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Antique Necklace with Deep Aquamarine Mounting and Chain handwrought with deep rose finish

REUSSILLE'S
RED BANK, N. J.

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• Diamantina

Diamond Mining in Brazil

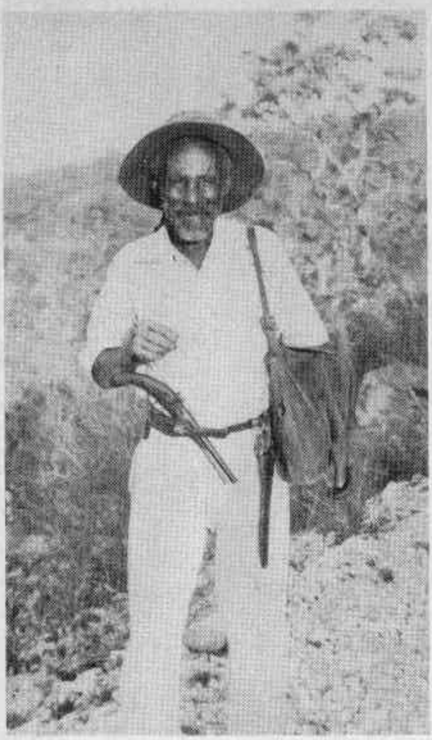
by

THOMAS DRAPER

Editor's Note: *Since the subject of diamond mining in Brazil is of such scope that it cannot be adequately covered in a single article, in this introduction of a series, the author has given a brief history of the industry and its growth. This will be followed by other articles in sequence, dealing with the different aspects of the mining and occurrence of diamonds in Brazil.*

DIAMONDS ARE OF widespread occurrence in Brazil and have been found in practically every state of the Union from the borders of Venezuela to Rio Grande do Sul. With the exception of a few organized enterprises, the production is due either to individual miners or to groups of three or four working in partnership. The methods used are those evolved by the pioneer discoverers except that, within recent years, diving suits have been used in the deeper rivers. A set of South African sieves for the final separation of the diamonds, instead of the cumbersome *batea,* is also a recent innovation.

New diamondiferous areas are constantly being discovered and rushed by a restless body of miners, — known as *garimpeiros,* some fifty thousand in number,—who dedicate themselves almost entirely to this medium to earn a living. It is in their blood —derived from their pioneering ancestors who braved the inhospitable interior of Brazil when it was still a "mere geograph-



• **Typical garimpeiro**

ical expression" — and, like their ancestors, they are also pioneers in opening up the remaining uninhabited regions which, but for their efforts would probably remain incognito indefinitely. Some of them are always searching for a new Golconda and, when they find it, send the news back to their families and friends. Then a *corrutela* —a little village of grass huts—springs up as if by magic on a river's banks, an enterprising *commerciante* appears with provisions and a good stock of liquor—followed by a bevy of parasites of the feminine gender—cabarets are opened within a few days, and life becomes hectic by night and by day. Order is maintained by the "law of the *garimpo*" which firmly discourages infractions of its code by tying a delinquent to a post where he becomes an object of derision to his companions. If necessary sterner measures are taken, more especially when the theft of diamonds is involved, but this seldom happens and valuables may be left lying about without any fear of their being stolen. Deaths occur either by design or by accident, the accidental ones being in the minority.

Each miner stakes his own claim and works it either by throwing the overburden aside or by laboriously carrying it away on his head in a *carrombe* — a wooden platter about fifteen inches in diameter. When he finally reaches bedrock, on which the diamond-bearing gravel reposes, it also has to be carried to the nearest water where it is washed in a set of screens of different meshes and the diamonds, if any, separated. Despite the exorbitant prices charged by the *commerciante,* the *garimpeiro's* earnings generally suffice to cover his needs, which are limited to *carne secca* (dried beef) and beans without trimmings. There is no need for him to journey elsewhere to sell his diamonds as there are always buyers waiting to snap them up at a price considerably lower than it should be. The buyers live on a higher social scale and have to get to the field as best they can, which usually means a *teco-teco* (taxi-plane) for which

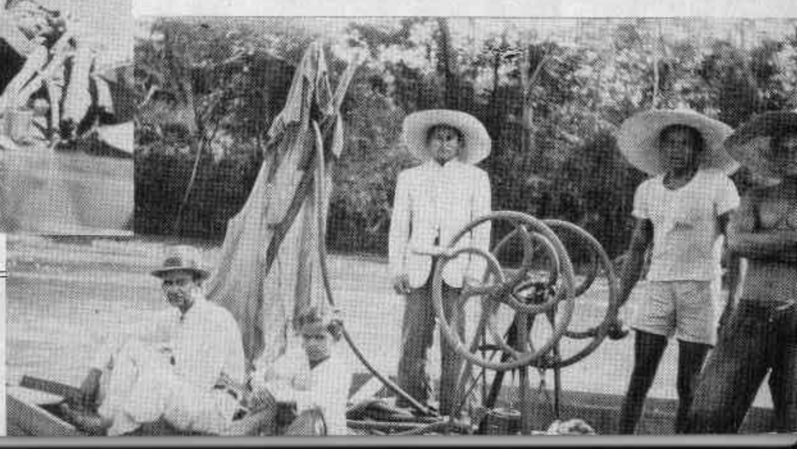
• **Overburden being carried out with carrombe.**

privilege the *garimpeiro* is elected. The field buyers are only the little spiders — the big ones live in *palacetes* in Rio and drive expensive cars for which the *garimpeiro* also pays.

With a few exceptions the tendency of the *garimpeiro* to have a good time (which incidentally he fully deserves) is his undoing. If lucky enough to *bamburrar* (strike it lucky), he makes a bee line for the nearest town and sheds his fortune on wine, women, and song. First of all he exchanges his ragged working suit for two new ones taken off the shelf and, probably for the first time in his life, owns a pair of boots. A spare suit naturally needs a suit case. So he acquires one and adds a few extras, — a razor, shaving soap, and some perfume—but the most important item of all is a revolver. Next, he provides himself with a companion of the feminine gender, hires a car by the day or week, and spends his money faster than he can count it out. But the day of reckoning comes. He sells his spare suit and the suit case but keeps the revolver for emergencies, which might be either for personal protection (or retaliation) or to fill an aching void. Then he goes back to work a sadder, but not a wiser, man. In the meantime his *garimpo* has probably petered out and its inhabitants have perhaps moved elsewhere. The *corrutela* with its grass huts now stands empty and desolate until a grass fire comes along and leaves only charred timber to mark its site.

Diamond fields are either wet or dry, or a combination of both, but from an alcoholic point of view they remain wet. Diamonds may occur both in the river and in its banks and terraces. River mining is more complicated and needs cooperation to seal off and dry out sections from which the overburden can be stripped to get down to bedrock, on which the *cascalho* (diamond-bearing gravel) reposes. In some cases the river can be entirely diverted from its course. In others, wing dams serve the purpose equally well. A forest, some tall grass, and plenty of earth is all that is needed and these can generally be found close at hand. When the river is too deep or too wide to be dammed, diving suits are used by those who can afford it. The less fortunate ones acquire a canoe and carry on by diving down to fill a sack with material from the bottom. This is then hauled up and the contents emptied into the canoe itself. Whatever its nature, work is carried on from daylight to

• In deeper water, when impossible to deflect stream, diving suits are used to remove sand.



dark and the least that can be said is that the *garimpeiro* earns his daily beans the hardest of hard ways.

Always an optimist, always hoping to *bamburrar,* he rushes to the newest discovery and tries again — and again. Spread throughout the interior of this vast country the *garimpeiros* are rounding out and filling the gaps left by their ancestors. Wherever they go they open up new roads and found new cities as Vargem Bonita, Poxoreo, Cassanunga, Aragarcas, and others testify. It is to them that Brazil owes ninety-nine per cent of its present production of diamonds including the Getulio Vargas, weighing 726.7 carats.

Diamantina, originally known as Tejuco, is the city in the northeastern part of the State of Minas Geraes near which diamonds were first found in Brazil. The discovery was made by the *bandeirantes* — or pioneer explorers (flagbearers) — who penetrated into that region in search of gold and whose efforts were rewarded by finding it in the valleys and on the slopes of the hill on which the city now stands. Later arrivals spread further afield and into the basins of the Jequitinhonha river and its tributaries. During the course of their gold mining operations diamonds were frequently found in the bottom of their *bateas,* — the Latin American substitute for a gold digger's pan. Some of these pebbles were quite small, others appreciably larger and, because of their brightness, some were saved and used as chips in their card games, others merely cast aside as worthless.

Gold mining began in 1703 but it was not until about 1714 that these pebbles were identified as diamonds, either by a priest who had been to India or by a local resident, or perhaps by both. The news of this discovery created great excitement in Portugal and even the Pope gave his blessing to this happy event. The government, however, was now confronted with a dilemma in taxation, which it never succeeded in solving satisfactorily either ot itself or to the miners in Brazil.

The original discovery of gold in the bed of the Rio do Carmo in the Ouro Preto district was followed by the opening up of other fields in Minas Geraes and extended even into the remote States of Goyaz and Matto Grosso. The short period of gold mining between 1695 and 1730 placed Brazil in the lead of the gold producing countries of the world.

Various forms of taxation of the gold mining industry were tried by the Portuguese government but none of them proved satisfactory and some even led to armed resistance and bloodshed. A "Capitation Tax" on the number of slaves employed in gold mining. was substituted by the "Quinto," or one fifth of the gross output of each miner. Notwithstanding the severity with which infractions were punished—including banishment and confiscation of assets—contraband mining and exportation of gold was being carried out on a considerable scale. The discovery of diamonds complicated matters considerably owing to the greater ease with which they could be smuggled abroad.

