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Bombarded Diamonds

by

MARTIN L. EHRMANN

The increasing number of green diamonds appearing on the market is arousing the curiosity of jewelers and gem dealers throughout the country. Since there is much controversy regarding the origin of such stones, a factual account of the writer's experience with green diamonds seems most timely.

It is known that diamonds have turned green after being treated by direct contact with radium. For the past thirty-five years, such stones have come on the market and have brought large sums. However, the radio activity of these stones may cause harm to the wearers.

When, in 1940, a green diamond weighing approximately fourteen carats and represented as a natural green diamond was brought to the writer's attention, it was viewed with great scepticism.

During a period of eight months, this green diamond was subjected to every possible test and was shown to leading authorities in the field. However, at the end of that time, it could not positively be stated that it was a natural green diamond. The only certainty established was that it was not a radium treated stone.

Dr. Roy Chapman Andrews, the Director of the American Museum of Natural History at the time, was very much intrigued by this diamond and wanted to acquire it for the Museum. Barbara Hutton, then Princess Mdvani, was interested in pur-

chasing an unusual gem to give to the Museum, and Dr. Andrews made arrangements for her to see the stone. She was told about all the tests made on it. She was also informed that, in spite of all the positive tests, there was a doubt of its absolute authenticity of color. No guarantee was given to her that it was a natural green stone. Under these circumstances, with a doubt of the authenticity of its color, the Princess decided against purchasing the stone for the Museum.

About the same time, several smaller green diamonds were appearing on the market, but none of them could be traced back to the original source. Upon being tested, some of these stones proved to be radium treated; others gave the same results as the large fourteen carat stone. Slowly a rumor began circulating that diamonds had been treated by the cyclotron and had turned green successfully.

In those days the only operating cyclotron was at the University of California at Berkeley. Upon checking there, it was learned that the cyclotron had never been used in any diamond experiments. The final conclusion was that the only test for this fourteen carat green diamond was to re-cut it, which the owner absolutely refused to permit even with the assurance of payment for any loss of weight.

The writer could not get green diamonds out of his mind and decided to do some-

thing about it. After discussing the problem with the late Dr. Harry Berman, Professor of Mineralogy at Harvard University, it was decided to investigate the possibilities of coloring diamonds in the cyclotron which Harvard University had acquired in the ensuing year. Dr. Berman contacted the Physics Department and received permission for the use of the cyclotron during the periods when it was free. Because diamonds were so costly (and the use of the cyclotron was costly, too), the most economical means were used. The experiment started with the cheapest small diamonds available. None of the physicists had ever worked with diamonds, but they were most eager to cooperate. A copper clamp was devised in which the diamond was mounted, held by prongs covering only a small part of the stone, and then placed under the direct beam of the cyclotron. The first bombardment of only one minute with a 5 micro amp beam current (voltage energy was not recorded) gave negative results. Increased bombardment time from one to two and then to three minutes, with increases in the micro amp beam current, began to give fairly decent results. The diamonds turned various colors, from light green to dark brown, even though the stones used were of the same quality and original color.

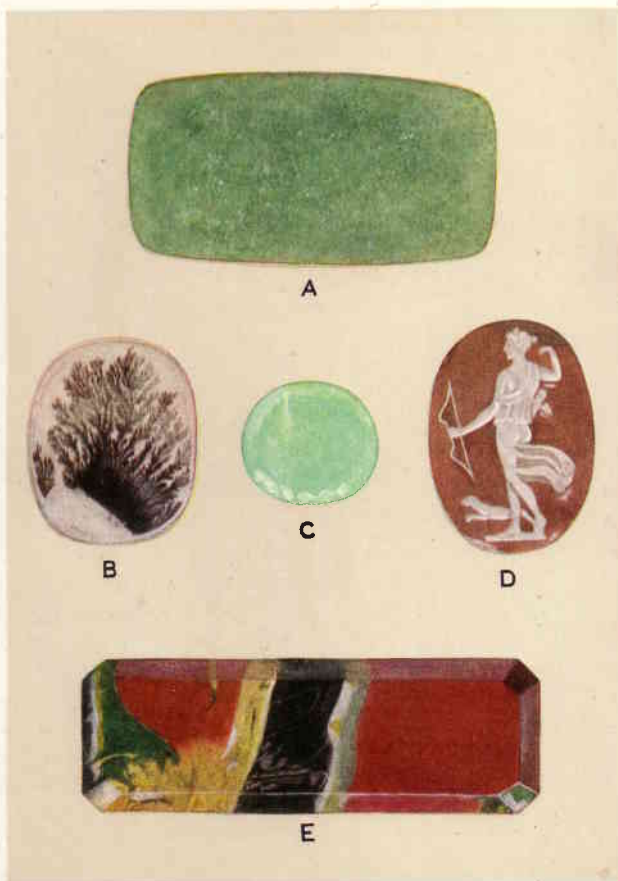
The stones were more or less Cape stones; they were the cheapest! Why some turned green and others brown could not be determined. To this day variations in color after treatment are unexplained. A solution to the problem may be found in the following facts. Contrary to popular belief that diamonds, beyond containing a little hydrogen, are pure carbon, it has been ascertained at Massachusetts Institute of Technology that as many as thirteen minor elements are present in diamonds. A spectrograph is used to detect what element is present. These minor elements are not present as inclusions, but they are distributed throughout the crystal structure. The foreign elements present in a diamond

range from very small traces up to one tenth of one per cent. The difficulty arises from the fact that only powdered diamonds can be used in spectrographic analysis. The thirteen different elements found in diamonds were identified by their emission spectra in the following order of their abundance: aluminum, silicon, calcium, magnesium, copper, barium, iron, strontium, sodium, silver, titanium, chromium, and lead. Aluminum, silicon, and calcium seem to be present in almost all diamonds thus tested. Iron and titanium seem consistently present in diamonds that have a definite tint, such as canary, pink, brown, etc.

It is assumed that the minute impurities in the diamond determine the ultimate color, when subjected to bombardment in the cyclotron. To establish this assumption, it would be necessary to obtain a spectrographic analysis of the diamond to ascertain its impurities, before it is treated. However, since spectrographic analysis of a diamond can be made only after the diamond is crushed, it is obvious that such analysis is unfeasible. Some day, perhaps, a spectrograph may be devised that will reveal impurities in the whole diamond. It would then be simple to find which impurity turns to what color under the cyclotron.

Subsequently, experiments were begun with larger diamonds of various colors. After bombardment in the cyclotron, there was no difference in result between a stone of very fine, white color and a stone of Cape color. If they did turn green, the colors were about the same; if they turned brown or golden color, it was not due to the original color. However, several brown diamonds thus treated turned to dirty olive green, rather than to light tourmaline green. The average time of deuteron bombardment was six minutes with a 5 micro amp beam current on each side, regardless of size.

When a diamond was treated only on one side, through the culet, it turned just about the same color as one treated on both



QUARTZ
(chalcedony)

Almost any choice of color can be satisfied in the many varieties of quartz gems. Those shown here are aventurine (A) from India, the light spots being reflections from metallic inclusions; an Arabian moss agate (B); chrysoprase (C) from Silesia, the latter often poorly duplicated by dyeing other light colored chalcedony; a sardonyx (D) carved into a cameo of Diana, and (E) a large piece of jasper. The various colors are due to the presence of other minerals. Specimens from the collection of British Museum (Natural History), London.



QUARTZ
(crystalline)

Rock crystal, such as the small quartz crystal (A) in a cavity in dolomite, has been fashioned and sold incorrectly as various types of diamond. Figure (B) is smoky quartz and citrine (C) is a common substitute for topaz. (D) shows an amethyst aggregate from Cornwall and (E) the fashioned stone. Specimens from the collection of British Museum (Natural History), London.

sides. The difference was that, upon close examination, one could see a slight color demarcation through the girdle. However, this slight difference of color was overcome by treatment on the other side of the stone. The only definite marks left by the cyclotron were very small burn marks, shown as minute black pin-points throughout the stone. As for radio activity, diamonds bombarded in the cyclotron lose all traces of radio activity from thirty minutes to twenty-four hours after bombardment.

The color of a cyclotron bombarded diamond is apparently permanent. Even though the color change is only skin deep, exposure to sun or light has not changed treated stones. It can be assumed however, the heat treatment of 1200 degrees Fahrenheit, or more, could restore the original color, since deuteron bombardment does not penetrate into the stone. This fact was proved at the time by re-cutting several stones which had been treated. Just slight re-cutting on every facet restored the original color. More recent experiments, which will be discussed later, have established that treatment with cyclotron possessing greater voltage and micro amp power can penetrate the stone completely.

Diamonds can also be turned green by placing them in the cyclotron for seven or eight days outside the area of the beam light. In this case, it is the Gamma rays and neutrons that cause the change. The color produced by the Gamma rays and neutrons is entirely different, as the stone turns a very light green, rather than a rich tourmaline green. Of twelve stones thus treated, the colors were exactly the same. It was also found that the color was not permanent. Upon exposure to daylight or sunlight, neutron treated stones gradually faded and returned to their original color.

In 1946 the Physics Department of Columbia University in New York City cooperated in further experiments with cyclotron treated diamonds, in the course of which a startling discovery was made. Prior to

bombardment, all diamonds used were tested for fluorescence. Some of the fluorescent stones lost every trace of fluorescence after bombardment, while others retained their fluorescence.

