearl along this direction. The diffraction photographs reproduced in Figure 5 were obtained with the X-ray beam along the direction of the

pseudo-hexagonal axes (P-42-14) and at angles of 10° (P-42-15), 20° (P-42-16), 30° (P-42-17), 45° (P-42-18) and 90° (P-42-19), respectively, to the direction of these axes. These patterns show a gradual change from halo to rectangular type as the angle between the X-ray beam and the direction of the pseudo-hexagonal axes is increased. Definite indications of the rectangular pattern are obtained when this angle is 30° (P-42-17) and it becomes clear enough for unambiguous recognition at 45° (P-42-18). Since Galibourg and Ryziger (1,c) have reported 37° as the minimum angle of diver-

gence between the X-ray beam and the pseudo-hexagonal axis for the appearance of the rectangular pattern, a diffraction photograph (P-42-23, Figure 6) was taken with the present pearl in this position. The resulting pattern (P-42-23) is more clearly recognizable as a distorted rectangular one than is the one (P-42-17, Figure 5) obtained when

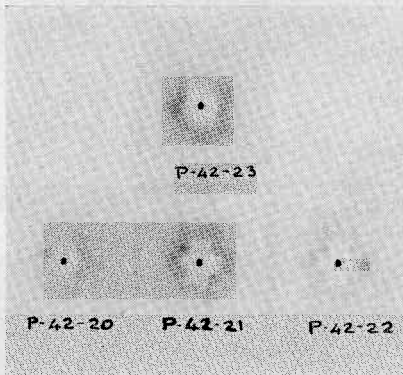


Figure 6

the angle between the beam and the pseudo-hexagonal axis was 30° . Since the transition from the halo to the rectangular pattern is gradual, however, the precise angle of divergence between the X-ray beam and the pseudo-hexagonal axis at which the rectangular pattern becomes unambiguously distinct probably depends on the physical characteristics of the particular mother-of-pearl core involved. The present results indicate that it is in the neighbourhood of 37° as found by Galibourg and Ryziger.

Since this angle is less than 45° , it follows that if the X-ray beam is at an angle of 90° to any direction along which a halo (or hexagonal) pattern is obtained, a cultured pearl

should give a recognizable rectangular one. Thus in Figure 6, the diffraction pattern P-42-20 was obtained with the X-ray beam at 90° to the direction along which photograph P-42-18, Figure 5, was taken. For P-42-18, the beam was at 45° to the pseudo-hexagonal axis; for P-42-20, therefore, it was also at 45° to this axis. Similarly, pattern P-42-21, Figure 6, was obtained with the X-ray beam at 90° to the direction along which photograph P-42-23, Figure 6, was taken. For P-42-23 the beam was at 37° to the pseudo-hexagonal axis; for P-42-21, therefore, the corresponding angle was 53° . Finally, pattern P-42-22, Figure 6, was obtained with the X-ray beam at 90° to the direction along which photograph P-42-17, Figure 5, was taken. For P-42-17 the beam was at 30° to the pseudo-hexagonal axis; for P-42-22, therefore, the corresponding angle was 60° .

These results show that, although the ideal rectangular pattern is obtained when the X-ray beam is normal to the direction of the pseudo-hexagonal axes in the mother-of-pearl core of a cultured pearl (P-42-19), almost perfect diagrams continue to appear as the angle between the beam and the direction of the pseudo-hexagonal axes is reduced from 90° to about 50° (P-42-21) and increasing distortion does not prevent recognition of the rectangular pattern until the angle decreases to less than about 37° (P-42-23).

If the layers of the mother-of-pearl core are perfectly plane, the diffraction patterns obtained when the X-ray beam passes through the pearl in a given direction with respect to the pseudo-hexagonal axes

(Continued on Page 440)

Color Range and Form Variations in Diamonds

by

RALPH J. HOLMES, Ph.D.

Instructor in Mineralogy, Columbia University, New York City

Some conception of the color range and the variations in external form of diamond rough can be gained from the accompanying color plate III which originally appeared in Gardner F. Williams' book *The Diamond Mines of South Africa* and later in his son's masterly work on *The Genesis of the Diamond*.¹

The principal crystal forms occurring on diamond are the octahedron, dodecahedron and cube. Often these forms are combined on the same crystal; the combination of octahedron and dodecahedron in which the twelve faces of the latter bevel the edges of the former is a frequent occurrence. The large gray stone in the lower right corner and the large white one in the center of the plate are excellent examples of octahedral crystals consisting of eight faces, each an equilateral triangle.

The dodecahedron, a twelve-sided form with rhombic-shaped faces, is illustrated by the large yellow crystal midway up the left side of the plate. Somewhat modified dodecahedra are also represented by the two green stones just above the violet-colored group near the lower left corner. The flat triangular stones in the upper right corner are twins or maclas. Contact twins of this type (spinel twins) are very common among diamonds. Less frequent in occurrence are the more complex star twins, three of which are shown. These star twins are actually pairs

of twins of the spinel type, consisting of four individual crystals.

Diamonds may also occur in an endless variety of distorted shapes and many of them are completely irregular. Such irregular types are to be seen among the pink and brownish red stones at the upper left.

In addition to well-formed crystals and completely irregular shapes, diamonds also occur in spherical or rounded nodular masses which, if light in color, are called ballas or, if very dark gray or black, are known as carbonado. The nodular masses which are never used as gem material, are especially valuable industrially since they are exceedingly tough. This excessive toughness is a consequence of the intricate aggregate structure; sometimes radial, sometimes random. Such stones are aggregates of large numbers of individual crystalline particles, frequently full of inclusions and varying from translucent to opaque.

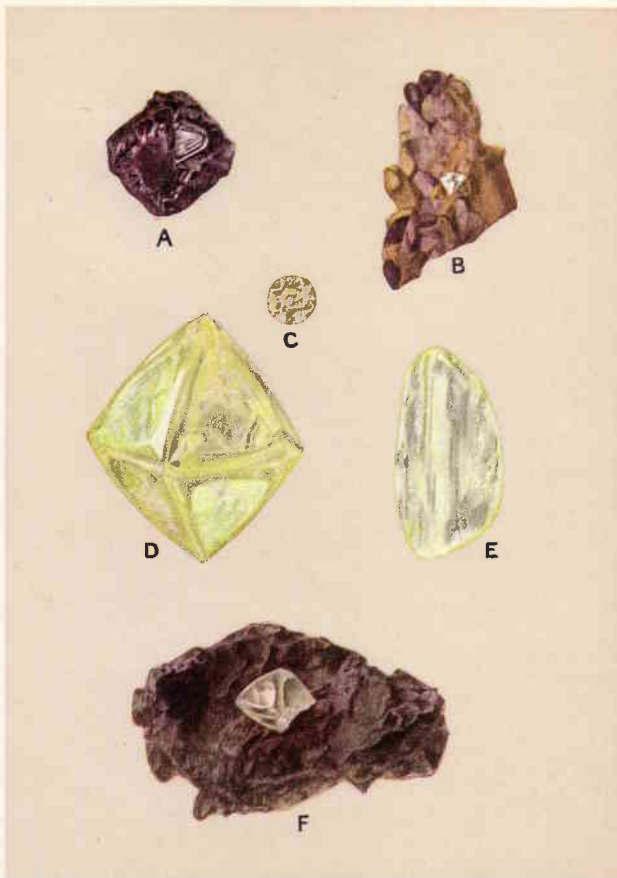
Although diamonds are usually thought of as colorless, or nearly so, they actually exhibit a wide variety of hues. For over forty years, Gardner F. Williams and then his son Alpheus F. Williams, were general managers of De Beers Consolidated Mines Ltd., Kimberley, South Africa, and had exceptional opportunities to secure unusual stones. The crystals illustrated are from the personal collection gathered by the father and son.