A capitation tax on the number of slaves engaged in diamond mining having proved unsuccessful, the "Contract System" was tried, by which the exclusive right to mine for diamonds was sold to the highest bidder for periods of four years. The government revenue in this case was derived from the number of slaves employed by the contractor, which number, according to the terms of the contract itself, could not exceed six hundred excluding those engaged in cutting timber and transporting supplies. The price fixed in the first contract was milreis 230.00 for each slave. In later contracts the price was increased. It was also stipulated that mining should be carried out systematically upstream from a given point (Lavro do Matto) in the Jequitinhonha river. This was to avoid pollution of intermediate areas. Likewise, it was required that the diamonds should be sold to the government at a fixed price regardless of color, size, or quality. Infractions and abuses of certain clauses were subsequently used by the government to exile and fine two of the contractors, Felisberto Caldeira Brant and Joao Fernandes de Oliviera Jr. The real reason, however, lay in the fact that their local influence might extend and become a menace to the Crown.

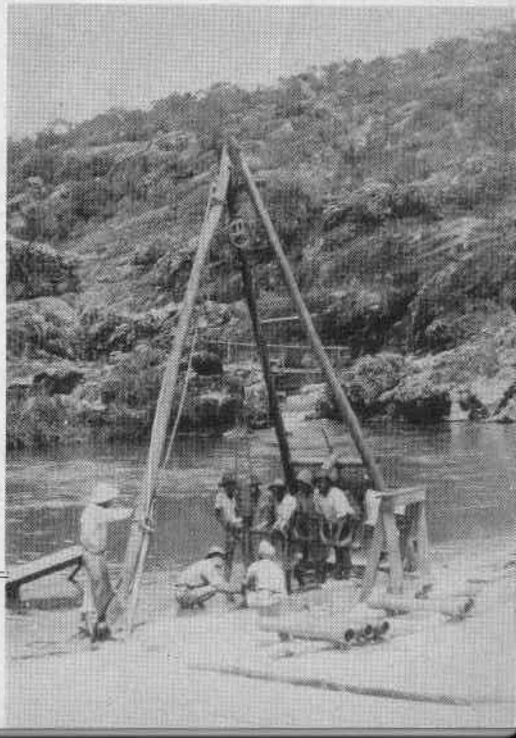
The monopoly of diamond mining having been conferred upon the contractors, the other inhabitants of the region were compelled either to move elsewhere or lease their slaves to the contractors. Some of them were allowed to mine for gold in areas where diamonds had not yet been discovered. But as the entire region has since been proved to be diamondiferous it is probable that they were able to carry on clandestine mining. The contractors themselves are known to have winked an eye at infractions by participating in the results.

The Contract System lasted from January 1742 to the end of 1771 when it was substituted by the "Royal Extraccao" during which mining was done by and for the Crown with from three thousand to five thousand slaves, the majority of whom were leased from local owners. Legally this system remained in force until 1842 but actually it petered out in 1823 when, owing to maladministration and political issues both in Brazil and abroad, the local authorities were no longer able to keep a sufficient force in the field to eject local residents from the rich area discovered about eight miles east of Diamantina.

During the period under review other discoveries of diamonds were made in Minas Geraes itself and also in Goyaz and Matto Grosso, but the severity of the conditions under which mining was permitted prevented their development.

Throughout both the Contract and Extraccao periods mining was confined to the most accessible spots including the river bed of the Jequitinhonha about Mendanha and its tributaries, and to the alluvial fields on the highland plateau. The Royal Extraccao also extended its operations across the watershed into the upper tributaries of the Rio das Velhas,—one of the largest arteries of the Sao Francisco river. Some of the minor streams—notably the Parauna and Rio Pardo Grande — proved to be exceptionally rich. Although more than two hundred years have elapsed since the diamond mining first began in the region, the upper tributaries on both sides of the watershed are still being worked and virgin patches, left over by the *bandeirantes,* yield rich rewards. The Jequitinhonha itself however, from Mendanha to its source near Serro, offers less possibilities although some of the older legends assert that certain areas were left intact either because of their depth or because of loss by out-of-season floods. As the *bandeirantes* were not only responsible for the discovery of diamonds but also for evolving the methods still used by their unprogressive successors, a sketch of the Diamantina field serves as a model for the entire country. Diamond mining in Brazil is of a seasonal character. During the dry months, lasting normally from May to October, the rivers shrink in volume and, if not too large, can be diverted either into canals or into flume. During the wet season

• **Drilling to determine if area has been previously worked.**



sufficient water can generally be impounded in convenient depression to permit ground sluicing.

The Diamantina field lies on an elevated plateau approximately four thousand feet above sea level, forming part of the Serra do Espinacho which extends from Ouro Preto northwards into the State of Bahia, where diamonds were discovered in 1852 in the Lencoes and Jacobina areas. This field subsequently became notable as the only source in the world of carbonados on a commercial scale. Excepting for a comparatively small production from India and from Borneo, Brazil became the source of the world's production of diamonds and maintained its position until ousted by the South African fields. Its most productive era was during the Contract and Royal Extraccao periods when the pioneer miners were able to pick and choose at will the most likely areas for exploitation. The physical features of the field itself favored the concentration of diamonds in the rapids and pools of the Jequitinhonha and its tributaries. In its upper regions, from Mendanha to its source near Serro, the river flows through a deep valley about five hundred meters below the level of the plateau. Rugged and precipituous sides of the valley frequently close down onto the river's banks and the stream itself flows down a series of rapids and cascades, with short intermediate sections of quiet waters and placid pools. Its tributaries are short and turbulent. These factors rendered the conditions ideal for the retention and concentration of diamonds in the pools and potholes with which they abound. It was from these that the *bandeirantes* and their successors obtained rewards which sometimes bordered on the sensational. The most notable example was the recovery in 1881 of twenty-three thousand carats from a pothole in the Ribeirao do Inferno during the course of one afternoon. The section of this "River of Hell" in which the pothole was found, had previously been worked either by the Contractors or the Extraccao but, sealed by a capping of cemented gravel, its presence had been overlooked. A crowbar dropped by a slave when it was being reworked on this occasion broke through the capping and revealed its presence. Another instance of the concentration of diamonds occurred when Joao Fernandes Jr. took one hundred and seventy-five thousand carats during the course of one year from a ditch dug for the purpose of washing his *cascalho* (diamond-bearing gravel). It was on this occasion that he is said to have prayed "that if such wealth should cost his soul the diamonds might be turned to coal." As recently as 1926, eleven thousand carats

• Panning for gold with batea. Note sorting shed in rear and tailings dump at right in lower picture.

• **The fervidor is used to extract gold and diamonds.**

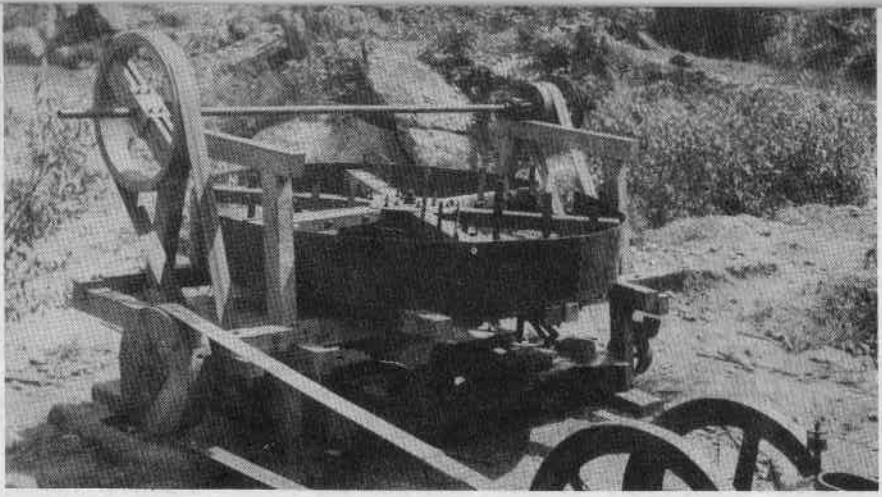
of diamonds were taken from a comparatively small wing dam about a mile above the bridge at Mendanha, in addition to sixty-seven kilograms of gold. Numerous other instances almost equally sensational are recorded in the annals of the region.

Having noted, during the course of their gold mining operations, that the diamond tended to remain in the bottom of their *bateas* the *bandeirantes* did not find it necessary to change their methods of mining, so they continued to use the *baco* and *fervidor.*

The purpose of both these types is to reduce to a minimum the volume of material by elimination of the lighter particles, so as to leave a concentrated product for final separation of gold and diamonds by the *batea.* The *batea* is a wooden dish about three feet in diameter, shaped like an inverted Chinese hat and is probably of Chinese origin.

The *baco* is a shallow recess about three by four feet square and from eight to ten inches deep cut into the bank of, and sloping slightly backwards from the edge of, any convenient pool or shallow stream. Standing knee deep in front of it, the operator pours water from right to left—stage by stage—and back again against a small quantity of gravel which, previously piled up on the back end of the *baco,* is scraped in as required. At its best it is a very imperfect process and loses both diamonds and fine gold.

The *fervidor* (fervor to boil), also called *canoa,* consists of three or four artificial cascades stepped down successively about eighteen inches each into a spoon-shaped depression lined with clay or flat stones. In this case the gravel or *cascalho* is fed in about the first fall in which an operator stands with a shovel and from time to time throws out a spadeful of concentrates and occasionally does the same in the lower falls. Easily constructed from material nearly always close at hand, the *fervidor* is more efficient than a *baco* but becomes unsafe when the water is thickened by slime and acts as a gravity solution. Practically all the old tailings heaps left by the *bandeirantes* have been rewashed and found to contain diamonds. Until the introduction in 1919 of the South African sieves by the writer's father, Dr. David Draper, the *baco,* the *fervidor,* and the *batea* were responsible for the greater part of the production of diamonds in Brazil. The curious superstition that it is unlucky to find both gold and diamonds in a *batea* may have originated with the *bandeirantes.* The writer himself has seen appreciable quantities of gold discarded.

