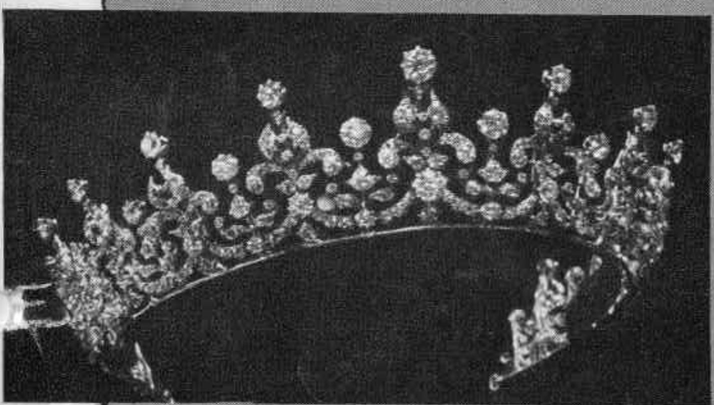
Gems and Gemology



Coronet for a Princess

One of Queen Mary's wedding gifts
to her granddaughter,
Princess Elizabeth.

WINTER 1947

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 | WINTER, 1947 | NUMBER 12

In This Issue:

Cover, British Combine Photo

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THE GEMOLOGICAL INSTITUTE OF AMERICA

(UNITED STATES AND CANADA)
Established 1931

541 South Alexandria Avenue — Los Angeles 5, California

CONTRIBUTORS IN THIS ISSUE

Charles M. Parkhurst Jr., author of the article (page 486) about the use of the Leveridge gauge for calculating the recut size of diamonds, speaks from extensive practical experience. He has recently spent almost two years with Donavan and Seamans, in Los Angeles, selling, grading diamonds, appraising and designing, and a year with the Los Angeles appraiser and gem merchant Walter Herz. He is at present in business for himself, and has just concluded a term as President of the Southern California Guild of the American Gem Society.

His educational background included an art major in the Framingham (Massachusetts) Public Schools, two scholarships in the Massachusetts School of Art, and extensive study of the art of steel and copper engraving and chasing under William Reynolds of Attleboro, Massachusetts. During the war he enlisted as a private, advancing to the rank of First Lieutenant in Intelligence.

Edward R. Swoboda, author of the article about Brazilianite, has opened a number of gem mines in South America, including the one in which this most recently-discovered gemstone was found. He has lately returned from South America to his native California after a trip through Minas Geraes and Espiritu Santo, in the course of which he acquired a notable collection of rare gems and minerals and a stock of cut stones.

He has spent much of the period since 1939 in Brazil. After his arrival there he was for a year and a half attached to an expedition which went into the Matto Grosso jungle for the purpose of acquiring birds and animals for the National Museum in Washington. Later, he was a member of the U.S. Geological Survey which did mineralogical, geological and topographical work concerning strategic minerals in South America.

Richard T. Liddicoat Jr., author of the brief article about the newest synthetic, Rutile, and of the discussion of the diamond with the visible included crystal which was studied at the Gemological Institute of America, is Director of Education of that organization. Education is a hereditary trade in the Liddicoat family: Richard T. Liddicoat Sr. is Professor of Engineering in the University of Michigan, where his son took his B.S. in geology, his M.S. in mineralogy, and assisted in the Department of Mineralogy until he came to the G.I.A. in 1940.

(Continued on Next Page)

CONTRIBUTORS IN THIS ISSUE (Continued)

His career with the Institute was interrupted by the War. He spent three years in the Navy as an ensign and Lt. (j.g.), studying meteorology at the California Institute of Technology and then serving as a meteorologist on aircraft carriers in the South Pacific and at Pearl Harbor until his return to civilian life, and to the Institute early in 1946.

Lelande Quick, author of the article about gem grinding, is the founder, owner and editor of the Lapidary Journal and one of the founders of the Los Angeles Lapidary Society, the first such group to be organized in the United States.

Dr. William H. Barnes, the fourth and concluding installment of whose article "Pearl Identification by X-ray Diffraction" appears in this issue, has recently resigned from the staff of McGill University, Montreal, to become a Senior Research Officer in the Radiology Section of the Division of Physics at the National Research Council, Ottawa. He is in charge of a laboratory devoted to research in X-ray diffraction, electron diffraction and electron microscopy.

Mark Chance Bandy, Ph.D., author of the articles on *The Hexagonal System* and *The Emerald in Fable and History,* is a native of Iowa, with a bachelor's degree from Drake University, the degrees of Engineer of Mines and Master of Science in Geology from Columbia, and a doctorate in mineralogy from Harvard.

Dr. Bandy, except for a year's period, has spent much of his working life in Mexico and South America. He functioned variously as petrographer and geologist for firms which included the Huasteca Petroleum Company and the Bethlehem Steel Corporation, and spent some considerable time collecting minerals for Harvard University and the Smithsonian Institution. He came to the Institute in October 1947, after eleven years with the Patino interests which supply some 50% of Bolivia's total tin production, first as geologist for the Patino Mines and Enterprises Consolidated (Inc.) at Llallagua in Bolivia, and later as manager of the Bolivian Tin and Tungsten Mines Corporation in Huanuni.

His translation of Agricola's *De Natura Fossilium* is now being prepared for publication.

Rutile Synthesis

Creates New Gem Material

by

RICHARD T. LIDDICOAT, JR.

Director of Education, Gemological Institute of America

A substance which, for all practical purposes, is a new gem material has been produced by the recent synthesis of rutile. The new synthetic is a development of the Linde Air Products Company and the Titanium Division of the National Lead Company.

The production of a gem was undoubtedly not the principal purpose of the research which led to this new synthesis. Rutile crystallizes in the tetragonal system, and is one of the trimorphic forms of titanium oxide. Titanium oxide is widely used as an opacity pigment in paint. Rutile occurs in nature, but in the natural mineral iron is almost always present. The complete separation of the titanium oxide from the accompanying iron oxide is a problem which the chemist has found almost impossible to solve. Because of the iron, which gives titanium oxide either a red or blue color and which usually renders it nearly opaque, transparent rutile is almost unknown in nature. It is, in fact, so rare that faceted gems are collectors' items. Opaque rutile is not sufficiently attractive to be used as a gem.

Transparent rutile is something else again. Gemologists have watched for it hopefully for years because of its unusual properties. Its refractive indices (w 2.62, e 2.90) are well above those of diamond (2.417); its dispersion is considerably greater even than that of demantoid garnet; further, its birefringence (.28) tops even that of calcite (.172). [These properties make it scintillant beyond any material known.] Unfortunately, it is soft—6-6½ (Moh's scale) in its natural form. However, even softer materials have been successfully used as jewelry, and what may be done with this brilliant gem substance is limited only by the creative imagination of the jewelry industry.

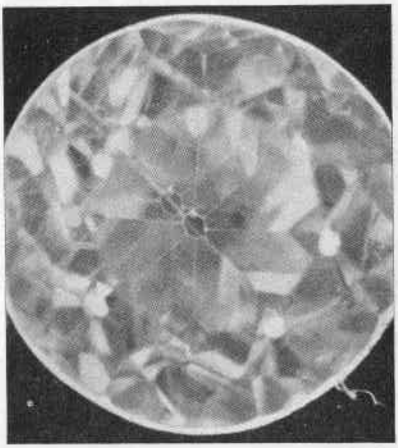


Fig. 1. The strong birefringence of synthetic rutile under 10x in dark-field illumination.

So far, a colorless synthetic has not been successfully manufactured; the finest transparent material has been a clear light yellow. Reds, browns and blues have also been produced—and the blue, so rare in natural rutile, offers particularly interesting possibilities.

(Continued on page 504)

Estimating the Weight of Recut Diamonds

By Use of the Leveridge Gauge

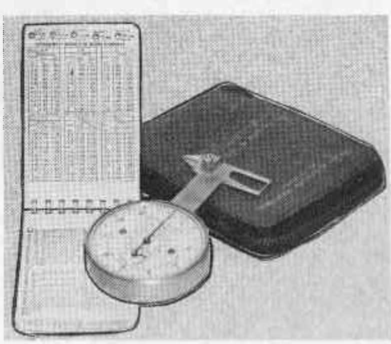
by

CHARLES PARKHURST

The ability to use the Leveridge gauge to estimate the weight of a recut diamond is a skill which is invaluable to either jeweler or gemologist. It is not a difficult skill to acquire, and its possession may prove of great service.

How great a service the jeweler may well discover by forming the habit of noticing how many diamonds are worn cut in the old European style, the Old Mine cut, or improperly cut by modern methods. It is interesting to consider, too, how often the owners of inherited diamonds feel great sentiment toward these treasured gems, yet are reluctant to wear them with their antique cut and in their unfashionable settings. Very often they can be shown how, through the diamond cutter's skill, their gems can be transformed and given new beauty and an increase in value greater than the recutting cost.

The process of estimating what an old-cut stone will weigh when recut is not difficult. With little or no practice, any jeweler can do this with confidence. With experience, it is possible to judge the approximate size of the customer's gem after recutting.



The Leveridge Gauge

Once this art is acquired, the simplest way of dramatizing to the customer the potential beauty of his gem when recut and its appearance when mounted is to bring out from the "loose goods" a modern stone which approximates the size the stone will be after recutting and then to work with it in the mountings.

The Old Mine cut lends itself most readily to recutting, since it can be altered to modern proportioning without great loss of weight.

The jeweler needs three facts in order to determine the desirability of recutting an Old Mine cut. These three are: (1) the present weight (2) the weight after recutting to the correct modern proportions (3) the cost of recutting.

The weight of the stone is easily estimated by using the Leveridge Gauge, or by weighing if the stone is not mounted. The cost is determined by calling on the nearest cutter, who will probably have a set price per carat for recutting stones of any given type of cut. Once this price is learned, the formula for approximating cost is, of course, very simple.

The Leveridge

gauge and weight estimator, illustrated herewith, is the simplest and most accurate instrument to use in obtaining the first figure if the stone is mounted and the second figure—that is, the weight when cut to correct modern proportions. This gauge, designed in 1926 by Athos D. Leveridge of New York, is standard equipment throughout the gem and jewelry field.

For the weight after recutting, it is necessary, using this gauge, only to get the depth from culet to table, and the smallest diameter of the girdle. What the weight will be after recutting to correct modern proportions is readily calculated, since the correct depth after recutting is 60% of the girdle diameter. Therefore, the narrowest girdle diameter of the stone in its present form will be the diameter of the stone after recutting, and the depth after recutting will be 60% of the same figure. The potential loss of weight may of course be arrived at by subtracting the estimated weight as shown on the gauge table from the present weight.

