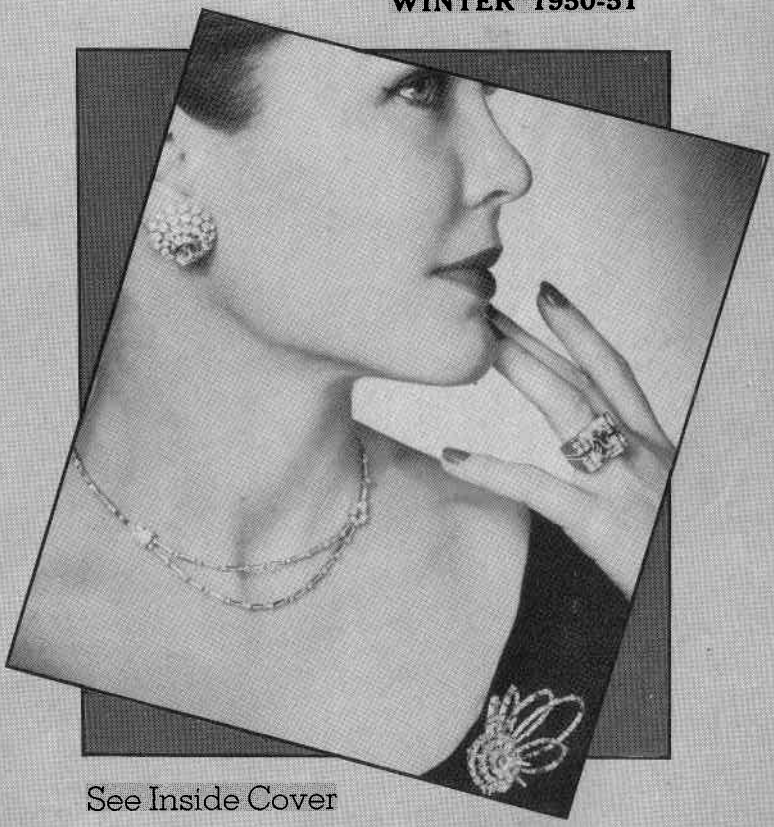
Gems and Gemology

WINTER 1950-51



See Inside Cover

GEMS & GEMOLOGY

VOLUME VI WINTER 1950-51 NUMBER 12

IN THIS ISSUE

On the Cover

LACE MOONBEAMS —a "new look" for diamonds. Shells make the earrings. Loops of baguettes rising from a sunburst of brilliants form the pin — a cob-web of baguettes and brilliants become a necklace. An emerald cut canary diamond is used in the center of the ring.

GEMS & GEMOLOGY is the quarterly journal 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 each four issues. Published by the Gemological Institute of America, an educational institution originated by jewelers for jewelers, at its International Headquarters, 541 South Alexandria Avenue, Los Angeles 5, California.

Laboratory Synthesis of True Quartz Crystals[1]

by

DR. ALBERT C. WALKER
Chemical Department, Bell Telephone Company Laboratories

EDITOR'S NOTE: *In private correspondence, the Gemological Institute is informed by the Bell Laboratories that thus far only colorless quartz crystals have been produced. Although it is hoped to eventually put synthetic quartz on a commercial basis, this phase of development is still in the laboratory stage.*

GEOLOGISTS have long speculated on how nature formed large quartz crystals. Efforts to solve this problem by growing quartz crystals in the laboratory date back about 100 years. Recently a German geologist, Richard Nacken, succeeded in growing small crystals at a rate that offered some promise of being commercially acceptable.

The method proved faulty, but with Nacken's lead as a starting point, crystallographers at Bell Telephone Laboratories have recently made important progress toward an understanding of the problem.

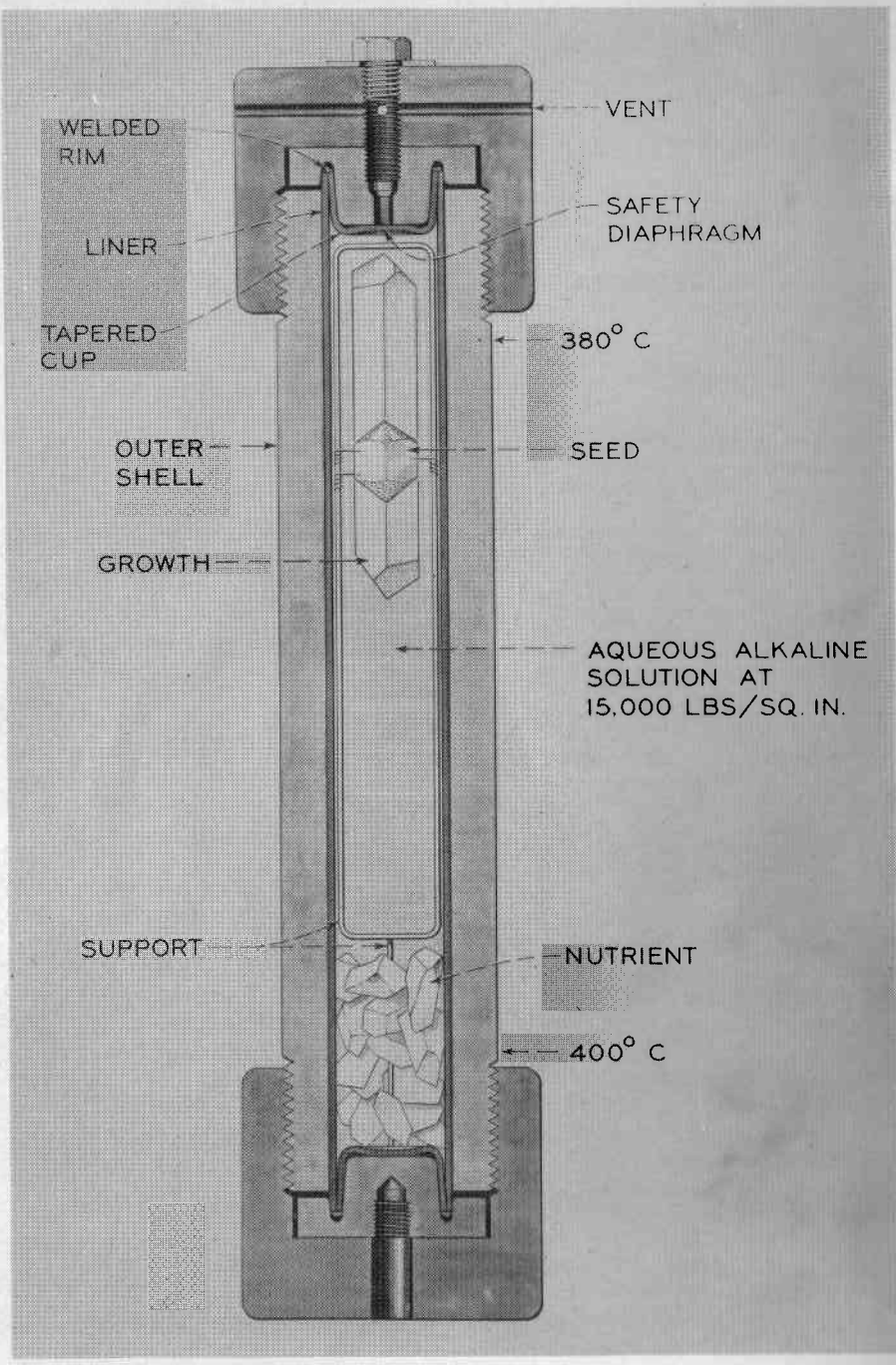
Clear, sparkling crystals of real quartz, identical in every way to those produced heretofore only by the processes of nature are now being grown inside bomb-like, steel "test tubes" at Bell Laboratories. The experiments have been so successful that commercial manufacture of the useful mineral seems possible for the near future.

It is now known that quartz dissolves and recrystallizes from alkaline solutions at high temperature and pressure in much the same way as salts do from water under ordinary conditions and at comparable rates. This knowledge has been used in over 300 experiments by the Bell scientists, who first described their efforts at a meeting of the International Union of Crystallography at Harvard University in 1948.

An important contribution to their work was the development of a welded liner autoclave in which pressures of 15,000 psi. at temperatures of 400° C. could be maintained for months at a time. Design of this autoclave is shown in the cross section diagram. It consists of a thin-walled steel tube, or liner, enclosed in a heavy-walled outer container. Each end of the liner tube is closed with a cup. The rim of each cup, flush with the end of the liner, is welded with an atomic hydrogen flame. The hermetically sealed liner contains the ingredients for growing quartz crystals. These are: a supply of nutrient quartz in the bottom, sufficient alkali solution to fill the free volume of the tube to 80% of its capacity at room temperature; and one or more quartz seeds mounted on an iron wire frame above the nutrient material. This liner is fitted into a heavy-walled outer shell with suitable retainer caps on either end to prevent the welded joints from opening up under pressure. The screw caps on each end apply enough retaining force to prevent any expansion, except that the pressure of the expanding heated liquids distends the liner so that it fits snugly within the retaining walls at all points, much as though it were a rubber balloon.

This filled autoclave is mounted vertically on a metal hot plate in a furnace, completely surrounded with suitable insulation. Quartz

1. Reprinted from *Wards Natural Science Bulletin.*


WELDED RIM
LINER
TAPERED CUP
VENT
SAFETY DIAPHRAGM
380° C
OUTER SHELL
SEED
GROWTH
AQUEOUS ALKALINE SOLUTION AT 15,000 LBS/SQ. IN.
SUPPORT
NUTRIENT
400° C

A

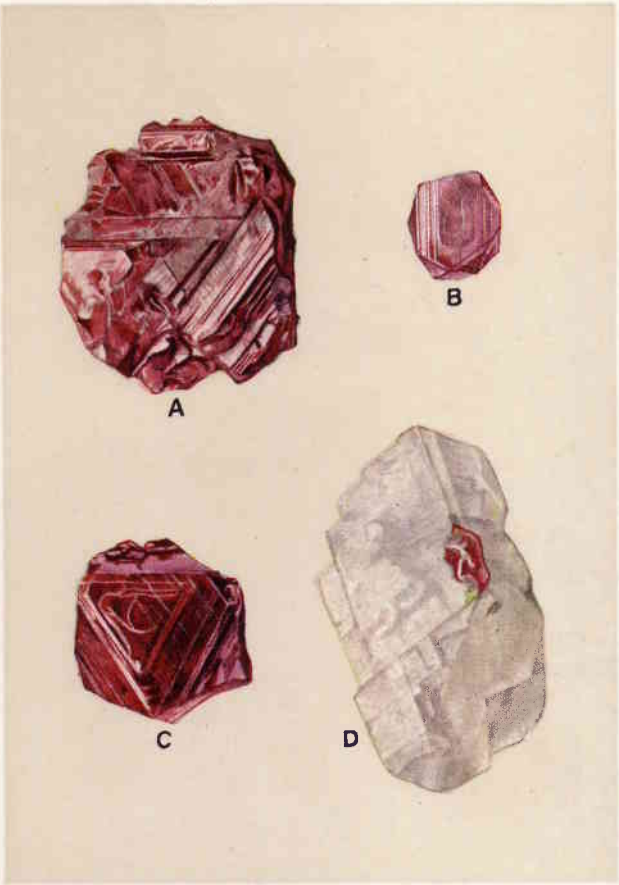
B

STEATITE, SERPENTINE

The figure (A) has been carved from Steatite (massive talc) which is often used as a jade substitute. The large piece of Serpentine (B) is from Lizard, Cornwall. When all green, Serpentine is also frequently used as a jade substitute. Specimens from the collection of British Museum (Natural History), London.