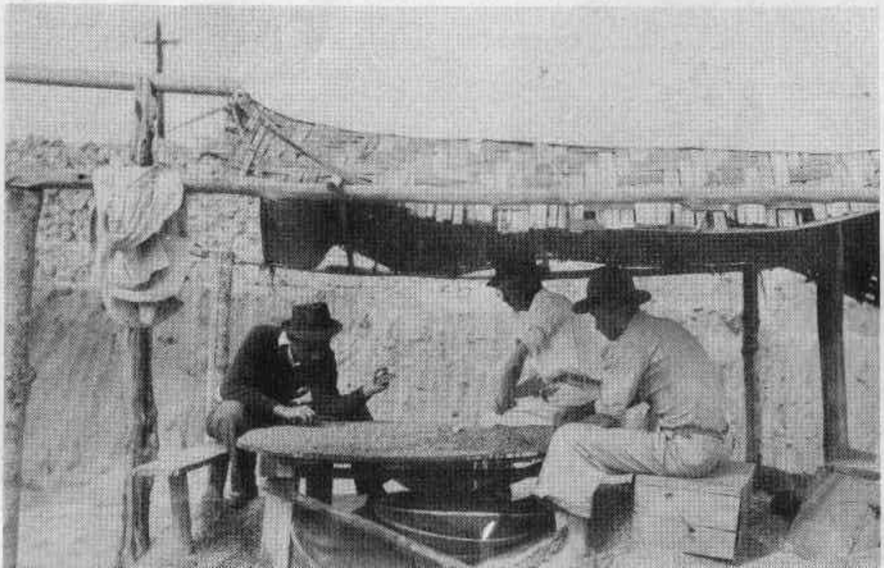


• **The South African Rotary Pan is used to produce a concentrated product in which diamonds are retained.**

However backward from force of circumstances the *bandeirantes* may have been in their methods of recovery, they were daring and ingenious in diverting rivers from their courses so as to enable them to seal off and strip sections down to bedrock. The overburden generally consists of lighter sand and loose gravel, sometimes underlaid by running sand. Although the overburden also contains diamonds, practical experiences showed them that it was not sufficiently rich to wash.

The Jequitinhonha river cannot be classed as a big river but it does nevertheless carry a considerable volume of water and, as previously stated, either flows through a succession of gorges or flat sections that open out into small valleys. In the valleys it was comparatively easy to dig a ditch, dam up the river slightly, and then sluice out a canal big enough to take the river itself. In the gorges the river had to be dammed and lifted into flume, sometimes overhead, and often dangerous to the miners working below. It was the collapse of his fluming that caused Joao Fernandes Jr. the loss of seventy slaves at the very moment when his *cascalho* had been uncovered and "diamonds

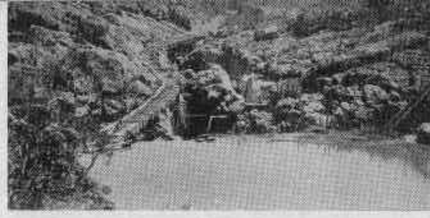
• **Inverted sieves are turned on a table and diamonds are hand sorted from the concentrates.**

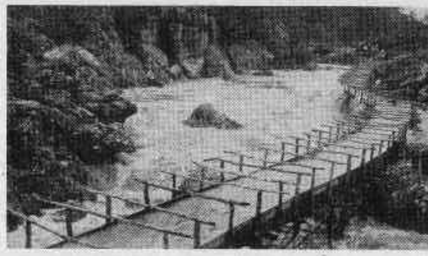


lay gleaming like stars in the sky."

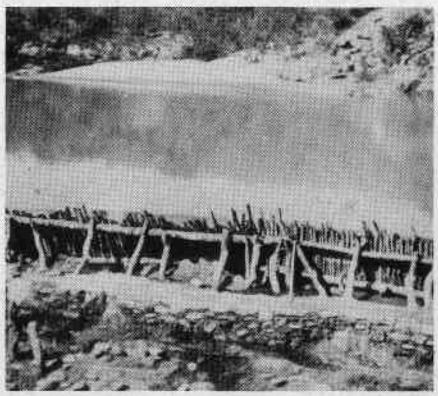
After selecting a suitable spot for their dam site, where the beams could be firmly anchored to the sides, the *bandeirantes* drove stout posts with forked tops down as far as possible and then strutted them well from behind. Then they laid the top beams in the forked posts and lashed others at a lower level with *cipo* (liana), the Brazilian substitute for rope. In front of the beams, on the upstream side, they drove saplings side by side across the river. From an oversized haystack and a mountain of earth, previously collected, they constructed "pillows" made with grass and filled with rocks which they sank against the foot of the saplings and then, by packing grass against the stakes and pouring earth in front of the grass, they carried on methodically until the earth took a natural slope with a width of about two meters on top. If well constructed these dams withstand even the heaviest floods but are not always watertight owing either to fissures in the rocks or other mediums of infiltration. A footdam, to prevent the water from flowing back up stream, is also essential but generally this is a comparatively easy operation as it is usually made after the river has been sidetracked to a point below the site of the footdam itself. Where flumes were necessary it generally took months to whipsaw the boards, cut and carry the timber, and pile up the earth and grass. The construction of the flume was done without the use of nails for which they substituted *cipo* lashings and wooden spikes. The caulking was done with the bark of a certain tree.

Infiltration and leakages in the flume necessitated appliances for keeping the pit dry. When this could not be done by hand, undershot waterwheels were constructed, driven by subsidiary flumes from the main flume. For piping they clamped four boards together with a foot valve in the bottom and another in the plunger itself. Driven from an arm on each side of the waterwheel, the capacity of these pumps was considerable but the depth to which they





• A flash flood ruins work done on a flume constructed to divert stream.



• Back view of a typical dam.

• Undershot wheel, turned by power from flume water, is used to keep pit dry between two dams. Pipes in foreground carry away seepage.

can operate is limited. With walking posts and connecting rods the stroke could be carried to any reasonable distance. Stripping the overburden from the pit was done by slaves using *carrombes* usually carried on their heads but passed rapidly from hand to hand when an emergency arose. The *carrombe* is still in use by the modern *garimpeiros* who prefer it to any other medium.

During the wet season when river mining had to be suspended, the *bandeirantes* transferred their gangs to the plateau where they either impounded rainwater in dams or brought it by means of ditches to the required point to ground sluice the areas selected. With these simple appliances the *bandeirantes* and their successors have been responsible for practically the entire production of diamonds in Brazil—estimated at four million carats or four metric tons since 1729. Production reached its zenith during the Contract and Royal Extraccao periods, after which it began to decline until the liberation of the slaves in 1881 and the discovery of diamonds in South Africa reduced it to insignificant proportions, but throughout the decline the world's greatest optimist, the *garimpeiro*, carried on bravely.

The history of the discovery of diamonds in Brazil would be incomplete without a brief sketch of the social conditions of the period. The discovery of gold played a major part in opening the interior of Brazil and its impact was great in Portugal from which thousands of emigrants left to enrich themselves in the new Eldorado. A stream of wealth began to flow in reverse to place Portugal at the pinnacle of its glory. The splendor of the Court of King Joao the Fifth, who eventually died a pauper, belongs to history. In Brazil itself new cities, Ouro Preto, Sabara, Sao Joao d'El Rei, Cuyaba, and many others, sprang into being and took a permanent form. Their inhabitants became rich and, as the antique shops of Rio testify, were able to import the best that Europe could supply to adorn themselves and their homes, but none of them outrivaled Diamantina in wealth and ostentation. It became celebrated throughout Brazil for the length and strength of its *festas* which frequently lasted a fortnight during which vast quantities of English ale were consumed. By pony express from Bahia its ladies received the latest fashions from Paris before the slow sailing vessels of the day reached Rio de Janeiro. They dressed in the richest of silks and satins and paid ceremonious visits to church and to each other followed by a retinue of slaves equally richly dressed. Its history presents too many colorful episodes to permit of recapitulation colorful episodes to permit of recapitulation. However, one of them known to every school child in Brazil—the case of Xica da Silva, the Uncrowned Queen of Diamantina —deserves mention.

Holding, as they did, the exclusive right to mine for diamonds, the contractors could hardly avoid becoming wealthy. As previously stated, the contracts were held for periods of four years, the first two of which were awarded to Joao Fernandes the Elder, the third to Felisberto Caldeira Brant, and the remaining three, with extensions, to Joao Fernandes and his son. Joao the Elder achieved his fortune in the short space of twelve years and retired to Lisbon where he squandered his wealth and died insane. Caldeira Brant had already made a fortune in gold mining in the Paracatu district, increased it in Diamantina, and became so arrogant and influential as to raise misgivings in Portugal that his power might extend and become a menace to the Crown. Under the pretext that he had infringed certain clauses of his contract, he was taken prisoner and exiled to Portugal where he was imprisoned, heavily fined, and his fortune, including thirty-three thousand carats of diamonds found in his safe in Diamantina, confiscated. Miraculously released by the Lisbon earthquake in 1755, he reported to the Marquis Pombal for which act of wisdom he was pardoned but not allowed to return to Brazil. The earthquake had the curious result of increasing the population

• The bottom of a pit is being cleaned out in final stage of operations.

• Below teams of mules are used in stripping the overburden for later screening. During the dry season the concentrate is carried away in old kerosene cans on the backs of mules and piled high above the water mark. Later, during the rainy season, it will be worked and the diamonds removed.