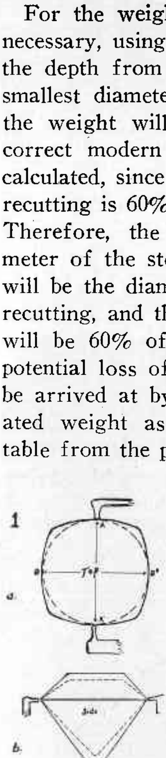


Fig. 1

Figure 1 shows top and side views of an Old Mine cut. Notice that the girdle of the Old Mine cut has a cushion-shaped outline. Measurements should be made with the Leveridge gauge to determine the smallest diameter. To do this, take the measurements as indicated on the diagram by A-A[1] and B-B[1]. One of these measurements usually will be smaller than the other. The smaller will be the final diameter of the recut brilliant, which will have a circular girdle. The depth of the recut stone will be 60% of this figure. Suppose, for example, that the measurement from A-A[1] is 5.0 millimeters and the depth is 3.25 millimeters. Turn the Leveridge gauge tables and find the table for a diameter of 5.0 millimeters, since 5.0 is the smallest diameter. 60% of this figure (3.0 millimeters) is determined by taking 60% of 5.0. Assuming the girdle will have a medium thickness, we see that the weight of the stone after recutting will be halfway between .43 and .50 carats. We can assume that the weight of the stone after recutting will be about .47 to .48 carats. Its weight before cutting would have been about .52 to .53 carats.

An old-style European cut has a circular girdle but like the Old Mine cut a depth above and below the girdle considerably greater than the correct proportion for the modern brilliant. Viewed parallel to the girdle, its appearance is the same as that of the Old Mine cut. (Figure 1a.) Determination of proportion in this case is done in exactly the same way as with an Old Mine cut except that several readings are taken around the girdle to make sure that the smallest diameter is determined. This is done because many early European style diamonds have girdles which are considerably out of round. The recut diamond will have a circular girdle with a diameter equal to the smallest diameter of the original stone. Otherwise the calculations are exactly the same.

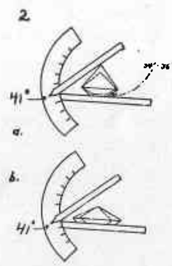


Fig. 2

The Old Mine cut and the heavy early European brilliant cut are the outmoded styles most frequently encountered by the jeweler and those for which the demand for recutting is fairly extensive. The recutting of emerald cuts or square cuts is of course no problem, since they were originally cut for size and weight rather than for brilliancy, and since the original cut conformed in general to the shape of the rough. Many existing emerald cuts, it is true, can be somewhat enhanced in beauty by recutting, but in general the loss of weight seldom warrants the expense nor is the value of the stone enhanced enough to warrant it.

Other poorly-cut diamonds, notably those which are shallow or spread, can be greatly improved in appearance by recutting, but the loss of weight is so great that few customers care to have them altered.

However, there is some occasional demand, and it is well to be able to make the calculation.

In these spread or shallow stones, the depth is considerably less than 60% of the girdle diameter. If a stone looks much too shallow, measure the girdle diameter in two or three places and then determine the depth of the stone from table to culet. If the depth is considerably less than 60%, the stone can be recut by reducing the girdle diameter and holding the depth constant.

3.

a.

b.

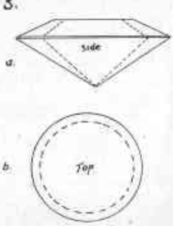


Fig. 3

The diameter after recutting is determined by calculating the girdle diameter, and reducing it until the depth measures 60% of it. In other words, where the depth is kept unchanged and the girdle diameter reduced, the following equation may be used to determine the new girdle diameter, where X represents the girdle diameter after recutting:

$$X = \frac{10}{6} \text{ times the depth measurement.}$$

To take an example—A stone has a girdle diameter before recutting of 6.0 millimeters and a depth of 3.0 millimeters. Since the depth is only 50% of

4.

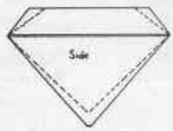


Fig. 4

the girdle diameter, and should equal 60%, the girdle must be cut down to make the proportion correct.

Substituting in the equation the figures obtained by measuring:

$$X \text{ (the girdle diameter after recutting)} = \frac{10}{6} \text{ times } 3.$$

Since the depth in this case is already established, and is 3.0 millimeters, the girdle must be cut until 3.0 millimeters is 60% of its width. The new girdle diameter, therefore, will be 5.0 millimeters. Thus, a stone which originally was about .70 carats will be cut until it measures .47 to .48 carats, a considerable (.225 carat) weight loss. The loss of weight is obviously much greater than in a recutting of an Old Mine cut because the entire girdle diameter must be reduced, but the resulting proportions—the depth equalling 60% of the girdle diameter—are those which bring out the maximum fire and brilliancy of which the stone is capable.

Diamonds similar to those shown in the last two figures require greater skill on the part of the user of the Leveridge gauge, since it is necessary for him to determine, in addition to the girdle diameter, the rough measurements of the proportions above and below the girdle. The American-cut brilliant has a proportion above the girdle of 16.2% of the girdle diameter. The proportion below the girdle is 43.1%. The correct angle from the girdle plane to the pavilion facets is roughly 41°. In recutting the stone the cutter will use this angle (see Figure 3). This means that in a stone which is cut too deeply, the recutting will take the form shown in Figure 4. A stone which is too deep above the girdle will take the form shown in Figure 5. In other words, in the first case the girdle diameter will remain the same; in the second it will need to be reduced. Diamonds which are too deep, thick or heavy below the girdle are frequently encountered in the trade. They are considered less brilliant than perfectly cut stones. They can, however, be recut inexpensively without great loss of weight. If a stone is correctly proportioned above the girdle but too heavy below, determine the smallest girdle diameter and proceed as in the case of the first illustration, the Old Mine cut.

Obviously, none of these calculations present any particular difficulties except possibly the rarely necessary determination of the weight after recutting of a shallow or spread stone. The few problems they offer are well worth the little time and effort necessary for their solution, since there is no more genuine service which a jeweler can offer to his clientele. It is very satisfying to see the customer's pleasure when a stone, which was lifeless and without luster, is returned to him cut to show its liveliest possible radiance and in a modern form which he can take more pride in wearing.

5.

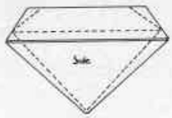


Fig. 5

Exhibit of Gold at Cleveland Museum

The Cellini Siren, shown in the accompanying photograph, is one of the many fine examples of workmanship in an "Exhibition of Gold" on view until January 11th, 1948, at the Cleveland Museum of Art.

Of interest to jeweler and gemologist are the many pieces involving gems. These include not only jewelry but religious pieces, weapons and other items. Objects on display date from early Egyptian, Mycenean and Etruscan periods to far more recent times. This unusual display includes rare articles on loan from twenty-eight other museums and private collectors.

The Siren, the reputed work of Benvenuto Cellini, has been the successive property of the Medici prince for whom it was designed, the Indian Mughal emperor to whom he presented it and the Rothschild family, who purchased it after its seizure during the Indian Mutiny. The torso is a single baroque pearl. It is shown through the courtesy of Duveen Brothers, Inc.

Cellini Siren
Courtesy, Cleveland Museum of Art

Gem-Grinding Hobby Attracts Many

Growth of the Amateur Lapidary Movement an Asset to Reputable Jewelers

by
LELANDE QUICK
Editor of "The Lapidary Journal," Hollywood, California

It has been roughly estimated that some ten million persons in the United States are interested in collecting semi-precious stones. That would mean one out of every fifteen persons is a gem collector. Doubtless it is as impossible to guess the correct number of gem collectors as to guess the correct number of stamp collectors, but there is certainly much evidence to indicate that despite frequent misinformation Americans are not nearly so ignorant about gems as they were a generation ago; indeed impressive numbers of people are so fascinated by the study of gemstones and their decorative possibilities that gem, mineralogical and lapidary societies are springing up all over.

Twenty years ago there were relatively few amateur gem cutters, or lapidaries, in the country—only a few dozen competent men—but the work of these individuals has so stirred the imagination of others that thousands of amateurs now meet regularly to discuss gem materials, gem cutting and gem lore.

One such person is William Pitts, who has been called the "Dean of the Lapidaries." Mr. Pitts is Honorary Curator of Gems and Minerals at the California Academy of Sciences, San Francisco. For forty years he has traveled over the country getting people in every state interested in gem cutting as a hobby and art form. His own handiwork is on display in nearly every important museum in the land.

Perhaps the greatest stimulus to the amateur lapidary movement in the United States has come from J. Harry Howard, of Greenville, South Carolina, whose "Handbook for the Amateur Lapidary" has become a "bible" for would-be gem cutters seeking to solve the mysteries of the art. Mr. Howard's interest dates back to 1927 when he first found a fine bit of red jasper and began to wonder how it would look as a cabochon. In pursuit of information on the proper way to cut and polish this gemstone, Mr. Howard became a real enthusiast and student of the whole field of gemology. It was after publication of his pamphlet on *The Working of Semi-Precious Stones,* in 1931, that the influx into the rapidly multiplying amateur groups began.

In September of 1932 *Rocks and Minerals,* a magazine for the amateur mineralogist and collector, established a lapidary department under Mr. Howard's supervision, and this he conducted for some years. It is still being continued. By early 1947 interest had developed to the point that *The Lapidary Journal,* a new national monthly magazine especially for amateur gem cutters and jewelry makers, began publication in Hollywood, California. The appearance of such a magazine in the West is only natural, as the growth of amateur groups has been most rapid in this area where there are such quantities of inexpensive gem material available for the amateur to gather—jasper in all colors, fine moss agate, petrified woods, tourmaline, etc.

In Los Angeles County alone, it has been conservatively estimated that there are some twenty thousand persons who own gem-cutting equipment. The Los Angeles Lapidary Society was formed in 1940 and grew so rapidly that its total membership has been limited to two hundred in order to insure the utmost benefit to individual members. Qualifications demand the presence of members at a reasonable percentage of monthly meetings, participation in at least one of the ten field trips made annually in search of gem material, and each member must cut and exhibit at least five polished stones a year.

The first public showing of the work of this Los Angeles organization occurred in 1942. Its success was so astounding that the Los Angeles County Museum of History, Science and Art invited the Society to arrange a major exhibition, which has since become an annual event and now enjoys a preferred location in the main art gallery, where it remains on display for a full month. In 1946 no less than eighty thousand persons went to see it—more than have turned out, before or since, for any other museum event. No 1947 exhibit has been held. It has been deliberately bypassed in favor of a still more sophisticated display scheduled to be held in the early months of 1948.