PLATE XXXI

Printed in England.



RUBY

The crystals shown here should be studied carefully. The triangular surface markings are characteristic of ruby crystals. Figure (A) shows the 162-carat "Edwardes Ruby." The hexagonal growth pattern of corundum is clearly shown in the tabular crystals (B) and (C). Another crystal of this type is shown at (D) in a crystalline limestone, found in the famous Mogok, Burma deposits. Specimens from the collection of British Museum (Natural History), London.

PLATE XXXII

Printed in England.

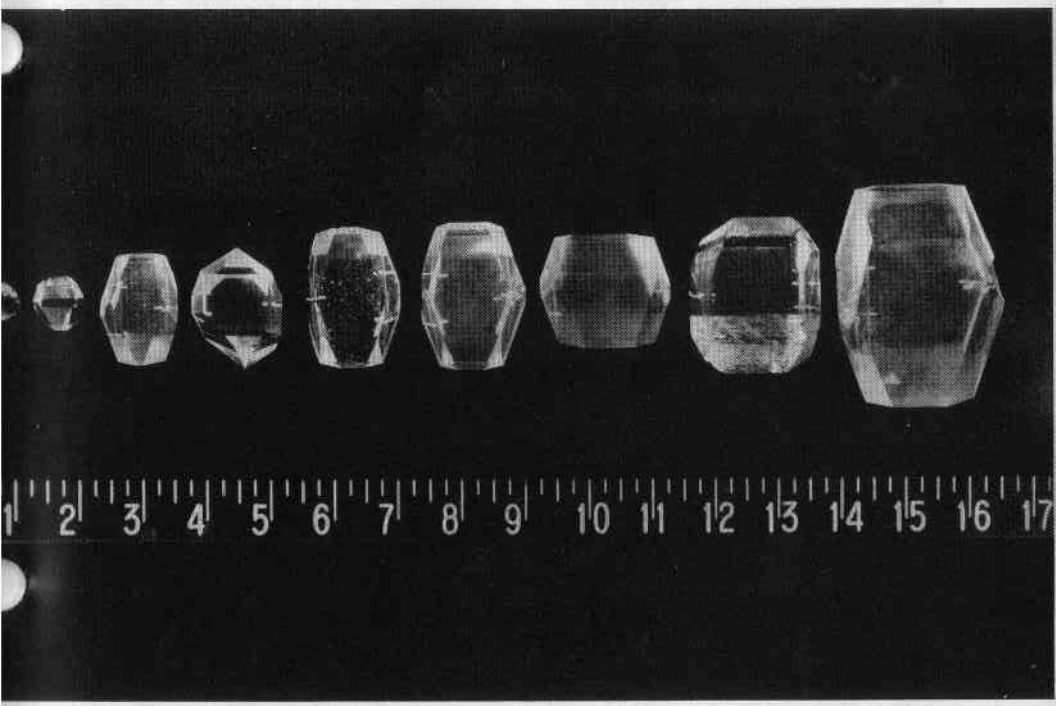
dissolves in the bottom of the autoclave until the alkaline solution is saturated with silica. Convection currents carry this saturated solution to the top of the pressure chamber where, at a somewhat lower temperature, the solution is supersaturated and silica deposits on the seed crystal. The process is continuous as long as nutrient material is available for solution in the bottom of the autoclave.

Crystals thus grown are not a substitute; they are the real thing, with a composition identical to the quartz crystals found in nature. The only difference is that they are synthetically produced and, due to the controlled uniformity of such production, the synthetically produced crystals are superior to natural ones.

Natural quartz crystals and another useful crystal, known as EDT (ethylene diamine tartrate) created by Bell Laboratories, are widely used in telephone communication. Both of these crystals are piezoelectric, which means that they can convert mechanical energy to electrical energy or vice versa. When electrical current is applied to them, they vibrate at certain specific frequencies. In telephony, this property is used in sending many conversations over the same channel at one time. A different crystal filter guides each conversation and keeps it from becoming tangled with all the others.

Another wide application of piezoelectric crystals is in radio communication. Every radio transmitter, either for commercial or military use, requires quartz crystals to control the band of frequencies over which the transmitter operates. Thus far no other crystal has been found, either natural or synthetic, which can be satisfactorily substituted for quartz for this purpose.

• Samples of quartz crystals which have been grown by scientists at Bell Telephone Laboratories. The photograph shows four years of progress in the growing of this useful crystal. The crystal on the right weighs 312 grams and was grown in 32 days



Synthetic Red Spinel

by

G. ROBERT CROWNINGSHIELD *and* RALPH JEROME HOLMES

THE attention of gemologists is called to the existence of synthetic red spinel with properties such that casual inspection might lead to its being mistaken for natural ruby. This material is of special interest in view of Dr. E. J. Gubelin's recent article in which he questioned the existence of synthetic red spinel suitable for gem purposes.[1] It is noteworthy for the additional reason that it occurs in the form of well developed octahedral crystals in striking contrast to the rounded or blunt edged boule charcateristic of synthetic spinel produced by the Verneuil process. The specimen examined was submitted for identification to the Gem Trade Laboratory of the Gemological Institute of America. Unfortunately, the only information concerning its source is that it was being disposed of by a Chinese gentleman of San Francisco who found it among effects left by his father.

The specimen consists of an unusually well formed, brilliantly reflecting octahedron 13.5 mm. on edge, intergrown with a smaller crystal of the same habit. *(Figure 1)*. One face of the large crystal is attached to a circular metallic disc about three quarters of an inch in diameter which chemical tests side of the disc carries a loop, probably of wire, about one half inch in diameter. Both the disc and the loop are encrusted with small octahedral crystals of the same material indicate may be palladium. The opposite *(Figure 2)*. The total weight of the specimen is 31.5 carats. The material is obviously artificial and not a product of the flame fusion technique of Verneuil.

Examination with the Diamondscope shows that the crystal faces have irregular and complex growth markings including occasional triangular pits similar to those observed on diamonds but lacking the symmetrical arrangement in relation to crystal edges characteristic of those on the latter mineral. The crystal is cloudy, a condition due to numerous internal imperfections and inclusions. Under the microscope these are found to include liquid "feathers" and larger irregularly distributed, flattened liquid bubbles and internal fractures. At first glance the microscopic appearance is similar to that of many emeralds.

Triangular growth markings on a submicroscopic scale were observed on the crystal when it was examined by electron microscope methods. The triangular markings are not uniformly distributed *(Figure 5)*. Certain areas are completely lacking in surface configuration of any sort whereas others bear markings of an entirely different type such as the rosettes illustrated in *Figure 6*, which exhibit a crude tendency toward six fold symmetry. The pictures were taken with an

1. *Gubelin's article was prompted by a clerical error in an earlier paper by A. K. Seeman of Linde Air Products Company in which the following statement appeared: "At the present time spinel boules in a variety of colors are available in this country. They include white, ruby, garnet, golden, pink, green, topaz, and aquamarine." In a personal communication Seeman pointed out that through an oversight, the word corundum was omitted in the copy submitted for publication and stated that this sentence should have read, "At the present time corundum and spinel boules in a variety of colors are available in this country."*

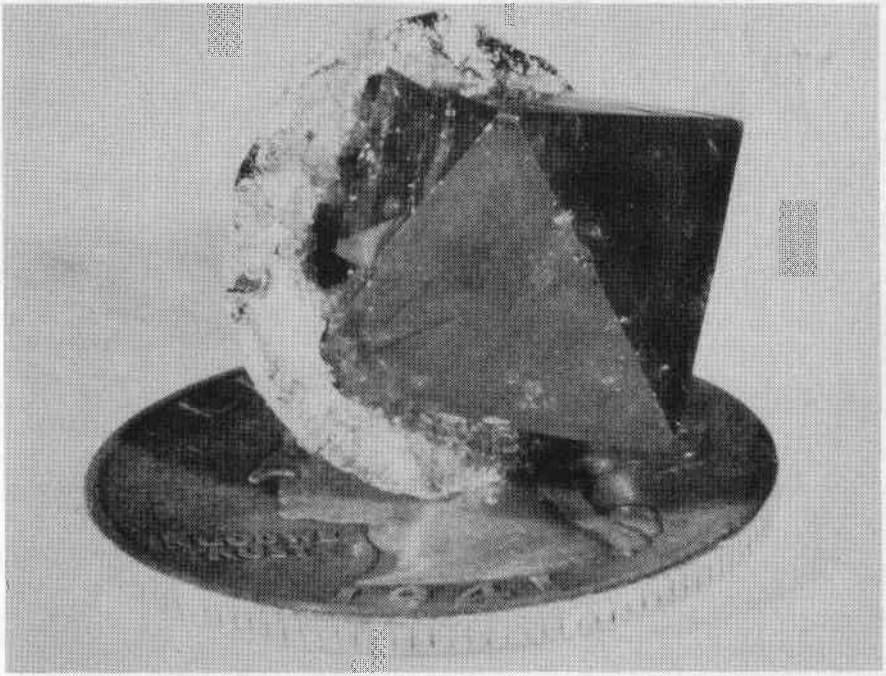
R.C.A. electron microscope, type E.M.U.-2B using the single step replica method, shadowing with palladium.

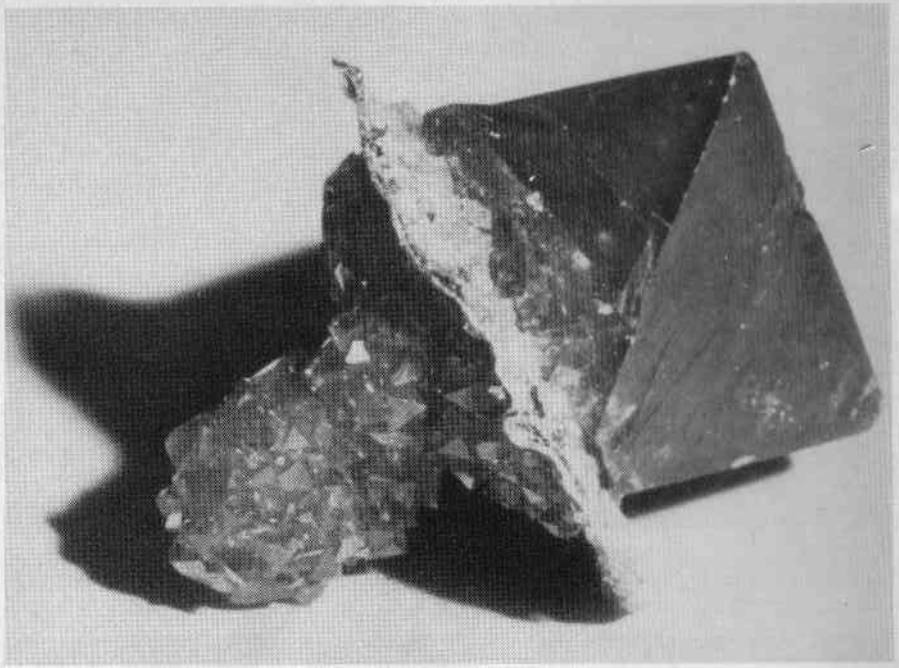
The hardness is greater than that of natural spinel and of synthetic spinel produced by the Verneuil process. It scratches topaz easily and with sufficient pressure can be made to scratch synthetic ruby. One of the small crystals from the surface of the disc was removed and by means of heavy liquids its specific gravity was found to be greater than 3.63 and less than 3.98.