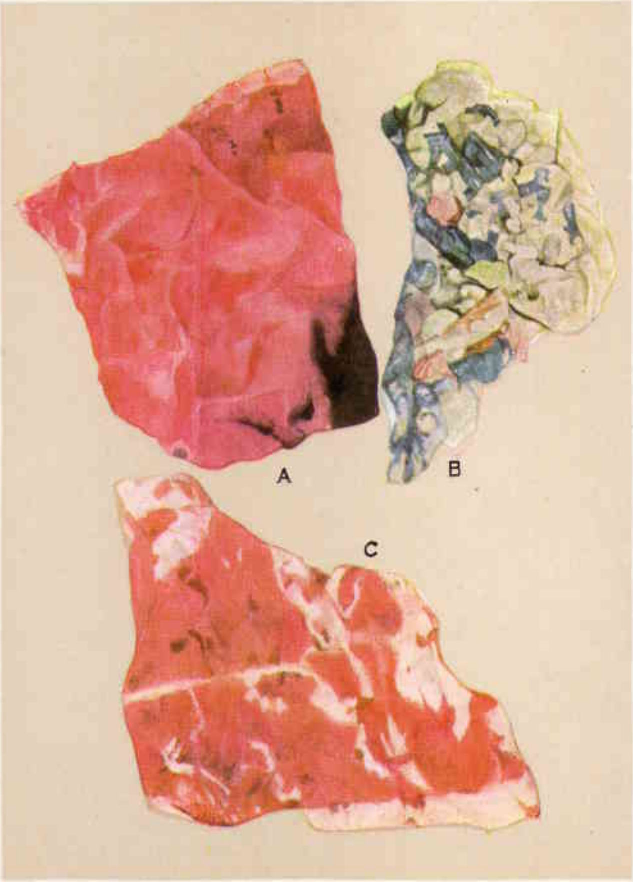
of Diamantina itself. Alarmed by the prophecies that a greater one would follow, many people fled from Portugal to Brazil.

Francisca (Xica) da Silva, a mulatto slave, was presented to Joao Fernandes by a friend and became his mistress. She is described by historians as unprepossessing and corpulent and may have become so in later life but copperplate engravings, recently discovered in Serro, show her as a comely girl without any trace of her Negro origin, richly dressed, and laden with jewelry. The devotion of Joao Fernandes to this woman was truly remarkable. A short distance from Diamantina he built a veritable palace which not only contained a private chapel but also a theatre which had the distinction of being the only one in the district. Here, and in her town residence, she entertained on a royal scale with regal arrogance. Even the highest in the land, including the Intendente himself, were offered her hand to kiss. Her wish to see a ship in full sail was gratified by the construction of a model vessel capable of carrying a crew of eight, for which a special lake had to be constructed at great cost by damming up the river in front of her palace. The best seat in the church was reserved for her, to which she was usually attended by twelve slaves richly dressed. The church of Nossa Senhora do Carmo, the most ornate in the city, and which Negroes were not allowed to attend, was specially built for her. It has the unique distinction of having its spire at the rear end because she thought the bells would make less noise at her home which was only a short distance away.

Joao Fernandes eventually suffered the same fate as Caldeira Brant on the pretext that he had employed more than six hundred slaves, for which crime he was exiled to Portugal and fined eleven million *cruzados*. The payment of this heavy amount did not impair his fortune to any great extent. His will refers to a palace near Lisbon in which he resided, an entire block of buildings in the city itself, several blocks in Rio de Janeiro and seventeen farms in different parts of Brazil. Xica was not allowed to accompany him and faded out of the picture. Her home in Diamantina is now being repaired by the Patrimonio Historico, but vandals of a later date left not a stone of the palace standing.

Diamantina itself is now shorn of its former glory but still adds its quota of diamonds to the national total. For reasons which the writer hopes to present on a future occasion, it has a special claim to distinction: It appears to be the only place in Brazil in which diamonds occur in situ.

• **The author's son, David, in typical mining camp.**

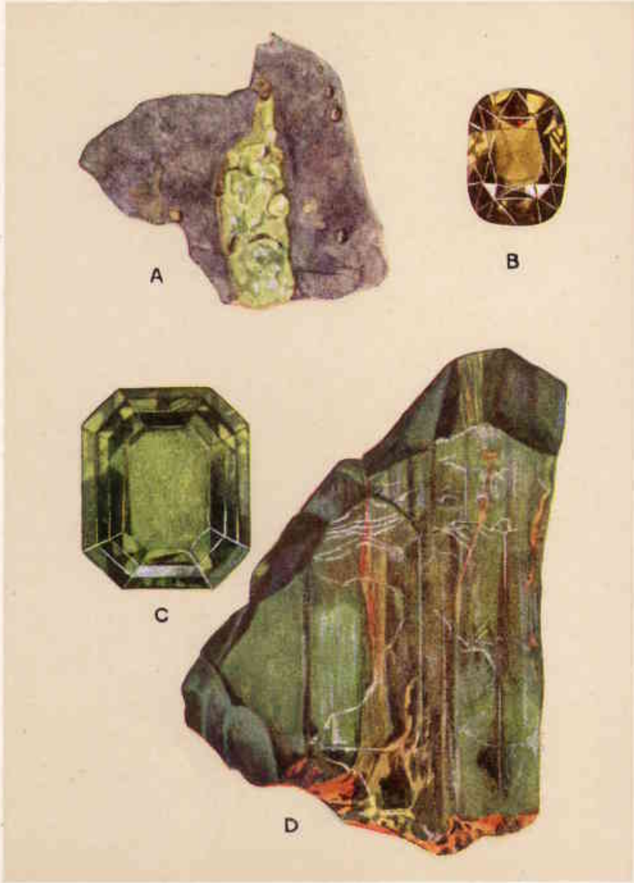


RHODONITE, THULITE

Rhodonite (A) is a translucent pink to red brown mineral. It finds wide use as an ornamental stone and for beads, buttons, etc. The specimen illustrated here is a fine example of the rose colored material from Sweden. The blue crystals at (B) are cyprine, a variety of idocrase, while the pink material associated with it is thulite. The pleasing color and hardness (6 - 6½) of both of these minerals makes them very desirable as ornamental stones. The pink specimen at (C) is a polished slab of thulite. Both (B) and (C) are from Norway. Specimens from the collection of British Museum (Natural History), London.

PLATE XXIV

Printed in England.



PERIDOT
(Olivine and Chrysolite)

The names olivine, chrysolite and peridot have been used by geologists, mineralogists, and gemologists respectively to denote the same species. However, in gemology olivine applies to the dark olive green to brown stones, chrysolite to the colorless to yellow to yellow green, while peridots are the olive to light yellow, green, brownish, or grayish varieties. Figure (A) shows olivine in basalt, Arizona. The fashioned yellowish gem (B) in chrysolite and (C) is peridot. The large crystal (D) is an olivine crystal from St. John's Island, Red Sea. Specimens from the collection of British Museum (Natural History), London.

PLATE XXV

Printed in England.

New Process of Artifically Beautifying Gemstones

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

FOR SEVERAL YEARS PAST, the optical industry has benefited by the results of an invention which consists of the "blueing" of optical glasses by coating them with a transparent film of definite thickness so that interference of light takes place among the rays reflected at the surfaces of air-film and film-glass. This impedes surface reflection and allows more light to enter and transgress the glasses. The results of this improvement are so striking that it seems but logical that similar attempts should have been carried out with gemstones. Now, upon the directions of the author, a number of experiments have been carried out, 53 gemstones have been treated, and the results obtained may be considered interesting for any gemologist.

Anticipating the importance that the application of this process may attain in the gem trade it is imperative to deal with the basic principles of the treatment upon which the effects depend. As light passes from the air into a gemstone it undergoes the shock of sudden slowing from its normal velocity of 186,000 m.p.s. in the air to something approximately half that speed in the gem. On account of the violent impact, part of the incident light is thrown back, i.e., reflected. In gemology this reflection at the surface of a gem is known as "surface brilliance" or "luster." Apart from other factors, such as quality of polish, hardness of surface, inclination of incident ray, etc., the intensity of the reflected light depends mainly upon this sudden change of velocity — the value which is determined by the refractive index — the greater the difference of speed the more brilliant the luster. It is known that the luster is intensified as the incident angle of the light is increased, especially when Brewster's angle is surpassed, so that a stone whose surface is obliquely illuminated shows only very little interior brilliancy but very strong luster. This is clearly demonstrated by the following table which compares the varying percentages of reflected and refracted light from different values of the angle of incidence on the surface of a diamond. (See table next page.)

This table shows that not only very oblique light rays, which are beyond Brewster's angle, are strongly reflected and thus lost for the effect of optimum brilliancy, but also that light striking a stone's surface at a sharp angle has to sacrifice a good deal of its energy to the surface reflection. In utilization of the aforementioned discovery made in the optical industry, the unfortunate and useless loss of energy of the incident light for optimum internal reflection in colorless gems and for more pronounced color absorption in colored stones can be markedly diminished, and a greater amount of light, otherwise reflected, can be guided into the stone by coating the latter with a thin anti-reflection film which causes the change of velocity air-to-stone to take place gradually, and the shock suffered by the light is mitigated, and thus less light is reflected, but transmission is increased. In order to understand the effect achieved by the treatment of coating gemstones it seems necessary to indulge in

REFLECTED AND REFRACTED LIGHT FROM SURFACE OF DIAMOND			
ANGLE OF INCIDENCE (i) IN AIR		REFLECTED LIGHT (Approximate)	REFRACTED LIGHT (Approximate)
	1°	16.99%	83.01%
	10°	17.23%	82.77%
	20°	17.23%	82.77%
	30°	17.36%	82.64%
	40°	17.73%	82.27%
	50°	18.73%	81.27%
	60°	21.12%	78.88%
Brewster's Angle	67°31′	24.85%	75.15%
	70°	27.21%	72.79%
	80°	43.33%	56.67%
	89°	89.97%	10.03%

Table I

a study of the optical theory. However, those who do not wish to delve into the technical details may skip the following paragraphs and turn to page 246.