(Continued on Page 447)



Crystal Form and Color of Diamond Rough
Diamonds from the collection of Alpheus F. Williams,
author of "The Genesis of the Diamond"

(twice actual size)



Diamonds

A gem diamond (A) is encased in a black crystalline nodule of bort. A diamond crystal in "blue ground," from the primary deposits of South Africa (F), and one in cemented gravel from a Brazilian alluvial site (B) illustrate the principal occurrences of this mineral. A well-formed crystal (D) and a distorted one (E) indicate the variability in form of diamond rough. The 133-carat Colenso Diamond (D) is an octahedron (eight large triangular faces), modified by faces of the tris-octahedron, which rim those of the octahedron and give a rounded appearance to the crystal. Triangular growth, or etch markings, frequently observed on diamond, are clearly visible on the octahedral faces.

(actual size)

PLATE IV

The New Standard Diamolite

by

WILLIAM COLLISON, C.G.

After considerable research and experimentation, the Gemological Institute has introduced the new Standard Diamolite which adds a source of ultraviolet radiation and greatly increases the efficiency of the Basic Diamolite. The first model known as the Basic Diamolite was designed to meet the dire need for a diamond color grading unit that would produce an artificial daylight light source from which exterior reflections are eliminated. By means of this instrument, many jewelers, although miles apart, have been grading diamonds at any time of the day under identical conditions with identical results—a long step forward toward an international standard of diamond grading.

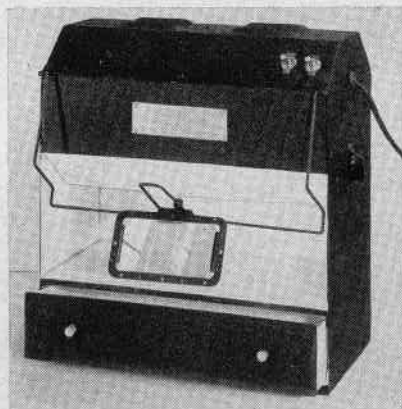
The Standard Diamolite has both a standard light source for accurate color grading and an ultraviolet source which serves a dual purpose. When the ultraviolet source is used in conjunction with the artificial daylight source, a light is produced that approximates sunlight and will show the diamond off under the most attractive and favorable conditions. Also, when the daylight source is turned off, the phenomenon of fluorescence, if present, will be revealed. This phenomenon is extremely interesting to customers and also more desirable since bluish or violetish fluorescence makes a diamond more valuable than a non-fluorescent stone of exactly the same color grade.

Since it has become apparent that body color can be distinguished more easily under magnification, this instrument is also equipped with a

large rectangular focusable magnifier, adjustable either into the line of sight or out of the way.

The Standard Diamolite is 13" high, 12" wide, and 6" deep, suitable for use either on a showcase or on a table.

Designed for both the buying and selling of diamonds, the new instru-



Standard Diamolite

ment makes it possible for stones to be examined under different intensities of light by shifting a movable pad on the floor of the instrument. If the diamond on the pad is moved forward to the lower intensities of light, there are almost no reflections from the top facets to impede a view of the true body color. The pad may also be lifted slightly at front or back to observe the stone in different directions, thus the most favorable lighting conditions can be obtained without changing the relative positions of the stones.

Jewels of the Russian Diamond Fund

by
ALEXANDER E. FERSMAN†
PART III

Historical Stones of the Diamond Fund

During three years we tried to clear up the history of some noted stones of the Diamond Fund. Many facts are yet unknown, many never will be at the disposal of science, but some facts as to the origin and history of the stones we were able to discover with accuracy. I will tell you about them. In the Diamond Fund the most noted are diamonds, and three of them have a distinct significance not only for the science

of jewelry, but also for mineralogy. These are the Diamond Tablet, the "Orlov" and the "Shah."

Diamond Tablet

It is a wondrous solitaire mounted like a mirror in a gold-enameled bracelet, Gothic in style, workmanship of the epoch of Alexander I (*Figure 8*). The tablet is a so-called portrait stone, the surface of which, with the side facets, is more than 7.5cm. square and weighs 23-25 carats. The stone is of rare beauty and clarity, in old Indian mounting

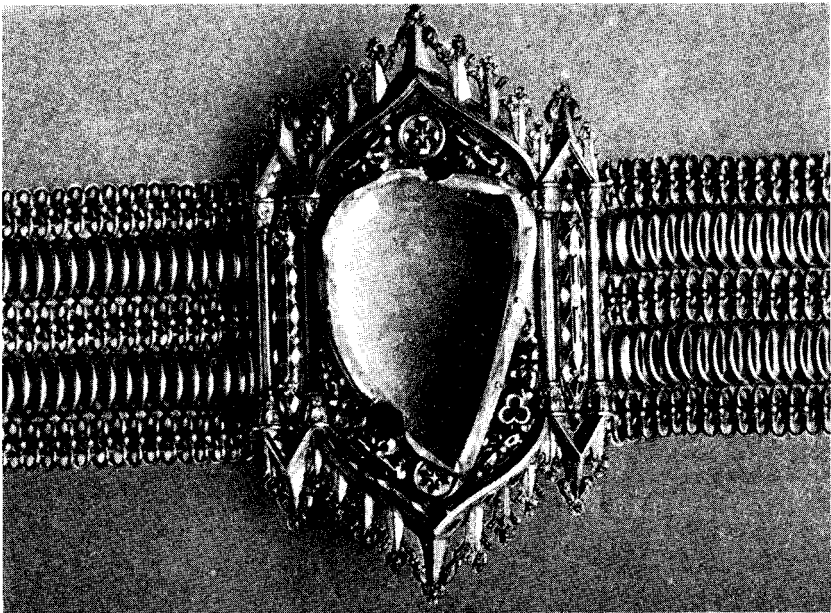


Figure 8

Center portion is shown of golden bracelet with a huge flat diamond (full size).