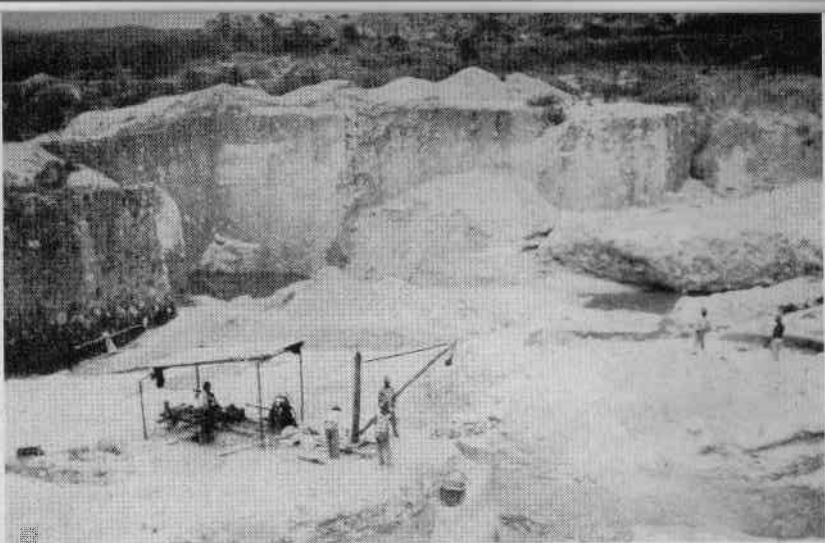
During this time, also, a diamond accidentally dropped into the inner works of the cyclotron. Naturally, strategic work that was being done could not be interrupted, and almost two weeks elapsed before the cyclotron was dismantled for its regular cleaning. The diamond was finally recovered in the midst of all the rubble. Its color was amazing. It had turned as red as the very finest pigeon blood ruby ever seen. The stone could not be touched for at least a half hour, until it lost its radio activity. Unfortunately, by the time it was cool enough to be handled, the color had changed to a dirty brown, making it much less attractive than its original Cape color. Except for that experience, nothing new was learned at the time.

It is a certainty that, with much patient experimenting and considerable outlay of money, it will be possible to change the color of diamonds into any color of the rainbow by bombardment in the cyclotron. It is not too farfetched to say that Cape diamonds can be made white. To accomplish this feat, it would be necessary to have a cyclotron built exclusively for such experimentation—and half a million dollars would be just the initial outlay for that purpose!

Recent experiments have just been completed at the University of California at Berkeley, where the cyclotron is much more powerful than Harvard's or Columbia's. Four stones were subjected to an Alpha particle bombardment for five minutes with a 2 micro amp beam current and 40,000,000 volt energy. Two of the stones turned a brown color; the other two lost some of their Capish color and turned whiter.

Another stone was bombarded with a 15 micro amp beam current of Alpha particles and 40,000,000 volt energy for four min-

Continued on Page 318



• A view of Serrinha showing the face and floor of the mine.

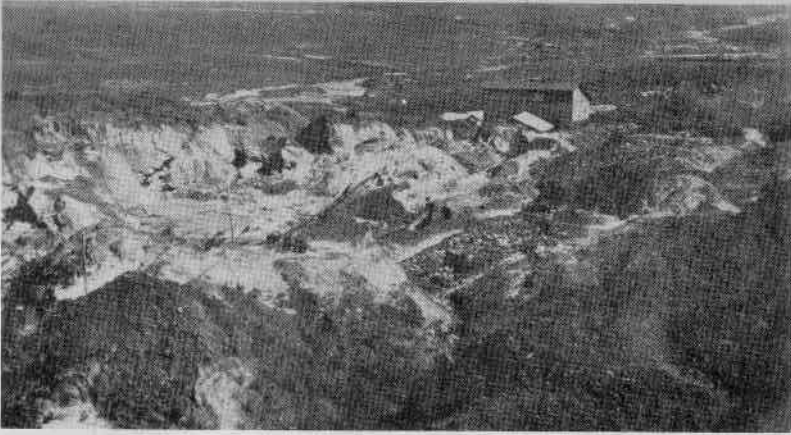
The Origin and Distribution of Diamonds in Brazil

by

THOMAS DRAPER

It is now an accepted fact that the diamonds found in Southern and Central Africa are being derived from an ultra-basic rock to which the distinctive name "kimberlite" has been applied. This intimate association has been confirmed by the discovery of diamonds under identical conditions near Murfreesboro in Arkansas. The inference that an ultra-basic magma is essential to the growth and formation of the diamond followed as a matter of course. It seemed reasonable to assume that the widespread occurrence of diamonds in Brazil would eventually be traced to the same source. Up to date, this expectation has not been realized. There is, however, evidence to show that the alluvial diamonds found at widely separated points in Brazil

are of local origin in areas where ultra-basic rocks have not, up to the present, been identified. The origin of these diamonds has been, and still is, a matter of scientific controversy which will not be settled until further evidence is available. The divergence of opinion ranges through various possibilities, including fluvialite, glacial, hydrothermal, metamorphic, and volcanic. Of these, both the fluvialite and glacial theories can be dismissed as untenable since they account for the migration of diamonds but beg the question of origin itself. It is difficult to imagine how any agent involving transportation could have spread diamonds throughout the length and breadth of Brazil without mixing them up. It is even more difficult to suggest



• A bird's-eye view of the Dattas mine, near Diamantina.

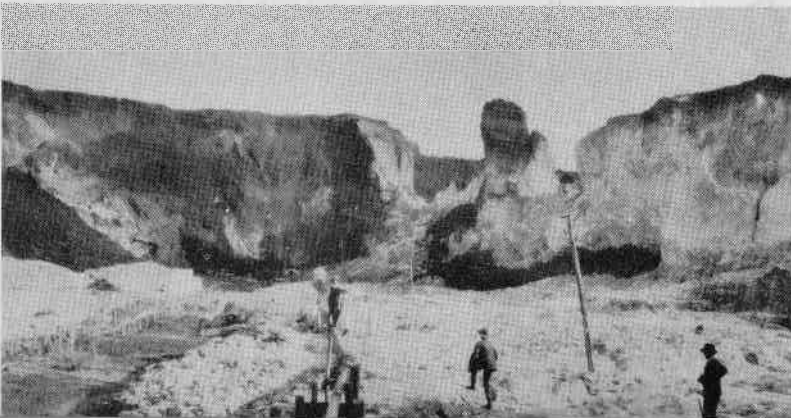
any point or points from which they could have been derived, other than those already discovered.

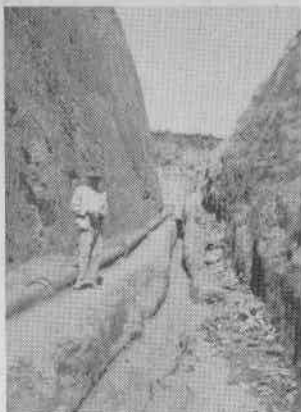
The discovery of alluvial diamonds in South Africa was followed shortly afterwards by noting that they also occurred in a soft underlying clay which the miners called "yellow ground." Later developments showed that this clay merged into "blue ground" and finally into "hard bank" or kimberlite in its indurated form. Eventually, it was found that kimberlite in its altered and unaltered condition occurred in isolated circular patches consisting of a highly ultra-basic rock. At the same time it became evident that these patches represented the stub ends of ancient volcanoes from which the upper portions have

been removed by denudation. Other pipes were discovered in the immediate vicinity. Within a few years Brazil was ousted from its position which had been seriously impaired by the Napoleonic wars, by the struggle for independence in Brazil itself, but more especially by the abolition of slavery at about the same time as the South African mines were consolidated into a single group and production intensified. At later dates other pipes were discovered in South Africa, including the recent sensational example by Williamson in Tanganyika.

Kimberlite is a distinctive rock. It is comparatively easy to identify microscopically by its heaviness and greenish color but more especially by the inclusion of

• A dyke in the Boa Vista mine near Diamantina. Diamond bearing material is on the left and right.





• A view of the canal at Datas mine located near Diamantina.

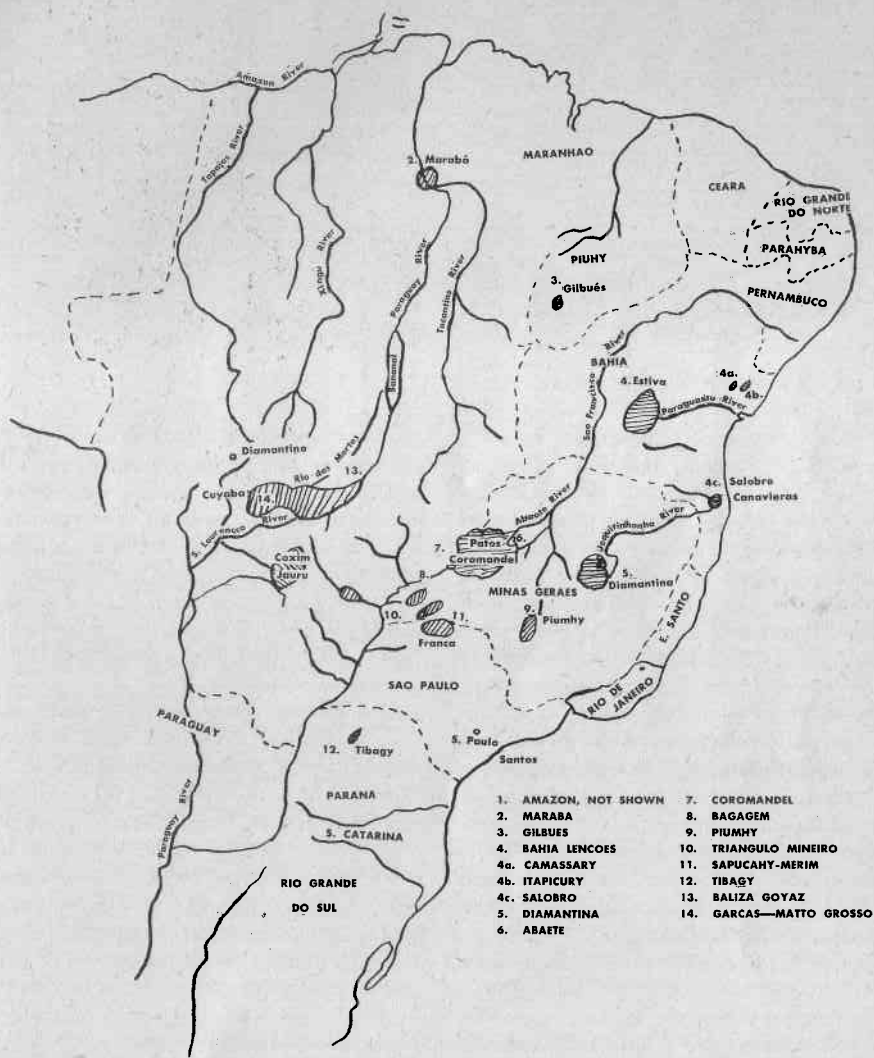
certain minerals, nearly all of which can be identified by the naked eye. Different varieties of kimberlite occur in South Africa, according either to the absence or predominance of certain of its elements. They all contain olivine in its amorphous and crystalline forms and a variety of accessory minerals, including pyrope garnets, ilmenite,

• A monitor operating against the left bank of the canal at Sao João da Chapada mine.



vaalite, mica, cyanite, chrome diopside, enstatite, chromite, and perovskite. Some of these minerals may be wholly absent or only distinguishable under a microscope. Taken in conjunction, they constitute the "satellites" of the diamond. Their profusion relative to the diamond itself is used by South African prospectors to track the diamond to its lair. These satellites are rarely found in any of the Brazilian diamond fields where the *garimpeiro* consists of a variety of minerals having no genetic relationship to the diamond itself. They are merely accidental associates derived from the rocks in the immediate vicinity or even from a greater distance.