The refraction of light by a transparent medium in air is expressed in an equation which was evolved by Fresnel, and afterwards called Fresnel refraction, as follows:

If i is the angle of incidence, r the angle of refraction, n_1 the index of refraction for air (nearly equal to unity), n_2 index of refraction for a medium, then the ratio of the reflected light to the incident light is:

$$R = \frac{1}{2}\left(\frac{\sin^2(i-r)}{\sin^2(i+r)} + \frac{\tan^2(i-r)}{\tan^2(i+r)}\right)$$

If $i = 0$ (normal incidence), and $n_1 = 1$ (approximate for air),

$$R = \left(\frac{n_2 - 1}{n_2 + 1}\right)^2$$

Fig. 1 demonstrates the path of a ray of light which, coming from 0 (source of light), reaches the surface of the film at A, here it is slightly refracted, travels through the film to C at the junction film-stone and, again slightly deviated from its direction, propagates into the stone to F. At A, C and E minute amounts are reflected; at D a certain percentage leaks into the air and the rest is totally reflected and travels to E and from there to G. The film coating the stone is so very thin that the points A and C are extremely close to each other and almost coincide with D and E respectively, so that the rays — thanks to the parallelism of their direction of propagation — seem to form one single ray.

It may be supposed that the thickness of the film be but $\frac{1}{4}\lambda$. The ray of light arriving at A undergoes a shock and slows down; it continues to C and experiences again the same retardation of ½ period and thus propagates towards F with the total retardation of one period. The ray C-D starts from C with an advance of half a period with regard to ray C-F; yet, as it has to run to and from C via D to E slowing down ¼ plus ¼ equal ½ period in order to arrive at E, its advantage is lost and accord of phase established with ray C-F. Consequently both rays C-F and E-G combine. In order to lose but a minimum amount of light by surface reflection and to collect a maximum amount of light into the stone the coating must possess a refractive power between that of air-to-stone, and it has been found that the refractive index of the film must be equal to the square root of the stone's refractive index.

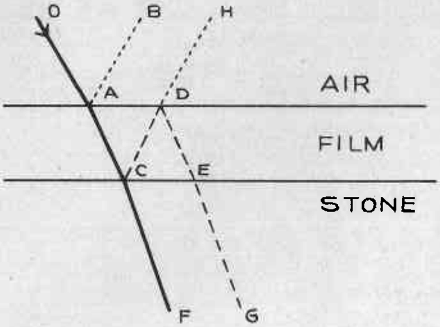


Figure I

The value of the refractive index of the film compared to that of the stone to be treated is determined by the choice of the coating material. Table 2 reveals the corresponding values between the limits of the range of the refractive index of gemstones in intervals of one tenth of the unit.

This table explains clearly why coated stones with a refractive index below 1.70 do not throw a shadow edge onto the scale of the refractometer while stones with higher refractive indices merely give a false reading which, depending upon the stone's refractive index, varies between 1.30 to 1.55 and might be mistaken for that of glass,

^{n}STONE		^{n}FILM
1.40	$^{n}\sqrt{ST.} = {}^{n}F$	1.18
1.50		1.22
1.60		1.27
1.70		1.30
1.80		1.34
1.90		1.38
2.00		1.41
2.42		1.55

Table II

opal or fluorspar (feldspar and quartz show birefringence, therefore, in their case the question does not arise — the anti-reflection films are amorphous). However, in practical application excellent results may be obtained by using a substance of medium refractive power. Another most important condition which is even more critical than the value of the refractive index of the films, briefly mentioned above, is that the depth of the film must be a quarter of a wavelength of the light used. If the light be monochromatic these conditions can readily be complied with, but it is more difficult with the more complex daylight which consists of a scale of wavelengths from 3500 AU to 7500 AU. The ideal solution would, therefore, be to produce a film which could respond to the complicated composition of the daylight in order to preserve a perfectly normal and chromatic balance between the incident and the transmitted light. Fortunately, this exaction is not absolutely necessary since empiric knowledge has proved without contradiction that brilliant results are obtained for all wavelengths of the visible spectrum, and that considerable reduction of reflection and increase of transmission takes place at a sufficient span of wavelengths on either side of the chosen wavelength if the depth of the film corresponds to ¼ of the wavelength of the medium region of the solar spectrum to which the human eye is most sensitive (i.e. approx. 555 mμ in the day and 510 mμ at night). Latest investigations have shown that, by varying the thickness of the film, other interference colors than blue can be obtained for special cases, so that the color of the film can be better adapted to the color of the treated stone.

There are four metallic fluorides whose refractive indices approach the ideal conditions nearly enough to cover the entire range of the refractive indices of gemstones. They are barium fluoride (BaF_2), calcium fluoride (CaF_2), magnesium fluoride (MgF_2) and sodium aluminium fluoride (cryolite, Na_3AlF_6). Sometimes titanium dioxyde (TiO_2) is applied as a substratum, and in order that the non-reflecting film may be protected it is often covered by a thin film of silica (SiO_2) whose hardness is slightly below 6 (Mohs' scale). The latter substances are insoluble in hot water. Silica has a high refractive index, although below that of quartz; as always the refractive index of an anti-reflection film is less than that of the same substance in its natural form. Three methods, two chemical and one physical, are known by which the film may be applied onto the stone. The chemical methods, which produce the film out of the optical object itself by dissolving away some of its constituents at the surface to a determined and uniform depth, are not applicable to gemstones. In the physical process the chosen fluoride is powdered and evaporated from a trough onto the surface, suspended face downwards in a high vacuum. This explains why, in the attempts heretofore carried out, either the crown facets or only the pavilion facets were coated, although it is not difficult to turn the stone into two opposite positions and treat it from both sides. Attempts achieved by the author proved that coating the crown only is an advantage. This technique of volatizing an anti-reflective film onto the surface of gemstones can, under certain circumstances and ideal conditions, considerably affect a stone's appearance and remarkably enhance its beauty and color contrast. The effect upon the surface luster and the internal brilliancy of a diamond is clearly portrayed by the following diagram.

Fig. 2 reveals that the curve of the coated stone bends significantly towards the untreated one after the angle of the incident light has surpassed Brewster's angle of the film and approaches almost normal conditions beyond Brewster's angle of the stone; the result of this is that almost all the light hitting a stone at a steep angle is collected into the stone, while the strong surface reflection caused by very oblique light is but slightly diminished by the film. This produces most ideal conditions in that the internal brilliancy is increased while the effect of luster, which also forms an important factor of a stone's entire brilliancy, is not completely destroyed.

All gemstones, regardless of their cut, size, or color, can be treated by this method of depositing an anti-reflective film onto their surface — preferably over the crown. Many colorless stones, well cut and treated, manifest increased internal brilliancy; colorless and slightly yellowish tinted diamonds may appear blue-white, and all colored stones show a more pleasing and more intense color. (A good ruby spinel may thus be strikingly beautified so that it looks almost like a fine ruby.) Furthermore, although the film does not exceed hardness 6, (Mohs' scale) and this is not soft, it may, by its presence and relative hardness, protect the stone's surface by parrying abrasion and corrosion caused by normal wear. It is also capable of withstanding very high temperatures.

Interesting as this process of embellishing gemstones may be, it conceals the great danger that unscrupulous elements might represent treated stones for what they appear to be but are not. This opportunity for fraud is all the more perilous as the beautifying effects are not lasting. When a stone is to be repolished or recut the deposited film will naturally be removed, and, although the coating is inert to most bases and some acids, it is soluble in boiling water and hot 30% acetic acid and in some strong acids such as H C1, H_2SO_4 and aqua regia, so that coated stones will lose their deceptive glitter when bathed properly and for a sufficiently long time in any of these liquids. Happily one need not fear this new "art" of doctoring gemstones, especially as above all and apart from those rather crude methods of detection mentioned above, the stones look "phoney" and the coating is sometimes revealed to the naked eye for colorless stones show a dull, purplish blue iridescent surface reflection, due to interference of light, if the gemstone is inclined and rotated. The latest development of the process has enabled the color of the film to be adapted to that of the stone, as, according to the film's thickness, blue, pink, green, and yellow interference colors can be obtained. As explained above, many treated stones do not give any refractive index reading on the refractometer. With stones of high refractive indices, i.e. above $n = 1.70$ shadow may be obtained, but the value is that of the film and has nothing in common with that of the processed stone.

In addition to the simple and crude

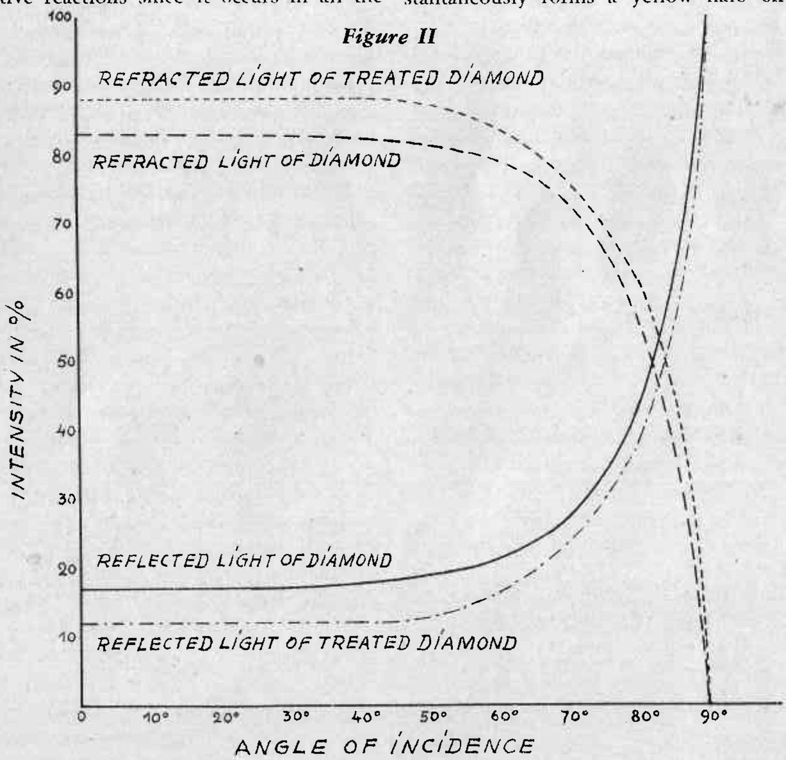
methods of detecting the film it seemed interesting to develop a more elegant and reliable method of detecting treated stones, and so such investigations were carried out and led to the preference for microchemical tests. The consideration of the relationship between the chemical composition of the treated gem and the anti-reflective film led to the conviction that in face of the infinitesimally small amount of the elements which comprise the film every chemical test will yield erroneous results, i.e. they will fail if the "beautified" gem contains the same chemical elements as those to be detected in the film. This is particularly true of the "hardening" silica film deposited onto silicate minerals. Therefore, a practical and reliable test had to be found that was capable of identifying the presence of the film,—even if it was covered by a layer of silica—and that was simultaneously influenced as little as possible by elements present in the gemstones. Fluorine offered the best possibilities for positive reactions since it occurs in all the anti-reflection films yet is a very rare constituent of gemstones, existing in fluorspar, topaz, and apatite only, while aluminum, barium, calcium, and magnesium are very frequently present.