†Translated by Marie Pavlovna Warner.

with two indentions which are covered by soft gold. Evidently this stone is soldered, being a chip from some unknown colossal crystal from the sands of Golconda in India. Unfortunately the history of the stone is unknown, and only from the correspondence of the ministry of court we find out its official name "table" and there is given an absolutely incorrect weight—68 carats. It is necessary to say that in XVIIth and XVIIIth centuries, when fine miniatures were in fashion, everyone was searching for the so-called "portrait diamonds" which were used instead of glass because they added exceptional beauty and brightness to the paints. In our days such tablets have not only artistic value, but technical, as they can be used in roentgenospectroscopical instruments.

Orlov

The "Orlov" was purchased by Count Orlov for Catherine the Great in 1772. Up to this time it has the form of the old Indian cut which it had when in possession of the Great Moguls. Many tales were created about this stone, but only now we know the real truth of its past. This stone was found in the beginning of the XVIIth century in Golconda, in the mines of Kollur, and it was cut in the shape of a high rose. Its original weight probably was about 300 carats and it was one of the two natural chips of the big stone of the Great Moguls. Shah Djekhan was not pleased by this cutting and ordered it to be recut to its present shape (*Figure 9*), with its approximate weight of 200 carats. In this shape the stone attracted the attention of the traveler Tavernier while in the palace of Aureng-Zeb. In 1661 Aureng-Zeb obtained another large diamond cut in the shape of an Indian rose, which later, in the

times of Shah Nadir, was named "The Kohinoor." This stone made a pair to our "Orlov," which at that time carried the name of "Great Mogul." In his historical notes Pallas says that the "Orlov" and "Kohinoor" were mounted in the throne of Shah Nadir, which at that time was in possession of Delhi. In 1737 "Orlov" had the name of Deria-noor,

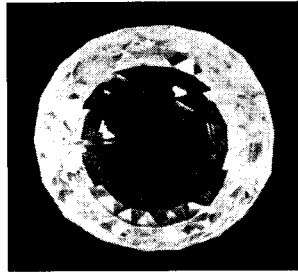


Figure 9
THE "ORLOV"

i.e., the sea of light, and the other stone of Kohi-noor, i.e., the mountain of light. The ultimate fate of these stones differs. Deria-noor was stolen, passed through many hands, and finally showed up at the market at Amsterdam where it was purchased by Count Orlov in 1772. At the time of Catherine II it was mounted in the scepter in silver, surrounded by a ring of diamonds from the inside.

Shah

The basic dates in the history of the "Shah" are engraved on the stone itself. Our investigations put an end to the old legends of Iran. It was found probably five hundred years ago in Central India by Hindu workers on the shores of the River Golconda. There they found a crystal, slightly yellow, about three centimeters in size, but an exceptionally clear diamond. It was delivered to the court of one

of the princes of Akhmednagar and was kept there among other priceless jewels. Local artisans accomplished almost the impossible: they took fine diamond powder, dipped sharpened sticks in it and thus cut out on one side in Persian letters: "Burkhan-Nazam-shah II, year 1000."

In the same year (our year 1591), the prince of Northern India, the Great Mogul, sent ambassadors to the central provinces to establish his sovereignty there also. But two years later the ambassadors returned with miserly presents, only fifteen elephants and five objects of value. The great Akbar decided to take the

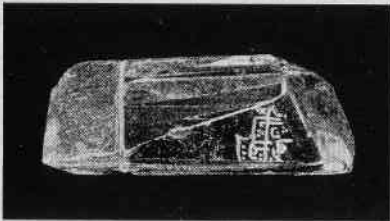


Figure 10
THE "SHAH"

provinces by force, and his military expedition brought back many more elephants and other valuable prizes. Among the latter was the "Shah," which thus came into the possession of the Great Moguls.

But now to the throne ascended Shah Djekhan, the "ruler of the world." He was a lover of precious stones and liked to cut them himself. In memory of himself, he ordered to be cut on the opposite side of the stone, "Son of Djekhan-girshakh, Djekhan-shakh, 1051" (our year 1642).

The son of this prince, jealous Aureng-Zeb, decided to get possession of the stone and of the throne of his father. After a long struggle,

including imprisonment of his father, he finally obtained the priceless stones of the Moguls, among them the "Shah." His fairy-tale court was described by the famous French traveler, Tavernier, who visited India in 1665. There is nothing in it pertaining to the stone except that in front of the throne of the Great Moguls was hanging a big diamond surrounded by the rubies and emeralds, and that in order to hang this stone there was made a groove all around; so to the two inscriptions was added a groove which artfully encircled the stone and made it possible to hang it by means of an expensive silk or golden thread.

Seventy-five years passed after the visit of Tavernier. The stone was kept at first in Djekhanbad, then in Delhi. In 1739 new calamity befell India. Shah Nadir came from Persia, took possession of Delhi and with it this stone.

The stone now was in Persia. Here, one hundred years later, a new inscription was artfully engraved on it: "Potentate Kadjar Fakhtalishakh Sultan, year 1242."

Now new events entered into the picture. On January 30, 1829, in Teheran, the capital of Persia, there occurred a fatal assault on the Russian diplomatic agent, who died at the hands of the paid assassin. Russia is in turmoil, as the person killed is not only a diplomat, but the famous writer, A. S. Griboedov. Persia must pacify the White Tsar. The son of the Shah, Prince Khosrev-Mirsa, comes to St. Petersburg and with him brings one of the most precious jewels of the Persian court—the "Shah." The "Shah" paid for the blood of Griboedov.

(To be Continued)

GEMOLOGICAL DIGESTS

Distinction Between Garnet and Corundum

By

G. MONTAGUE BUTLER†
Geologist and Mining Engineer

One of the more difficult identifications occasionally met by a gemologist is to distinguish with certainty between red corundum and red garnet with strong anomalous double refraction. Most red garnets are clearly singly refractive when tested in the polariscope. However, not infrequently a specimen is encountered which has such strong anomalous double refraction that it appears to possess true double refraction.

When this condition is coupled with a refractive index of 1.76-1.77, which value is possible for both almandite and pyrope, it is not always easy to decide whether the gem being tested is garnet or corundum (ruby or sapphire). In such a case, the presence or absence of true double refraction may be quickly checked with the dichroscope. Garnet, even though it possesses strong anomalous double refraction, will exhibit no dichroism, whereas red or brownish red corundum shows strong dichroism.

A confirmatory test by which the thermo-electric properties of the

gems are determined may be performed in the following way:

Hold the gem with the table in contact with a lighted 40-watt incandescent globe for one minute. If the gem is a tourmaline, a pith ball about one-eighth of an inch in diameter will jump up to it from a distance of nearly a quarter of an inch. If a garnet, it will jump about a sixteenth of an inch; and if a precious topaz, it will adhere to the surface of the gem when it is touched to the ball. If it is corundum, no reaction is observed. The distances given apply when the gem weighs about two carats.