Kimberlite is also characterized by the fact that it contains a variety of xenoliths or fragments of any or all of the rocks through which the magma stopped its way upwards. These include eclogite and lherzolite, both of which are of deep-seated origin. Xenoliths constitute an important factor in prospecting for kimberlite pipes since the occurrence of any rock foreign to the locality attracts attention and needs explanation. It is on record that the Roberts' Victor mine was discovered by noting the presence of a few lumps of granite in a region where granite should not have occurred.



- | | |
|----------------------|-------------------------|
| 1. ANAZON, NOT SHOWN | 7. CORMANDEL |
| 2. MARABA | 8. BAGAGEM |
| 3. GILBUES | 9. PIUMHY |
| 4. BAHIA LENCOES | 10. TRIANGULO MINEIRO |
| 4a. CAMASSARY | 11. SAPUCAHY-MERIM |
| 4b. ITAPICURY | 12. TIBAGY |
| 4c. SALOBRO | 13. BALIZA GOYAZ |
| 5. DIAMANTINA | 14. GARCAS—MATTO GROSSO |
| 6. ABAETE | |



• A view of the Boa Vista mine.

The presence of eclogite and lherzolite in some of the South African mines has led to the interesting conclusion that they constitute the true matrix of the diamond since Professor Bonney's discovery of ten small diamonds in an eclogite boulder from the Newlands mine. It has also been noted that eclogite and lherzolite proportionately contain all the characteristic minerals of the eruptive diamond bearing breccia. Fragments of eclogite occur in the Agua Suja mine on the Bagagem river, in the State of Minas Geraes (No. 8 on the accompanying map). Here the presence of ilmenite, perovskite, pyrope garnets, and other satellites has also been noted. This mine is remarkable for the fact that it is probably the only one in the world that consistently produces cube diamonds.

The manner and circumstances under which diamonds occur in South Africa seemed to justify the conclusion that in Brazil they would eventually be traced to the same source. Since this has not happened, it either leaves the problem unsolved or implies that an ultra-basic magma is not essential to the formation and growth

of the diamond. Kimberlite itself easily decomposes and seldom outcrops on the surface. The absence of the satellites of the diamond in nearly all the diamond fields of Brazil seems to preclude the possibility of its occurrence. The exception is the Abaeté region, where ultra-basic rocks, closely related to kimberlite, have been found and where the diamond and its satellites also occur.

The diamond fields of Brazil begin on the borders of Venezuela and British Guiana where diamonds are also found, extending into the State of Parana in the south and across Brazil from its eastern coast to its western borders. The fields occur in isolated patches which, in some cases, have no apparent relation to each other. The diamonds, themselves, show marked variations in size, shape, color, and quality from those of the nearest neighboring field. In certain cases, more especially in the Diamantina area, certain characteristics identify the product of mines lying in close proximity to each other. In the river beds and valleys, where denudation has been responsible for their deposition, they are



• Where it is not possible to deflect the stream by dams, sand is removed from under water by divers. Usually a raft is secured in the center of the stream by cables from either shore. This is a view of the Rio das Velhas Triangulo Mineiro.

mixed. In some cases, the tributaries entering on one side of a river are diamantiferous and their opposite number barren. The principal diamond fields of Brazil correspond to its major watersheds and most elevated points.

It is not difficult for an experienced buyer to recognize the origin of a parcel of diamonds coming from any particular area or mine or even to identify individual stones in mixed parcels.

The fields at present under exploitation are shown on the accompanying map, corresponding to the following numbers and descriptions:

1—Amazonian. Alluvial diamonds are found in the Rio Branco and other tributaries of the Amazon. Diamonds are small but of good quality, with a low percentage of industrials.

2—The Marabá field. This is an isolated patch in the Tocantins river in the State of Pará near the border of Maranhao. A recent discovery in the river bed which can be worked only during the dry season. Diamonds below ten carats, of good quality, hardly any industrials.

3—Gilbués in the southern part of the State of Piahy. Diamonds small, low percentage of gemstones of good color.

4—The Bahia field, discovered in 1841 or thereabouts, lies on the same watershed as the Diamantina field, the Serra do Espinacho. There are many points of resemblance, geologically, to justify the conclusion that they are intimately related as regards origin. Situated at a mean elevation of 3500 feet above sea level, this field begins at Estiva and extends southward to Chique Chique and Mucugé.

Included in the intermediate areas are Pedro Cravada, Santo Antonio, Lencoes, Genipapo, Roncador, and Andarahy. All of these areas are situated either on or lying between the tributaries of the Santo Antonio river, itself a tributary of the Paraguassú. The diamonds of this field, although showing local variations, are characterized by the high qualities and even size of the stones. More important is the fact that it is the only field in the world in which carbonados occur in commercial quantities. At one time in its history, Bahia not only exceeded Diamantina in production but also considered its gemstones of secondary

importance to carbonados. It also produces the highest percentage (eighty per cent) and the highest quality of industrial diamonds hitherto found in any part of Brazil. Diamantina, lying at the southern extremity of the same watershed, produces neither carbonados nor industrial stones. Why there is such a difference in two areas formed under the same conditions is one of the outstanding problems in the genesis of the diamond in Brazil. Satellites of the diamond are only represented by a few particles of ilmenite and garnets.

4 A & B—The isolated alluvial patches at Camassary and Itápícury lie north of the city of Sao. Salvador (Bahia). Probably derived from main field by transportation.

4 C—The Salobro field at Canavieras in Bahia is slightly north of the mouth of the Jequitinhonha river to which it may possibly owe its diamonds. This field has the distinction of lying further east and being lower in elevation than any other in Brazil. Originally discovered by the presence of a diamond in the roots of a fallen tree, it became the scene of great activity towards the end of the last century because of the exceptionally high quality of its diamonds. The unhealthy climate and waterlogged condition led to its abandonment. Desirous of obtaining information regarding its diamonds, the writer asked a local buyer who answered that he had never heard of it.

5—The Diamantina field which will be described more fully below.

6—The Abaeté field in the State of Minas Geraes comprises an extensive area embracing the northern slope of the Serra da Matta da Corda. This constitutes the watershed of the Paranahyba, flowing south, and the Sao Francisco river flowing north. The Indayá, Borrochudo, Abaeté, Somno, and Santo Antonio tributaries of the Sao Francisco river are the principal sources of the diamonds in this area. Mining is done either by diverting the river, by diving, or by working their benches and banks. Next to Diamantina, it is the oldest field in

Brazil. A clause in the contract granted Felisberto Caldeira Brant in 1748 stipulated that he should exploit that region with a minimum of 200 slaves but for reasons which need not be stressed here, the results were disappointing.

Of all the diamantiferous areas in Brazil, Abaeté is the one which most closely resembles the South African occurrences. Ultrabasic rocks, related to kimberlite, outcrop in various localities and the typical satellites of the diamond also occur. Its diamonds show characteristics not found elsewhere in Brazil. They are invariably much larger. Splinters and colored stones, rare in other parts, are not infrequent. The satellites may have been shed by the outcrops mentioned but their association with the diamond itself is significant. The possibility of finding kimberlite in this field has been dismissed by Brazilian geologists with a considerable amount of contempt. Brazil, they say, is different.

7—Coromandel and Patos, on the south side of the Matta da Corda with local variations, represent the extension of the Abaeté field on the upper tributaries of the Paranahyba. The Getulio Vargas diamond, the largest hitherto found in Brazil and the fourth largest of the world's diamonds, weighed seven hundred twenty-six and a quarter carats. This stone was found by two *garimpeiros* working on the banks of the Santo Antonio river who sold it for Cr\$200,000. Eventually it was bought by Jonas Polak who sold it to Harry Winston for \$500,000.

The Abaeté-Coromandel field has also produced the Darcy Vargas, four hundred and twenty-six carats, the Dutra, and other large stones, including the Eugenia. The latter weighed one hundred and twenty-seven carats and was one of the purest ever found in Brazil. Splinters and fragments weighing over fifty carats are not uncommon in this area. Although attracted by the possibility of finding another Getulio Vargas, *garimpeiros* are not usually suc-

cessful in this field due to the scarcity of small diamonds. The big ones, they say, are "longe," i.e., too far apart.

8—The Bagagem or Estrella do Sul field is on the head waters of the Bagagem river, a tributary of the Paranahyba. This ranks as one of the most famous in Brazil for the purity and even size of its diamonds but more especially because it produced the Estrella do Sul in 1853. In its original form it weighed two hundred and fifty-four carats and one hundred twenty-five after cutting. Although surpassed by others of later date, it still ranks among the finest. The Agua Suja Company, formed by an Anglo-French group in 1909, is one of the few mines in Brazil that has been successful due to the fact that circumstances permit the use of hydraulic methods. It is, as previously stated, the only one in the world which consistently produces the adamantine rarity, the cube diamond. The Dresden diamond, one hundred and seventeen carats in the rough, was also found in this field in 1857.

9—The Piumhy field, near the source of the Sao Francisco river, probably owes its diamonds to an undiscovered area in the Serra da Canastra above the Sao Roque falls. Its diamonds seldom exceed two carats, with a high percentage weighing less than twenty points.

10—In the Triangulo Mineiro, lying between the States of Sao Paulo and Goyaz, there are several patches of alluvial diamonds. In Uberaba the diamonds are generally under half a carat, white, and of good shape. Tupaciguara, on the Rio das Velhas, produces stones under ten carats, few small stones, and varied colors, browns predominating. In Ituiutaba, on the Rio Tijuco, a diamond weighing one hundred and five carats was found immediately below the Ituiutaba power plant.