Immediate and direct detection of even insoluble fluoride is guaranteed by means of the *Zirconium - Alizarin test.* The reagent needed can easily be prepared after the following recipe:

> 0.05 g zirconium nitrate is dissolved in 45 ml. water and 10 ml. concentrated hydrochloric acid, and 0.05 g sodium alizarin sulphonate is dissolved in 55 ml. water. Both solutions are stored separately and only small but equal quantities are mixed 10 to 15 minutes before the test is carried out.

A tiny drop of this reagent is placed onto a coated facet and after a minute or two the violet solution turns yellow. This reaction may be made permanently visible by touching the drop with the edge of a strip of zirconium alizarin paper which instantaneously forms a yellow halo on the

Figure II



purplish paper. This test is very valuable as the hydrochloric acid solution of the zirconium alizarin dissolves insoluble calcium fluoride.

The reagent prescribed above may again be advantageously used to impregnate quantitative filter paper for another, even more sensible test. Those who are afraid of preparing the paper themselves may purchase it from Eastman Kodak. The paper is of purple or red-violet color. To perform the test put a tiny drop of dilute hydrochloric acid (1/10 conc.) on to a facet of the treated gem and press this upon a piece of the zirconium alizarin paper for a while. After the stone is removed a yellow stain is left behind which contrasts conspicuously with the red-violet background of the paper. The test is very sensible and very reliable, provided that the treated stone is neither fluorspar, topaz, nor apatite. Despite these exceptions it offers the essential advantage of not being impaired by a coating of silica on the fluoride film, as silicofluoride is formed which behaves in the same way as fluoride ion.

A third fluorine test has the same practical advantage of detecting not only fluoride but also silicofluorides which react likewise. This test is called *The "Etching" Test* and is based upon the property of pure concentrated sulphuric acid to wet the surface of the glass smoothly and evenly, but to withdraw immediately from a spot where the glass was etched by hydrochloric acid. To proceed one must warm 1 ml. concentrated sulphuric acid in a narrow test tube and add a few grains of magnesium dichromate in order to clean any traces of grease from the glass. After the grains are completely dissolved pour the solution very carefully into a flat watch glass and pivot until the surface is clean. The sulphuric acid moistens evenly and spreads over the glass surface as a thin film. Then press a small facet of the "beautified" gem onto the glass and remove after a minute or so in order to observe that, at the point of contact glass-stone, the glass is slightly etched and the sulphuric acid has withdrawn and wets no more. (N.B. it is imperative to carry out this test in a very dry room, as sulphuric acid is strongly hygroscopic and fails to perform this test when it has become "wet.")

Those who are eager to specialize in learning more of the film's exact chemical composition—and this may be necessary in the case of topaz, fluorspar, and apatite—may carry out the classical tests for barium and magnesium. Any attempt at detecting calcium is too difficult and unreliable and may therefore better be discarded.

The barium test is easy to carry out and is based upon the excellent solubility of BaF_2 and the ability of an aqueous solution of sodium rhodizonate to produce colored reactions with solutions of the salts of divalent heavy metals (sodium rhodizonate responds very conspicuously to barium). Barium fluoride is extremely soluble in water (solubility at 18° C. = 1.63 mg./ccm.) so that a layer of barium fluoride can be dissolved in a drop of hot water or hot 30% acetic acid water without any danger of affecting the gem's surface. A facet of approximately 2 x 2 mm. should be large enough to enable a good test to be carried out. After a few minutes—sufficient lapse of time for the drop to dissolve the barium fluoride—this drop, which contains the barium fluoride, is, by means of a dropper pipet, transferred from the stone to a piece of filter paper upon which the sodium rhodizonate reaction takes place, i.e. a small drop of aqueous sodium rhodizonate is dropped onto the moist spot of the dissolvent on the paper. If necessary, in order to discolor the strong orange color of the sodium rhodizonate, a drop of acetic acid may be added. Within a few minutes and according to the amount of barium dissolved in the first part of the test a more or less intense red-brown stain appears. This test may yield misleading

Continued to Page 254

Another Rough Diamond Found in INDIANA

by

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FROM TIME TO TIME a gold panner comes to my door believing he has finally found a rough diamond. In ninety-nine per cent of these cases it is necessary to remind him that more than one half of the crust of the earth is composed of quartz, and that all of his treasures are also quartz.

The other day, however, there arrived another finder whose little box was full of quartz pebbles but, in a bit of paper carefully folded, was also a stone that looked like a triangular piece of double thick window glass. Not a scratch showed on it. It was water white and transparent and, on examining it with a 10 power Hastings aplanatic triplet lens, a depressed triangular marking was seen on the triangular top face and on the reverse face were three such depressed triangular markings. (Figures I, II, and III)

On the straight edge of the crystal was a ragged depressed place also with triangular markings on the tiny crystal faces.

The markings on the top and bottom faces were in reverse position to the large triangles on which they appeared, which is the usual case with such markings when they are seen on the triangular faces of a regular octahedron of rough diamond.

This much distorted crystal may then be a hemihedral form with great overgrowth of two octahedral faces and suppression of some of the other faces of the octahedron.

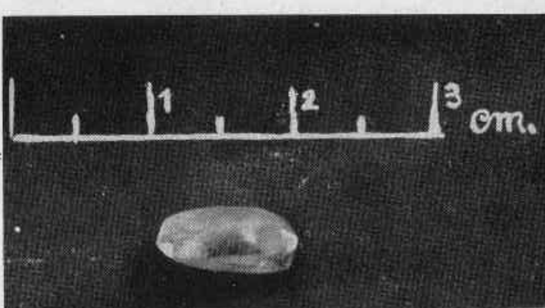
The stone weighed 3.93 carats (the largest Indiana stone I have seen in the rough) and measured 14 x 9 x 3.2 mm. It is, therefore, much too thin and spread to cut to advantage. It might, however, make a shallow marquise-cut brilliant of perhaps 1.25 carats. It could be cut to a fancy triangular form of considerably greater weight by leaving a central portion of some width with little or no reflecting power (on the order of a table-cut).

This crystal was discovered by a farmer in a field in Miami County near Peru, Indiana. All other finds in the state have been in heavy concentrates from stream gravel and have been made by gold panners who were working the bedrock bottoms of streams in Brown or Morgan Counties. Here nature concentrates tons of glacial gravel in the potholes and crevices in the stream bottoms, and panners further concentrate the heavy materials.

This makes the tenth diamond found in Indiana of which I have had personal knowledge. The others are as follows:

1. A diamond of 3.06 carats in the rough (since cut to a shallow marquise brilliant of 1.33 carats) from Salt Creek in the northeast corner of Brown County.

• Diamond from Brown County, Indiana. 3.06 carats.



2. A rough diamond of 3.64 carats from Morgan County (northwest of Martinsville, Indiana).

3. A tiny dodecahedron no bigger than a grain of sand from Gold Creek in Morgan County and from about the same neighborhood as the second case.

4. A cut stone of about 2.5 carats which was cut from a rough piece found in nearly the same vicinity as stones two and three.

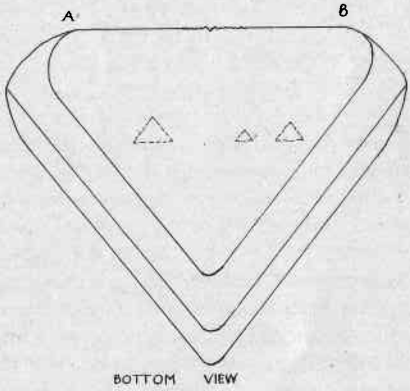


Figure I

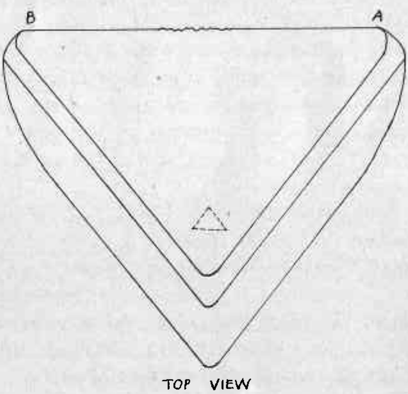


Figure II

5. A matched pair of brilliants of about .87 carats each cut from a rough stone purchased from a Brown County gold panner.

6. A rough stone of 1.05 carats bought by the Indiana State Geologist from a Brown County gold panner.

7-8-9. Three rough stones found by the late Dr. Kelso of Mooresville, Indiana in Gold Creek, Morgan County, and two of them shown to the author. The weights of these stones are 1.25, .625, and .75 carats.

Other finds have been reported from time to time (some in the annual reports of the State Geologist of Indiana). These finds have all been from Brown or Morgan Counties where terminal moraines exist and where shaley bedrock is always present in the stream beds to concentrate the glacial gravel.

For those interested in tracing the Wisconsin glacier I may report the finding of chlorastrolite by Dr. Kelso in Gold Creek (Morgan County). This material is found in situ only on Isle Royal, and in that vicinity in Northern Lake Superior.