German Synthetic Gem Production

*(Digested from Watchmaker,
Jeweller & Silversmith,
January 1947)*

Two plants in Germany produced synthetic sapphire and spinel boules during the war. These were the I. G. Farben plant at Bitterfeld and the Wiedes Karbid Werke at Freyung. Both plants use the basic Verneuil process. The Wiedes Karbid Werke boule plant has a capacity of 60,000 carats per day, with 204 boule burners. The I. G. Farben plant has a somewhat larger capacity, with about 300 burners.

Production at the Wiedes plant is now 90 per cent aquamarine colored spinel. The following data on growth conditions are given: boule size, 150 to 200 carats; boule growth time, 4 to 5 hours; cooling time in furnace, ½ to 1 hour; tapping frequency, 60

†G. Montague Butler, dean of the College of Engineering at the University of Arizona, was a pioneer in the study and teaching of gemology. After teaching mineralogy for several years, reading everything available on gems, and working with jewelers and lapidaries for several summers, Mr. Butler initiated a course in gemology at the Colorado School of Mines in 1909. It was the first college course in this subject given in the United States.

GEMOLOGICAL DIGESTS

to 80 per minute; hydrogen consumption, 4 cubic meters per hour; hydrogen-oxygen ratio, 2 to 3; overall powder utilization, 60 per cent. In normal operation, the yield of boules is 60 per cent first quality, 20 per cent second quality, and 20 per cent third quality.

The most interesting development in the synthetic industry in Germany during the war was that of Dr. Wilhelm Eppler, working with Dr. Albert Maucher and Professor Drescher Kaden. Because of a serious shortage of diamond powder, they developed a method of surface hardening spinel jewel bearings after they were fashioned. Thus the jewels could be fashioned with carborundum powder, whereas diamond powder was required to work corundum.

No evidence was found that the German plants had developed synthetic corundum or spinel in rod form, such as is being made in the United States. —G.S.

German Synthetic Emerald

The United States Department of Commerce recently released, as a newspaper report, information gathered in Europe regarding German synthetic emeralds. Most of the report contained nothing new to readers of *Gems and Gemology*. However, some data are given about the method used, which is of special interest because it throws some light on a process hitherto a closely guarded secret. The chief experimenter in this work was Professor

Richard Nacken, who stated that he worked for the most part with water solutions at temperatures of about 500° C. —G.S.

Brazilian Gem Production

The following excerpts have been taken from a report by Minerals Attaché Emerson I. Brown, which appeared in *Mineral Trade Notes*, Vol. 23, No. 5, November 20, 1946. (Published by the United States Bureau of Mines).

The production of semiprecious stones in Brazil is in excess of demand. The price of calibrated stones for export has declined as much as one-third in the past six months. A new discovery of amethyst at Campo Formosa, State of Baía, north of Brejinha, has depressed the price of this gem. Current retail prices are approximately as follows:

Cruzeiros per carat*	
Amethyst	3 to 14
Citrines, good color.....	12
Tourmaline, dark green.....	20 to 40
Tourmaline, light green.....	90 to 180
White beryl.....	Cr. \$6.50
Blue topaz.....	14
Golden beryl.....	50 and up

*The cruzeiro is considered as roughly equivalent to 5.3 cents U.S. currency.

During World War II, gemstone production in Brazil was affected in several ways. The volume of production was reduced by the diversion of labor to strategic-mineral production, such as quartz crystal and mica mining. In normal times there was a market for the inferior gem material in Germany, and it was said that the loss of this market for the low-grade material inevitably mined

with that of good quality (which paid the expenses) caused much of the gem mining to be suspended. The miner usually is an independent worker who must have a daily income and cannot finance himself until he encounters rare material of good quality.

Much more cutting of the stones was done in Brazil during the war than in prewar times and at relatively low prices—10 to 15 cents per carat; but the cost was still too high to permit use of the large volume of inferior rough that was formerly cut at Idar, Germany, and re-exported.

Gem Sources

More gems come from Minas Geraes than from any other state. The pegmatite gem region lies roughly east of Belo Horizonte and extends north into the State of Baía, the worked deposits becoming sparser, perhaps because the population is thinner, toward the north.

Some of the centers of activity are Teófilo Ottoni, Governador Valadares, Salinas, Itabira, and Arasaahy. Their names give only a general indication of the locality. Many of the mines are some distance from the nearest town. The nature of specimens observed indicates that gems probably are quarried from solid rock in the region of Governador Valadares. It is apparent that elsewhere the gems come from soft, decomposed material or stream beds.

With the exception of fine-quality amethyst, which seemed to be getting scarcer in 1944, it was believed that the potential supply of rough gem material was still large. On the other hand, it was observed that lit-

tle gem material was disclosed in all the pegmatite mining for mica, tantalite, and beryl.

Aquamarines are found associated with other beryl gems, such as pale morganite and golden beryl, throughout the range of the pegmatite zone. Green beryl, pale in color, found in several localities in Baía and Goiaz, were sold (in 1944) for about \$5 per carat. No stones comparable to Colombia emeralds have been seen.

Green tourmaline is common and inexpensive; much of it is too dark. Fine red rubellite is scarce and expensive. Very few of the stones were perfect enough to command a good price or to find a ready sale.

White and blue topaz are common in the pegmatite dikes and in stream-worn gravels. Fancy deep-colored stones command better prices than aquamarines.

Yellow topaz, called Imperial topaz in Brazil and precious topaz in the United States, is rarer than aquamarine, but the demand in 1944 had not yet been reflected in high prices.

Brown precious topaz occurs in the vicinity of Ouro Preto, Minas Geraes. Numerous small deposits have been worked, but the production is very small, and fine gems are uncommon. The best mine is said to be the Boa Vista near Rodrigo Silva.

Heat Treatment

Some of the stones sold as topaz are amethysts that have been heated in a bed of sand until the color has changed.

Citrine may be a natural stone, or one in which the color has been changed by heating or "burning"

GEMOLOGICAL DIGESTS

amethyst or smoky quartz. Natural citrine of a fine yellow color is found in Baía. It is also found near Anapolis, State of Goiaz, where the crystals are in alluvial gravels. These citrines are said to be splotchy in color, ranging from yellow to red. A popular grade of citrine is produced by heating amethyst from Rio Grande do Sul. Most of the citrine gems are from smoky quartz that has been heated to produce the desired colors, which range from light yellow to orange; a cognac color is considered the best. Evenly colored stones of many sizes can be produced. The amethysts of Xique-Xique, Baía, are successfully heat-treated to produce yellow citrine. The citrine market declined during the first part of 1945; possibly the material was oversold.