11—The Sapucahy-Merim area on the borders of the States of Sao Paulo and Minas Geraes near the town of Franca in Sao Paulo.

12—The Tibagy field in the State of Parana. About forty-five per cent of its production is industrial stones of good quality. Its white stones are of the finest quality.

13—In the State of Goyaz, west of the Abaeté-Coromandel area, on both sides of the watershed separating the northern and southern river basins, there are a number of patches under exploitation. These include Baliza, Registro de Araguaya, Barra do Rio Garcas, Sao Domingos, and Santa Rita do Paranahyba. The two first mentioned produce gemstones of the finest quality and shape, generally under two carats in weight and also well rounded, brownish industrials comprising about fifty per cent of the total production. At Santa Rita, diamonds are recovered by divers during the dry season. Its production is low but of good quality.

14—Matto Grosso. The Goyaz field extends across the border. It embraces the area lying between the Rio das Mortes and the Araguaya and their tributaries flowing north and Sao Lourenco and Itaquira flowing south into the Paraguay river. Poxoreu, Cacanunga, Lageado, and Bonito are the centers of diamond mining in this region. Large quantities of small stones, under one carat in weight, predominate. However, larger ones, up to forty carats, have been found occasionally. Other areas in this State include Diamantino, Rosario, Raizinha, Cuyabá Coxipó, and isolated patches at Coxim and Jauru on the Taquary river and Aquidauana further south.

Matto Grosso is noted for the excellent quality of its gem diamonds but more especially for the quality and quantity (forty per cent) of its industrials. The diamonds vary in aspects in different fields in size, quality, shape, and defects.

5—The Diamantina field is not only the oldest but also the most consistent producer in Brazil. It is also the only field in which there is definite evidence to show that its diamonds are of local origin. That they

are, in fact, being derived from material which has no affinity with kimberlite and in which the satellites of the diamond are absent. At first sight this material appears to be an ordinary conglomerate. On closer examination, it is seen to be composed of rounded boulders and pebbles, derived from the surrounding quartzites and schists, separated by a sericitic binder. The boulders rarely touch each other and appear to have been suspended in a highly plastic material. They show no signs of selective stratification and are invariably highly decomposed without any apparent reason for being so. They are oblong rather than rounded and present the same orientation in different mines.

Locally known as "Massa" mines because of their pasty condition, they conform to the watershed separating the Sao Francisco and Jequitinhonha river basins and to the anticlinal fold which the watershed represents. From north to south, in isolated patches which have no apparent connection, they occur in the following order: Corrego Novo, Jobó, Camp Sampaio, Pagao, Barro, and Douro at Sao Joao da Chapada Morrinhos, Alto de Morrinhos, Damasio, Spoa, Lavrinha, Guinda, Canudinhos, Dattas, and Tejucal. With one or two

exceptions these are opencast mines covering a considerable area including Boa Vista, Serrinha, and Cavalo Morto mines. These lie somewhat off the watershed to the east. Each and every one of them yields diamonds differing from its nearest neighbor. It is, for instance, impossible to confuse the inferior stones of Campo Sampaio with those of Pagao less than a mile distance across the same valley. To enumerate all the differences and distinguishing characters of the diamonds from these mines would extend this article to an indefinite length. To quote all the opinions and arguments for and against the different theories would extend it into a book. The writer has purposely refrained from presenting any evidence other than that which can be deduced from the differences in size, quality, shape, or other characteristics of the different productive areas. Based on these factors, it appears evident that the Abaeté-Coromandel area is the one in which to find kimberlite but that the other fields tend to show that an ultra-basic magma is not essential to the growth and formation of the diamond.

Brazilian production of diamonds is thirty per cent gemstones, thirty per cent industrials, and forty per cent inferiors.

- Mining for diamond on the Parauna River near Diamantina. Spot tests are taken by hand drilling when it is believed diamonds may be present in the gravels, thus determining the value.



Are Synthetic Red Spinel Available?

by

DR. E. J. GUBELIN, C.G., F.G.A.,
Lucerne

In *Gems & Gemology*, Spring 1949 Issue, A. K. Seemann published a paper on "American Synthetic Crystals,"¹ in which he made the inadvertent statement that spinel boules were available in a variety of colors in the USA, including ruby and garnet red. To me this seemed to be definitely a new achievement in the production of synthetic spinels and I was indeed surprised when I read his assertion, as until then I had been under the impression that synthetic red spinels could not be obtained in sufficiently good color quality. Further, it is known that neither the I. G. Farben (German Dye Trust), Wiedes Carbide Werke (specializing in the production of synthetic spinels), nor any of the highly developed Swiss Synthetic Plants were able to turn them out as a commercial product.

Until I learned that this article was a copy of a speech delivered at the American Gem Society Conclave and that the statement in question when edited for publication had been overlooked by both the author and the staff of *Gems & Gemology*, I felt bound to challenge the article. It would seem that, if this really proved to be a new development, the gemologist should at least be prepared and any red spinel with synthetic features need not cause concern.

The results gathered from ensuing inves-

*Vide list of literature consulted.

tigations—a study of relevant literature,* and correspondence with the world's greatest authority on synthetic spinels, Dr. W. F. Eppler²—will throw light on the dilemma in the following paragraphs.

It is well known to gemologists that the chemical compound of the synthetic spinel discerns itself from that of the genuine gem by a considerable excess of alumina, because the verneuil process does not lend itself to the manufacture of spinels of normal composition. The structure of natural spinel contains equal amounts of Al and Mg oxides corresponding to the formula $MgO \cdot Al_2O_3$. Synthetic spinels made from such an equimolecular mixture do not grow as single crystals, but form aggregates of several crystals with varied orientation, although externally they resemble ordinary boules. These manufactured crystals crack easily when cooled. It was an accidental discovery, subsequently proved beyond doubt, which led to the production of spinel boules consisting of single crystals from raw material with an unusual excess of alumina.

While in natural spinel the chemical composition of MgO and Al_2O_3 conforms to a ratio of 1:1, in the synthetic counterpart the amount of alumina increases to as much as 3.5, giving the approximate formula: $1 MgO \cdot 3.5 Al_2O_3$. Dr. W. F. Eppler³ assumes this excess alumina to act as a crystallizer in the spinel synthesis. Today

scientists⁴ are further aware that this surplus Al_2O_3 is present in the cubic lattice of spinel in the form of cubic gamma-corundum molecules.

Spinel's manufactured according to this chemical formula are colorless. Yet, the industry has at its disposal numerous possibilities for inducing a veritable rainbow of attractive colors in synthetic spinels by the addition of some foreign pigmentsing elements—metal oxides, such as oxides of chromium, manganese, vanadium, cobalt, copper, and iron. Although the inherent difference between the coloring matter of precious and man-made stones is obvious, a few of these coloring impurities are responsible for more or less natural hues which also occur in the genuine gem, for instance, greenish blue and pink. Chromium is the source of color in the natural pink spinel, while the artificial product's blushing shade is effected by copper. A far wider range of pleasing hues may be developed which are not encountered in earth-borne spinels. Apart from the profusely appearing blue spinels in imitation of aquamarines and zircons, we are acquainted with sapphire and cyanite blue, with green synthetic spinels like green beryls and, besides tourmaline green and alexandrite-like varieties, stones are also made of a sickly, cobalt blue or of a fluorescent yellow-green. Each different metal oxide, or a varied blend of same, causes another color; in addition, it is a definite fact, gained by empiric experience, that the same coloring agent does not give the same hue to both the synthetic corundum and the synthetic spinel, because their relative crystal lattices, in which it is incorporated, are completely dissimilar. Take, for instance, cobalt, to which the phony blue color of synthetic spinel is ascribed—it does not absorb color in artificial corundum. Instead of copper as in synthetic pink spinel, the addition of a small amount of chromium to the corundum lattice results in pink tones. On the other hand, chromic

oxide of the formula Cr_2O_3 , which infuses that gorgeously flaming ruby red to natural and synthetic corundum, dyes man-made spinel a dark green color reminiscent of tourmaline. This color difference is due to the distinct chemical compounds of synthetic spinels and synthetic corundums. The highly diagnostic absorption spectrum of chromium colored corundum has been discovered and excellently described by B. W. Anderson⁵ and should be well known to gemologists. Also, in synthetic green spinel the chromic oxide, which affects the spinel's crystal lattice by a small-scale isomorphous substitution in the excess alumina, betrays itself readily through the spectroscope in that it produces a distinct fluorescent line at 6900A.U. and the characteristic absorption in the red region of the spectrum must also be attributed to chromium. In this feature ruby and synthetic green spinel, both owing their absorption to Cr_2O_3 are closely associated with each other, whereas their reaction with regard to the heat treatment is in strong divergence, so that the following correlation is quite typical:

Under the influence of heat at approximately 500-600°C. a ruby assumes a strong green color which cannot be further observed at higher temperature on account of the stones' self-radiation, but reverts to the original red as the gem is cooling off. Upon heating the green synthetic spinel to a temperature of 950-1050°C., part of the excess alumina is precipitated and the transparent stone becomes quite cloudy. Raising the heat to above 1075°C. results in a weakening of the spinel's structure and the destruction of all the desirable properties, i.e., its transparency and the gem beauty are so impaired that the alteration into red is accompanied by a serious disimprovement in quality, and such stones would be definitely rejected by the gem trade. This inversed conduct of ruby and green synthetic spinel, as well as the color alteration itself is due to the difference of the two crystal lattices and stands in direct causal

connection with the dimorphism of the the ruby red corundum exists in the stable ditrigonal-scalenohedric α (alpha) modification which converts into the unstable cubic γ (gamma) corundum at increased temperature, a process which, on account of the embedded chromic oxide, becomes evident by the change of color.

In synthetic green spinel the inevitable excess alumina occurs as the unstable cubic form of the oxide isomorphous with spinel. To a certain extent it is also isomorphously replaced by chromic oxide attributing a green hue to γ corundum. Under the influence of the heat treatment, i.e., raising the temperature about 1075° , the green γ alumina modifies into the α form and turns red. Even in this case the transformation is evidenced by a change of color; thus chromic oxide may be appreciated as an indicator for alpha- and gamma-corundum.