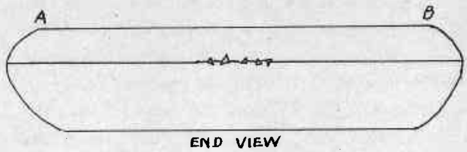


Figure III

Another significant find was that of a nugget of virgin copper in Boulder Canyon in Turkey Run State Park (Parke County, Indiana). This material probably came from the Keewenaw Peninsular extending up into Lake Superior.

If all of these discoveries of diamonds are plotted on a map it will be found that lines, drawn from the discovery points to the North, converge in the high lands west and south of Hudson Bay, from which the ice of the Wisconsin glacier is believed to have come. Several diamond finds in Wisconsin (two near Milwaukee) corroborate these findings.

Annual Review of the Diamond Industry for 1948

Digested by

KAY SWINDLER
G.I.A. Public Relations Director

Published by JEWELERS CIRCULAR-KEYSTONE from a handwritten manuscript left by the late Dr. Sydney H. Ball who for the past seventeen years has prepared and edited such reviews.

THE DIAMOND TRADING COMPANY and Industrial Diamonds, Ltd., for the Diamond Corporation, market 95% of all the world's rough diamonds. Sales during 1948 totaled £38,058,843, of which 70.3 per cent were gemstones. The 29.7 per cent which were industrial stones showed an increase of approximately £7,000,000 value over the previous year. Highest total for any previous year was when sales totaled £29,610,000 in 1946.

At the sales sights in London approximately 54 per cent of diamonds offered are purchased by the United States and eventually 75 per cent of all diamonds reach this country. It is reported that available rough was insufficient to meet demands but that the opening of the Premier and New Jagersfontein should help this situation.

MARKET CONDITIONS

In America generally the day of high priced articles seems temporarily over. Most clients want something in the $250 to $350 price range. The American public has less money for luxuries than during war years and Hollywood's cut payrolls are reflected in falling off of sales in that market.

Instability of the market was registered in Britain, reflecting a shortage of buying power in that country.

European market for cut diamonds was good because of the desire of Europeans to own diamonds rather than their own currency. In Australia the public displayed caution in buying, while in Hong Kong diamond trading expanded with much of the buying being for investment.

U. S. IMPORTS

Imports of diamonds in 1948 were worth almost four times as much in dollar value as imports of 1942, namely, $100,705,299. However, the largest year for imports was 1946 when $166,637,049 was spent.

Total U. S. imports of rough or uncut diamonds in 1948 was 912,762 carats, most of which came from South Africa. Most cut stones came from Belgium and Luxembourg.

CUTTING

Shut down of cutting plants in Europe during the war resulted in a boom for this industry in the United States. However, by 1948 Belgium had regained its place of world supremacy and the 5,000 cutters in America at war's close had dwindled to 2,000. Of this number 50 per cent were unemployed the major part of the year. However, American cut diamonds are considered the finest cut and are unsurpassed anywhere. Melee and very small stones are still cut abroad.

In Belgium at the end of 1947 there were 15,500 cutters employed. At the close of 1948, 7,000 were unemployed not counting those on part time and who had left the industry. Many factors contributed to this condition—black market, devaluation of the franc, shortage of rough, smuggling of cut, and exchange problems.

In 1947 there were 92 Dutch factories of which Asscher, the largest, employed just over 100 cutters. Palestine continued its hectic existence as a cutting center. In the second half of 1947, 2,500 cutters were employed in 30 of the 34 shops reopened and nearly 1,000 more cutters were working at home. By the end of the year the industry was concentrating on cutting brilliants of one half carats and up.

South Africa, like the United States and the Netherlands, is a cutter of large stones.

Little actual information is available concerning the cutting of diamonds in Germany but since the last half of 1947 rumors have persisted that industrials are being cut in the American zone. Efforts have been made to prevent rough from reaching Germany since the low cost of labor makes competition difficult for other centers.

A few cutters are working in Canada and the work is said to be excellent. Normally melee to one carat is cut. Small stones are cut by about 650 cutters in Great Britain, France has two centers, Brazil has from 600 to 3,000 cutters, Puerto Rico has 600 cutters, and Australia has two or three small shops. Other centers operating on a small scale are Egypt, India, Venezuela, British Guiana, Sweden, and South Borneo.

WORLD PRODUCTION

In 1948 the Belgian Congo again ranked first among diamond producing districts, showing 6,500,00 metric carats in 1948—an increase of approximately one million over the previous year. Total production of the Union of South Africa alluvial fields and mines was 1,200,000 carats. This includes industrials.

THE BELGIAN CONGO

Although still the largest producer in weight, the Belgian Congo in 1948 lost top place for money value to South Africa. The Congo still produces about three-fourths of the world's crushing bort.

ANGOLA

Diamonds are the principal export of Angola, or amount to more than twenty-one per cent of the total value of all exports. More than 30 mines in the district are open cuts. Small stones of good quality, averaging 5.4 carats, are recovered. The largest stone ever reported weighed 102.71 carats. Although no unusual progress is noted, there has been a gradual increase in production.

SOUTH-WEST AFRICA

Since the first diamond was found in 1908 production has been steady. Although production has been less in recent years, actual income from diamonds has not decreased appreciably as the stones recovered are larger and of fine quality. No production figures for 1948 are available.

TANGANYIKA

Tanganyika is currently one of the important diamond fields in the world since only 20 per cent of its production is industrial quality.

The first diamond was found in Tanganyika about 1910 and production began in 1926. The diamonds come mainly from the Williamson mine and other mines at Mwadui. Total production to November 1, 1948 is given as 827,537 carats.

Theft is reported to be high in the Williamson mines but better controls are being set up and it is anticipated improvement will be seen in the future.

SIERRA LEONE

The British holding company known as

"CASTS" (Consolidated African Selection Trust) is the dominant diamond producer of the colony. To January 1, 1949 total production of the Sierra Leone Selection Trust, Ltd.,—subsidiary and principal profit-maker of CASTS — was 9,500,000 carats. Stones from this district are small on the average and about 70 per cent industrials. However, the 770-carat Woyie River Diamond—largest alluvial gem diamond ever recovered—was found here as were two other large stones weighing 230 and 530 carats.

BRAZIL

Although little authoritative information has come out of Brazil, it is said that approximately 30 per cent of diamonds recovered are of gem quality. Some of the deposits are found in modern streams but most of them are in old stream channels. The state of Matto Grosso is said to be the most important producer and it is stated by some that the upland mine of Serinha, Minas Geraes, is approaching exhaustion.

In the summer of 1948 a fine 200 carat stone was found near Catalao, State of Goiaz.

BRITISH GUIANA

The first diamond, positively identified as such, was found in 1887. From 1901 to the close of 1947, 2,357,000 carats had been recovered, from which the largest single stone was a 97 carat bort found in 1937. The largest gemstone recovered was found in 1926 and weighed 56.75 carats.

Early in 1948 rich gravel was reported on the boundary between British Guiana and Brazil. It is claimed twelve men recovered 6,000 carats there in one week. The stones were largely industrials and some of fair size.

OTHER COUNTRIES

Diamonds found in the Victoria Commonwealth of Australia are alluvial and most are found during placer gold mining. The stones are small—largest six carats—and many of them are of gem quality.

Few diamonds are produced in India any more, the current production believed to be about 1,650 carats yearly. In comparison, South Africa in 1947 produced 4,020 daily. Early in 1948 V. S. Dubey of Benares claimed to have found a diamondiferous pipe in the state of Panna which he stated would grade one carat per four tons. No further information is given.

Although it is known diamonds occur in the Ural regions of Russia, no information is available from the Soviet Union concerning the current production.

INDUSTRIAL DIAMONDS

Sales of industrial diamonds in 1948 were large—either taxing or over-taxing the supply. This condition was a result of prosperous business conditions and increased stockpiling by the United States government.

In Britain also more industrial diamonds were used than in the pre-war days in order to speed up industrial production. It is said that America uses 60 per cent of the world's industrial diamonds (and 40 per cent of the gemstones).

Increased mining costs make it imperative that the price for industrials must increase or poorer stones must be used. If these procedures are not followed, the increase of cost must be charged through gem diamonds which are recovered from the same mines. As an economy measure, there is a tendency by some firms to use smaller industrial stones.

Rightfully enough, the U. S. government continues to stockpile industrial diamonds, essential to munitions making. The statement has been made that strategic materials will be purchased more vigorously even if industry is pinched by the shortage.

Intended to further the use of industrial diamonds, a Diamond Research Laboratory has been established in Johannesburg by the Industrial Distributors, Ltd., and its principals, De Beers and associated companies. The laboratory is well equipped and has a capable and experienced staff.

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results with treated benitoite.

The magnesium test is still less generally reliable as it may show positive reaction with all gems that contain magnesium amongst their chemical constituents and also reacts in a similar manner with beryllium and zirconium. However, this test may be applied to all other gemstones which do not contain magnesium, beryllium, or zirconium.

Dissolve the film in hot aqua regia and add sufficient sodium hydroxide to make this solution alkaline; then place a drop of this test solution and a drop of distilled water in adjacent depressions of a white porcelain test plate; add a drop of an alcoholic solution of quinalizarin. The test water turns a faint blue-violet, while the test solution assumes a cornflower-blue coloration if magnesium be present.

It is to be hoped that the facility of the above described possibilities of detecting coated stones will deter frauds from misrepresenting such stones and free the trade from the disquieting aspects of this new process of artificially beautifying gemstones.

The author is indebted to R. Shipley, Jr. for interesting information and to Dr. H. Waldman, one of the prominent chemists of the Hoffmann-La Roche Concern, Bale, for valuable assistance and advice in the investigation of the methods of chemical detection.

LITERATURE CONSULTED

1) *Spot Tests* by F. Feigl, Eng. Dr. Sc.

2) *Chemical Tests for Paste and Quartz* in the Gemmologist, Feb., 1948, by M. D. S. Lewis, A.R.C.S., B.Sc., F.G.A.

3) A. Smakula, *Ztschr. f. Instrumentenkunde* 60, 1939.