The formation of new mineralogical societies is continuing at a rapid pace. These organizations usually style themselves "mineral and gem" societies, and their activities invariably include gem grinding, which is also taught as a special subject in evening classes for adults in many cities.

Lapidary societies, as such, have also been formed and their members are becoming highly proficient jewelry makers as one activity leads to another.

During the war period the ability of these amateurs to grind gems helped to overcome one of the most severe industrial bottlenecks. In Southern California, where so many of them happened to be anyway, they were given unexpected invitations by the government to enter the large war plants and help cut quartz crystals and synthetic gems for radar and instrument panels on airplanes and sea equipment. Simultaneously many amateurs were developing their own machinery in home shops and the equipment now in use is often far ahead of the lapidary equipment to be found in many professional shops.

Should the jeweler or professional gem cutter become alarmed about this situation? Certainly not. The smartest thing to do is to get behind the amateur gem-grinding movement locally and earn the goodwill of these society members—they are potent advertising! Just as the amateur cabinetmaker, building a bookcase in his home workshop, acquires a greater appreciation for the fine furniture offered by local merchants, and buys from the most reputable among them with an eye for soundness and detail, so the amateur gem cutter, after cutting an agate or faceting a tourmaline, has a better appreciation of good workmanship and invariably visits a reputable jeweler to purchase his finer gemstones.

One such jeweler in Los Angeles, wholly unaware of the source, has profited enormously from the writer's goodwill, for instance. He would not recognize me if I went into his establishment, but I have recommended him frequently, over a period of years, to persons seeking dependable information on gemstones.

Some critics forget that the man or woman (about one-third of the members in the mineral and gem societies are women) who becomes an amateur

(Continued on page 503)

An Unusual Diamond Crystal

by
RICHARD T. LIDDICOAT, JR.
Director of Education, Gemological Institute of America

Although it is generally believed that small crystals of diamond occur in larger crystals, they seldom can be seen. Many authorities believe that included crystals in random orientation are the cause of the abnormal hardness of many diamonds, especially those from Borneo.

It was therefore of great interest to the Gemological Institute to have the opportunity, through the courtesy of L. & M. Kahn Co., of New York City, of studying an unusual octahedron of diamond in which a large included octahedron was plainly visible. There are several features of this crystal which are notable.

The crystal weighs 7.25 carats and shows plane octahedral faces with typical triangular depressions and rounded edges (Fig. 1). The form of rounding suggests that it is due to oscillatory

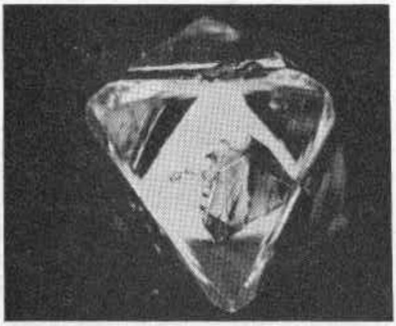


Figure 1

combination of the octahedron and tetrahexahedron. The crystal is completely developed and of almost perfect proportions.

The included octahedron is visible because of a faint dusting of some light to dark brown material over almost all the crystal faces. In a few areas this

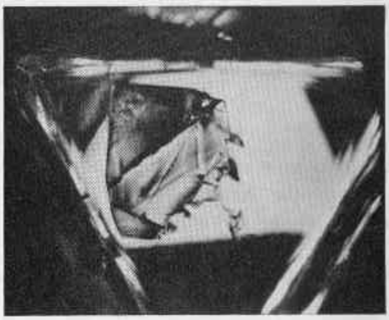


Figure 2

coating is relatively thick and shows lines which could be imagined as due to brushing with stiff bristles and in other places it resembles an arborescent growth. As shown in Fig. 2, approximately one-fourth of the crystal is missing. This surface which is rounded and not a crystal plane is difficult to observe except through reference to the edges of the crystal planes of the octahedron. It is obviously smooth and illustrates the difficulty of observing an included crystal of diamond in diamond if there are no surface phenomena.

In Fig. 2, the contact surface of the non-crystal plane of the inclusion appears to be very rough and jagged. This roughness is an optical illusion caused by strain fractures which have developed around three sides of this surface of the inclusion. These fractures or strains have developed only at this point and at no other place on the crystal.

Careful study showed no pitting on the surface of the inclusion. Some of the faces are not plane but show step growth. These steps are sharp and the lines of junction between the areas of different elevation are parallel to the octahedron. One such line is shown in Fig. 2 on the right. The included crystal is not as perfectly proportioned as the enclosing crystal and does not show as much rounding. It is not in crystallographic orientation with the enclosing crystal, Figs. 2 and 4.

This crystal offers many features which present fundamental problems. Why is one portion of the included crystal missing? It may have been dissolved in the enclosing crystal and the smooth rounded surface supports this possibility. But if one advances this idea some explanation must be offered for the solution of only this particular portion of the crystal. This rounded surface may represent a point of attachment of the crystal during growth. Diamond crystals usually show no evidence of being attached to any support during growth and it is generally accepted that they grew freely in a fluid medium. If the crystal was attached to some other substance what has happened to the support? The absence of the brown coating on this surface supports either theory. However, if the solution theory is accepted one would expect to find the brown coating material in the body of the enclosing crystal, a feature which was not observed.

Figure 3

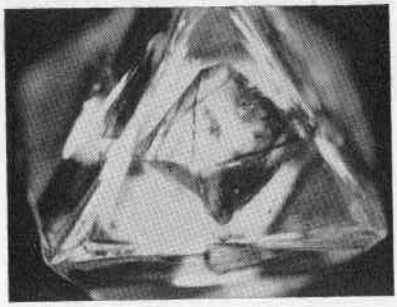


Figure 4

The series of strain areas around the edge of the non-crystal plane surface presents another problem. Why did they develop at this point and why on only three sides? Obviously they have developed since the formation of the enclosing crystal. If they are due to the difference in orientation between the included and enclosing crystals, we must explain why they do not occur at other points on the surface. Why are there no strain fractures at any of the apices of the octahedron?

Fig. 5 was taken looking down on the apex of the enclosing crystal and shows the included crystal in all four octahedral faces, a graphic illustration of the refractive power of the diamond. This unusual and interesting crystal is presented to the reader as a problem whose solution must be a matter of personal experience and prejudice.

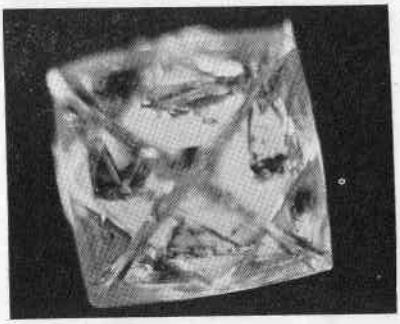


Figure 5

Brazilianite — Its Original Source

by

EDWARD R. SWOBODA

New gem minerals are hardly daily discoveries. The stone Brazilianite, transparent, vivid yellowish-green, glassy and brilliant, found in the rugged jungle-covered mountains of Minas Geraes in 1942, was the first to be added to the list of known gems in almost thirty-five years. To the chemist, it is hydrous sodium aluminum phosphate. To the layman, it is spectacular, and merits wider acquaintance.

The original discovery was made when some farmers, clearing off a hilly slope to plant rice, uncovered several pieces of semi-transparent yellow-green stone. Following the float material up a canyon, they came upon the pegmatite which was its source. For a few months they worked the deposit intermittently, but since they found no market for the unknown gem, and since they found little of the stone of better quality, their efforts seemed hardly worth making.

A few months later, one of their specimens fell into the hands of a gem buyer who periodically made trips through that part of Minas Geraes in search of rough gem material. He, thinking that the mineral was chrysoberyl, which at first glance it resembles, went about staking a claim on the property. Still under this false impression, he began mining operations to extract gem material for cutting purposes. Many beautiful crystal specimens must have been taken out during the four months that he was mining. Little of it, however, remains. With the exception of a mere handful of crystallized specimens which were adorning the tables of his friends, and a few small loose crystals which he showed to the writer, all of the material was broken up to clean the portions which would give flawless stones. None of these was very large. When they were sent for lapidation, and it was discovered that the material was much softer than chrysoberyl and that easy cleavage made it difficult for the lapidaries to cut, the owner became discouraged and discontinued his mining operations.

On the southern slope where Brazilianite was discovered are two pegmatites, only a few yards apart and almost at right angles to each other, intruding in the mica schist. The lower pegmatite, which is about a yard in thickness, was worked at a point where it crosses a little stream. Some fine crystallized pieces were scratched out of weathered pegmatite, but due to cave-ins from the steep bank and the difficulty of underground waters, work was discontinued at this point.

The mine contains a variety of interesting minerals. The upper pegmatite is on a steep slope and about fifty yards above the one crossing the stream. It is nearly vertical, and about a yard and one-half thick. It is composed of an outside zone of massive feldspar and mica which grades into an intermediate zone of massive quartz. The Brazilianite crystals are found in small mica-filled cavities on the edge of the quartz and almost to the edge of the schist on the hanging wall. These cavities or pockets contain also crystallized albite, slender blue-green apatite crystals, beryl crystals, and some as-yet-unidentified minerals—one a dark blue material resembling lazulite, and another a malachite-green in acicular crystals. Many fine specimens of Brazilianite were uncovered in these upper workings, but they were also shattered in the extraction of clean gem material. These upper workings were abandoned when it was found that this mineral would not serve for lapidation.

The finest cut stones of Brazilianite were obtained by Dr. Frederick H. Pough, Curator of Geology and Mineralogy, American Museum of Natural History, from material which he obtained on one of his trips to Brazil. A few other cut Brazilianites were obtained by the writer from material mined from the pegmatite after he acquired the Brazilianite property.

Correction

GEMS AND GEMOLOGY *is in receipt of a letter from Mr. H. Paul Juergens, C.G., of Juergens & Anderson, Chicago, in which he questions Dr. William Foshag's statement, in his article on the cultured pearl industry in Japan in the summer issue, to the effect that for pearl nuclei, small beads about the size of buckshot were used.*

Dr. Foshag's reply follows.

Mr. Paul Juergens has called my attention to the misleading use of the term "size of a buckshot" referring to the size of the nuclei used in cultured pearls. I used this term as one of a familiar object about the size of many of the nuclei. I was probably influenced in the use of this term by the fact that the nuclei being used at the time of my visit were about this size.