Referring to the long, persistent attempts to produce ruby red synthetic spinel, M. T. Mackowsky⁶ wrote in her paper on synthetic stones:

"The red spinel which occurs most frequently in nature can hardly be produced synthetically, since the red color—induced by an addition of chromium and manganese—appears only if magnesium oxide and alumina are mixed to a ratio of 1:1, a fusion which, however, causes accompanying conditions most unfavorable for this synthesis."

From correspondence exchanged with Dr. W. F. Eppler on this subject, the following sentence may be of special interest and dispel some of the uncertainty enshrouding this problem.

"I can confirm according to my own experiments that synthetic spinels may be dyed red if the ratio quoted in Dr. Mackowsky's paper be maintained. However, the quality of these tiny red synthetic spinels is never satisfactory, and the stones are almost always cracked and shattered. In any case, I have never succeeded in producing a red

synthetic spinel of good quality suitable for cutting with a ratio of 1:1. If the percentage of aluminium is increased, i.e., by coming closer to the ratio of $MgO:A1_2O_3$ -1:ca.3.5, as in the case in normal spinels, the red color of the synthetic spinel turns immediately to green."

Thus we may conclude that in principle and theory red synthetic spinels are producible, but that practically no specimens of good cutting and trading quality can be produced. Therefore it is my opinion that one should not mention synthetic red spinels in any gemological paper, since they are practically impossible to obtain and can be grouped with synthetic chrysoberyls, zircons, aquamarines, euclases, topazes, and spodumenes, which can all be produced synthetically and scientifically, but almost never result.

Above all it is important to state that until this day it has not been possible to obtain red synthetic spinel as a commercial product. Alas, I should not be surprised if Linde Air Products should someday succeed in producing ruby red synthetic spinel, since in the course of the last few years they have thrice stupefied gemologists by making synthetic rod crystals, star corundums, and rutiles. What next?

LIST OF AUTHORS AND LITERATURE CONSULTED

1. A. K. Seeman: *American Synthetic Crystals*, Gems and Gemology, Spring 1949, page 156.
2. W. F. Eppler: *Synthetische Steine*, Der Schweizer Goldschmied, page 23.
3. W. F. Eppler: *Jewel Bearings of Hardened Synthetic Spinel*, Industrial Diamond Review, Vol. 7, 1947, pages 259-263.
4. Friedrich Rinne: *Morphological and physico-chemical investigations in synthetic spinels, being examples of non-stoichio-metrical combinations of materials*, Neues Jahrbuch Mineral, etc., Vol. 58, 1943, page 108.

Continued on Page 322

G.I.A. Officers and Board Members Named

At the regular spring meeting of the Board of Governors, Edward H. Kraus, Ph.D., Dean Emeritus, College of Literature, Science and the Arts, University of Michigan at Ann Arbor, was elected president of the Gemological Institute of America. Dean Kraus is serving his fifth term in this capacity.

Elected to his second term as secretary-treasurer of G.I.A. is Fred J. Cannon, Slaudt-Cannon Agency Company of Los Angeles.

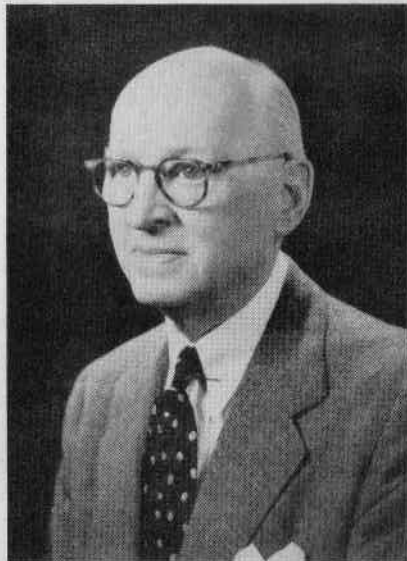


- Dean Edward H. Kraus
- H. Paul Juergens



- J. Lovell Baker

H. Paul Juergens, C.G., was elected for a third term as chairman of the Board of Governors of G.I.A. Mr. Juergens is a member of Juergens & Andersen, Chicago. J. Lovell Baker, C.G., of Henry Birks & Sons, Ltd., Montreal, Canada, again serves as vice-chairman of the Board.

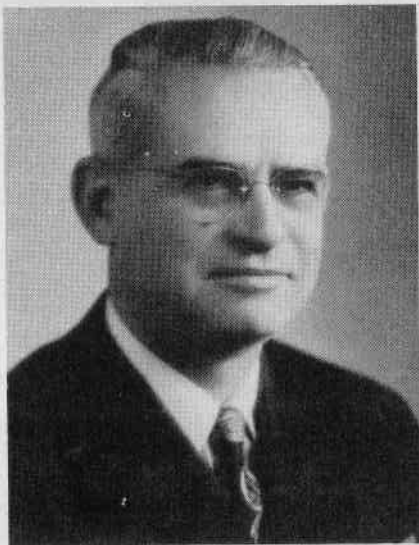


Robert M. Shipley remains the Director of the Institute, which is located in Los Angeles, with Eastern headquarters in New York City. Continuing as executive secretary of the Institute and secretary to the Board is Dorothy M. Jasper.

Three new members elected to serve on the Board of Governors include: Carleton E. Broer, C.G., of the Broer-Freeman Company, Toledo, Ohio; C. I. Josephson, Jr., C.G., of C. I. Josephson Jewelers, Moline, Illinois; and William P. Kendrick, William Kendrick Jewelers, Louisville, Kentucky. Retiring members of the Board are: Maurice Adelsheim of Minneapolis, Minnesota; Leo J. Vogt, C.G., Hess & Culbertson Jewelry Company, St. Louis, Missouri; and O. C. Homann, The C. B. Brown Company, Omaha, Nebraska. These members have given, without recompense, many years of service to the Gemological Institute and the advancement of the science of gemology in this country.

Other members of the Board of Governors, in addition to those already named, include: Charles H. Church, Church & Com-

• Fred J. Cannon



• Robert M. Shipley

pany, Newark, New Jersey; Glynn Cremer, C.G., of Glynn Cremer, La Crosse, Wisconsin; Myron Everts, A. A. Everts Company, Dallas, Texas; Edward F. Herschede, Sr., C.G., Frank Herschede Company, Cincinnati, Ohio; Geo. Carter Jessop, C.G., J. Jessop & Sons, San Diego, California; Earl E. Jones, C.G., Jones Bros., Jewelers, Pekin, Illinois; Lazare Kaplan, Lazare Kaplan & Sons, New York City; John S. Kennard, C.G., Kennard & Company, Boston, Massachusetts; E. A. Kiger, C. A. Kiger Company, Kansas City, Missouri; P. K. Loud, Wright, Kay & Company, Detroit, Michigan; Ernest J. Meyer, Meyer's, Grand Island, Nebraska; Charles D. Peacock III, C.G., C. D. Peacock, Inc., Chicago, Illinois; and Jerome B. Wiss, C.G., Wiss Sons, Inc., Newark, New Jersey.

GIFTS TO THE INSTITUTE

Recently received for the library of the Gemological Institute of America, was a copy of the second edition of *The Jewelers' Dictionary*, published by *The Jewelers' Circular-Keystone*.

From Lieut. Col. G. M. Sprague has come a copy of his book, *An Easy Guide to Stones in Jewelry*, published in Cairo, Egypt. Sprague is an A.M.I. Mech. E., F.R.G.S., Fellow, Tully Medalist, and Anderson prize winner of the Gemmological Association of Great Britain.

G.I.A. Adds 46 New Sustaining Members to Its Roster

H. PAUL JUERGENS, Chairman, has just announced the election of forty-six jewelry firms as new Sustaining Members of the Gemological Institute of America. This election is the outgrowth of action taken by the Board last year to expand Institute membership and thus distribute the voting power, which governs G.I.A. policies, to what it considers a broader cross section of the jewelry industry.

Sustaining Member firms annually elect G.I.A. governors and thus control the formation and direction of G.I.A. policies. It is from this membership also that governors of the Institute are elected. It was the opinion of the G.I.A. governors that through election to sustaining membership additional representative firms in the industry, G.I.A.'s membership would not only be broadened but afford more active rotation of governors. Thus the scope of future accomplishment would be greatly benefited and extended.

Sustaining Members are elected by the Board of Governors from among jewelry firms who have enrolled at least one student in any courses of the Gemological Institute of America. Continued membership is subject to annual re-election by the G.I.A. Board.

There are also eighty-nine Sustaining Members of the Gemological Institute who have served faithfully in such capacity from three to eighteen years. These are given in the alphabetical list which follows, together with the new members who are indicated by italics.

Adams & Meador, Hutchinson, Kansas
Loring Andrews, Co., Cincinnati, Ohio
Appel Jewelers, Allentown, Pennsylvania

Constant J. Auger, San Francisco, California
Harry E. Berg, South Bend, Indiana
Harry S. Bick & Son, New York, New York
Henry Birks & Sons, Ltd., Edmonton, Alberta, Canada
Henry Birks & Sons, Ltd., Halifax, N.S., Canada
Henry Birks & Sons, Ltd., Hamilton, Ontario, Canada
Henry Birks & Sons, Ltd., Montreal, Quebec, Canada
Henry Birks & Sons, Ltd., Ottawa, Ontario, Canada
Henry Birks & Sons, Ltd., Quebec, Quebec, Canada
Henry Birks & Sons, Ltd., Vancouver, B.C., Canada
Henry Birks & Sons, Ltd., Toronto, Ontario, Canada
H. Bockstruck Company, St. Paul, Minnesota
Bramley & Company, Inc., White Plains, New York
Raymond Brenner, Youngstown, Ohio
Brock & Company, Los Angeles, Calif.
Broer-Freeman Company, Toledo, Ohio
Bromberg & Company, Birmingham, Alabama
C. B. Brown Company, Omaha, Nebraska
Robert Brown, Ltd., Sudbury, Ontario, Canada
Brumer-Fischer, Clinton, Iowa
J. A. Buchroeder & Co., Inc. Columbia, Missouri
W. R. Burke, Berkeley, California
Carter Bros. Co., Portland, Maine
Church & Company, Newark, New Jersey