Amethysts are found in five states in Brazil: Rio Grande do Sul, Baía, Goiaz, Espirito Santo, and Minas Geraes; the mode of occurrence differs with the locality. In Rio Grande do Sul cavities are lined with quartz, which is sometimes amethystine. Amethyst in Minas Geraes and Espirito Santo has an entirely different origin, as it is found in veins in pegmatite dikes. On the Rio Pardo and Rio Preto in Espirito Santo, large crystals are found loose in the soil. At the Brejinha mine in Baía, amethyst crystals line the cavities in a friable white sandstone. Water-worn pebbles of amethyst have been found which are derived from the erosion of a similar formation.

The most desirable amethysts are those that come from Brejinha, Baía, the best of which have a deep purple hue. The least desirable are the light-colored, large and uniformly tinted stones that are found as river-worn pebbles at Xique-Xique, Baía.

Uncommon Gems

Other less common gems are interesting and valuable. Chrysoberyl found near Suassuh, Minas Geraes, makes attractive lemon yellow stones that sell from \$5 a carat up to 10-carat sizes, and 20-carat stones may command a price of \$10 to even \$40 a carat for exceptionally fine ones.

Andalusites seem to be relatively common near Sta. Maria do Suassuh. Gem garnets have been produced near Salinas, but in 1945 better ones were reported occurring in Ceará. A small quantity of good-quality kunzite of a deep rose-lilac color was found at Cuite, near Governador Valadares, Minas Geraes. A new occurrence, said to be the first in Brazil, of milky white precious opal has been reported, with no mention of location.

Chrysoprase of an attractive light green color occurs in veins an inch or more thick from the vicinity of São José do Tocantine, Goiaz; commercial gem-cutting of this material has not yet been developed.

Agate was being dyed black to supply the demand for black onyx.

The official statistics for exports from Brazil in 1944 and 1945 and the first six months of 1946, follow:

	1944		1945		First half 1946	
	Grams	Value, \$US	Grams	Value, \$US	Grams	Value, \$US
Agates	19,226	13,061	20,918	22,457		
Aquamarines	72,857	578,945	107,144	652,897	63,055	350,542
Amethysts	131,075	311,202	149,283	392,408	185,516	404,483
Garnets	32,177	93,490	80,354	255,026	43,622	109,642
Cat's-eyes			121	9,204	270	12,028
Topaz	22,072	68,197	135,464	707,483	10,107	23,511
Tourmalines	9,592	42,888	19,950	78,277	4,824	27,317
Citrines (quartz).....	137,565	272,527	131,923	275,940	93,351	137,428
Other semiprecious.....	59,037	96,846	750,210	570,327	557,515	312,525
	483,601	1,477,156	1,395,367	2,963,637	958,260	1,377,476

—G.S.

SYNTHETIC EMERALDS ENTER THE AMERICAN MARKET

Prior to the war, only minute quantities of synthetic emerald reached the American market, coming largely from Germany, but beginning in 1940, the Chatham Process for the manufacture of synthetic emerald has gradually changed this situation and it is now important that the jeweler learn exact methods of distinguishing the synthetic stones from the real gems they so closely resemble.

Carroll F. Chatham, the San Francisco chemist who originated the new process, is releasing between 3,000 and 4,000 high-quality stones a month through his distributors, one of whom has displayed papers of from 500 to 1,000 fine-appearing stones, ranging in size from .05 to .87 carats. The average size, however, is from .50 to .75 carats. They are of excellent quality and color, very similar to natural emerald.

The Chatham Process is completely different from the Verneuil Process employed in the production of synthetic corundum and spinel, by which powdered material is fused as it passes through an oxyhydrogen flame to fall upon a revolving refractory rod, forming pear-shaped "boules." Instead, the Chatham synthetic emerald is apparently "grown"

in solution by a secret method evolved by its originator, producing well-formed crystals.

Synthetic emerald was manufactured successfully for the first time in 1884, in France. Not until 1931 did the I. G. Farbenindustrie of Germany succeed in making synthetic emerald crystals. Gems were finally produced from "Igemerald" crystals which, when cut, measured five millimeters in length.

Dr. George Switzer, in an article on synthetic emerald which appeared in the Spring, 1946, issue of *Gems & Gemology*, has this to say of its physical and optical properties:

"The refractive indices and birefringence of synthetic emeralds are in general lower than genuine emerald.

"Inclusions have been reported in synthetic emerald as being of three types (Gübelin and Shipley, 1941): (1) Solid particles spread swarm-like throughout the synthetic emerald. These are probably inclusions of the green coloring agent (Shipley, 1942); (2) Groups of liquid inclusions shaped as feathers, making up wisp-like, veil-shaped formations in the synthetic; (3) Systems of almost parallel rod-like inclusions. Liquid inclusions are not shown."

(Continued from Page 429)

should be the same regardless of the particular portion of the pearl in the path of the beam. Under these conditions, displacement of the cultured pearl in any direction in a plane normal to the X-ray beam should cause no change in the diffraction pattern as discussed in detail in a later section of this paper. On the other hand, lack of regularity in the plane parallelism of the layers should result in more or less marked changes in the pattern. Thus in

X-ray beam and the direction of the pseudo-hexagonal axes. Although the horizontal adjustments of the pearl for these tests were not geometrically precise, any slight change in the direction of the pseudo-hexagonal axes relative to the X-ray beam due to this factor could not have been as large as that indicated by comparison of patterns P-42-24 and P-42-27, respectively, with P-42-14. Similarly, displacement of the pearl 3 mm. horizontally along a line at right angles to the X-ray

beam from the position in which it gave the very regular rectangular pattern P-42-19, Figure 5, was ac-

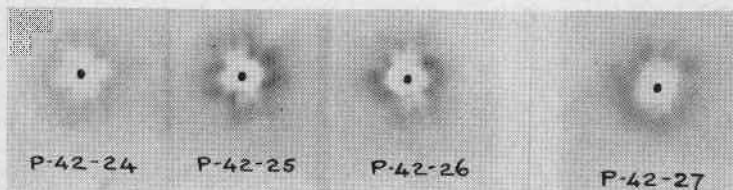


Figure 7

Figure 7, P-42-24 was obtained after displacing the cultured pearl 3 mm. horizontally to the right along a line at right angles to the X-ray beam from the position it occupied for P-42-14, Figure 5. But, although the pseudo-hexagonal axes of the crystals in the path of the beam for P-42-14 were along the direction of the beam, they must have been inclined at an angle of at least about 50° to the beam to give the distinctly rectangular pattern, P-42-24, Figure 7.

Similarly, P-42-27, Figure 7, was obtained after a 2 mm. displacement of the pearl to the left along a horizontal line at right angles to the beam from the position occupied for P-42-14, Figure 5. Again the pattern shows rectangular characteristics (although not as well developed as in P-42-24) indicating an appreciable angle of divergence between the

companied by some distortion and rotation of the pattern as shown in P-42-25, Figure 7.