As Mr. Juergens remarked, larger nuclei are used for larger-sized pearls, the resultant thickness of nacre on 3 to 4 year old pearls being about ½ millimeter. Since the mollusk usually cannot survive the introduction of a large nucleus, these larger "seeds" are apparently seldom used. Presumably only the larger, more robust individuals are inoculated with large nuclei. Mr. Juergens is quite right in stating that the size of the nuclei are about 1 millimeter smaller in diameter than the final pearl.

—W. F. Foshag.

Gifts to The Institute

Robert I. Olsen, of Olsen & Ebann, Chicago, has recently presented the Institute with a number of stones to be used for educational purposes. These include two beautifully-carved cuvettes, a sapphire, a tourmaline, a fancy citrine, several synthetics and imitations, and broken diamonds in varying shades.

Gem Mines Reopened Near San Diego

According to a bulletin published by the Division of Natural Resources, Department of Agriculture, San Diego County, California, new interest in gem mining has resulted in that district from a recent geological survey of the San Diego Pegmatites.

As an outgrowth of this survey, and its resultant increase of interest, the Department states that a group of seven mines have been sold recently in the Pala area. These mines, which have been comparatively idle in recent years, were in the early years of the century good producers of tourmaline, beryl and kunzite.

In the Aguanga Mountain Area another mine, which was once a good producer of topaz, but idle for many years, has been sold. It is the intention of the new owners of these mines to bring them into commercial production immediately.

The Hexagonal System

by

MARK C. BANDY, Ph.D.

Director of Research, Gemological Institute of America

The hexagonal system has always been of special interest because of the presence of three horizontal axes instead of two as in all other systems. In addition to this unique feature, the system is the only one which some writers treat as two systems and most writers treat in two divisions, the normal and rhombohedral divisions. The principal difference between these two divisions is the six-fold symmetry of minerals in the normal division and the three-fold symmetry of minerals in the rhombohedral division.

The normal division includes only three of the more important gemstones, beryl, including aquamarine and emerald, benitoite and apatite. The rhombohedral division or system is the most important of all systems to the gemologist. Included among the common and uncommon gem minerals in this division are the ruby and sapphire, the many hues of tourmaline, the numerous crystalline and cryptocrystalline quartz minerals and the less common gem minerals such as smithsonite, phenakite, calcite and hematite.

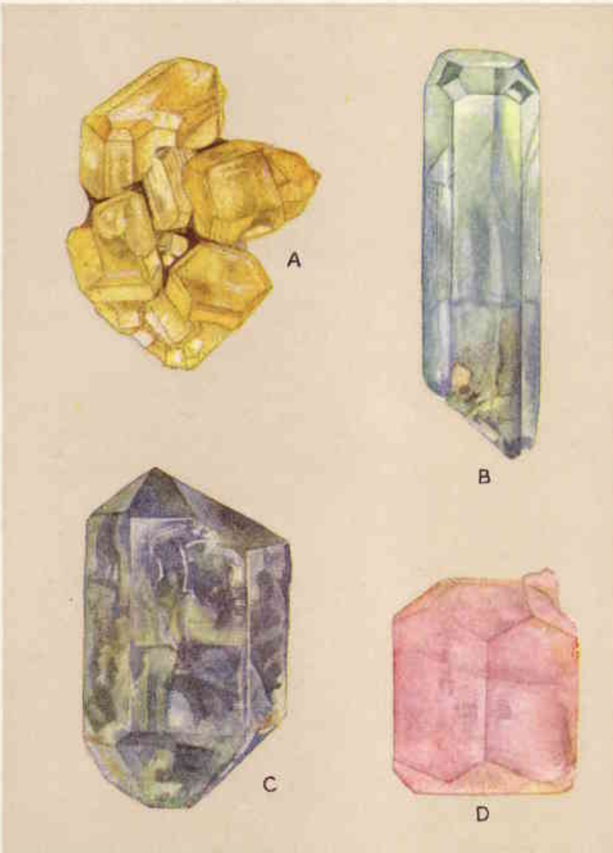
The most common forms in the normal division are the prism, base and pyramid while the most common forms in the rhombohedral division are the rhombohedron and prism. If the horizontal crystal axes occur at the junction between two prism faces the prism, pyramid, etc., are said to be of the first order and if they occur in the middle of the face the forms are said to be of the second order. A somewhat similar relationship of the rhombohedrons are known as positive and negative forms.

Typical crystals of the hexagonal system are shown on Plates VIII and IX. It is to be noted that all crystals on Plate VIII belong to the rhombohedral division while the emerald crystals on Plate IX belong to the normal division.

The crystal of citrine quartz (A) shows a second crystal on the side in the position of parallel growth. Quartz belongs to the rhombohedral division and the crystal shows prisms of the first order and both positive and negative rhombohedrons. Three of the rhombohedral forms, which resemble pyramids, are larger than the others. In quartz these larger faces are usually the positive form.

A second quartz crystal (C) is also shown on the plate to illustrate a habit which is most commonly encountered in igneous rocks. This habit is usually called bi-pyramidal and is a characteristic habit of the sapphire. It is usually impossible to distinguish which of the rhombohedral faces in these crystals is positive or negative. Crystals of this type often have a narrow line of prism faces around the girdle. When these crystals occur scattered through an igneous rock they present an appearance not unlike that of diamonds in matrix.

The tourmaline crystal (B) shows two faces in the prism zone and two termination forms. Many gem varieties of tourmaline crystals are highly complex although the crystals of black schorl are usually simple. The faces in the prism zone are often deeply striated and distinct faces are difficult to recognize. These crystals usually display a trigonal cross section which indi-



CRYSTALS: HEXAGONAL SYSTEM

This plate illustrates four interesting forms of the hexagonal system. The mineral at (A) is mimetite, a tri-pyramidal form of the hexagonal system, from Johanngeorgenstadt, Saxony. (B) and (D) are two characteristic forms of beryl, both from Nerchinsk, Siberia. (C) is an excellent doubly terminated apatite crystal from Sludianka River, Siberia. Specimens from the collection of British Museum (Natural History), London.

PLATE VIII

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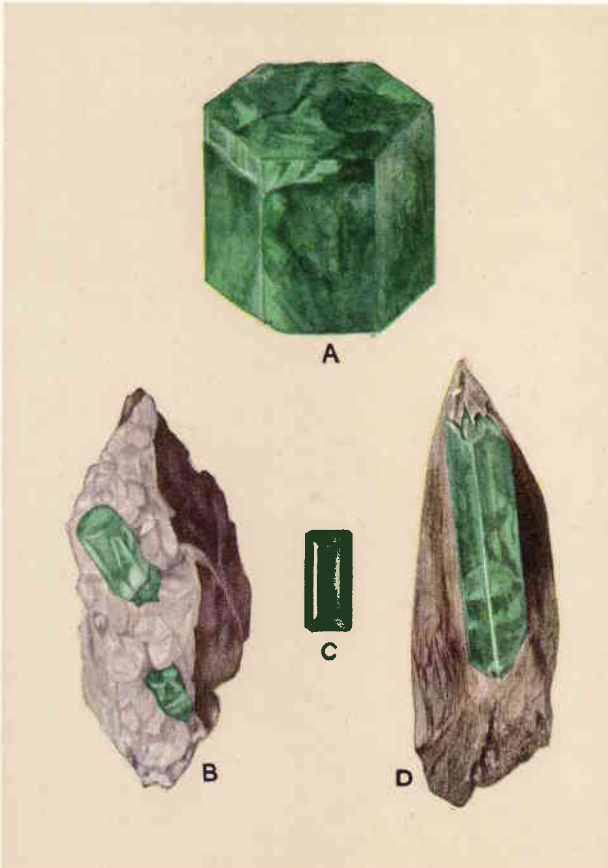
Printed in England.



EMERALD

The deep green chromium-bearing variety of beryl (emerald) is shown in the characteristic matrices in which it occurs at two of its principal localities: in calcite veins traversing a black slaty shale, Muzo, Colombia (B); and in foliated gray mica schist from the Uralian deposits (D). The simple prismatic habit of the hexagonal crystals of this mineral, as well as the extensive internal fracturing so frequently observed in emerald rough, are well shown in (A). Specimens from the collection of British Museum (Natural History), London.

PLATE IX

Reproduced by permission of the Trustees of the British Museum.
Printed in England.

cates the trigonal character of the mineral and serves as a means of identification. When crystals are found doubly terminated they show a different arrangement of the faces on the two terminations and are therefore said to be hemimorphic (half-form). When speaking of gem tourmalines one usually thinks of the magnificent bi-colored and transparent crystals from Pala, California and Madagascar and seldom thinks of the black schorl as being a variety noted for its beauty. Nevertheless the crystals of schorl from Pierrepont, New York, are true gems without the necessity of additional fashioning.

The most spectacular specimens of uncut gem minerals usually found in museums are species of hexagonal minerals, the beryls, tourmalines, quartz, calcites and apatites. In studying crystals of minerals belonging to this system it is often easy to confuse them with certain orthorhombic and tetragonal crystals since the three systems may produce elongated crystals with more or less cylindrical outline. The hexagonal crystals may be identified by a careful study of the prism faces.

The silicate minerals in the normal division do not show perfect cleavages as a rule, while most of the rhombohedral minerals show perfect cleavages. Most carbonate minerals that do not contain water have perfect rhombohedral cleavage while all other carbonates of this type lack a perfect cleavage. All natural elements crystallize in the isometric or rhombohedral systems with the exception of sulphur and those belonging to the rhombohedral division show perfect cleavages. Obviously, cleavage is a distinctive feature of most minerals belonging to this division. Corundum and hematite, both rhombohedral minerals, are type examples of parting and tourmaline and quartz are type examples of piezoelectricity.

The Emerald in Fable and History

The emerald occupies a rather unique position in the history of precious stones. It has been the gemstone most appreciated by the cultured few of each age and lacks the background of violence and intrigue associated with the diamond with its cold, hard beauty. It is particularly appropriate that this gem with its fine green color should be chosen as the birthstone for May to symbolize the beauty and promise of Nature in the Spring of each year. It is equally appropriate that the gem is chosen in hagiology to symbolize faith, faith in adversity, kindness and goodness. What other gem could be more symbolic?

The name is of uncertain origin but apparently has come down in its present form through French corruptions of the Greek and Latin name *smaragdus*. The ancient Greek and Latin writers undoubtedly included a number of green minerals under this name but the true emerald was well known to them. Some authorities question the translation of the Hebrew name used by Moses as emerald, but Egyptian rulers had been buried with emeralds among their prized possessions for centuries before the time of Moses and this gemstone must have been known to him.