- Churchwell's, Inc.*, Wilson, North Carolina
- Fred J. Cooper, Inc.*, Philadelphia, Pennsylvania
- Cowell & Hubbard, Cleveland, Ohio
- Glynn Cremer, La Crosse, Wisconsin
- Geo. D. Davidson Company, Los Angeles, California
- Davis & Hawley Company, Bridgeport, Connecticut
- Alfred H. Dickinson, Buffalo, New York
- Donavan & Seamans, Los Angeles, California
- Edwards & Company*, Kansas City, Missouri
- Louis Esser & Company, Milwaukee, Wisconsin
- A. A. Everts Company, Dallas, Texas
- Fort & Goodwin, Trenton, New Jersey
- W. J. Frank Company, Akron, Ohio
- P. A. Freeman, Inc., Allentown, Pennsylvania
- Friedlander & Sons*, Seattle, Washington
- Fulmer & Gibbons, Philadelphia, Pennsylvania
- Galt & Bro., Inc., Washington, D.C.
- Julius Goldstein & Sons*, Mobile, Alabama
- Grogan & Company, Pittsburgh, Pennsylvania
- E. Gubelin, Lucerne, Switzerland
- Gulliksen Jewelers, Detroit, Michigan
- Gurney Bros., Company, Brockton, Massachusetts
- Hale's Jewelers*, Greenville, South Carolina
- Hardy's, Inc., Seattle, Washington
- Hardy & Hayes Jewelers, Pittsburgh, Pennsylvania
- Henke's, Inc.*, Montclair, New Jersey
- The Frank Herschede Company, Cincinnati, Ohio
- Hess & Culbertson Jewelers, St. Louis, Missouri
- C. F. Hoffman & Sons, Inc.*, Gadsden, Alabama
- M. D. Hohenstine, Columbus, Ohio
- B. D. Howes & Son*, Los Angeles, California
- J. B. Hudson Company, Minneapolis, Minnesota
- Jabel Ring Mfg. Co.*, Newark, New Jersey
- Jaccard Jewelry Corporation, Kansas City, Missouri
- S. Jacobs & Company, Minneapolis, Minnesota
- J. Jessop & Sons, San Diego, California
- Jones Bros., Pekin, Illinois
- S. Joseph & Sons, Des Moines, Iowa
- C. I. Josephson Jewelers, Moline, Illinois
- Juergens & Andersen, Chicago, Illinois
- Lazare Kaplan & Sons, New York, New York
- Keller & George, Charlottesville, Virginia
- Wm. Kendrick Jewelers, Louisville, Kentucky
- Kennard & Company, Inc., Boston Massachusetts
- C. A. Kiger Company, Kansas City, Missouri
- S. Kind & Sons, Philadelphia, Pennsylvania
- Samuel Kirk & Son, Inc.*, Baltimore, Maryland
- P. H. Lachicotte & Co., Inc.*, Columbia, South Carolina
- Larter & Sons, Newark, New Jersey
- H. F. Legg & Son*, Minneapolis, Minnesota
- Lemon & Son, Louisville, Kentucky
- S. T. Little Jewelry Co.*, Cumberland, Maryland
- Thomas Long Company, Boston, Massachusetts
- Maier & Berkele, Inc., Atlanta, Georgia
- Mappin's, Ltd., Montreal, Quebec, Canada
- Mayer Bros.*, Seattle, Washington
- Mermod-Jaccard-King Jewelry Co., St. Louis, Missouri
- Meyer's, Grand Island, Nebraska
- J. Milhening Company, Chicago, Illinois

Moon Jewelry Company, Tallahassee, Florida
Ray Moore, Billings, Montana
Allyn S. Morgan, Winona, Minnesota
H. Morton Company, Oakland, California
Fred H. Myers Jewelers, Warren, Ohio
S. Nathan & Company, Inc., New York, New York
S. M. Nathan, Inc., Fitchburg, Massachusetts
Page's, Portsmouth, New Hampshire
C. D. Peacock, Inc., Chicago, Illinois
D. C. Percival Company, Boston, Massachusetts
Plumb Jewelry Store, Des Moines, Iowa
F. J. Preston & Son, Inc., Burlington, Vermont
Avard T. Purdy Company, Gardiner, Maine
H. T. Purvis & Son, Inc., Jonesboro, Arkansas
Henry C. Reid & Son, Bridgeport, Connecticut
Reussille's, Red Bank, New Jersey
John Rich, Painesville, Ohio
John M. Roberts & Son Co., Pittsburgh, Pennsylvania
Jos. J. Schaefer, Milwaukee, Wisconsin
Schiffman's, Greenboro, North Carolina
Schwanke-Kasten Company, Milwaukee, Wisconsin
Shreve, Crump & Low, Boston, Massachusetts
Leo J. Simard, Holyoke, Massachusetts
Sloan's Jewelers, Tulsa, Oklahoma
The Philip H. Stevens Company, Hartford, Connecticut
Robert E. Stone, Meadville, Pennsylvania
A. Stowell & Company, Boston, Massachusetts
Strasburgs, Hollywood, California
Sylvan Bros., Columbia, South Carolina
Talcott Brothers, Olympia, Washington
C. L. Thomas, Kennett Square, Pennsylvania
Thorpe & Company, Sioux City, Iowa

Tilden-Thurber Corporation, Providence, Rhode Island
Traub Manufacturing Company, Detroit, Michigan
Van Cott Jeweler, Binghamton, New York
Van Horne & Company, South Bend, Indiana
J. W. Ware, San Diego, California
Bruce Watters, St. Petersburg, Florida
Wefferling, Berry & Company, Newark, New Jersey
Wickersham Company, Bakersfield, California
Wight Jewelers, Ontario, California
Wiss Sons, Inc., Newark, New Jersey
J. R. Wood & Sons, New York, New York
Wright, Kay & Company, Detroit, Michigan
Zell Bros., Portland, Oregon

HONORARY MEMBERS

H. T. Dickinson, Johannesburg, South Africa
Dean Edward H. Kraus, Ann Arbor, Michigan

RESEARCH MEMBER

Edward Gubelin, Lucerne, Switzerland

NETHERLANDS GEMMOLOGICAL ASSOCIATION

Increasing importance of the gemological movement is evidenced in the formation of new associations, clubs, and societies throughout the world. The most recent organization is the Netherlands Gemmological Association, reported to the Gemological Institute of America by private communication. Membership is open to Fellows of the Gemmological Association of Great Britain and such persons as may be invited to become members. The first President of this Association is Ing. J. Hammes, Zeist, while D. Dresme, Amsterdam, and C. A. Piek are acting as Treasurer and Secretary respectively.

Gemological Digests

INDIAN DIAMOND PIPE DESCRIBED

According to an article appearing in the *Quarterly Journal of the Geol. Min. Met. Society of India*, the origin and source of Indian diamonds has been traced to volcanic pipes similar to those in South Africa. It is reported that diamonds have actually been recovered from one such recently discovered pipe which is exposed at the surface. In addition, conglomerates have been worked.

The exposed pipe is said to be located near the village of Majgawan, about twelve miles southwest of the town of Panna. The diamondiferous plug is described as oval with an area of about 150,000 to 200,000 square feet. On the surface are a few feet of greenish clay, which gets harder as the depth increases until greenish tuff is eventually reached. According to Dr. A. L. du Toit, who examined it some years ago, the rock is similar to the blue ground of the Kimberley Mine.

Early in 1948, according to the *Annual Review of the Diamond Industry for 1948*, V. S. Dubey of Benares claimed he had located a diamondiferous pipe in the state of Panna. At that time it was pointed out that D. R. Wadia, Indian geologist, believed that the diamonds in the conglomerate of the Upper Vindhyan formation in Panna originated from basic igneous dikes cutting the older Bijowar series.

It is reported by the *Diamond News* that detailed prospecting by geological methods will be required before accurate analysis of the recently discovered pipe can be determined. Efforts are being made by the editors of *Gems & Gemology* to obtain a more detailed account of the latest pipe discovered and a report will be given in this publication as soon as available.

DE BEERS MINES REPORT LOWER 1949 PRODUCTION

Although De Beers Consolidated Mines, Ltd., in its 62nd Annual Report to Stockholders, announced a decrease in 1949 production of 127,781½ carats as compared to 1948, it pointed out that reserves in quantities of blue ground in sight above the present hoisting level at each of the mines—at the current rate of mining—is sufficient to maintain production for many years.

One of the contributing factors in decreased production, De Beers officials explained, was the policy of drawing as heavily as possible—consistent with maintaining a satisfactory yield—from the accumulated blue ground capping at all three Kimberley mines. Apart from technical advantages, this policy is believed by officials of the company to be economically sound as it prolongs the lives of the mines and delays lowering of the hoisting levels.

Closing of the Bultfontein Mine, which operated only the first half of the year, and operation instead of the Dutoitspan Mine during the last half of the year, was given as another major reason for the decrease in 1949 production figures. Average recovered from Bultfontein was .269 carats per load, whereas Dutoitspan produced only about half that yield. A decrease of 25,398½ carats from the Kleinzee alluvial diggings also helped in reducing the yearly total of carats recovered.

Total 1949 production from mines operated by De Beers Consolidated Mines, Ltd., is given in its annual report for 1949 activities as 920,596¼ carats.

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COLOMBIAN EMERALD MINES REPORT GIVEN

An account of current developments in Bogota was provided in a recent report by American Embassy officials of that country.

According to the information provided in this report, the traditional terrace type of mining at the Chivor-Somendoco workings has been almost completely abandoned. In this type of operation, the emerald-bearing strata was exposed by digging a succession of horizontal trenches around the mountain and washing away the accumulated residue by primitive hydraulic methods. Due to increased labor costs and lack of water for waste removal, the conventional tunnel mining is now used to obtain stones.

Although the quantity of material removed in this way does not compare with the vast quantities removed under the terrace operations, the company is able to operate with a smaller crew. The possibility of loss through oversight on the part of the workers is reduced to a minimum.

If production reaches the scale anticipated by the owners it is their belief that the price of emeralds will be substantially reduced, making it possible for a greater portion of the buying public of the United States to own genuine stones, and that they can compete in price with synthetic emeralds on the market.

In addition to benefiting the company itself, the increased production and sale of emeralds is expected to produce a gain in foreign exchange for the Colombian government and re-opening of the long dormant Muzo deposit. The efficiency of the present system of mining is reflected in a study of comparative production figures: an increase from 5,000 carats of commercial

emeralds during the latter part of 1947, to 46,123.40 carats for 1949. Fine stones totaling in excess of 100,000 carats are anticipated when the final figures for 1949 are tabulated.