The large crystal, as well as the small octahedra coating the disc and loop, exhibit a marked zonal distribution of color. An ill defined center and a narrow outer zone are darker than the intermediate portions of the crystal. The outer zone is sharply demarcated and exhibits a straight line boundary with sharp angular changes in directions at the apices of the crystal. The straight line and angular color bands in gemstones cut from such material might result in their being mistaken for natural ruby or spinel. The color of the larger crystal is a deep ruby red whereas the smaller encrusting ones are deep pink to pale red.

Optically the material is singly refractive and shows no evidence of the anomalous double refraction commonly observed in synthetic spinel produced by the Verneuil process. The refractive index (1.75) is unusually high for gem spinel, either natural or synthetic, which generally ranges from 1.72 to 1.74. Good readings were obtained on several of the crystal faces and are in agreement. The unusually high index is unfortunately close to the value for corundum (1.76-1.77)

• *Figure 1.* **Octahedral crystal of synthetic red spinel mounted on a quarter to indicate size. Color zoning is evident on the right hand face of the larger crystal and on the small crystal on the left near the surface of the metallic disc**





• *Figure 2.* **Synthetic red spinel showing relation of the large octahedron to the crystal encrusted metallic disc and loop**

hence reliance on index alone might lead to the conclusion that the material is ruby.

Examination with the Beck hand spectroscope, using carbon-arc light source, provides an absorption spectrum *(Figure 3)* which shows similarities to the spectra of both ruby and natural red spinel. When observed in scattered (reflected) light there is a strong fluorescent doublet in the spectrum of ruby. A very weak line occurs at approximately 6590. A.U. By using a monochromatic sodium vapor lamp in addition to the carbon arc, the sodium line at 5900 A.U. is superimposed on the spectrum and serves as a reference guide. The broad absorption band begins in the orange at almost the same position as it does in the case of ruby and covers a broad zone on either side of the 5900 A.U. line of sodium. This is a peculiarity not observed in the spectrum of natural red spinel. The general absorption from the orange to the green is stronger than that of ruby. The two lines in the blue ground in the spectrum of ruby are missing and the blue transmission is slight. There is almost complete absorption of the violet.

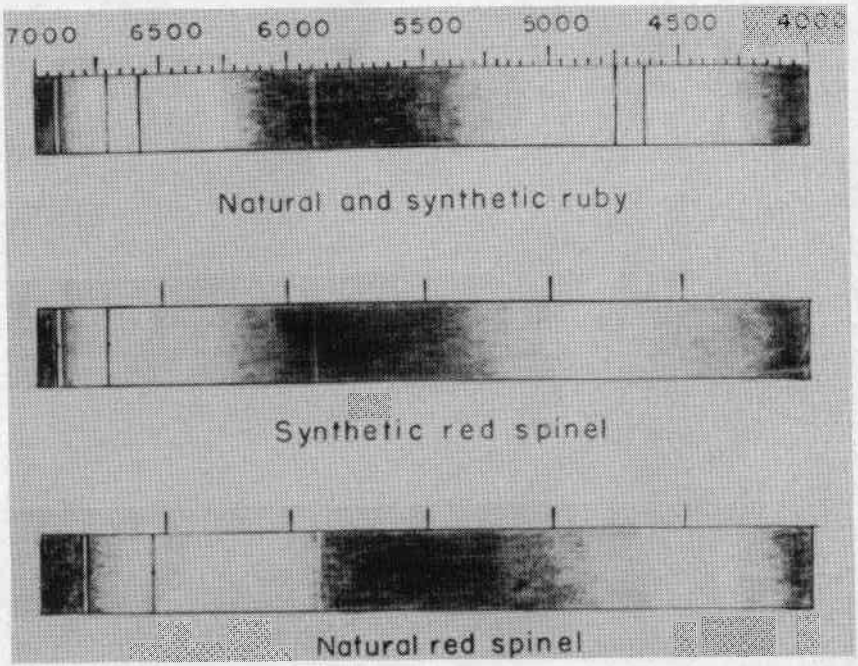
An X-ray powder diffraction pattern of one of the small crystals was obtained using a Debye camera (radius 57.3mm.) and unfiltered iron radiation. This pattern is compared to *Figure 4* with those of natural red spinel from Ceylon, natural ruby from Burma, and synthetic pink spinel produced by the Verneuil process. It is clear that the pattern of this material is entirely different from that of corundum (ruby) and is almost identical with that of natural red spinel. The lines in the three spinel patterns were measured and indexed and the unit cell size (lattice constant) of each was calculated and found to be as follows:

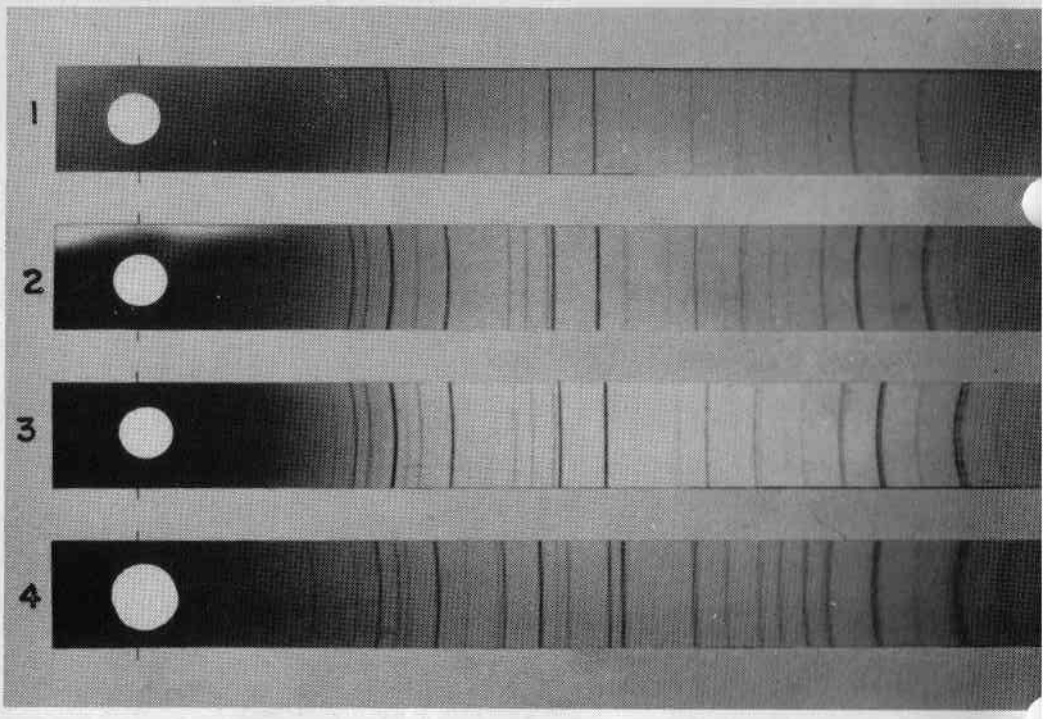
Syn. red spinel (octahedral crystal) 8.084 A.U.
Natural red spinel (Ceylon) 8.089 A.U.
Syn. Pink spinel (Verneuil proc.) 7.975 A.U.

The lattice constant calculated for natural spinel is in good agreement with published values for the red gem variety of this mineral. The lattice constant of the synthetic red octahedron is surprisingly close to that of the natural red spinel. The X-ray data prove that the material possesses the spinel structure. It should be pointed out that the gamma form of Al_2O_3 also has a spinel structure. This substance, although not found in nature (the mineral corundum is the alpha form of Al_2O_3) has been produced artificially and the possibility was considered that the red synthetic octahedron might be this substance. However, the spectrographic examination indicating the presence of magnesium as a major constituent excludes this possibility.

A few of the small crystals were examined with the aid of a 1.5 meter emmission spectrograph to determine the essential chemical composition. Only qualitative data could be secured since there was insufficient material available to make a quantitative study of the specimen. Comparison spectrograms were prepared of the red synthetic octahedra, the natural red Ceylon spinel, and the pink synthetic (Verneuil process) spinel. Magnesium and aluminum were found to be the principal constituents in all three. Strong chromium lines occur in both the natural red and a synthetic red spinel but are essentially absent in the spectrum of the pink synthetic. The spectrographic analysis indi-

• *Figure 3.* **Absorption spectra of synthetic red spinel compared with those of ruby and natural red spinel. The bright line at approximately 5900 A.U. is the line of sodium used as a reference point**



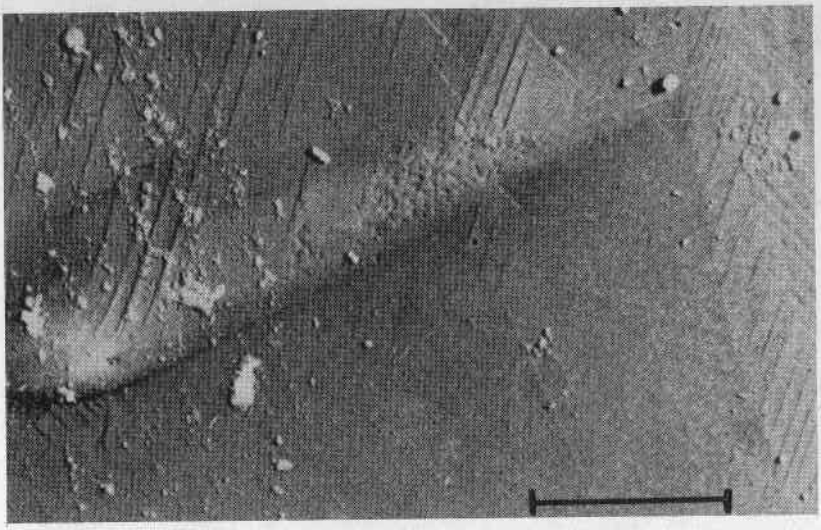


• *Figure 4.* **X-ray powder diffraction patterns of 1) Natural red spinel, Ceylon — 2) Synthetic red spinel — 3) Commercial synthetic pink spinel (Verneuil process), and — 4) Natural ruby, Burma**

cates that the red synthetic octahedrom is an aluminum magnesium compound containing appreciable chromium, its spectrum being very similar to that of natural red spinel.