As is well known, the emerald was the first of the more valuable gems to be mined on a systematic scale. The famous mines of Cleopatra were essentially worked out in ancient times and during the Middle Ages emeralds were seldom or never encountered except in pieces of old jewelry. The gem was so uncommon at the close of the Middle Ages that few people had ever seen one and gems of fine quality were almost legendary. When the Conquistadores spread over the New World they were surprised to find large quantities of a green mineral in the hands of the natives of Mexico and Peru. Probably much of the so-called emerald brought back by Cortez from Mexico was either jade or some other green mineral. It is unfortunate that Pizarro and his followers discovered quantities of emeralds in the hands of the natives of Peru. These are reported to have been of such size as to tax the credulity of these ignorant men. They readily accepted the story that genuine emeralds would withstand the blows of a hammer and destroyed much of the treasure. But even with this destruction, after the conquests of Peru and Mexico the emerald became less rare in Europe and appreciation of the gem was revived. With varying fortune, the Spaniards located a number of emerald deposits in Colombia during the sixteenth century and these have been worked intermittently since then. In 1830 emeralds were discovered in the Ural Mountains and there has been a continuous although declining production from this source.

Emeralds have been found in various other localities but they are of inferior quality, in general, and no deposit has ever equalled in average quality the gems from Colombia. In any locality where gem quality beryl is found there is always the chance of finding some of a deep green color, but this seldom, if ever, equals the deep velvet green of the finest quality Colombian gems. In fact, gems of perfect color are so rare that this has never become a popular gemstone. Because of the softness of the gem and the relative abundance in Egypt and Asia Minor prior to and during the early centuries of the Christian Era, the stone was a favorite medium for the engraver's art. It has always been highly esteemed by the Mohammedans since green is the sacred color of the Prophet, and hence it has been the ideal stone for engraving texts from the Koran. There are numerous examples of this art. From time to time cut stones appear on the market from Middle Eastern sources with engraved inscriptions.

There are a number of crystals and cut stones of notable size. Probably the most famous is the crystal belonging to the Duke of Devonshire which is two inches high and weighs over eight ounces. There are a number of gems of fine quality which are reported as weighing from seventy-five to one hundred carats or more. Since emerald is a variety of beryl and this species occurs in all tones and intensities of green from the finest velvet-like deep green to colorless one must accept many identifications in the literature with some skepticism. A gem which would pass as finest emerald a thousand years ago would probably be graded as light green beryl today.

Due to the scarcity of this gem during the Middle Ages and even in the Ancient World, a number of men became proficient in producing glass imitations. Many of these were accepted as emeralds for centuries. Although these would be readily detected today, they were preserved for centuries as objects of priceless value.

It is said that gem cutters of Europe are accustomed to keep an emerald on their work benches so they may look at it to relax their nerves and soothe their eyes after severe strain. The so-called emerald which Nero was supposed to have used to soothe his eyes while watching gladiatorial contests was probably a green glass, since emeralds of such size would be too badly flawed to serve in this fashion.

Of the many fables regarding this gem, two are of interest. Until modern times there was a belief that the sight of an emerald would blind a serpent. This myth has come down to us from the Hebrews and it has been given the dignity of various "scientific tests," one experimenter having held a cut gem before a poisonous viper and watched its eyes melt from their sockets as the reptile sank to the ground in a coma. Another myth concerns the ability of the gem to color and lighten the air or water around it. The most famous variation of this theme is the story told by Pliny regarding the emeralds which were placed in the eyes of the statue of a lion on the island of Cyprus. These stones shone with such brilliance as to frighten all the "tunny fish" from that vicinity.

Freedom from flaws is a quality demanded of all gems, yet the emerald, almost never found without numerous flaws, ranks nevertheless as one of the most precious of gems. Since the mass mind sees only its flaws and fails to appreciate the magnificence of its color, it can only be appreciated by a few and has never become a popular gem. To the person of culture, the true gentle man or woman, its unique color is a constant delight and its flaws are as the flaws of friends who are appreciated for their fine qualities and not discarded for their shortcomings. To these cultured few, the emerald serves as an unconscious mirror of their own beauty of character.

—M. C. B.

Ownership of Sancy Diamond in Question

A question has arisen as to the present ownership of the famous Great Sancy Diamond. Lady Astor stated not long ago that it was in the possession of her husband, Viscount Astor. However, a letter has lately been received by the Gemological Institute of America from the secretary of the Maharajadhiraj of Patiala, in India, saying that His Highness is the owner of the diamond.

There are two historic diamonds, the Great and Little Sancy, both named for the French collector Nicholas Harlai, Seigneur de Sancy, who was at one time French Ambassador at the Ottoman Court. Because of the similarity of their names, there has been confusion at other times as to the ownership of the two stones. The Great Sancy weighs 54 carats, the Little Sancy 34. In order to establish the present ownership, the Gemological Institute has written to both Lady Astor and to the Maharajadhiraj of Patiala asking them the weights of their respective stones.

Their replies, when received, will be reported in these pages.

GEMOLOGICAL DIGESTS

Diamond Synthesis Attempted at Harvard

The most recent attempt to synthesize diamond was made at Harvard University, Cambridge, Massachusetts, by Dr. P. W. Bridgman, Professor of Physics. Although greater pressure and temperature conditions were attained than in any previous attempts, the experiment was unsuccessful.

Professor Bridgman is world-famous as a physicist who has investigated the nature of many materials at extremely high pressure. Using apparatus of his own design, he has been able to reach pressures greater than any other worker in this field of physics. Therefore, Professor Bridgman's laboratory at Harvard was the logical place for an attack on the problem of diamond synthesis. The apparatus necessary for these experiments was too costly to be supported by the University, and financial aid was given by the General Electric, Carborundum, and Norton companies.

A goal was set for apparatus that would produce a pressure of 30,000 kilograms per square centimeter (approximately 412,500 pounds per square inch) on a sample 1½x2 inches in size, at a temperature of 2000°C (3600F). Pressure was produced by a 1000-ton press of standard commercial make. The specimen holder was of steel having an external diameter of 36 inches. Heat was applied in two different ways. In the earlier experiments, the specimen (graphite) was heated externally, then quickly pushed into the specimen holder and the pressure rapidly applied. The interval from the time heating was stopped until full pressure was attained was approximately 7 seconds.

In later experiments, heat was applied internally by imbedding the graphite in a special type of thermite. Pressure was then applied to the cold specimen. When a pressure of about 15,000 kilograms per square centimeter was reached, the thermite ignited and raised the temperature of the graphite to the desired value, and full pressure was attained in an additional fraction of a second. Thus maximum pressure and temperature were reached simultaneously. Pressure was maintained at a maximum while the contents slowly cooled to room temperature.

Numerous runs were made under various conditions but in no case was any diamond formed. In an experiment, three ½-carat seed diamonds were placed in the graphite, with the result that the diamonds were themselves partially altered to graphite.—G. S.

Abstracted from "An experimental contribution to the problem of diamond synthesis," by P. W. Bridgman. *The Journal of Chemical Physics,* vol. 15, No. 2 (Feb. 1947).

1946 Gem Production

The following excerpts have been taken from a report by Sydney H. Ball, appearing in Minerals Yearbook, 1946, published by the Bureau of Mines of the United States Department of the Interior.

The lapidary industry, professional and amateur, in the Western States

GEMOLOGICAL DIGESTS

continues to expand. In consequence, production of gem stones may have skyrocketed from an estimated value (at the source) of $40,000 in 1945 to some $325,000 in 1946.

Jade, followed by agate, turquoise, and then variscite, were the most important gem stones produced. Wyoming led, followed by Oregon, Alaska and Washington. Nephrite occurs as float and pebbles in the Kobuk River region, Alaska, also in place in the Jade and Cosmos Hills. The principal producer and fabricator shipped 13¾ tons in the summer of 1946, and a Fairbanks trader 100 pounds. Wyoming increased its production of nephrite from the Lander region, and at least one new occurrence of jade in place is reported. Most of the material is of more or less the quality of New Zealand jade.

After jade, agate and related quartz minerals were the most important gem stones produced. Where virtually all of the float has been collected, underground work has been started in several districts, a condition permitted by the higher price paid for the raw material. From a single pocket near Post, Oregon, $8,000 worth of agate was recovered in 3 days, including a single mass weighing 186 pounds, which was sold for $1,000. Idaho's production of moss agate increased in 1946. Gordon Brower of San Luis Obispo, California, produced about a ton of moss agate worth $6,000. Considerable plume agate was produced in south central Colorado. Red jasper was mined near Hot Springs, Sierra County, N. Mex. A new source of dendritic chalcedony was discovered during the year near Fort Cummings, Luna County, N. Mex. Charles E. Hill reports finding a new agate locality in Yavapai County, Ariz. Agate nodules, weathering from lavas in Trans-Pecos, Tex., were collected in quantity. Arizona produced some agate. The number of lapidary shops in Utah has grown remarkably during the year and several new deposits of agate have been discovered. So much material is being shipped to other States that the Mineralogical Society of Utah is preparing a bill to prohibit non-residents from shipping these minerals in quantity beyond the State boundaries.

In value, turquoise was probably the third most important American gemstone produced. The Nevada Turquoise Co., of Mina, Mineral County, is said to have produced turquoise valued at more than $20,000. The Pedro claim of the Copper Canyon Mining Co. produced perhaps nearly as much. Rough turquoise was recovered by the Castle Dome Copper Co., Inc. The King turquoise mine at Manassa, Conejos County, Colo., produced 2,000 pounds worth $30,000. A "composite turquoise" (small fragments of Arizona turquoise in a matrix of black cement) is on the market. Los Cerillos, N. Mex., produced a little turquoise, largely by local labor near the mine. It was sold to lapidaries in the vicinity. The United Indian Traders Association has set up standards for hand-made Navajo and Pueblo jewelry and is prepared to license its mark.

Utah continues to produce some variscite. Some geophysical work was done in the vicinity of the Murfreesboro, Ark., diamandiferous pipes. The main company is again in litigation. Some 40 years ago a few small, allu-

GEMOLOGICAL DIGESTS

vial diamonds were reported to have been recovered at a gold placer near McCall, Idaho. Late in 1946 that ground was leased and some development work started. A considerable amount of "flowering" obsidian was mined in Utah. In Arizona some "marekanite" was produced. This is a semi-transparent smoky glass nodule occurring in obsidian. Kelley and Branson describe small Tertiary pegmatite masses on the west slope of the Black Range, Grant County, N. Mex. The pegmatite consists largely of quartz and sanidine; the latter, which occurs in fair-sized masses, "displays blue and white opalescence, giving rise to a moonstone of commercial quality." The Barton Mines Corp., North Creek, Warren County, N.Y., sells some of its garnets to lapidaries. Valley and Adams Counties, Idaho, have garnet deposits. In the extreme southeastern part of Utah, pyrope of good color, some over a half inch in diameter, occur in gold placers.