Finally, the pattern P-42-26, Figure 7, was obtained after displacing the pearl 2.5 mm. horizontally in a direction at right angles to the beam from the position in which it gave pattern P-42-18, Figure 5. If the mother-of-pearl layers of the core had been perfectly plane, the X-ray beam should have made the same angle (45°) with the direction of the pseudo-hexagonal axes in each setting. The rectangular pattern, however, is somewhat less distorted in P-42-26, Figure 7, than it is in P-42-18, Figure 5, indicating a larger angle between the beam and the direction of the pseudo-hexagonal axes after the horizontal displacement.

That the layers of mother-of-pearl in the core of a cultured pearl of

moderate or large size may be curved to a greater or lesser degree might be expected from the probability that the larger beads for insertion in the mollusc come from thicker regions near the hinge. In connection with the present work, visual examination of the beads in a mother-of-pearl necklace showed that the striations on the surface of the beads in many cases formed whorls and loops rather than parallel straight lines. Diffraction pat-

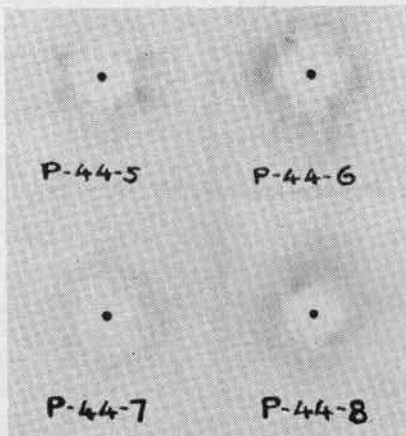


Figure 8

terns obtained from one of these beads are reproduced in Figure 8.

The bead, shown in Figure 4, had a diameter of about 8.5 mm. and a weight of 17.96 pearl grains. It was mounted with the drill hole vertical and with the (horizontal) X-ray beam passing through its centre in a direction estimated to be as nearly as possible parallel to the average direction of the striations (i.e., normal to the approximately horizontal pseudo-hexagonal axes). In this position pattern P-44-5, Figure 8, was obtained. The bead was rotated through an angle of 45° about the vertical axis, giving pattern P-44-6,

in which it will be observed that the trace of the pseudo-hexagonal axis no longer is horizontal. A further rotation of 45° yielded P-44-7 which appears to be a rectangular pattern superimposed on the halo that would have been expected if the beam had coincided with the direction of the pseudo-hexagonal axes. These three patterns may be compared directly with P-42-19, P-42-18, and P-42-14, respectively, Figure 5.

Finally, the bead was displaced 1.5 mm. horizontally along a line perpendicular to the beam from the centred position in which P-44-5 was obtained. In the new setting the X-ray beam passed through a particularly irregular region of the mother-of-pearl and a correspondingly unsymmetrical diffraction pattern, P-44-8, was the result.

The cultured pearl employed for the patterns illustrated in Figures 5, 6 and 7 was remounted with the direction of the pseudo-hexagonal axes vertical and thus perpendicular to the X-ray beam. For pattern P-42-28, Figure 3 (Part I), the pearl occupied an arbitrarily chosen position about the (vertical) direction of the pseudo-hexagonal axes with the X-ray beam passing through its centre. It was rotated about the vertical axis through 45° , giving pattern P-42-29 in this position. It was then rotated to a new position at 90° to the first and pattern P-42-30 was obtained. The pearl was displaced 2.5 mm. off centre along a horizontal line perpendicular to the X-ray beam (i.e., in a plane containing the vertical pseudo-hexagonal axes and normal to the beam) and in this setting gave pattern P-42-31. These patterns illustrate the fact that regardless of the orientation of the cultured pearl with respect to the X-ray beam, ex-

cellent rectangular patterns are obtained as long as the direction of the pseudo-hexagonal axes of the mother-of-pearl core remains perpendicular (or nearly so) to the X-ray beam.

Finally, the same cultured pearl was remounted so that the X-ray beam passed through its centre at the same angle to the pseudo-hexagonal axes and to each of two directions at 90° in a plane normal to the pseudo-hexagonal axes. For these two directions the axis of the X-ray beam giving patterns P-42-28 and P-42-30, respectively, was chosen.

This setting of the pearl is equivalent to directing the X-ray beam along the diagonal of a cube of which the three mutually perpendicular edges correspond to the axes in the pearl that are at equal angles to

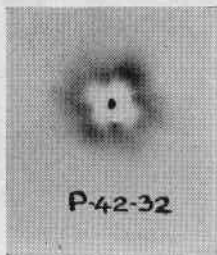


Figure 9

the X-ray beam. The resulting pattern, P-42-32, Figure 9, is recognizably rectangular.

The foregoing data on the cultured pearl show that for a random setting of the specimen with respect to the X-ray beam and with the beam passing through the centre of the pearl, there is a much greater chance of obtaining a rectangular type of diffraction pattern than one of the halo or hexagonal type. Two factors contribute to this result; the large angular range between the direction of the pseudo-hexagonal axes and the X-ray beam over which the rectangular pattern persists and the divergence of the mother-of-pearl layers from perfectly plane parallelism. In fact, if a pearl under

examination is suspected of being cultured, it is worth while developing the X-ray film after a single exposure of the pearl in a randomly selected orientation with respect to the X-ray beam. In most cases, if the pearl is cultured, a clearly recognizable rectangular pattern will be obtained. If a hexagonal halo or an ambiguous one appears, a second photograph with the X-ray beam passing through the centre of the

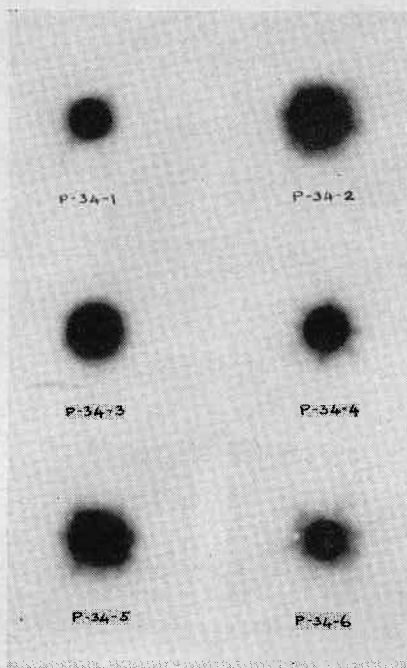


Figure 10

pearl in a direction at right angles to the first usually is sufficient to produce the rectangular pattern. Occasionally, troublesome cases are encountered when, probably due to excessive irregularity of the mother-of-pearl core, a number of ambiguous patterns may be obtained before a chance direction of the X-ray beam results in a clearly defined

rectangular pattern. The diffraction photographs, P-34-1 to P-34-6, reproduced in Figure 10, were obtained from such a pearl.