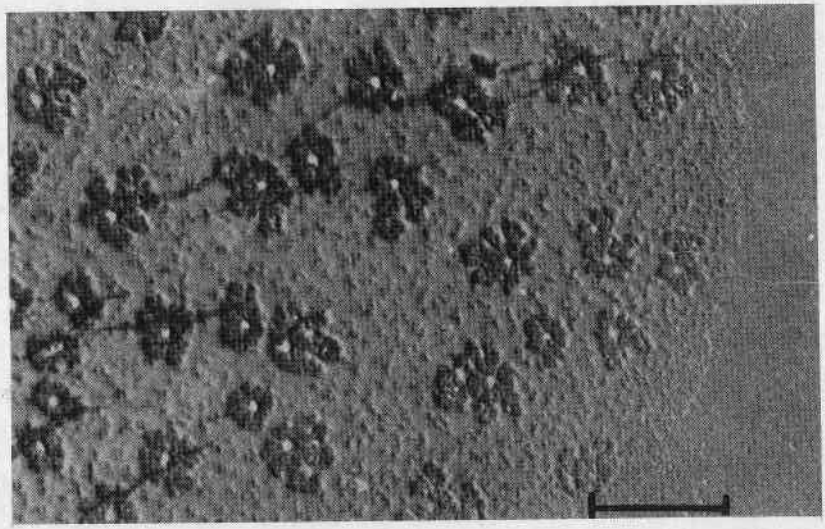
The X-ray, spectrographic, optical, and other data secured on this specimen establish it as a chromium bearing red spinel. The physical aspect of the crystal makes it clear that it was not produced by the flame fusion method of Verneuil. What process was used in its production is not known. It may possibly have been crystallized in a sealed chamber or bomb from an aqueous solution or from a vapor in a manner similar to that employed in the production of synthetic quartz crystals. It would be interesting to know how that material was produced, for although the specimen examined is not of fine gem quality it is altogether possible that improvements in technique will make possible the production of clear crystals from which good sized gems could be cut. In view of the similarity of its properties to those of both natural ruby and natural spinel, jewelers should be aware of the existence of this material. As pointed out at the beginning of this paper the crystal studied had actually been purchased in the belief that it was natural ruby.

The authors are indebted to Mr. H. O. Oppenheimer of New York City, through whose kindness the specimen was made available for study, and to Dr. Ming Shar Sun, Mr. John Edwards and Mr. Karl Ture-



• *Figure 5.* Electron microscope photograph showing development of triangular growth markings on the octahedral face of a synthetic spinel crystal. Magnification is indicated by the black line which represents a length of 1/10,000 inch

• *Figure 6.* Electron microscope photograph showing rosette like growth markings on the octahedral face of a synthetic spinel crystal. Magnification is indicated by the line which represents a length of 1/10,000 of an inch



kian, assistants in the Department of Geology, Columbia University, who were responsible respectively for the taking of the X-ray patterns, the photographing of the specimen, and the spectrographic examination. Thanks are due to the Department of Geology, Columbia University for the use of X-ray and spectrographic equipment.

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Fifty-two Diplomas Awarded

Since last reported in the fall issue of *Gems and Gemology*, fifty-three students have completed the correspondence and residence courses of the Gemological Institute of America. The following thirteen have received diplomas in the Theory and Practice of Gemology:

William H. Bell, Beverly Hills, Calif.
John G. Ellison, Chicago, Illinois
John Fillos, Salem, Massachusetts
Morris Fisher, Los Angeles, California
Neal H. Guffey, Washington, D. C.
Hidemasa Higuchi, San Jose, California
Martin P. King, Miami Beach, Florida
Leo E. Langley, Williamsburg, Iowa
Lee R. Miller, San Rafael, California
Neil C. Morrison, Inglewood, California
Robert B. Rohweller, Vallejo, California
James T. Sample, Harlingen, Texas
John Samuelian, Philadelphia, Penn.

Diplomas in the Theory of Gemology from the Gemological Institute of America awarded upon completion of correspondence courses were received by the following persons:

George A. Arbogast, Chicago, Illinois
Jerome J. Atlas, Philadelphia, Penn.
Larry I. Baker, San Francisco, California
Neele S. Barner, Manhattan Beach, Calif.
S. J. Barrett, Danville, Kentucky
Joseph Francis BeBolla,
Mount Vernon, Washington
Harry Earl Behney, Stockton, California
William J. Bingham, St. Paul, Minnesota
Thornton M. Broomfield,
New York, New York
Frank E. Corsi, Iron Mountain, Michigan
Charles H. Crosman, Auburn, New York
Thomas L. Davies, Jr., Falls City, Neb.
Donald K. Dewar, Indianapolis, Indiana
John H. Dorrell, Newport, Delaware
John H. Fredrickson,
East Weymouth, Massachusetts
Raymond Hales, Bethesda, Maryland
Myles Edward Hanley, Dayton, Ohio
James C. Hayes, La Crosse, Wisconsin
Wendell F. Henby, Nebraska City, Neb.
Labar P. Hoagland, New York, N. Y.
Gwyn Hamilton House, Junction, Texas
Elmer E. Huber, Olympia, Washington
Raymond Jarosz, New York, New York
Edward J. Johns, Bristol, Connecticut
Raymond A. Kader, Sanford, Florida
Lorenzo E. Lawrence, Bayville, N. J.
Douglas J. MacDonald, Glendale, Calif.
James W. McCary, Shreveport, La.
Hyman Meltz, Port Chester, New York
Ellsworth A. Miller, Dodge City, Kansas
Russell A. Moyer, Chippewa Falls, Wis.
Robert F. Noesges, Springeld, Illinois
Emmett E. Pack, Charlottesville, Virginia
Jack E. Schunk, Sheridan, Wyoming
Harry H. Schwier, Fort Worth, Texas
James R. Stedman, Whittier, California
Robert J. Swain, Washington, D. C.
Joseph Andrew Valenti, Detroit, Mich.
George C. Ward, Sharon, Pennsylvania
Ross G. Wells, Winnipeg,
Manitoba, Canada

• Market Day in the Tourmaline Country

The Gemstones of Brazil

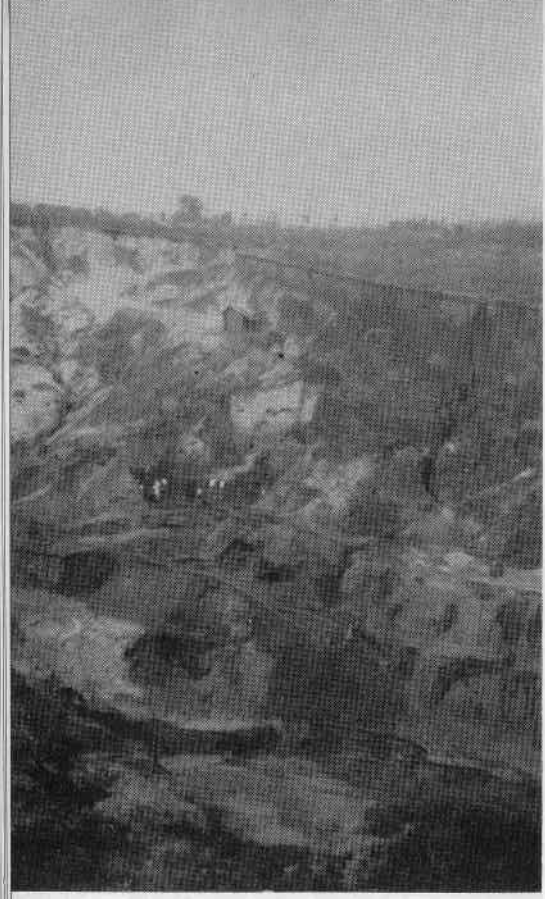
by

THOMAS DRAPER

TWO minerals – silver and emeralds – both of which were believed to occur in fabulous quantities, played an important part in stimulating exploration of the interior of Brazil by its pioneer settlers. Strangely enough, neither of them fulfilled expectations, The silver mines hitherto discovered may have a potential value but fall far short of the visions of wealth imagined by those who sought them so persistently. Why they should have preferred silver to gold "which no one sought" is not explained.

In the "Land of Emeralds"—as Brazil was optimistically christened—the "Green Hill," described in the orthography of the day as *"fermosa e resprandescente."* beautiful and resplendent, where the emeralds were "clean and of an honest size," remained an obsession that outlasted 150 years of search and adventure but, nevertheless, contributed in no small degree to the unveiling of the mysterious and inhospitable interior of Brazil.

Expeditions, under chosen leaders, disappeared into the unknown, remained away for years, traveled hundreds of leagues only to return eventually, broken in health and depleted in numbers; defeated but never discouraged. In their aimless wanderings they untangled the complicated river systems and geography of the country and eventually dis-



• Precious topaz workings — Rodígra Silva, Matto Grosso

covered the gold and diamond fields that lifted Brazil from obscurity into international fame.

The gold fields of Ouro Preto, Marianna, Sao Bento, Sabara, Sao Joao d'El Rei, Serro Frio, and Paracatu in Minas Geraes; those scattered throughout Goyaz; and the famous mines of Coxipo de Ouro, Cuyaba and Rio das Contas in Matto Grosso owe their discovery to the incentive furnished by the "dream of emeralds." The diamond fields of Diamantina, Abaete, Bagagem, those of Goyaz and of Coxim, Coxipo, and Diamantina in Matto Grosso followed as a tribute to the persistence and courage of the *"Bandeirantes."* Although they did not achieve their original objective they did, as a matter of fact, come within a few miles of doing so and incidentally discovered the richest source of the less expensive precious stones in Brazil. They also could not have failed to notice the presence of crystal, beryllium, and mica for which Brazil has since become famous.

The search for emeralds was based on information received from friendly Indians and probably also from some of the more daring, lone explorers themselves.

Inflamed by the reports of fabulous quantities of green stones in a locality "where even the fish are green," an expedition was organized in 1554 under the leadership of Bruzo Espinoso and a Jesuit priest but, after wandering about for more than two hundred leagues, it returned empty handed as did also the second under Martin Carvalho in 1567.

Sebastiao Fernandes Tourinho appears to have made two attempts — the first in 1555 when he left "Bahia with a big body of guides, service men, and Portuguese to explore the margins of the Sao Francisco, Jequitinhonha, and Doce Rivers."