Other gem stones produced in small amounts in 1946 include agatized wood (Ariz. and N. Mex.); alabaster (S. Dak.); amethyst (Utah); aquamarine (Deep Creek, Utah and San Diego, Calif.); kunzite (San Diego); kyanite (Upson County, Ga.); opal (Ida.); opalized wood (central Wash.); pipestone (Pipestone, Minn.); rock crystal (Crystal Mt., Ark.); rose quartz (S. Dak.); staurolite (Cherokee County, Ga.); topaz (Tarryall Mts., Colo. and Topaz Mt., Utah); and tourmaline (San Diego, Calif, and Mt. Apatite, Me.).

The Term "Semi-Precious"

(Reprinted from the *Journal of Gemmology,* Vol. 1, No. 4, October, 1947.)

In connection with the Gemological Institute of America's recommendation that the term "semi-precious" should no longer be used, it is interesting to quote from the Retail Jewellers' Course of the National Association of Great Britain: "The term 'semi-precious' is often used in the jewellery trade to describe those gemstones that remain after diamond, ruby, sapphire and emerald have been grouped as 'precious.' It is not a fair division and not even logical. It is true that in many cases there is a drop in prices per carat after the 'precious' varieties named due mainly to the fact that other gemstones are often found in too great quantity, but this fact should not allow the jeweller to prejudice public interest (or even his own) in lesser known gemstones, some of which are very beautiful.

"The term 'semi-precious', being open to misunderstanding, should be discontinued, and all real stones referred to as 'gems' or 'gemstones'."

Spinel Formulas Available

Detailed formulas for the manufacture of synthetic spinels are now available in a report, PB-78652, on the German synthetic stone industry, now obtainable from the Office of Technical Services, Department of Commerce, at $1.25 a copy.

GEMOLOGICAL DIGESTS

Footnote On Linde Stars

It is probable that the inclusions which produce the asterism of Linde synthetic corundum stars are confined to a surface layer ½ mm. or more in depth. This appears from an examination of two cut cabochons at the G.I.A. laboratory.

An examination of the new synthetic star corundum made by the Linde Air Products Company shows that two of the cut cabochons show asterism produced by needle-like inclusions distributed throughout the surface.

From this distribution, it appears that the usual corundum boules are first oriented and then roughed out to cabochon form before the inclusions which cause the star are incorporated.

It seems probable that inclusions are incorporated by remelting the surface either in the Verneuil oven or by the Linde flame polishing process. The resulting surface recrystallizes as an integral part of the cabochon. If this surmise is correct, and it would seem to be further borne out by Ralph J. Holmes' article on the Stars in the Fall issue of GEMS AND GEMOLOGY, it might account for the fact that no rough synthetic star corundum is available.

—R.T.L.

"Cave Pearls"

In a cave in Wisconsin and in a mine in Idaho, "cave pearls" have been found recently (*Northwestern Jeweler,* Dec., 1946; *Journal of Geology,* Jan, 1945).

"Cave pearls" are pisolites (round concretions about the size of a pea) and are of inorganic origin. Pisolites are formed by the accretion of concentric layers of calcium carbonate and a nucleus, the nucleus being generally a grain of sand or small rock fragment. Pisolites are very common, but become "cave pearls" only under special conditions of formation where they grow unattached in a cavity in the floor of a cave, and are given a high polish by agitation due to dripping water.

G.S.

Certified Gemologist Awards Announced

The American Gem Society takes pleasure in announcing the award of the title of Certified Gemologist to the following: C. Noble Lednum, of Cambridge, Maryland, and E. M. Allen, of Birks-Ellis-Ryrie Ltd., of Toronto, Ontario, in August; Murray S. Sauvage, of V. T. Eaton Co., Ltd., Toronto in September, and Edward F. Wright, of Wright, Kay & Co., Detroit, in October.

Gem Grinding Hobby

(Continued from Page 491)

gem grinder immediately becomes a gem "authority" to an admiring circle of friends. The goodwill of half a dozen such individuals may often be worth more financially, in my opinion, than much of the jeweler's advertising.

The hobby of gem grinding in the United States, where people have more leisure time than anywhere else in the world, is important to the commercial jeweler and serious thought should be given it as a force for good in his business. It is something to be encouraged; not feared.

Rutile Synthesis

(Continued from Page 485)

The National Lead Company has been manufacturing the material in large sizes, and both that company and Linde Air Products have apparently been producing it in boules similar to the form in which corundum is synthesized. So far, production has undoubtedly been primarily experimental, but apparently at least one of the companies is planning to increase production as rapidly as possible.

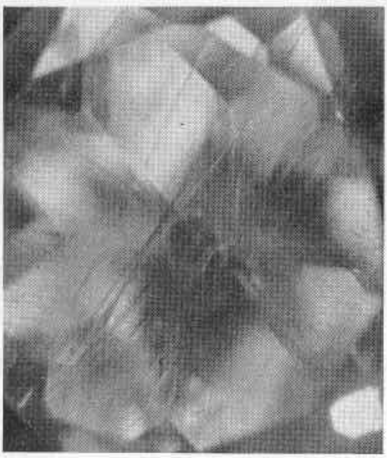


Fig. 2. Pronounced streaked effect in synthetic rutile (under 30x in dark-field illumination).

Two faceted rutile specimens were examined recently in the laboratory of the Institute. This new synthetic material makes a most spectacular addition to gem materials. Its most striking feature is its immense dispersion which gives it an appearance in sunlight comparable only to an impossibly brilliant opal. Stone 1 was a 1.88 carat light yellow stone, poorly cut and polished, which resembled a "cape" or "light yellow" diamond under artificial light. Stone 2, of 1.10 carats, was a light blue in color. It could be likened to a pale zircon, except for the greater dispersion and brilliancy it exhibited, despite its poor make.

Stone 1 had a specific gravity of 4.264; stone 2 of 4.258. The specific gravity of natural rutile is given by Dana as 4.18 to 4.25 for varieties with little iron oxide.

The birefringence of synthetic rutile is enormous. Double images of an inclusion no more than 1 mm. below the table of the yellow stone appear to be about one-tenth of the width of the table apart. (See Figure 1.)

No attempt was made to measure the refractive indices of the dispersion of the new synthetic. Values for these properties will be included in a later report, when a larger number of stones can be examined. Some of the inclusions which appeared in the two stones examined were similar to those found in synthetic corundum and synthetic spinel. Gas bubbles were apparent, spherical in the smaller sizes. Larger gas bubbles were not perfectly spherical. One of the two stones gave a streaked appearance under magnification. The streaks were roughly parallel.

Little difficulty will be encountered in the identification of synthetic rutile because of the enormous birefringence and strong dispersion in a stone at least as brilliant to the eye as diamond. There seems to be little doubt that synthetic rutile will become important in the jewelry trade.

Kraus-Slawson Book In New Edition

Of interest to all gemologists is a newly-published Fifth Edition of *Gems and Gem Materials,* by Edward H. Kraus and Chester B. Slawson (McGraw-Hill, $5.50), with improved format and valuable additions which include expansion of the chapter on Inclusions and many additional illustrations.

BOOK REVIEW

***The Mystery of the Pearl*, by J. Bolman. (170 pp. 38 plates, 19 figures, 1 map.) E. J. Brill, Leyden, 1941.**

In his "Mystery of the Pearl," Mr. Bolman has covered the subject with great thoroughness from all possible viewpoints. The results of his writings have appeared in a very handsome quarto, printed on high quality paper, with 188 fine photographs and a large map showing locations of the principal pearl fisheries of the world.

To a large extent, the contents of the "Mystery of the Pearl" are a compilation and summary of the voluminous literature on this gem. Part of the material presented, however, appears to be the result of original research.

New material of particular interest is presented on pages 83 and 84, where a method is described for improving the color of pearls by irradiating with infra-red rays. According to the author, a permanent change in color from brownish-yellow to a very light yellow was brought about by alternately wrapping the pearls in cotton soaked in a solution of sodium chloride, and then exposing them to infra-red rays. The color change was brought about by six days of radiation, alternating with six days of soaking. The color was not bettered by further treatment.

Another subject of special interest is covered in Chapter IX. Tables by Riedl are reproduced in which figures are given for the thickness of the mother-of-pearl layers and rate of growth of pearls. *The mother-of-pearl layers range in thickness from 0.06 to 0.8 millimeters,* and the average rate of formation of the mother-of-pearl layers is approximately 0.05 millimeters per year.

In the introduction, after a discussion of the origin of the word "pearl," Mr. Bolman delves into the early history of man's knowledge of pearls. One of the first records known of the mention of the word "pearl" was by Theophrastus (372-287 B.C.). Mr. Bolman points out, however, that the scientific study of pearls is not yet one hundred years old.

The first part of the book describes in great detail the pearl-producing mollusks, the marine Lamellibranchiata (Bivalves), the Gastropod (Snails) and the Unionidae (fresh-water mussels). Included here is a description of the localities inhabited by the various species, and of the types of pearls found in each species. This section is followed by a detailed description of the shell of many of the principal pearl-bearing species. There are also several sketches showing the shell structure as seen under the microscope.

In Chapter III is discussed the different places within the mollusk where the pearls are formed. In order to make this matter more understandable, it is preceded by a description of the structure of the body of the mollusk with respect to the position of the body in the shell. According to the places in which the pearls form, they are classified into four large groups: (1) shell-pearls and blisters, (2) free-pearls, (3) muscle-pearls, (4) hem-pearls.

Part II of the book (Chapters IV through X) deals first with the subject of origin of the pearl-sac and the underlying causes of pearl formation. This is followed by a lengthy description of the types of nuclei that have been found in pearls. The nuclei are of various types and origin, and are classified as follows: (1) Conchiolin-nucleus, (2) Nucleus of organic matter, (3) Nucleus of inorganic origin, (4) Secondary nucleus, (5) Pearls without a nucleus. A number of excellent photomicrographs of the various types of nuclei accompany this section.

In Chapter IV Mr. Bolman points out that pearls are formed of different sorts of layers, identical to the substances making up the shell of the mollusk, and that the color and kinds of layers depend in many cases upon the place in which the pearl is formed within the mollusk. Chapter VI is a further amplification of this subject, in which pearls are classified according to their structure. The classification used is: (1) Conchiolin-pearls; (2) Nacre-pearls; (3) Calcite-prism-pearls; (4) Aragonite-prism-pearls; (5) Pearls of translucent layers; (6) Pearls of composite structure.