Natural Pearl (Oriental, Conch, Fresh-Water)

Different types of diffraction patterns that may be given by natural

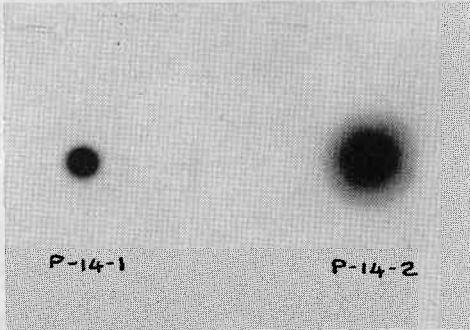


Figure 11

(oriental) pearls when the X-ray beam passes through the geometric centre of the specimen and hence along the direction of the pseudo-hexagonal axes of the crystals of aragonite are illustrated in Figure 2 (Part I). Patterns P-5-3 and P-5-4 were obtained from the same pearl with the X-ray beam along each of two directions at right angles, respectively. They are typical of the hexagonal "spoke" or "ray" type. On the other hand, patterns P-14-1 and P-14-2 in Figure 11 from another specimen exhibit an hexagonal "spot" diagram and a broad halo, respectively. As in the previous example, this pair of photographs was obtained by directing the X-ray beam along each of two directions at right angles through the centre of the pearl. As previously mentioned, such diffraction patterns are given by cultured pearls only when the direction of the X-ray

beam coincides with that of the pseudo-hexagonal axes (i.e., when it is normal to the mother-of-pearl layers) or within a relatively small angle thereto.

In Figure 2 (Part I), the diffraction patterns from an almost perfectly spherical oriental pearl are shown. This pearl, also shown in Figure 4, had a diameter of about 9 mm. and a weight of 19.86 pearl-grains. It was mounted with the drill hole (diameter about 0.7 mm.) perpendicular to the X-ray beam. Pattern P-46-2 was obtained with the X-ray beam passing through the centre of the pearl in an arbitrarily selected direction. After rotation through 45° about a vertical axis perpendicular to the X-ray beam, the pearl gave pattern P-46-3. Finally, after another 45° rotation (i.e., 90° from the initial position) of the specimen, pattern P-46-4 was obtained. This series illustrates the fact that hexagonal or halo type patterns are given by natural pearls regardless of the

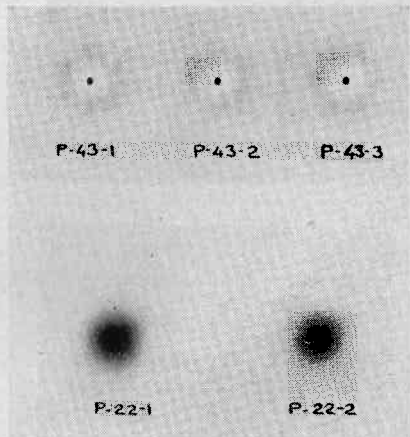


Figure 12

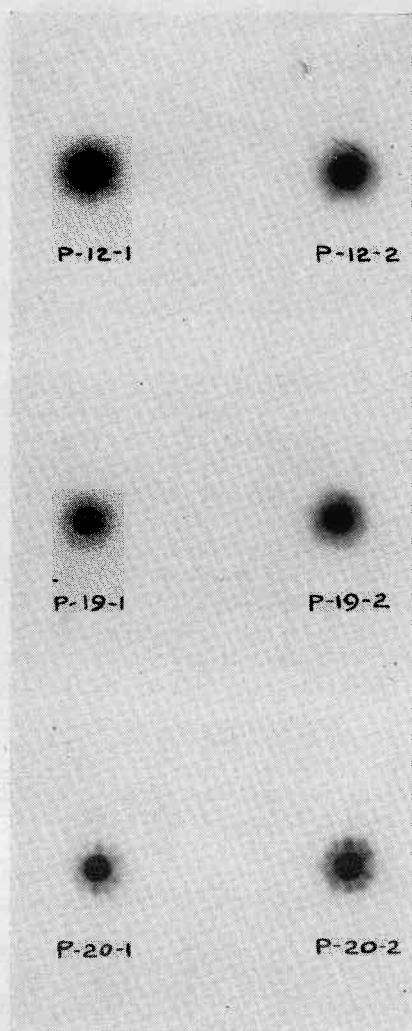


Figure 13

orientation of the pearl with respect to the X-ray beam, providing the beam passes through the geometric centre of the pearl.

Conch pearls give the same type of diffraction patterns as do oriental pearls. Thus, in Figure 12 patterns P-43-1, P-43-2 and P-43-3 were obtained with the X-ray beam passing

in three mutually perpendicular directions, respectively, through the centre of an undrilled spherical conch pearl (shown in Figure 4) of 8 mm. diameter and weighing 21.27 pearl-grains. Similarly, the halo patterns P-22-1 and P-22-2, Figure 12, were obtained with the X-ray beam passing in each of two directions at right angles through the larger end of a somewhat flattened pear-shaped conch pearl.

Fresh-water pearls also yield hexagonal or halo patterns when the X-ray beam passes in any direction through the centre of the pearl. Such patterns are shown in Figure 13, where each of the pairs of photographs (P-12-1, P-12-2; P-19-1, P-19-2; P-20-1, P-20-2) was obtained from a different fresh-water specimen. In each case, the two patterns from each pearl were obtained with the beam along each of two directions at right angles. Although all the patterns shown in Figure 13 are of the hexagonal or halo types, Alexander (1, *f*) also has obtained rectangular patterns from natural fresh-water pearls.

Off-Centre X-Ray Diffraction, Natural and Cultured Pearls

The X-ray diffraction patterns obtained when the X-ray beam does not pass through the geometric centre of the pearl are of considerable interest from both a theoretical and a practical point of view. A natural pearl is shown diagrammatically in Figure 14, the directions of the pseudo-hexagonal axes in a horizontal plane through the X-ray beam being represented by the radial lines. The photographic film (not shown) is to be imagined as perpen-

(Continued on Page 446)

BOOK REVIEW

Jewelers Pocket Reference Book

reviewed by

BILL THEIS

The *Jewelers Pocket Reference Book*, by Robert M. Shipley (Los Angeles, California, 1947, 320 pages, \$2.75), was inspired by the demand for a convenient-size, authoritative text containing information of value to the newer generation of jewelers, those somewhat more advanced in scientific knowledge, and the older practical jewelers who, from time to time, must refresh their memory on data infrequently used. This book admirably fulfills these requirements.

In addition it contains much of interest to the specialist in antique jewelry and probably the private collector of gemstones. It is hard to see how any public library could afford to be without it.

Primarily designed for use of the jewelry industry, it offers a splendid glossary of names and technical terms constantly employed, and is replete with concise charts, lists, maps and tables covering many phases of scientific knowledge relating to the field of gemology and other special concerns of the jeweler, such as silverware, watches, clocks and fraternal insignia.

One of the chief virtues of this handbook is the practicality of the information presented and its ready accessibility. The pages devoted to sketches and descriptions of mountings and findings will remind anyone who has ever worked in a

jewelry store service department of the hours of lost time and anxious effort so often involved in finding the answers to just such questions as are dealt with conclusively in this compact little volume.