In 1572 Tourinho was appointed leader of the third expedition on which occasion "he hurled himself into the barbarous forests of the Rio Doce" and must finally have reached the watershed dividing the rivers flowing east from the tributaries of the Arassuahy and Jequitinhonha Rivers. Here "he entered an enchanted land in which he found green stones resembling turquoise . . . and red stones . . . and blue stones all very resplendent." Finally he found not only "the emeralds themselves *but also sapphires.*" With an ample supply of samples he returned to Porto Seguro from where they were sent to Portugal for identification. His return created great enthusiasm which was not in any way dampened by the news that his samples were pronounced to be "emeralds from the surface baked by the sun . . . that the earth had rejected as refuse." It was suggested that better ones would probably be found "by digging deeper." It is evident from the localities mentioned that Tourinho must be credited with having discovered the

richest source of precious colored stones in Brazil—the area of which Teofilo Ottoni, in Minas Geraes, is the present center for the purchase of rough stones.

Encouraged by the prospect of finding emeralds by digging deeper, the governor of Bahia himself organized the next expedition in 1574. This he entrusted to the leadership of Antonio Dias Adorno with "150 companions, 400 peaceful Indians and many slaves" to explore the margins of "the opulent Rio Doce das Esmeraldas." Adorno appears to have covered practically the same ground as Tourinho and met with the same result—baked emeralds. His expedition lasted four years and he took so many samples that he was unable to add a few specimens of rocks which, because of their weight, he thought might contain gold and silver. On this journey he entered the valley of the Jequitinhonha River and missed his opportunity of discovering gold and diamonds.

Martin Cao, the "butcher of blacks," followed Adorno in 1596 but seems to have been more interested in enslaving Indians than in finding emeralds.

Marcos de Azeredo Coutinho, in 1612, found the emeralds that satisfied Portugal where they were pronounced genuine. For the discovery he was awarded the *"'habito de Christo"* and 4000 *cruzados*. Invited to lead another expedition he obstinately refused to do so unless and until paid his reward. He died without revealing the secret of the locality. Nearly sixty years of effort were nullified because the governor of the state could not, or would not, pay the equivalent in value of approximately three and one half kilograms of gold.

Now, with positive evidence that they existed, the "dream of emeralds" took on a firmer hold. Even the Church became interested because it hoped by this means to liquidate a debt of 150,000 *cruzados* it owed locally. But its expedition under Padre Ignacio de Sequira also failed. Twelve years later an expedition led by two of Azerado Coutinho's sons also failed to discover their father's enchanted land of emeralds. Three more expeditions followed and suffered the same disappointments.

• **Typical Garimpiero and Wife**

These early expeditions had nearly all started from different points in Bahia but in 1674 Fernao Dias Paes Leme, from Sao Paulo, made an attempt to rediscover Azeredo Coutinho's locality where the emeralds had been pronounced genuine. Leme's expedition is described by historians as the most epic of its kind made during the *Bandeirante* days. A man of wealth, of good family and influence, living a carefree life in Sao Paulo but no longer young, he had acted as mediator in the bitter quarrel between the Church and the *Paulistas* and also in the sanguinary

• Quartz crystal taken from the Barra da Salinas Pegmatites

feuds between the Pires and Garmabgo families. With the firm resolution either to succeed or never come back, his effort cost him his life, his entire fortune, seven years of iron courage, and the life of his illegitimate son whom he ordered to be hanged for taking part in a conspiracy to abandon the expedition. Fortunately for him he died before suffering the disappointment of learning that the samples taken, as he thought, from Azeredo Courtinho's old pits, were identified as common tourmalines. In recognition of his services in exploring the interior of Brazil he had previously been appointed "Governor of all those engaged in prospecting for emeralds and silver." His appointment specified that he should be implicitly obeyed. Deep in the heart of a jungle he was suddenly confronted with a similar appointment conferred by the Prince Regent upon Castel Blanco, a Spaniard who had been to the emerald mines in Colombia. In the dispute which naturally followed, Blanco was killed by Leme's son-in-law, Borboa Gato, who, as a fugitive from justice, also became one of the celebrated *Bandeirante* explorers and was subsequently pardoned.

During the course of his wanderings, Paes Leme passed through the valley of the Jequitinhonha and, like Odorno, also missed his opportunity of discovering the gold and diamond of that region.

The last expedition was organized in 1713 by Sebastiao Raposa Pinheiro Travares who preferred to carry on the search for emeralds rather than for gold. This metal, which had been discovered a few years previously, was engaging the attention of all the adventurers in Brazil. His search led him far into the wilds of Matto Grosso where he ended by discovering the famous alluvial gold deposits of the Rio das Contas from which he recovered 'many arrobas." (1 *arroba*-15 *kilograms*) His expedition is described as one of the blackest pages in the history of the *Bandeirantes.*

It is not clear whether the emeralds discovered by Azerado Coutinho were genuine or erroneously identified in Portugal. If genuine, it took nearly four hundred years to rediscover them.

Thus ended the strange story of the search for emeralds. For more than 150 years the dream of emeralds was responsible for producing some of the most daring explorers in Brazil. That they left behind them a trail of blood and brutality against the Indians and slaves was only in accordance with the spirit of the day, but there was a time when the Pope himself had to remind them that even savages have souls. When eventually found at Brumadinho in Bahia, these elusive emeralds proved to be of the Colombian variety but less deep in color. A few years later they were also found in the Rio Doce region itself in the very same area that had so often been examined by the *Bandeirantes.* Their "Green Hill" is now known as the "Serra do Esplendor." Conquista in Bahia and Itaborai in Goyaz are also recent discoveries.

Gemstones may have both a commercial and a sentimental value, but a historical background lends additional interest and those from Brazil reflect an exciting page of its history.

Sapphires have been reported associated with diamonds in various states and are regarded by *garimpeiros* as a good augury. The late Glenn Byrkett had a few small crystals from the Coxim River in Matto Grosso, but the owner of the property discourages further investigation. They are also reported to occur at Salobro at the mouth of the Jequitinhonha River, once the scene of diamond mining activity but now abandoned on account of its waterlogged condition.

Rubies, also small in size, have been found in the Abaete, Abbadia, and Agua Suja areas in Minas Geraes but only as

• Overlooking the Jequitinhonha River from the Barra da Salinas Tourmaline Group of Mines

alluvial associates of the diamond. The *Brazilian Engineering and Mining Review,* long since defunct, quotes the *Gazeta de Uberaba* of March 1908 to the effect that Antonio Lin de Andrade found a beautiful ruby which he sold for $600.00 and that Mr. Galvao extracted a great many stones, weight and size unknown, 'from the Douradinho River." Unfortunately the river itself is not identified. The present limited supply of rubies comes from three sources—the Coxim River in Matto Grosso, Portela in Bahia, and Piuna in Espirito Santo.

Topazes were first found at Ouro Preto and are the finest of their kind in Brazil. They also occur in Gamba, Sarmento, Tripui, Rodrigo Silva, Boa Vista, Bom Jardim, and Turvo in Minas Geraes; at Belmonte and Conquiata in Bahia; and Caxias in Espirito Santo. The Brazilian Imperial topaz is one of its most appreciated gems and quite recently green stones, classed as topazes, have appeared on the market in limited quantities but the identification is dubious.

Diamonds—The occurrence of diamonds in Brazil has been dealt with in previous contributions to this journal and need not, therefore, be repeated. However, the annexed list of the largest stones hitherto found may prove useful for reference.

Brazil is noted for the variety and quality of its colored gemstones. The following table shows the zones in which they occur—the localities being too numerous to specify or to show on a small scale map:

NORTHERN ZONE

(*Piahui*—Agate, amethyst
(*Ceara*—Agate, amethyst, tourmaline
(*Rio Grande do Norte*—Aquamarine, beryl, epidote
(*Alagoas*—Beryl

CENTRAL OR BANDEIRANTE ZONE

(*Bahia*—Agate, aquamarine, amethyst, beryl, emerald, garnet, topaz, tourmaline
(*Minas Geraes*—Agate, aquamarine, amazonite, amethyst, *brazilianite,* citrine, *chrysoberyl,* diopside, *euclase,* garnet, *phenakite, spodumene, spinel,* topaz, tourmaline
(*Espirito Santo*—Agate, amethyst, andalusite, aquamarine, beryl (morganite, golden, and green), citrine, *chrysoberyl,* epidote, escapolite, garnet, iolite, *spinel,* tourmaline, and topaz

SOUTHERN ZONE

(*Sao Paulo*—Spinel
(*Panama*—Topaz
(*Santa Catarina*—Agate, *crysolite,* diopside, epidote

WESTERN ZONE

(*Rio Grande do Sul*—Agate, amethyst
(*Goyaz*—Agate, *emerald,* citrine, *chrysolite*
(*Matto Grosso*—Agate, amethyst

The development of the Brazilian trade in precious stones is largely due to a few enthusiasts including the late Luis de Rezende, for many years the most prominent jeweler in Rio; Germon-born Emilio Schupp who established a firm there and made annual trips to Brazil to purchase rough stones for cutting in the historic city of Idar-Oberstein, for the revival of which he was largely responsible; Francelino Horta, born and brought up in Diamantina, who abandoned diamond mining in favor of the gem trade, and was one of its principal exporters until his death a few years ago; Glenn Byrkett who came out to Brazil as an electrician, became interested in gems, and built up a fine trade including such customers as President Hoover, the Prince of Wales (Duke of Windsor), and other celebrities. Hugo Brill should also be mentioned.

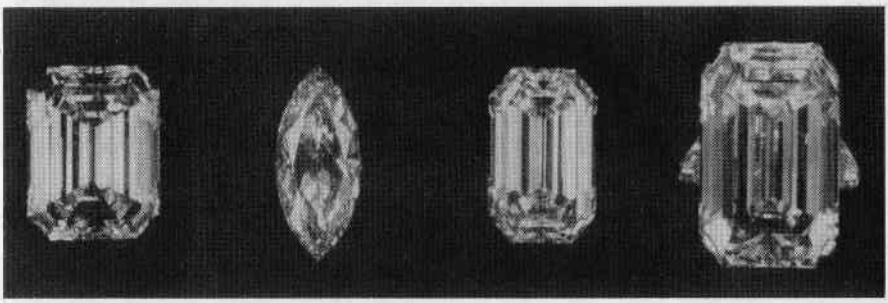
Like the diamond, other precious gemstones furnish the ubiquitous *garimpeiro* with a means of livlihood. (It is estimated there are about 30,000 engaged in this trade.) The sporadic nature of the occurrences and the sparce distribution of the gems themselves in the lodes combines to deter organized efforts from engaging in this branch of mining. Physical handicaps such as the scarcity of water in the northern states or of transportation facilities, are largely responsible for the lack of interest shown by capitalists who might otherwise be tempted to risk the necessary expenditure for mechanical appliances. There is also the fact that the

Brazilians themselves have a wide choice of safer commercial ventures and prefer to leave speculative mining enterprises to "crazy foreigners" who, handicapped by restrictive nationalistic legislation, do not show any great enthusiasm for mining ventures in Brazil. Practically the entire production of gemstones in Brazil is due to *garimpeiros* who earn a precarious living under conditions that only a benign climate render possible.