Lawrence L. Copeland, G.I.A.

PROGRESS MADE AT PREMIER MINE DURING YEAR 1949

Satisfactory progress in the re-equipment of the Premier Mine during 1949 was reported by De Beers Consolidated Mines, Ltd., in its 62nd Annual Report recently received by the Gemological Institute of America.

Although most diamonds taken from this mine are industrials, a total of 132,267 carats were recovered during the year. Major portion of this recovery was "run of the mine," but old dump tailings were also treated and yielded an average of 1.23 carats per load. This is in comparison to 2.437 carats given as the average recovery per load for all Premier mining in 1949.

Recovery operations continued on a scale commensurate with the capacity of the experimental Heavy Media Concentration plant, the pilot plant of which operated on three shifts throughout the year. Systematic prospecting operations during 1949 were carried out on the 1,080 foot level. Samples tested were encouraging and indicated the persistence of payable values to a depth of 270 feet below the present mining level.

In their annual report to De Beers, officials of the Premier Mine state that sampling is to be continued and if results from remaining areas of the pipe are satisfactory, the life of the mine will be increased by some twenty years at the contemplated rate of production.

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SIR WILLIAM 'CROOKES' GREEN DIAMOND

In April of this year the writer had occasion to visit England and the Continent and while in London made a point of visiting the British Museum (Natural History) in Cromwell Road, where the beautiful color prints of gems, now familiar to all readers of *Gems and Gemology*, originated. Although the war years necessitated dismantling all exhibits, tremendous strides have already been made in replacing them with interesting and well-lighted displays.

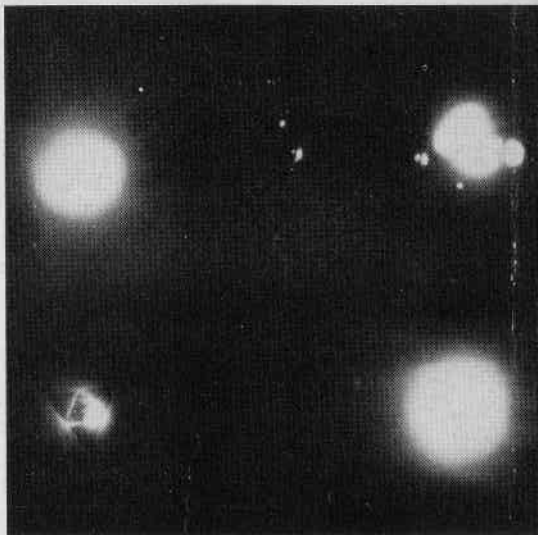
The gemstones are in the first cases on the right as one enters the Hall of Minerals and in the second one the writer found the small diamond crystal, which the late Sir William Crookes exposed to radium emanations for many months with the result that it turned a fine green (bluish). It is a small octahedron weighing 0.179 gram. Sir William reported the phenomenon in *Phil. Trans. Roy. Soc.*, London, 1914, volume 214, ser. A., p. 438, and presented the crystal itself to the British Museum in 1916. The present Keeper of Minerals, Dr. W. Campbell Smith, was kind enough to search out Sir William's letter to the Museum in which he listed some of his gifts and stated that this particular stone was the one he had treated.

After the passage of some thirty-six years it seemed rather worth while to ascertain if the stone still retained its radio activity.

• *Top left*, torbernite from Cornwall, England; *top right*, autunite from Autun, France; *bottom left*, diamond treated with radium by Sir William Crookes in 1914; *bottom right*, uranite from Cornwall. This is the result of a seventeen-day exposure on Kodirex code 1, X-ray film.

W. H. Palmer of Kodak, Ltd., insisted on donating several sheets of X-ray film to make the test. The writer, having three amateur photographers in his family using untold quantities (or so it seems) of film, felt rather pleased that he had always used Eastman film. Dr. Campbell Smith was most cooperative and the test was accomplished with the results indicated in the accompanying photograph. The auto-photograph made by Dr. Campbell Smith and his assistant, D. L. Williams, was taken through a thin sheet of black paper which separated the minerals from the film surface, the exposure being seventeen days. It seemed a pity not to take full advantage of the opportunity so several other minerals were spread out at the same time. The latter may be of interest to those readers who have been following the public prints on new strategic minerals.

In view of the conflicting reports on residual radio activity, this clear print taken thirty-six years after treatment surely shows



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that with sufficient treatment the residual activity can be extremely long lived.

Another interesting aspect is the form taken by the internal illumination. On a subsequent visit to London, the writer called on Basil W. Anderson, F.G.A., author of the well-known *Gem Testing for Jewelers*, who was kind enough to show him an auto-photograph of a green diamond left with him for testing. In that case the illumination was general, almost as though by transmission, whereas the Crookes' octahedron shows a part of the light coming from discrete points, as was the case of the stone reported in the August 1949, issue of *Gems and Gemology*.

— John A. Hardy

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utes and turned a beautiful tourmaline green. Ten other stones were bombarded with deuterons ranging from 10 to 15 micro amp beam current and 20,000,000 volts energy. The resultant range of colors was fantastic. Some stones turned an olivine green, some a bluish zircon green, and others a tourmaline green. The range in brown was from light to dark golden brown.

Many of these stones have been re-cut. As much as fifteen per cent of the surface of the stone was removed and, amazingly, no change in color occurred. This phenomenon has proved conclusively that bombardment with higher micro amp beam current and higher volt energy could penetrate the stone completely.

More work is contemplated with the latest model cyclotron which can use proton, alpha particle, deuteron, and even carbon ion bombardment. If sufficient beam current can be produced, stones thus treated should give amazing results. The outcome

of further experiments will be published at a later date.

75 DIPLOMAS AWARDED BY G.I.A.

Since last reported in the winter issue of *Gems and Gemology*, 75 students have completed studies and examinations of the Gemological Institute of America. Of these the following twenty have received diplomas in the Theory and Practice of Gemology:

- Fred G. Bricker, East Cleveland, Ohio.
- James W. Coote, Los Angeles, California.
- Alfred W. DeScenza, Medford, Massachusetts.
- Donald W. Deziel, Venice, California.
- Belden Dukes, Huron, South Dakota.
- Francis N. Hamilton, Los Angeles, California.
- Charles W. Hundley, Jr., Lansing, Michigan.
- Luke S. Israelian, Worcester, Massachusetts.
- John Jennings, Toronto, Ontario, Canada.
- Bertram Krashes, New York, New York.
- Sol Lynn, Washington, D. C.
- Gilbert B. Oakes, New York, New York.
- John W. Platt, Cedar Rapids, Iowa.
- Joseph Rayce, Kalamazoo, Michigan.
- Joseph L. Roberts, Pittsburgh, Pennsylvania.
- James E. Smith, Klamath Falls, Oregon.
- Kenneth L. Sullivan, Bozeman, Montana.
- Keith L. Tanke, Fremont, Nebraska.
- Jules Tapelband, Los Angeles, California.
- Gordon Uhl, Dormont, Pittsburgh, Pennsylvania.

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The following persons have received diplomas in the Theory of Gemology from the Gemological Institute of America:

Merton E. Anderson, Crookston, Minnesota.
Kenneth J. Benner, Medina, Ohio.
Robert Bensick, Sandusky, Ohio.
Harold Bergstrom, Minneapolis, Minnesota.
Terrence A. Bidelman, Pasco, Washington.
Albert C. Bonney, Boston, Massachusetts.
Eric A. Cameron, Washington, D. C.
Robert Comroe, Los Angeles, California.
Ralph W. Fasig, Jr., Reading, Pennsylvania.
Charles L. Fleet, Coraopolis, Pennsylvania.
Robert D. Franklin, Clatskanie, Oregon.
Wm. J. Furbish, Wausaukee, Wisconsin.
Sidney Golden, Hicksville, L. I., New York.
Donald W. Green, Mt. Clemens, Michigan.
Fred P. Gurney, Brockton, Massachusetts.
Marvin Gustafson, Minneapolis, Minnesota.
Joseph M. Handley, Los Angeles, California.
Donald B. Harris, Tomah, Wisconsin.
Richard H. Haviland, Cortland, New York.
Frank J. Holmes, Ancon, Canal Zone.
Clifford V. Johnson, Cleveland, Ohio.
George Karr, Brentwood, Missouri.
Sam Koulisch, New York, New York.
Raymond R. Landsberger, North Wilkesboro, North Carolina.
Bertil H. Lawson, Minneapolis, Minnesota.
Robert Limon, Washington, D. C.

John W. Lloyd, La Junta, Colorado.
Harvey H. London, Chicago, Illinois.
Howard F. McCoy, Carlsbad, New Mexico.
Thomas H. McDonough, Everett, Washington.
Grant Miller, Phoenix, Arizona.
Henry C. Miller, Jr., Lexington, North Carolina.
Harold Myers, Warren, Ohio.
Luther W. Nicar, Norfolk, Virginia.
Clariel L. Ogle, M.D., Grants Pass, Oregon.
Leonard J. Olkowski, Dearborn, Michigan.
Marion C. Owens, Hagerman, New Mexico.
George Paris, Wilmington, Delaware.
Thomas H. Pierce, Safford, Arizona.
Howard C. Rhea, Tulsa, Oklahoma.
Nat Robertson, Gainesville, Florida.
Gorden Rosenthal, Toronto, Ontario, Canada.
Franklin A. Sauer, Cleveland, Ohio.
George A. Savolainen, Washington, D.C.
Herman Schwab, Alhambra, California.
Benjamin Schweig, Miami, Florida.
Leo A. Silver, Hollywood, California.
Norman A. Smith, Glendale, California.
Lester S. Smyth, Baltimore, Maryland.
John R. Sneed, Copperhill, Tennessee.
Edgar F. Strother, Louisiana, Missouri.
Alfred T. Tudor, APO, San Francisco, California.
W. Tim Welch, Dallas, Texas.
Adolph L. Westlind, Clatskanie, Oregon.
David Widess, Pasadena, California.

SWEDEN'S FOURTH ANNUAL GEMOLOGICAL COURSE

On three successive days, May 22, 23, and 24, Sweden's Gemological Association (Sverige's Gemmologiska Forening) held

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its fourth gemological course, which took place at Dalaro, a tiny fishing village in the beautiful land- and seascape of the Stockholm Skerries.