The excellent drawings of clocks, watch sizes, styles of chains, silver designs and hundreds of similarly important items are particularly valuable to younger jewelers who wish to increase their knowledge of the trade and consequently their worth to both employer and customer.

Those starting in business will study it carefully and often, turning to it much as the drowning swimmer does a friendly hand from shore. But the professional gemologist and busy jeweler of long experience will be equally delighted with it; especially with the sections dealing with gem identification. It serves the needs, in fact, of every type of person connected with the production or sale of jewelry.

As one who once attempted to compile a similar text and became mired in the complexity of the task, the writer has great respect for the patient labor obviously involved in developing this reference book. There are always afterthoughts as to material which might have been included, and new editions are often greatly improved by constructive criticism from users of such a book.¹

The dimensions, for instance, might be increased and reading facilitated by enlarging the type size. The index is rather complicated. Paging could be simplified by use of consecutive numbers rather than division into sections as at present. Some errors, such as one on watch sizes, have crept in, not all readily detected.

However, the warm reception of the *Jewelers Pocket Reference Book* indicates that it fills a long-felt want in a major segment of industry. Issued in early spring, popular demand completely exhausted the first edition in three short months. Revision of forthcoming editions will doubtless make this handbook a still finer tool.

—Bill Theis

¹Editor's Note: *The Second Edition of "Jewelers Pocket Reference Book" is on the press and will be available in late September. As Mr. Theis suggests, numerous changes and corrections are being made. With reference to size, however, while the book will not fit every vest pocket, it has purposely been kept small enough to carry there. Comments from users will be greatly appreciated. The Second Edition may be ordered from the G.I.A. Book Dept.*

Pearl Identification by X-Ray Diffraction

(Continued from Page 444)

dicular to the plane of the figure and normal to the X-ray beam. The pattern on the developed negative is due to the diffraction of X-rays by the crystals in the narrow rod-shaped path of the beam passing through the pearl. If the centre of the pearl is in the path of the X-ray beam, as represented at A in Figure 14, the pseudo-hexagonal axes of most of the crystals contributing to the diffraction effect will be closely parallel to the direction of the beam. Under these conditions, the usual hexagonal or halo type of pattern is given. If the beam, represented by B, does not pass through the centre, the axes are inclined to the beam

and diverge less and less from a direction at right angles to the beam. This gives rise to the rectangular (fibre) pattern.

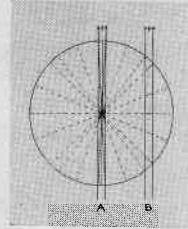


Figure 14

- (1) a. Dauvillier, A., *Compt. rend.* 179, 818 (1924); *Rev. Scientifique* 64, 37-45 (1926).
- b. Shaxby, J. H., *Compt. rend.* 179, 1602 (1924); *Phil. Mag.* 49, 1201 (1925).
- c. Galibourg, J. and Ryziger, F., *Compt. rend.* 183, 960 (1926).
- d. Mayneord, W. V., *Brit. J. Radiology* 23, 19-30 (1927).
- e. Anderson, B. W., *Brit. J. Radiology* 5, 57-64 (1932).
- f. Alexander, A. E., *Am. J. Sci.* 238, 366-371 (1940).
- (2) Pub. No. 138/3, Adam Hilger, Ltd., London, 1939.
- (3) Bernal, J. D., *J. Sci. Instruments* 4, 273-284 (1927); 5, 241-250 (1928); 6, 314-318, 343-353 (1929).
- (4) Barnes, W. H. and Hampton, W. F., *Can. J. Research*, B13, 218-227 (1935); *R.S.I.* 6, 342-344 (1935).
- (5) Astbury, W. T., *Fundamentals of Fibre Structure*. (Oxford Univ. Press) 1933.
- (6) Alexander, A. E. and Sherwood, H. F., *The Gemmologist* 10, 45-48 (1940); *Photo Technique* 3, 50-52 (1941).
- (7) Barnes, W. H., *Gems & Gemology*, V, 359 (1946).

Dr. Kraus Re-elected G.I.A. President

(Continued from Page 420)

Homann, R.J., The C. B. Brown Co., Omaha, Nebraska, secretary.

Among the policies approved by the Board of Governors at the recent meeting was the formal adoption of *Gems and Gemology* as the official journal of the Institute, with a special Editorial Board to be named to determine policies and suggest articles for publication. Editorial Board appointments will be noted on page 415 of this issue.

Contributors in This Issue

(Continued from Page 416)

1906 replaced him as general manager of the De Beers Consolidated Mines, Ltd., in which capacity he served for twenty-six years. The De Beers company is one of the world's major diamond producers.

During the war, Mr. Williams was Director of Ambulance and trained hundreds of men and women who later formed the South African Army. Now 73, he has not been actively associated with De Beers since 1931, occupying his time with the structural steel business carried on by his four sons under the name Alpheus Williams & Dowse Ltd., and also with his diamond collection, which he inherited from his father and has greatly enlarged.

Unfortunately, expense prohibits the acquisition of many diamonds of scientific importance, but in order to have a record of these specimens in his collection, Mr. Williams has employed both ordinary and micro-photography, as once a diamond enters the trade it is lost to science.

Mr. Williams is author of *The Genesis of the Diamond*, a monumental work on his specialty. His noted father, Gardner F. Williams (1842-1922), was also author of a splendid standard book, *Diamond Mines of South Africa*, long considered a classic on the diamond industry, covering every phase of its history and technology.

The great diamond collection pictured opposite page 430 in this issue will be handed down to the elder son

of Alpheus Williams who, like his father and grandfather, will continue to carry on and improve it as a labor of love.



Gifts to the Institute

A gift of a variety of useful material including a fluorescent lamp, lenses, ring sights, a large number of cut stone and a variety of rough material were recently presented to the Institute by one of its first students, E. L. Van Pelt of Jacksonville, Florida. Mr. Van Pelt is now in the United States Navy.

Varied stones for identification, examination and study have been received from Milo O'Dell, a student at Waukegan, Illinois.

Charles Milner, a student at Chicago, recently gave the Institute four sapphires.

Color Range and Form Variations in Diamonds

(Continued from Page 430)

The plate represents some of these strikingly colored "fancy" diamonds. Excellent examples of yellow, orange, brown, rose, pale violet or mauve, green, and red stones are shown. The greens are all rather pale as compared to emerald. Also absent is a truly ruby red stone. It is doubtful if deep emerald green or ruby red stones have ever been found. The only major color variety lacking in this collection is a distinct blue.

¹Williams, Alpheus F. *The Genesis of the Diamond*. Part II. 1932. Ernest Benn Ltd. London. p. 440. (These two volumes may be secured from the Gemological Institute of America for \$30.)