Largest Diamonds Found in Brazil

NAME	ROUGH	CUT	YEAR	STATE
Empress Eugenia	?	51	1760	?
Rosa de Abaete	80.30	?	1935	Abaete, Minas
Ituiutaba	105.00	?	1940	Ituiutaba Minas
Benedito Valladares	108.00	?	1940	Estrella do Sul Minas
Dresden	120.00	76.5	1857	Bagagem Minas
Jalmeida	109.50	45.40	1924	?
Nova Estrella do Sul	140.00	?	1937	Abaete Minas
Coromandel	141.00	?	1936	Coromandel Minas
Minas Geraes	172.50	?	1937	?
Estrella de Minas	179.30	?	1910	Bagagem Minas
Coromandel	180.00	?	1934	Coromandel Minas
Tiros	182.00	?	1938	Tiros Minas
Tiros	198.00	?	1938	Tiros Minas
Coromandel	228.00	?	1936	Coromandel Minas
Abaete	238.00	?	1926	Abaete Minas
Carmo de Paranahyba	245.00	?	1937	Carmo de Paranahyba Minas
Estrella do Sul	261.00	127.00	1857	Bagagem Minas
Patos	324.00	?	1937	Patos Minas
Tiros	354.00	?	1938	Tiros Minas
Darcy Vargas	400.00	?	1939	Coromandel Minas
Presidente Dutra	409.00	?	1949	Coromandel Minas
Presidente Vargas	726.00 (Winston)		1938	Patos Minas

• **Four Stones cut from the Vargas Diamond**



Report on Chivor Emerald Mines

by

RUSSELL W. ANDERTON
(formerly Manager of Mines at Chivor)

AT THE present writing Chivor, for all practical purposes, is closed. During the past year, approximately 18,000 carats of emeralds were taken out and marketed. Approximately 90 per cent of these were light in color—typical of Chivor—and commanded a modest price on the New York market.

The year was marked by a bitter struggle between the Colombian interests and the New York officers for control of the mine, a situation prevailing at the moment. The writer experienced such local drolleries as attempted murder, blackmail, pistol fights, and was arrested and held incommunicado for three days working at Chivor with the wrong technical type of visa.

All of the present workings at Chivor are of the tunnel type. First, because they are easier to lock and guard at night and second, because there is such a number of gem-bearing tunnels already extant. When labor was cheaper, as in the time of Major Rainier and Klein, the terrace workings were used extensively. Also, in those days the labor did not fully realize the value of emerald rough and thievery was almost unknown. One of the larger tunnels at Chivor has four separate, interconnected levels into the mountain side.

The best emeralds are found between the second and third of three wide iron bands that cut the property horizontally. Chivor is situated on a mountain top and most of the modern workings are on the eastern slope although the Spaniards tunneled extensively on the opposite side. The finest color of emerald is found in a location on the east side known as the Piedre Cal.

Small and large veins crisscross the property at forty-five degree angles, running roughly from South to North. Gems are found further inside the veins which become quartz-like and sometimes crop out on the surface. Inside the tunnels, a quartz vein may attain a width of approximately two feet. Pyrite is found generally in all veins. Usually, before a pocket of emeralds is discovered (i.e., a 'Recovery') *Moralla,* a local word for imperfect and worthless crystal, is encountered. It is considered an excellent sign although the *Moralla* may peter out and the quartz become empty of all signs of gem. *Moralla* is usually perfectly formed hexagonally, larger than the precious emerald, mottled with iron inclusions, and generally has a cracked and off color appearance. Occasionally, good gem material is found lying at the bottom of a burned out iron pocket — a hole covered with the usual iron rust. It is necessary to scrape with a knife to identify other than the typical beryl shape. The largest crystal ever taken out of Chivor weighed approximately 650 carats and was of good color. A second and larger crystal was shattered when dynamite was used in the same location.

Most of the labor presently is employed

by contractors who pay their own men, turn the gems over to the company inspector and receive half of the Bogota valuation placed on them by the Minister of Mines. Thievery is, of course, the biggest word in this or any gem mining operation.

The typical laborer at Chivor is either a short, stocky Chibcha Indian who does most of the digging — or the Spanish Colombian, generally a contractor or inspector.

From childhood, a man carries his knife (or *Cochillo*) at his belt. When he becomes more affluent he carries a pistol at all times, and generally settles his disputes on the spot with whichever weapon he happens to have. On the occasion of a murder or brawl, when the far away policeman comes to investigate, the men suddenly have a failing recollection of what did or did not take place.

However, once the loyalty of these men is attained, there is no reason to have any fear for personal safety. Their emotions are as primitive as the tools with which they work.

One section of Chivor, to the South, contains many perfectly formed quartz crystals of varying sizes and generally contains few gemstones of emerald. The quartz vein, in which the emerald is generally found, is of a soft quality which makes it possible to cut and pry out many times with an ordinary knife. Also, a gray, granite-like formation generally surrounds the vein which gives a soapy feeling to the touch and can be modeled easily with a knife. At other times, generally when the vein narrows to a fraction of an inch, the vein will run into solid rock and may necessitate occasional blasting. This is avoided wherever possible due to the danger of shattering whatever gems it may contain.

The Spaniards worked Chivor with primitive tools, probably of wood, and used forced labor, recruited at sword's point among the natives, until the bishop of the province excommunicated the entire area, including and surrounding the mine. It became a haunted spot and was lost for centuries. It was rediscovered in 1912 through ancient Spanish documents which pointed out that Chivor was located at the only spot in the area where the limitless Llanos could be seen through a gap in the mountains. Spanish bowls and cooking utensils are occasionally dug up on the property and the ancient tunnels are mostly in a state to permit present day exploration.

The Spaniards inaugurated an ingenious system of bringing water many miles through the mountains to Chivor by a series of cut-offs and wooden troughs which make it possible to divert the constant flow into large excavations known as *Tambres*. These are situated on various parts of the upper levels and may be filled and spilled out over the mountainside wherever it is desired to quickly wash away the result of tunnelling or excess rock and debris. A primitive horn is sounded to warn the men of the coming of the great rush of water over the mountainside.

A large percentage of the almost perpendicular sides and area of Chivor has at one time or another been terraced. At present it is all overgrown with a moss-like growth and consequently when a new contractor starts to look for what seems to be the most promising vein, he will terrace the hill further, only to uncover the structure beneath the overgrowth. Once he decides on his vein, he will get the manager's approval and start a tunnel on that particular spot. Several of the tunnels have been abandoned after months of work, having yielded nothing but slate-like black carbon, which seemingly fills the interior of several hills. When a vein disappears in a given direction, it may be the opinion of the contractor that the vein will be picked up again farther ahead, as in the case of the above-mentioned carbon tunnels.

Very little material of gem quality is washed away and whatever may escape the keen eye of the worker is many times broken to small pieces by the action of the rolling boulders and water.

Emeralds of gem quality are occasionally

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TANGANYIKA DIAMOND PRODUCTION AND EXPORTS GIVEN FOR 1948

FOR the analysis of 1948 diamond production and exports in Tanganyika, the Gemological Institute of America is indebted to Edwin F. Thompson, Chief Inspector of Mines, Tanganyika.

The Annual Report of the Department of Lands and Mines for that country states that at the beginning of 1948 three diamond producers were operating in Tanganyika. In June, Williamson Diamonds Ltd. purchased the Premier Diamond Mine at Udahe (estate of J. H. Stanley White, deceased), leaving only the Williamson interests and Alamasi Ltd.—both of Mwadui—operating during the last half of the year.

During 1948, 327 stones, weighing more than ten carats each, were exported from Tanganyika. This shows a considerable increase in the number of sizable stones recovered since only 178 are recorded for the previous year. Of the 327 exported in 1948, 280 came from the Williamson Mines, forty-one from Alamasi, and six from the White estate.

The largest diamond so far recovered by Williamson Diamonds Ltd. was found in 1946 and graded as a "brown piece." The stone weighed 174 carats. During 1948 a stone of almost exactly the same weight (173.8) was produced by the same company. It is described as a "colored cleavage piece" and valued at £5,212. 10s. 0d.

Production from the Williamson and Alamasi properties at Mwadui continued to be from gravels worked by opencast methods. At the Williamson mine, No. 8 shaft was sunk a further fifteen feet to the 200 foot level and 678 feet of cross cutting was carried out at that horizon in connection with underground investigation of the kimberlite. An intensive program of geophysical survey by magnetometer and electrical resistivity methods was understaken.

WILLIAMSON PRODUCTION AND EXPORTS

Analysis of diamond production and exports for the year 1948, as given below, was determined by the Crown Valuer for assessment of Government royalty.

During the year 272,978 loads of gravel were treated by the Williamson mines as compared with 132,975 the previous year. Total caratage recovered is given as 119,636 which is an increase of approximately 50 per cent over the previous year. Average weight recovered for each 100 loads of gravel is given as 43.8 carats.

In 1948 Williamson exported 49,293 carats of cuttable rough which shows an increase of a little more than 8,000 carats exported the previous year. Including industrial exports, a total of 117,956.5 carats were exported in 1948 by Williamson. Whereas the White mine, later acquired by Williamson exported only 651 carats of cuttable diamonds in 1948, value per carat was 340s. 11d. as compared to the average value of 257s. 1d. of those from the Williamson mine at Mwadui.

MADAGASCAR GARNET PRODUCTION REPORTED

THE U. S. Bureau of Mines quotes Consul General Robert F. Fernald as follows, concerning garnet production in Madagascar.

"The garnet mines at Ampanihy were visited in the spring of 1950. There is a considerable plant for breaking the rock and washing the garnet gravel. The owner, C. Borsa, a Swiss, stated that he exported 52 metric tons of garnet in 1949, virtually

all to England for watch jewels and sandpaper . . . .

"The better garnets (almost like rubies) are air mailed to a jewelry firm in France. A small problem is to obtain or make more glass boxes with a light inside, by which the women employed as selectors can separate the garnets according to luminosity."

Figures given for the first half of 1950 show 6,405 grams (including 120 of beryl) exported in the first quarter. Total exports show 181,627 kilograms of industrial garnets produced. The major portion of gemstones recovered is exported to England and Switzerland.

Continued from page 377

picked up in other localities, water-borne from above. Plans are being readied to reopen the famous Muzo Mine which is to be operated by the government. There are no present plans for the third mine, Cosquez, also operated in the time of the Spaniards. The gems of best color and quality are purported to come from long-closed Cosquez*; next Muzo; and lastly Chivor. The Chivor rough is more perfectly formed than Muzo which generally gives a water worn appearance and cuts with less risk of shattering or losing color, according to the local authorities.

It is illegal to transport rough emeralds anywhere in Colombia without their first having been appraised and sealed by the Ministry of Mines. Export is permitted on a reintegration basis with the official *peso* valued at approximately two to an American dollar.

*Editor's Note: ***Earlier reports have indicated that the Cosquez product was more comparable to that of Chivor and poorer in color than Muzo materials.***

AUSTRALIAN PEARLERS ARE AGAIN ACTIVE

ACCORDING to an article in *South-West Pacific,* published by the Commonwealth of Australia, pearling fleets of that country are again busy after an enforced wartime suspension of activities. In the interim, many changes have occurred including the disappearance of the Japanese divers.