The general characteristics of pearls, including chemical composition, hardness, density, color and luster, are the subject of Chapter VII. Of special interest here are chemical analyses of various parts of the shell, and a comparison of these analyses to those of different types of pearls.

In Chapter IX the decay and loss of color of pearls is considered. Deterioration of pearls is attributed to loss of water and decay of the organic matter (conchiolin). Methods of altering the color are also described, such as lacquering, irradiating with ultra-violet or infra-red rays, and bleaching.

Chapter X is a detailed description of the world's principal pearl fisheries, subdivided into marine and fresh water localities. The important regions described are the Persian Gulf, Ceylon, the Red Sea, Australia, America, and Europe. Production figures and values are included.

Part III is devoted to cultured pearls, describing fully the development of methods of production from earliest times to present-day techniques.

Methods of distinguishing between natural and cultured pearls are covered in great detail. The tests described are: (1) density, (2) surface structure, (3) magnetic field, (4) fluorescence, (5) testing nucleus in the drill hole, (6) x-rays and Laue photographs, and (7) beaming through the pearl.

The supplement includes a discussion of Tridacna pearls, fossil pearls, and vegetable pearls. There is also a glossary of 172 entries of the terminology used in describing pearls. Finally, and one of the most valuable features of the volume, is an exhaustive bibliography of pearl literature, in which 130 separate references are listed.

George Switzer, Ph.D.

New Editions

Lately appearing in new editions are *5000 Years of Gems & Jewelry,* by Frances Rogers and Alice Beard, J. B. Lippincott Company, Philadelphia and New York, publishers ($3.75) and *Jewelers Pocket Reference Book,* by Robert M. Shipley, Gemological Institute of America, Los Angeles, publishers ($2.75).

There have been no important additions to the Rogers and Beard work, but it remains interesting and valuable, written in terms which appeal to the layman without previous background in the field of gemology and fully illustrated with line drawings by the authors and with sixteen half-tone illustrations.

Shipley's *Pocket Book,* now in its second edition, contains a newly-added section including descriptions of synthetic stones and listing their current trade names, and has other valuable additions including tables of mark-ups on sales, additions to the glossary, up-to-date maps showing gemstone production areas, and a chapter on precious and semi-precious stones.

L. C. Eichner Releases Experimental Refractometer Model

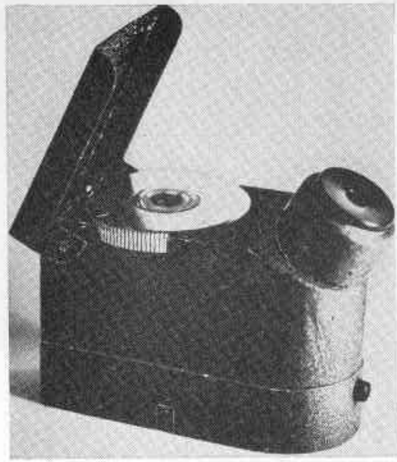
Built-in Light Source Featured in New Instrument

At last the built-in light source—which every refractometer maker seems to have considered and rejected—is to be made available to those with whom its advantages outweigh its disadvantages.

The Eichner refractometer, which, it has recently developed, will shortly be perfected and placed on the market, is the first American-made refractometer to incorporate a light. It has a battery-operated built-in light source. The instrument, at the present time, is still in a developmental stage. The optical system has not been perfected, although it is possible to get refractive index quality readings when a stone is on one position on the hemisphere. The experimental model has a scale which is very small and difficult to read.

There are certain disadvantages to a built-in light source within a refractometer. It makes its use with a monochromatic lamp—an exceedingly useful accessory—a very difficult project. If an extremely small battery lamp is used, as in the Eichner, the battery deteriorates in a short time and must be replaced. Even in the G.I.A. laboratory, where the refractometer is probably used more frequently than in any jewelry firm, it was found that the trouble of changing batteries was a disadvantage for most users who prefer a smaller size and prefer daylight, a substage lamp or a gooseneck lamp to be entirely inadequate.

If a light in a refractometer is designed to utilize a standard supply, the instrument must also be large to avoid damage due to excessive heat. In addition, foreign power supplies are often such that the instrument couldn't be used on foreign buying trips. No electrical supply is available in many gem producing areas.



Th Eichner Refractometer

On the other hand there are advantages to the refractometer with a built-in light. It can be used in dark corners where no light is available, while other refractometers should for best results be set on a table or showcase in daylight or near any lamp. Although readings can be obtained by simply pointing the ordinary refractometer in the direction of any good light, the best results are obtained by using the especially accurate monochromatic lamp or the inexpensive substage lamp, a less compact affair than if the lamp is part of the refractometer.

The experimental model indicates that the Eichner Company will probably be able to make their instrument an efficient and valuable refractometer with a few minor changes. The present design includes a revolving hemisphere and an unusually clever construction which permits rapid disassembly for cleaning or battery replacement. Present indications are that the instrument will be the least expensive refractometer with a rotating hemisphere available to the American jeweler. We are awaiting with interest the production model of the new Eichner instrument. When the instrument is available, it will be announced in GEMS AND GEMOLOGY.—M.E.C.

Pearl Identification by X-Ray Diffraction

Mappin's Gemmological Laboratories, Montreal

WILLIAM H. BARNES, M.Sc., Ph.D.

Associate Professor of Chemistry, McGill University

PART IV — RESULTS and SUMMARY

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

EDITOR'S NOTE: *For figure numbers under Figure No. 21, see previous three issues of Gems & Gemology.*

Experimental verification of these deductions is presented in Figure 21. By means of preliminary X-ray diffraction photographs the setting of the cultured pearl employed for Figures 5, 6, 7, and 8 was adjusted until the pseudo-hexagonal axes of the core were vertical. For pattern P-42-35, Figure 21, the X-ray beam passed through the pearl slightly below the centre, as represented at A, Figure 20. The pearl was displaced 2.5 mm. horizontally to a position corresponding to B, Figure

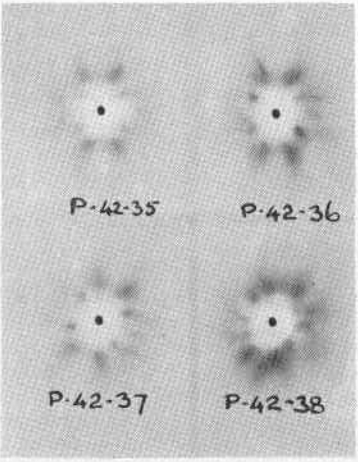


Figure 21

20, and pattern P-42-36 was obtained. Rotation of the pearl through 22.5° to a setting similar to that shown at C, Figure 20, but clockwise, resulted in the corresponding rotation of the pattern exhibited in P-42-37. The pearl was then returned to the setting in which it gave pattern P-42-36 (position B, Figure 20) and was displaced 1.5 mm. vertically upwards to a position corresponding to D, Figure 20.

The diffraction pattern, P-42-38, obtained in this setting, however, is disappointing. Its ambiguity may be due to either (or both) of two causes; irregularity of the laminations of the mother-of-pearl core or inclusion in the path of the beam in the inner sections of the nacre covering of the pearl. As shown at D in Figure 20, the combination of a horizontal and a vertical displacement of the pearl may bring the direction of the X-ray beam very close to the surface layers of the specimen.

It should, of course, be noted that appreciable departure from plane parallelism of the mother-of-pearl layers of real cultured pearls will result in some deviation from strict adherence to the ideal behaviour deduced from Figures 17 and 20 for a geometrically perfect specimen. This has been pointed out previously in connection with the patterns P-43-24 to P-42-27, Figure 7, obtained from a cultured pearl, and in a discussion of patterns P-44-4 to P-44-8, given by a mother-of-pearl bead.

That the irregularity in a particular specimen may be more marked in certain directions than in others is evident from the fact that the same cultured pearl was employed for the patterns, P-42-24 to P-42-27, referred to in the foregoing sentence as for P-42-31, Figure 19, and the sequence P-42-35 to P-42-37, Figure 21, in which no appreciable departure from the expected patterns occurs.

Although the patterns from an ideal

cultured pearl, as deduced from Figures 17 and 20, should be the same for a given displacement of the specimen regardless of whether the X-ray beam passes initially through or above (or below) the geometric centre, the radial structure of natural pearl affects the orientation of the patterns from such a specimen when the X-ray beam passes above (or below) its geometric centre.

Thus in Figure 22, A represents the same relative position of pearl and X-ray beam as that shown at A, Figure 17, except that the trace of the X-ray beam in Figure 22 is below the geometric centre. If this vertically off-centre displacement is not very great, the pseudo-hexagonal axes of most of the crystals in the path of the X-ray

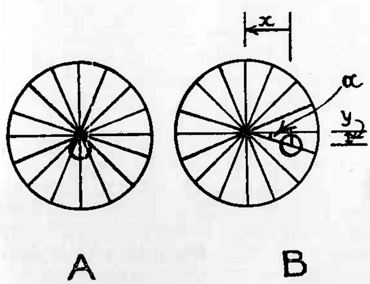


Figure 22

beam will still be in almost the same direction as that of the beam. The path of the beam through the pearl can readily be visualized by reference to Figure 14, and considering the beam at A to be moved slightly to the right or left of its centred trace while remaining parallel thereto. Under such conditions there will be little or no distortion of the hexagonal, or halo, diffraction pattern.

Now, if the pearl be displaced horizontally from position A, Figure 22, to that represented at B, Figure 22, the rectangular pattern should be obtained (as explained with reference to Figure 14) but the trace of the pseudo-hexagonal axis will no longer be horizontal (as for the corresponding setting, B, of the natural pearl in Figure 17) but will be inclined at angle "a" to the horizontal. As is evident from diagram B, Figure 22, the angle "a" will depend on the horizontal displacement (x) and on the distance (y) that the centre of the pearl is above (or below) a horizontal line through the trace of the X-ray beam.