A most gratifying occurrence was the full attendance by all the members of the Association, and Mr. Stromdahl, the Association's Secretary, had most expertly and efficiently prepared the lecture hall and looked after all the details of the course.

As the members of the Swedish Association have been regularly receiving a correspondence course in Swedish on the theory of gemology during the past eighteen months, which was composed by myself and subsequently translated, the present course was concentrated mainly on the practical side of gemology, i.e., gemstone determinations. These determinations were conducted according to color groups:

FIRST DAY

Systematic and methodical determination of unknown yellowish green stones.

Determination of yellow stones.

Determination of blue stones, aquamarine group.

Determination of rose and pink stones.

Determination of brown stones.

Determination of green stones, tourmaline group.

Determination of refractive indices of cabochon cut stones by the distant vision method.

SECOND DAY

Identification of gemstones round the quartz group.

Determination of gemstones of the group, R.I. 1.60 to 1.70 (the lower and the upper "one-sixties").

Coated stones; lecture on theory; exercises on practical identification.

Lecture on new development of synthetic

emerald and synthetic rutile and practical determinations.

THIRD DAY

Lectures on: a) Gemstone fluorescence, diagnostic importance of fluorescent colors. b) Methods of gem cutting. c) Artificial coloring of gems by heating, radium, X-ray, and cyclotron radiation. d) Discussion of various problems, particularly appertaining to the correspondence course.

I state with pleasure and satisfaction that the members of Sweden's Gemological Association have made considerable progress during the last four years and have already attained a remarkable sureness in testing gemstones. It is to be expected that, with continued studies, as achieved during the last two years, and with one or two more annual courses, the members of Sweden's Gemological Association may easily reach the capacity of C.G.'s and F.G.A.'s. Furthermore, it is to be expected that by then they will all be able to pass a Diploma examination, which, I hope, will be acknowledged by the Gemological Associations of other countries. *Dr. E.J.G.*

DE BEERS RENEWS JAGERSFONTEIN LEASE

Announcement has been made by officials of De Beers Consolidated Mines, Ltd., that, in January 1950, the company renewed its lease of the Jagersfontein Mine for an additional ten years and that the mine and surface works have now been re-equipped on the most modern lines.

After having been closed for seventeen years, the mine was re-opened in July 1949 and at the close of the year was operating at a capacity of 6,000 loads per shift. During the period a total of 40,016½ carats was reported recovered.

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EMERALDS

MINED IN INDIA

Information regarding a heretofore little known Indian emerald deposit has been received recently by the Gemological Institute of America, from Howard Donovan, Counselor of the American Embassy in New Delhi. First described by Dr. H. Crookshank, Director of the Geological Survey of Pakistan, in 1949, supplemental data was made available after the property was visited by the Minerals Attaché of the American Embassy in New Delhi, November 1949.

Located at Kaliguman, a village in the Udaipur district of the State of Rajasthan, the mine was operated by an Indian mining concessionnaire during the early part of the war. At that time, Dr. Crookshank reported that emerald crystals ranging from one half inch to five inches in length and up to one and one quarter inches in diameter were removed from the workings. While the operation was formerly of the open pit type, now the principal site of activity is a shaft more than seventy feet deep. Galleries open out of it at various levels. The operation has proved expensive because of excessive timbering necessitated by the disintegrated nature of the country rock, an altered hornblende-mica schist.

Stones of first quality comparable in color to the Colombian material, though slightly less "soft" in luster, represented a small proportion of the crystals, it was said.

Production of all qualities for 1948-49 was estimated at from 13,500 to 16,200 carats. The owners intimated that much of the rock of a "promising character" had been investigated and was expected to yield profitably. No beryl of an industrial quality has been observed.

ABOUT THE AUTHOR

"Bombarded Diamonds" on page 295 of this issue, authored by Martin L. Ehrmann, is the result of approximately ten years of study and experiment by the author, who has been intensely interested in producing colored diamonds since 1940. At that time, he owned his own colored stone firm in New York City and conducted experiments on diamonds with the use of cyclotrons at both Columbia and Harvard Universities. The project was interrupted by Ehrmann's service in the United States Army during World War II.

After his discharge from the service, Ehrmann accepted a position with Lazare Kaplan & Sons, Inc., New York, and came to Los Angeles as West Coast representative for the firm. In March of this year he left the Kaplan firm to open his own wholesale diamond establishment in Los Angeles. Since he came to the West Coast he has made extensive and repeated experiments with cyclotronic bombardment of diamonds at the University of California at Berkeley. The results of these experiments are outlined in detail in this article.

Born in Germany, Ehrmann was graduated from the University of Hamburg, receiving a degree in Engineering from that Institution. He had, however, been interested in gems and minerals since his early boyhood and when he came to New York City in 1923, he entered that business.

When the army had sudden and immediate need for strategic minerals, Ehrmann—because of his interest in gemstones, and knowledge of the subject, and his familiarity with the German language—was chosen to procure minerals most urgently needed, in the least possible time. Serving as a Colonel in the Intelligence Service, Ehr-

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mann successfully completed his mission to obtain tons of tourmaline from German-occupied France during 1944. Without this tourmaline it would not have been possible to use the atomic bomb the following year.

In collaboration with the late Herbert P. Whitlock, Ehrmann authored *The Story of Jade*. In addition, he has written many articles on gemstones and gem materials for numerous magazines. He is currently preparing *The Story of Diamonds* for early publication.

NEW AGREEMENTS BETWEEN PRODUCERS, DIAMOND CORP., AND SALES ORGANIZATIONS

Announcement was made in the annual report of De Beers Consolidated Mines to its shareholders of the renewal of agreements between the Diamond Corporation and the producers of the Belgian Congo, Angola, Sierra Leone, and the Gold Coast for the purchase of their production, for a period of six years beginning January 1, 1950.

At the same time, sales agreements were also entered into for the same period between the Diamond Producers Association and the newly formed Diamond Purchasing and Trading Company, Ltd., for the sale of gem diamonds. Similarly, an agreement was renewed between the Diamond Producers Association and Industrial Distributors, Ltd., for the sale of industrial diamonds.

During 1949, De Beers Consolidated sold its share in Industrial Distributors, Ltd., to Diamond Corporation, Ltd., and acquired 47,500 of the 500,000 shares originally subscribed to the new Diamond Purchasing and Trading Company, Ltd. An additional 2,000,000 shares is later to be subscribed, of which De Beers is to receive 190,000 shares.

ON THE COVER

The lovely diamond necklace shown on our cover was designed and created by the firm Gubelin Brothers, Lucerne, Switzerland. The lower strand, attached to the upper row by means of a delicate "S"-curve is removable. The necklace contains a total of 167 diamonds, weighing 65.50 carats.

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5. B. W. Anderson: *Gemstones and the Spectroscope*, Gems and Gemology, Winter 1944-45, page 180.
Absorption and Luminescence in Diamond, Part III, The Gemmologist, April 1943, page 34.
Gem Testing for Jewellers, Heywood & Co. Ltd., London, 1947, page 99.
6. M. T. Mackowsky: *Synthetische Edelsteine*, Die Umschau (Heft 27, Jahrgang 1942).
7. B. W. Anderson: *One Hundred Years of Artificial Gemstones*, The Gemmologist, January 1947, page 1.
8. H. Barnes: *Synthetic Sapphire and Spinel Production in Germany*, Journal of Gemology, page 39.
9. Karl F. Chudoba: *Vom synthetischen Rubin zum synthetischen Rutil*, Achat, Spring 1949, page 205.
10. F. W. Hirsch: *Kristallisationsversuche an Tonerde mit dem Verneuil'schen Ofen*, published 1941 by Kemink en Zn., Utrecht.
11. F. H. Pough: *Synthetic Corundum and Spinel Manufacturing in Switzerland*, The Jewelers' Circular-Keystone, August 1949, page 136.
12. For further reference see Letters to the Editor—*The Colouring of Synthetics*, from R. Webster, The Gemmologist, February 1947, page 57.

Book Review

"A Roman Book on Precious Stones" including an English modernization of the 37th Book of the *Historie of the World*, by C. Plinius Secundus. By Sydney H. Ball. Gemological Institute of America, Los Angeles. \$6.75.

For one whose central literary interest has been 17th century English writers, Pliny is an old and valued friend, represented in the library by two tall folio volumes put into English by that most noted "Translator General" of the Elizabethans, Philemon Holland, and published first in 1601. By American reckoning 1601 is a long time ago: even so, the first appearance of the book in its original language goes back some fifteen hundred years more, that is to say around A.D. 77.

Holland's translation held its own, even as North's *Plutarch*, but the reason lies in its pleasing and eloquent English rather than its ability to convey exact knowledge. For Pliny's book is really an encyclopedia and not only the words but the ideas of his time require re-interpretation if moderns are to understand them.

The 37th book, dealing as it does with precious stones and the localities where they were found in ancient times, requires especial annotation and re-translation in the light of the past two centuries. For not only has there been an advance in mineralogical knowledge, but there have also been many and confusing changes in nomenclature. Just here the expert is called for, and here at last the expert has responded.

The late Sydney Ball, eminent geologist and authority on gems, labored many years

to bring Pliny's knowledge (a summary of practically all the mineralogical and gemological knowledge of his own and of all recorded time) to the modern reader. To this end he modernized Holland's excellent version and annotated it. Then he wrote about Pliny and his forerunners in terms of their knowledge of gems. He makes plain to us here and now the geography and distribution of stones mentioned by the ancient, tells of their industrial uses as well as of jewelry and the lapidary arts, and provides tables for identifying the ancient names of stones.

As if that were not enough, he has added voluminous notes explaining locations, citing ancient and modern authorities, and discussing legends and superstitions concerning gemstones. Also he describes the mining and locations of mines in those early times.

So in reality we have here three books in one: an introduction to Pliny and his past; Pliny's own modernized text; and valuable notes (entertaining as well as informative) which will further illuminate the text and add materially to the knowledge of the 20th century reader.

All in all, then, we have here a very valuable and fascinating work of scholarship, and a mighty good book to read and to own.

Paul Jordan-Smith

Literary Editor, Los Angeles Times