Although pearl fishing in Australia is principally productive of shell which is used for buttons, ornaments, and inlay work, the hope never dies that another "Star of the West" may be found. This pear-shaped pearl, weighing 100 1/8 grains, was fished up at Broome in 1917 and sold for 6,600 pounds.

Recently, it is reported, the Australian Council for Scientific and Industrial Research, working in collaboration with the Queensland Government, set up a research station at Thursday Island to experiment with the culturing of shell in Australian waters. The post war new deal of the commonwealth promises to consolidate its position in relation to its income-producing marine sources, and it can be expected that in the future pearl fishing will be more business-like—if perhaps less romantic.

Gemological Digests

1949 REPORT OF U. S. BUREAU OF MINES

REPRINTS of the Gemstone Chapter from the Bureau of Mines' Minerals Yearbook for 1949 are now available from the Superintendent of Documents, U. S. Government Printing office, Washington 25, D. C. Price of the booklet is five cents.

Prepared by W. F. Foshag, George Switzer and G. W. Josephson, the book covers such subjects as the Jewelry Industry in 1949; Fashions in Jewels; Domestic Production; Canadian Gemstones; Imports; Diamonds; Ruby, Sapphire, and Emerald and Lesser Gems.

Based on a survey made by the National Wholesale Jewelers' Association, it is pointed out that diamond sales during the year 1949 showed a 19 per cent decline as compared to sales for 1948. At the same time, as reported in the *Jewelers Circular-Keystone,* statistics from the United States Department of Commerce and data from the Internal Revenue Department indicate that volume done by jewelry stores in 1949 showed a decline of 12 per cent compared to the previous year—or amounted to an approximate total of $1,055,-000,000.

As in previous years, gem mining in the United States, continued to be a minor part of the mining industry during 1949 and it is estimated that value of the domestic output of rough gems did not exceed $400,000 to $500,,000. Forms of quartz, chiefly cryptocrystalline, were most predominant of the gem minerals recovered. Oregon, Wyoming, Washington, and Texas led the states in production.

The authors of the bulletin state that deposits of light green jade (nephrite) in Wyoming have been largely depleted, but that new finds of dark green and black have been made. Sales of Wyoming jade for 1949, one of the poorest years in the past thirteen, amounted to about $20,000. A newly discovered field at Daniel, Wyoming, is reported to be of poor quality.

In November 1949, a deposit of jadeite jade, none of which has been of gem quality, was found on Clear Creek, San Benito County, California. Other than worked pieces which have been recovered from tombs of ancient civilizations in Central America, this is the first jadeite found in the Western Hemisphere.

BURMESE RUBY, SAPPHIRE OUTPUT DECLINES IN 1949

INFORMATION released by the U. S. Bureau of Mines states that Counselor of Embassy Henry B. Day gives 1949 gemstone production in Burma as follows: Rubies, 100 carats, value 70,000 rupees*; Sapphires, 2,500 carats, value 150,000 rupees; Spinels, 12,500 carats, valued at 35,000 rupees; and approximately 21.37 hundredweight of jadeite valued at 98,995 rupees.

According to information published in the last issue of *Gems and Gemology,* this indicates a considerable decline in the quantity of rubies and sapphires mined in that country as compared to 1948.

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*The rate of exchange of the Burmese rupee into dollars in 1949 was as follows: Before September 20, one United States dollar equalled 3.3 rupees and subsequent to that date, 4.75 rupees.

Gemological Digests

BRITISH COLLECTOR NOW OWNS THE PANDORA OPAL

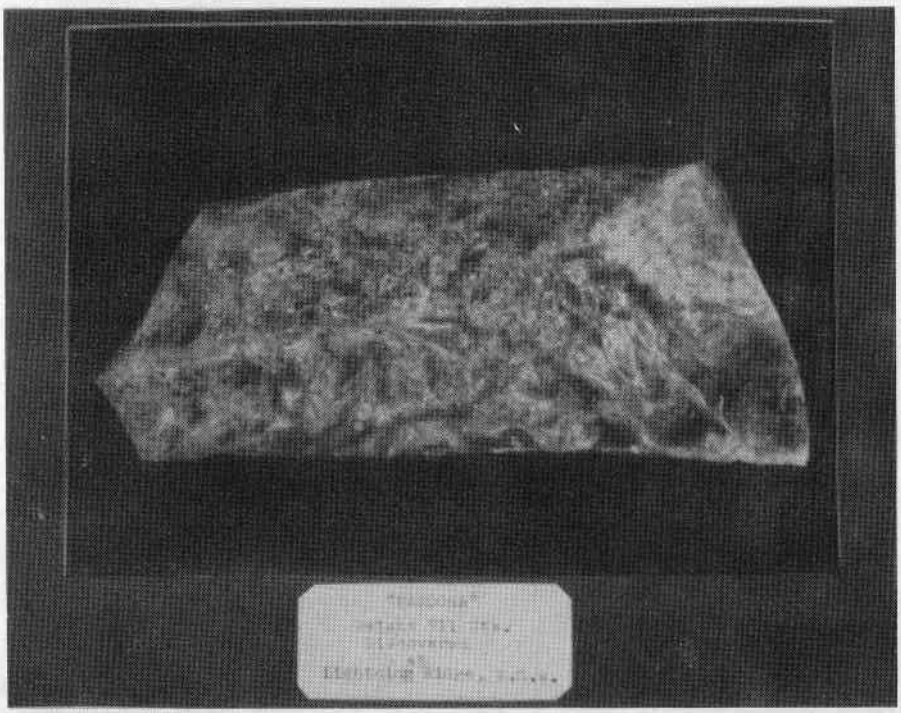
ACCORDING to Jack S. Taylor, Federal Secretary of the Gemmological Association of Australia, the famous Pandora Opal is now owned by a collector in England who paid 2,000 pounds for the gem in 1945.

Said to be the largest semi-black opal ever recovered, the stone was found May 8, 1928, at Angledool Field, Lightning Ridge, New South Wales by Jack McNicol who originally sold it for 600 pounds.

Taylor, who handled the sale of the stone in Sydney, describes it as four inches long, two inches wide, nearly one inch deep, and weighing 711 carats. The surface is true light opal of good quality with a blood red pattern, interwoven with lightning flashes of brilliant bronze, gold, and blue. Many experts contend that it has black underneath the surface.

Another interesting feature of the magnificent stone is that it is one of the best existing specimens of a fossil bone part of the blade bone of a plesiosaurus, an extinct sea reptile, similar to the monster claimed sighted at Loch Ness.

• **The 711 carat Pandora Opal found at Angledool Field, New South Wales**



Gemological Digests

57 FELLOWSHIPS ANNONCED BY AUSTRALIAN ASSOCIATION

ANNOUNCEMENT has just been received by the Gemological Institute of America from Jack S. Taylor, Federal Secretary of the Gemmological Association of Australia, that fifty-seven members have qualified in the 1950 diploma examination for fellowship.

Three first positions in Australia were filled by B. J. Skinner, K. N. S. Hall, and G. A. Tombs. Outstanding students in each of the four states represented were: K. N. S. Hall, New South Wales; B. McMaster, Victoria; Miss H. Mole, Queensland; and B. J. Skinner, South Australia.

On October 25, 1950 the Gemmological Association of Australia celebrated its fifth anniversary of operation.

DIAMOND AND SAPPHIRE DOUBLETS REPORTED SEEN IN CHICAGO STORE

ACCORDING to G. R. Crowningshield, Director of Gem Trade Laboratory, New York City, a Graduate Gemologist—who wishes to remain anonymous — reports on authoritative evidence seeing dozens of synthetic sapphire and diamond doublets in the hands of a Chicago dealer. The dealer, according to our informant, claims that he has been pawning the doublets for years and has literally stacks of pawn tickets as proof. He has a twisted Robin Code of ethics and chooses "unethical" pawn shops for his dupes. His method in making the doublets is to use egg white as cement as he claims balsam causes too many air bubbles.

MORE THAN $6,000 PAID FOR FOUR SYNTHETIC SPINEL RINGS

RECENTLY examined in the Gem Trade Laboratory in New York City were four stones which resembled diamonds but proved to be emerald cut, transparent, colorless, synthetic spinel. G. R. Crowningshield, director of the laboratory, reports that these stones were all set as engagement rings in identical mountings of white metal with a tapered baguette of synthetic spinel and a round diamond brilliant on each side. The stones, sold in a small Connecticut city, cost the investor more than $6,000. Three of them were purchased from private parties and the fourth from a retail store.

SYNTHETIC BEING SOLD AS NATURAL EMERALD

IT HAS come to the attention of the Gem Trade Laboratory of the Gemological Institute of America in New York City that synthetic emeralds of fine quality have been sold as natural stones in Boston for prices which make them quite attractive.

During the month of February, Gem Trade Laboratory had occasion to identify such stones for three individuals. The stones examined were exceptionally clear and of finest color and ranged from .80 carats to 1.32 carats.

All jewelers should beware of emeralds offered through dubious sources as synthetic emeralds cannot be identified on sight.

G. R. Crowningshield

Book Review

"Pearl Culture in Japan" ***by Dr. A. R. Cahn. Report No. 122 from the General Headquarters Supreme Commander for the Allied Powers, National Resources Section. October 31, 1949.***

THE EARLY history of the pearl culturing industry and the procedures used for pearl culture in Japan have long been cloaked in obscurity. The great variety of publicity statements and propaganda published both by the Japanese and by the marketing firms in this country made it difficult to separate the actual facts relating to the methods by which pearls are cultured. For this reason, *Pearl Culture in Japan,* by Dr. Cahn, an aquatic biologist with the Fisheries Division of Natural Resources Section, is exceedingly valuable to students of pearl culture industry.

Contrary to common belief, the method by which pearl culture is made possible was developed not by K. Mikimoto, but principally by Mise Nishikawa. The method of sewing the bead into a sac on which Mikimoto got a patent in October 1914 was never satisfactory. The Nishikawa patent application was made in October 1907, but not granted until June 1916, almost two years after the Mikimoto patent was granted. The method Nishikawa developed was a simpler one by which the bead was inserted in an incision accompanied by a small piece of mantle tissue. Nishikawa, a nephew of Mikimoto, died shortly after his patent had been developed. Later, his son reached an agreement with Mikimoto and the patented method was used by Mikimoto from about 1920 on. It is interesting that work on cultured blister pearls was begun before 1896 by K. Mikimoto and that he received a patent in 1896 on his method for producing blister pearls.