Starting with the pearl in the off-centre position represented at B in Figure 22, subsequent rotation or vertical translation should result in changes in the orientation of the diffraction pattern that may be predicted from Figure 23. In this figure, the directions of all pseudo-hexagonal axes have been omitted except for the one passing through the trace of the X-ray beam (indicated by the small circle as in the previous diagrams) and the one that is horizontal. The latter is shown as a broken line. It should be remembered that the former (shown as a full line passing through the centre of the pearl and the trace of the X-ray beam) determines the orientation of the rectangular diffraction pattern on the film. Diagram A of Figure 23 corresponds to diagram B of Figure 22. If the pearl in the off-centre position represented in these two diagrams be rotated about an axis corresponding to the initial direction of the beam (i.e., the centre of the small circle in diagram A, Figure 22) the geometric centre of the pearl will trace the small dotted circle shown in A, Figure 23, and the upper end of the vertical diameter will move around the large broken circle. If the rotation be

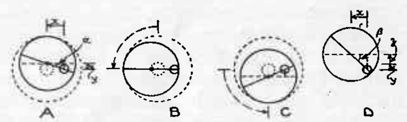


Fig. 23

anticlockwise, the angle "a" will decrease, becoming zero when the angle of rotation becomes 90°, as represented at B, Figure 23, and will then increase again to the same maximum value "a" on the opposite side of a horizontal line as the angle of rotation increases to 180° as shown at C, Figure 23. It will be seen by examination of diagram A, B and C, Figure 23, that the same effect will be achieved by rotating the pearl in a clockwise direction. Thus, in the case illustrated in Figure 17, where the beam in position A passes through the centre of the natural pearl, a horizontal displacement to B should produce a rectangular pattern with a horizontal trace of the pseudo-hexagonal axis. In the example shown in

Figures 22 and 23, where the beam in position A, Figure 22, passes through the pearl below its centre, a horizontal displacement to B, Figure 22 (i.e., to A, Figure 23) also should produce a rectangular pattern, but with the pseudo-hexagonal axis inclined at an angle "a" to the horizontal.

Rotation of the natural pearl in the first case (C, Figure 17) should have no effect on the orientation of the pattern (i.e., the pseudo-hexagonal axis remains horizontal), while in the second case (B and C, Figure 23) a corresponding rotation should result in a change in the orientation of the pattern (i.e., in the angle between the pseudo-hexagonal axis and a horizontal line.)

Finally, if the pearl in a position corresponding to A, Figure 23, be given a vertical displacement (z) upwards as represented at D, Figure 23, the angle between the trace of the pseudo-hexagonal axis and a horizontal line will be increased to an angle "b," so that $\tan b = (y+z)/x$. If the vertical displacement were in the opposite direction (downwards in diagram D, Figure 23) then $\tan b = (y-z)/x$ and the pattern should be rotated in the opposite direction, with the angle between the trace of the pseudo-hexagonal axis and a horizontal line first decreasing to zero, and then increasing, depending on the relative magnitudes of y and z. The observed effect; namely, rotation of the pattern following a vertical displacement, therefore, should be the same as that of the natural pearl described in the previous case (diagram D, Figure 17) except that the magnitude of the rotation would be affected by the initial vertical displacement of the pearl.

The X-ray diffraction patterns given by a natural pearl (i.e., that employed for Figures 9 and 16) under the conditions represented diagrammatically in Figures 22 and 23, are reproduced in Figure 24. With the X-ray beam passing through the pearl slightly below the geometric centre (as represented at A, Figure 22) the normal "natural pearl" pattern (in this case, a combination of hexagonal and halo types) shown in P-46-10 was obtained. The pearl was displaced 2.5 mm. horizontally (as represented at B, Figure 22, and A, Figure 23) and gave the rectangular pattern P-46-11 in which the trace of the pseudo-hexagonal axis is rotated approximately 7° clockwise from a horizontal line. The vertical distance (y) between the direction of the X-ray

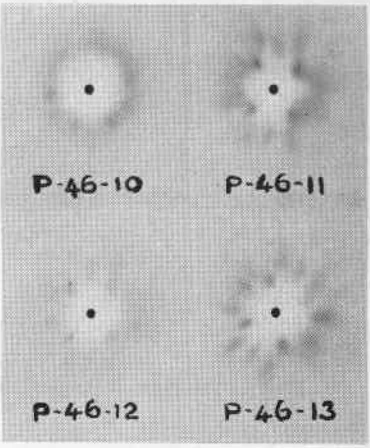


Figure 24

beam and the geometric centre of the beam in the initial setting, therefore, must have been approximately 0.3 mm. The pearl then was rotated through an angle of 22.5° about an axis coinciding with the original path of the beam to a position between those represented at A and B, respectively, in Figure 23, and it will be observed that the inclination of the trace of the pseudo-hexagonal axis to the horizontal has been reduced slightly in the resulting pattern P-46-12. The pearl was restored to the position in which pattern P-46-11 was obtained (corresponding to diagram A, Figure 23) and it was then displaced 1.5 mm. vertically upwards, as represented at D, Figure 23. The expected clockwise increase in the angle between the trace of the pseudo-hexagonal axis and a horizontal line through the centre of the pattern is clearly shown in the resulting pattern P-46-13. Due to the small size and diffuse nature of the patterns, exact measurement of the angles involved is not possible, but they are of the same order of magnitude as those predicted from a geometrical consideration of the experimental displacements.

Summary and Conclusions

From the practical point of view of the routine examination of pearls by the X-ray diffraction method, the present investigation leads to the following conclusions.

Since conch and fresh-water pearls give diffraction patterns identical with those obtained from natural (oriental) pearls, and since fresh-water specimens also, on occasion, may yield patterns identical with those from cultured pearls, it is first necessary to eliminate conch and fresh-water pearls on the basis of other properties such as density, surface texture and orient.

To distinguish between the natural and the cultured pearl, the specimen, if mounted, should preferably be removed from its setting, since the ideal method of examination by X-ray diffraction technique involves directing the X-ray beam through the centre of the pearl. If the pearl is cultured, one X-ray diffraction photograph, is sufficient to obtain the characteristic rectangular (fibre) pattern. If a hexagonal or halo pattern appears, a second photograph with the X-ray beam again passing through the centre of the pearl but in a direction at right angles to the first will show the rectangular pattern if the pearl is cultured, but another of the hexagonal, or halo, type if the pearl is a natural one. In cases where ambiguous patterns are obtained, the process of taking two diffraction photographs with the beam through the centre of the pearl along each of two directions at right angles should be repeated. Distorted patterns, sometimes recognizable as probably rectangular, are encountered more frequently with cultured than with natural pearls, and are due to lack of regularity among the internal laminations of the specimen. In the case of the cultured pearl, it is usually possible by trial and error to locate a direction along which the X-ray beam gives rise to a good rectangular pattern. In fact, if all attempts to obtain a definitely rectangular pattern from a given pearl when the X-ray beam passes through its centre are unsuccessful, the specimen almost certainly is a natural one.

If the pearl cannot be removed from its mount, it probably will be impossible to direct the X-ray beam through the centre of the specimen. By fluoroscopic examination of the piece of jewelry, the depth to which the mounting pin penetrates the pearl can be determined. If the pearl is relatively large, a series of two or three X-ray diffraction photographs can be taken, the first with the X-ray beam passing through the pearl as closely as possible to its centre, and the second and third at increasing distances from the centre. For these tests, the pearl should not be rotated but simply be moved from one position to the next along a line through its centre and perpendicular to the direction of the X-ray beam. If each of the successive patterns so obtained is perfectly (or almost perfectly) rectangular, the pearl probably is a cultured one. If they show a progressive change from very distorted to almost perfectly rectangular patterns as the distance between the centre of the specimen and the X-ray beam is increased, the pearl probably is a natural one.

The following procedure may be employed to test the conclusions reached as a result of the foregoing test or may be applied directly to a pearl that is too small, or in which the pin penetrates too far to permit a sequence of diffraction photographs at increasing distances between the centre of the pearl and the X-ray beam.

The pearl (cultured or natural) in an off-centre position with respect to the X-ray beam gives a rectangular pattern. If the pearl, in this position, is rotated through an angle (20° or 30°) about an axis through its centre and parallel to the direction of the X-ray beam, the rectangular diffraction pattern obtained in the new position will be rotated through a corresponding angle in the case of a cultured pearl, but its orientation on the film will be unchanged in the case of a natural pearl.

If, instead of a rotation, the pearl is given a vertical displacement (assuming that the X-ray beam and the line perpendicular to the beam through the centre of the pearl are horizontal), the orientation of the rectangular pattern on the film will be unchanged in the case of a cultured pearl but will be rotated (clockwise for an upward displacement; anticlockwise for a downward displacement) through an angle, the tangent of which will be proportional to the magnitude of the displacement, in the case of a natural pearl.

Thus, rotation of the pearl in an off-centre position has no effect on the rectangular pattern if the pearl is a natural one but rotates it if the pearl is cultured; whereas a vertical displacement rotates the pattern if the pearl is a natural one but has no effect on it if the pearl is cultured. Furthermore, the trace of the pseudo-hexagonal axis in the rectangular pattern from the natural pearl coincides with the trace of the plane containing the geometric centre of the pearl and the direction of the X-ray beam (i.e., horizontal if the pearl is mounted with its centre in the path of the X-ray beam and is then displaced horizontally along a line perpendicular to the beam).

On the other hand, the trace of the pseudo-hexagonal axis in the rectangular pattern from the cultured pearl depends on the orientation of the mother-of-pearl core with respect to the X-ray beam and is thus independent of the line through the centre of the pearl at right angles to the X-ray beam. For this reason, if the X-ray beam passes through the pearl slightly below (or above) a horizontal line through its centre, no effect on the patterns from a cultured pearl is observed, whereas, in the case of a natural pearl, a slight rotation of the pattern occurs when the pearl is rotated and an exaggerated, or diminished, rotation of the pattern takes place when the pearl is displaced vertically.

Since imperfection of the internal structure affects the regularity of the patterns obtained from certain specimens; particularly in the case of cultured pearls; it may be necessary to repeat some of these tests with different initial settings of the pearl with respect to the X-ray beam before full confidence in the results for a particular pearl is felt.

As mentioned previously, the present paper has been concerned solely with the identification of pearls by the X-ray diffraction method. This does not mean that the technique of X-radiographic examination is not appreciated. The advantage of the radiographic method lies in the large number of pearls that may be photographed simultaneously and in the relatively short exposure times required. It suffers, however, from the fact that positive identification of a pearl as "natural" depends essentially on negative evidence; namely, the *absence* of a line of demarcation in the radiograph between core and outer layers. On the other hand, the diffraction method provides positive evidence for both natural and cultured specimens. Unfortunately, it requires an individual examination of each pearl and exposure times for the photographs are much longer. Thus, the ideal procedure for the routine identification of pearls as "natural" or "cultured" is to radiograph them first, identify from the radiograph any that are at all ambiguous, and finally examine each of these individually by the diffraction method.

In conclusion, it may be emphasized that in many cases (particularly those to which the endoscope cannot be applied), X-ray methods provide the surest and often the only means of distinguishing between the natural and the cultured pearl without damage to the specimen.

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