In his very interesting report, Dr. Cahn describes in detail the methods by which spherical cultured pearls are produced today and the areas in which they are produced. In addition, he has compiled lengthy tables showing the amount of nacre accretion during the normal nacre growing period in cultured pearls. The average length of time that a cultured pearl remains in the mollusk is three and a half years according to Dr. Cahn. In addition to discussing in detail pearl culture in Japan and showing maps indicating concentrations of various pearl producing areas, Dr. Cahn discusses the experimental stations in the Palau group and the Celebes that were in operation before World War II. Both stations were closed at the beginning of the war and have not been reopened. It is interesting to note that while nacre accretion is at the rate of roughly .15 to .20 mm. per year in Japan, that the rate of accretion in Palau and the Celebes was roughly ten times that great, but that the nacre was both coarse and of poorer luster than that formed in Japanese waters. Dr. Cahn shows, among other matters, the rate of nacre accretion in relation to the mean water temperature in various months of the year. He discusses in addition the various patents that have been taken out from the beginning by the Japanese. The patents apply to the increasing beauty of nacre, the effect of light on nacre production, and a variety of other details. He discusses in detail the method by which mantle tissue and the mother-of-pearl bead are inserted into a channel cut into the mantle tissue of the living mollusk. Thus, the Nishikawa method is used almost exclusively today. Dr. Cahn discusses in detail the equipment necessary to set up the pearl farm, the operation laboratory, and in general all of the equipment necessary to start and maintain a pearl farm. He goes so far as to diagram the equipment used and the methods by which each step is completed.

Book Review

One of the most interesting additions to the information on pearl culture contributed by Dr. Cahn is the discussion of a fresh water pearl culturing station on a large lake in Jaqan where pearls are cultured without nucleus. This culture station is on the Hirako Reservoir, an arm of the large lake on central Honshu Island. The mollusk used for this purpose is a large slow-growing clam which produces pearls at the end of three years growth. These cultured, fresh-water pearls are elongated and irregular, measuring roughly 6 x 3 mm. According to Dr. Cahn, "both color and luster are beautiful, but the shape leaves much to be desired." Such cultured pearls without nuclei would be very difficult to identify, except by their unusual shape and by their characteristics as fresh water pearls (which differ in several respects from salt-water pearls).

The Cahn report is a major contribution to the information available on the pearl culture industry. The clearly presented picture given indicates Dr. Cahn's exhaustive research in this field and his thorough knowledge of the subject.

Richard T. Liddicoat, Jr.

"Leitfaden Fur die Exakte Edelsteinbestimmung" ***(Guide to the Accurate Identification of Gemstones), by Dr. K. Schlossmacher. Published in Stuttgart, Germany, 1950. Price 13.60 German marks.***

THIS manual, by the author of the third edition of Max Bauer's *Edelsteinkunde,* makes available to German readers information concerning gemological progress in recent years. The book contains 174 pages which cover the properties of gemstones and methods of identification of the principal gems, pearls, coral, synthetics, imitations, and doublets. It contains some excellent photomicrographs plus illustrations of gem testing instruments and various line drawings for clearer understanding of the text. It includes also eight properties tables and an alphabetical listing of principal gemstones and their properties.

Dr. Schlossmacher, recognized world authority on gemstones, is now Director of the Gemological Institute of Idar-Oberstein and was for many years Professor of Mineralogy at the University of Konigsberg. He is currently working on a new edition of the important *Edelsteinkunde.*

Kay Swindler.

"Jewelry Making and Design" ***by Rose and Cirino. Published by Davies Press, Worcester, Mass. Price $8.95. Reviewed by C. A. Jakobb, Instructor in the Art of Jewelry Designing and Modeling, New York.***

THE first sentence in the foreword—"The subject of jewelry in this book is treated from an educational standpoint" — covers fully the book's true principles. The reader is, without effort, carried from paragraph to paragraph into a field of knowledge in the art of jewelry — a field that has long been neglected and misinterpreted.

The book covers a subject that deserves more intensified attention by the educational world and in the field of literature as a fundamental resource of man's progress from prehistoric times up to this day. The introductory paragraph of this book in itself is enlightening and gives fact after fact associated with data and outstanding names of artists and scientists generally unknown to jewelers and the public, even to those who are engaged in the arts and crafts of jewelry. It carries the reader directly to the interesting, carefully and consecutively arranged material which is presented in simple, readable form. It gives many practical suggestions to the layman and beginner, covering every

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Recovery of Diamonds by Electrostatic Separation[1]

by

A. A. LINARI-LINHOLM

Due to the nature of diamond, difficulty has been encountered from the early days of diamond mining in determination of diamond content in ore, and the processing of diamond bearing ground. In the mining of metal it is fairly simple to apply chemical methods to the determination of quantities of various metals in ores. With diamonds, hand sorting has been necessary.

Sorting by hand is exceedingly expensive and with tiny stones is prohibitive. In "pipe" mining, recovery of diamonds from concentrates has been limited to the grease table techniques. While this was considered efficient in treating primary diamond ores, it was found that it was not effective with alluvial stones. Apparently the clean surfaces of diamonds fresh from the pipe mines are non-wettable, whereas alluvial stones have lost this property. In any event diamonds from the Kleinsee, Congo, and other alluvial deposits tended to wash off the tables into the tailings. This was also true of the diamonds from kimberlite which had been allowed to decompose by weathering on the "floors" used for that purpose.

The need for more effective means of concentration led to a number of experiments in the Diamond Research Laboratory in Johannesburg. The results of several of the more interesting of these has been summarized in this paper by Linari-Linholm. Briefly, experiments have been concerned with adapting electrostatic processes to the separation of diamonds from concentrates, and the effects on efficiency of such separation of variations of the equipment plus various pre-treatments of the ores. The general idea has been to take the concentrate from some means of gravity concentration—either the old method or the more recent heavy liquid method—and subject this material to an electrostatic separation which depends upon relative conductivity. It was found that the poor conductivity of diamonds, compared to the other minerals associated with diamonds in the concentrates, would provide an effective means of separation.

Basically the equipment used in the experiments consisted of a feeder that would feed limited sizes of ore onto a grounded and rotating non-metallic electrode, with adjustable metallic electrodes a short distance from the grounded electrode. Between the metallic and non-metallic electrodes any charge of from 0 to 25,000 volts could be maintained. Beneath the electrodes were placed two bins, one directly below the roll electrode and the other displaced slightly so that good conducting materials attracted by the charge would be collected. During the experiments various voltages, and electrode separations were used.

It was found that different conditions worked most effectively for different ore sizes and ores from different localities. In addition, it was found that separation of diamonds from the other material in the concentrates was most effective if the concentrated material were milled before handling. In this way impurities that increase conductivity were removed from the diamond surfaces and, at the same time, sixty per cent of the original concentrate was removed as slime. It was also found that fresh water concentrates reacted most favorably if first immersed in a weak salt solution, and that humidity and heat control were both important. At several points controlled tests were conducted by adding a known number of diamonds to diamond free concentrate and then checking the separation to be sure that all diamonds were in the proper bin, and the concentration of non-diamond materials in the other. In other words, the efficiency was judged not only by whether all diamonds were in one bin but by how much of the non-diamond material was dropped into the same bin. Some of the electrostatic concentrates were treated by another process which utilizes the non-wetting nature of clean diamonds. The concentrates (previously cleaned in a hot water bath, boiled in caustic soda, chromic acid, and then milled to remove surface impurities) are boiled up in concentrated hydrochloric acid. This is then diluted and decanted until the liquid just covers the stones. At this point, the diamonds are floated by "skin-flotation" when the container is tipped back and forth. If the diamonds are small enough and clean enough, the surface tension of the liquid supports them, but not the other minerals which are wetted.

Theoretically, the upper limits of particle size which could be handled by electrostatic separation is that reached when the forces of gravity and inertia neutralize the effect of the charge. In modern electrostatic separators, the upper limit to particle sizes are about six mesh (six to a linear inch). Experiments showed that larger particle sizes of diamond could be concentrated effectively by this method.

The experiments which are considered in detail in this paper would seem to provide a valuable means of separating especially the small stones previously lost in many cases during hand sorting processes. An electrostatic separation has been used on stones smaller than ten mesh in the Jagersfontein Mine since March 1950. In the six months prior to that time 919 carats were hand sorted from the concentrates representing approximately two per cent of the weight of the total quantity of diamonds recovered. In the six months after installation of the electrostatic separator, 1948 carats, representing 3.3 per cent by weight of the total quantity of diamonds recovered, were handled. Since there is no additional labor required and the material costs represented only 12.3 per cent of the value of the additional diamonds recovered, this represents an important savings of tiny stones otherwise lost.

An interesting sidelight on the experiment was the discovery of free gold in minute amounts in the concentrates. Gold had never been reported in kimberlite previously but it is apparently associated with pyrite in the blue ground.

Condensed by Richard T. Liddicoat, Jr.

1. Journal of the Chemical, Metallurgical, and Mining Society of South Africa.

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branch of jewelry making from raw material to piercing, filing, sawing, repoussé, modeling, polishing, enameling, drawing, designing, to the finished object. Its directions could be easily followed by anyone whose ambition urges him to know more of jewelry and its making. In addition, it also includes many illustrations which will be of value to the advanced jeweler.

The book, *Jewelry Making and Design,* is a competent teacher in its field and should be highly regarded as a practical guide by every jeweler regardless of his position in the field of jewelry.

Contributors in this Issue

A. C. WALKER, Ph.D., directs research on quartz crystals at Bell Telephone Laboratories. He was graduated from Massachusetts Institute of Technology in 1918 with a bachelor of science degree in chemical engineering. Previously he had studied two years at the University of Colorado. In 1923 he received his doctor's degree in physical chemistry from Yale University and joined the staff of Bell Laboratories. In 1918 he was with the Chemical Warfare Service and later worked as a research chemist for a paper mill and a firearms plant. During World War II he operated a pilot plant at Bell Laboratories for the production of synthetic piezoelectric crystals (ADP) used for submarine detecting devices. He afterward designed and operated plant equipment for growing EDT crystals, then turned to the problems of growing quartz.

RUSSELL W. ANDERTON while serving as a Crash Boat Skipper and stationed at Trincomalee, Ceylon during 1944-45 did original exploration of the Ratnapura gemming section. After the war he returned to Ceylon to study gem mining and local trading methods. Returning to New York early in 1950, he was placed in charge of the Chivor-Somondoco Emerald Mines, Boyaca, Bogota, in March. He has recently returned to New York and is now negotiating with the Colombian Ministry of Mines for lease of the Cosquez Mines, adjacent to Muzo.

RALPH J. HOLMES, Ph.D., is Asst. Professor of Mineralogy at Columbia University and also conducts the University's extension classes on Gems and Precious Stones. He majored in geology at Columbia, where he received both his bachelor's and doctor's degrees. In 1935 he was awarded the University's Research Fellowship in Geology and since the year following has been a staff member of the Department of Geology there. Dr. Holmes serves as Consultant to the Gemological Institute of America and is an active member of its Educational Advisory Board. For several summers he instructed Resident Courses of the G.I.A. both in Los Angeles and New York. Many readers of *Gems & Gemology* know Dr. Holmes through his annual lectures at the Conclaves of the American Gem Society.