4) *Prism and Lens Making* by F. Twyman, F.R.S., Hilger Publication, 1943.

5) Treatise by Metal-Lux, Chiasso, 1948.

Editor's Note: It is to be noted that the foregoing applies to methods for determining the presence and nature of a coating. However, as pointed out, a first indication of the presence of coating often is a fantastic refractive index reading, or none at all. When such an effect is observed, and it is not desired to retain the coating, it can quickly be removed from the table of the stone by brisk rubbing with jewelers' rouge. A power buff will remove the coating in the matter of seconds.

JAGERSFONTEIN MINE OFFICIALLY RE-OPENS

ALTHOUGH the new Jagersfontein development has been in a producing stage since July, the mine was officially re-opened December 12, 1949 with a ceremony attended by dignitaries of the Free State, as well as diamond industry officials.

Opened in 1870 originally, the Jagersfontein Mine continued to produce until 1932 when a slump period caused its closing. Work of remodeling and re-equipping the mine started in July, 1946 and when production was resumed in July of last year eight hundred loads of blue ground were being shifted, washed, and treated each day.

Leased by De Beers, the mine was reconditioned at a total cost of £1,700,000 and the monthly expenditure for operation is estimated at £50,000. Despite any vicissitudes which may be in store for the diamond trade, Sir Ernest Oppenheimer expressed the resolve to maintain continuous and uninterrupted operations until the payable blue ground of the mine is exhausted.

"I speak today with utmost confidence about the future of the diamond trade because an efficient organization has been built up and those responsible for the conduct of the business have created such large cash resources that any temporary falling off in demand will not embarrass them. New discoveries will no doubt be made in the future and new situations will arise which will make it essential that those responsible for the diamond trade should follow a conservative policy so as to augment the already very large resources."

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G.I.A. GOVERNORS MEET IN NEW YORK

THE governors of the Gemological Institute of America met at a luncheon conference at the New Weston Hotel in New York on January 14.

Governors present were Leo Vogt of the Hess and Culbertson Co., St. Louis; John Kennard of Kennard and Co., Boston; Lazare Kaplan of Lazare Kaplan and Sons, New York City; Myron Everts of A. A. Everts Co., Dallas; Charles H. Church of Church & Co., Newark; and Jerome Wiss of Wiss Sons, Inc., Newark. Other members of the Gemological Institute of America present were Fred Cannon of Slaudt-Cannon Agency Co., Los Angeles, Secretary-Treasurer of the Institute; C. I. Josephson, Jr., of C. I. Josephson, Moline, Illinois; and R. T. Liddicoat, Jr., Assistant Director of the G.I.A.

This meeting was held to receive the treasurer's report for 1949 and was preliminary to the annual meeting to be held this spring.

AMETHYST COLOR INDUCED IN CLEAR QUARTZ BY CYCLOTRON

A SHORT NOTE has recently appeared in the August 1949 issue of the *Review of Scientific Instruments* which was intended for the nuclear physicist, but which should prove equally interesting to the gemologist. The article is entitled "Note on removing the deuteron—induced color from quartz target plates," and the authors are A. A. Schulke and R. E. Nuelle.

Transparent, colorless quartz plates are frequently employed as an aid in aligning the target assemblies in a cyclotron. The plates fluoresce a bright blue under deuteron (heavy hydrogen) bombardment, and rough measurements of the beam pattern can be made visually. It was found, however, that the quartz plates turn deep purple after relatively short bombardment, and that the color change is apparently stable under normal conditions. It was further found that the color could be destroyed by heat treatment. At 280°F the amethystine color very slowly disappeared, accompanied by a strong blue fluorescence. The color disappeared more rapidly at temperatures of 300°F to 400°F, while at 600°F to 700°F the plates glowed brightly for a minute or two after which the glowing ceased suddenly, leaving the plates perfectly clear.

The exact cause of the color in many allochromatic gems such as amethyst has never been satisfactorily explained. This incidental sidelight may or may not have a bearing on the problem of the cause of color of natural amethyst, but is certainly worthy of thought and perhaps further experimentation.—G. Switzer.

DEATH COMES TO ANNA BECKLEY

ON THURSDAY, January 12, 1950 Anna McConnel Beckley — for many years literary research director of the Gemological Institute of America — passed away after a lingering illness at her home in Pasadena, California. She was 76 years of age.

Her precise observance of accurate detail made her invaluable to the G.I.A. and from its founding in 1931 until her retirement in 1947 she served faithfully and well in conducting literary research. Many of the early assignments of the Institute's correspondence course are based on facts which she gathered and coordinated.

Her first position—one which she held for twenty years — was with the Los Angeles

Public Library where she worked in the Reference Department, eventually becoming its head. For another twenty years before coming to the Institute she taught history of art, medieval and modern history, and riding at Marlborough—an exclusive school for girls in Los Angeles. She was an expert horsewoman.

She was co-author of *History of Art* which at the time of its publication was one of the most comprehensive works written on the subject. She collaborated with Robert M. Shipley on the research for his book *Famous Diamonds of the World* and assisted in research for his *Dictionary of Gems and Gemology.*

Although for almost three years her health has not permitted active participation in the work of the G.I.A., the impress of her fine, clear mind is evident on many of its courses and publications, and all who use them are more deeply indebted than they know for the brilliant and careful work of Anna Beckley.

G.I.A. AWARDS
53 DIPLOMAS

SINCE last reported in the fall issue of *Gems & Gemology* 53 students have completed studies and examinations of the Gemological Institute of America. Of these the following eight have received diplomas in the Theory and Practice of Gemology.

GRADUATE GEMOLOGISTS

Thomas C. Hayes, Monrovia, Calif.
C. E. Heighes, Los Angeles
Joseph R. Occhipinti, Brooklyn, N. Y.
Max S. Pyrene, New York City
Charles S. Sheppard, Jr., Russelville, Ark.
Walter E. Singer, Winston-Salem, N. C.
Leon J. Trecker, Hollywood, Calif.
George A. Vonderhaar, Rockford, Ill.

GEMOLOGISTS

Arthur A. Barth, Los Angeles, Calif.
Sacha Bollas, Los Angeles, Calif.
William A. Brice, Chicago, Ill.
Merlin A. Bullard, Cottage Grove, Ore.
Eugene C. Canfield, Charleston, S. C.
Gustave Cohen, Summerville, Mass.
James W. Coote, Los Angeles, Calif.
John Dickey, Casper, Wyo.
Edward A. Dillon, Tallahassee, Fla.
Elmer Dory, Paris, Tex.
Roger Dumoulin, Sudbury, Ont., Can.
Leopold Farber, Washington, D. C.
Frank C. Hamilton, Brockton, Mass.
R. G. Henne, Pittsburgh, Pa.
Julius D. Jacobs, Jr., Cincinnati, Ohio
Harold F. Jennings, Roanoke, Va.
John D. Jennings, Windsor, Ont., Can.
C. F. Johnson, Tyler, Tex.
George Lautares, Greenville, N. C.
John C. Lennox, Indianapolis, Ind.
C. A. Lewis, West Hollywood, Calif.
Howard M. Little, Bedford, Pa.
Durant B. Mathes, Topeka, Kan.
Clifford J. Mikkola, Minneapolis, Minn.
Ralph W. Molkentin, Plainfield, N. J.
Carl Nelson, Bessemer, Pa.
Joseph Paul Ouellet, Nashua, N. H.
Dennis S. Pearce, Phoenix, Ariz.
Joseph F. Person, St. Pétersburg, Fla.
Michael Prohodsky, Ellenwood, Kan.
Leonard A. Pulliam, Denver, Colo.
Victor Ritter, Spokane, Wash.
Irving Robbin, Chicago, Ill.
Paul H. Robinson, Westfield, N. J.
Ralph W. Rohlfing, South Bend, Ind.
Joseph F. Shea, Clinton, Mass.
Wilbur L. Stahr, Grand Rapids, Mich.
William L. Stone II, Pottstown, Pa.
Sol Toscher, Pittsfield, Mass.

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Richard V. Trowbridge, Coshocton, O.
Ben Walters, Toronto, Ont., Canada
Raymond L. White, Cove, Ohio
Don E. Wight, Ontario, Calif.
John M. Wise, Baltimore, Md.

TITANIA NOW MADE AS DOUBLET

THOMAS L. DANIEL, Los Angeles lapidary, has successfully manufactured a number of doublets, consisting of a Titania base and a colored corundum crown. Top and bottom positions are fashioned separately and then cemented together. Virtually the entire range of synthetic corundum colors is represented. In each case, however, the synthetic rutile is of the very slightly yellowish quality. These stones do not appear to have suffered any appreciable loss of brilliancy or "fire" as a result of the combination of the two materials. Practicability of this idea has not yet been proved but, other factors being equal, the increase in hardness of the exposed crown from approximately seven to nine should be advantageous.

BUREAU OF MINES REPORTS ON DIAMONDS IN ARKANSAS

AVAILABLE from the Bureau of Mines Washington, D. C. is its *Report of Investigations 4549*. This is a report of the Bureau's investigation of the Prairie Creek diamond bearing area in Arkansas. This area contains the kimberlite pipe near Murfreesboro from which approximately 50,000 diamonds had been recovered at various times since 1907. Begun in April 1943, the investigation was the result of a request to the War Production Board for wartime priorities by The North American Diamond Corporation, the owners of the largest mine. The resulting examination of the Prairie Creek area by the Bureau of Mines was concluded in 1944 and described in this report which was released by the U. S. Department of the Interior in November, 1949.

Samples of kimberlite weighing 435 tons recovered from 49 test holes distributed equally over the entire area yielded 32 stones averaging 0.256. Of these 57.5 in weight came from 20 feet or less in depth. There was ample indication that the yield from the blue ground (i.e. the kimberlite which had not weathered) would be considerably less. Only one stone came from below 36 feet.

Of three appraisers, one suggested the possibility that the four largest of the 32 stones might be of gem quality. All graded the entire lot as of excellent industrial quality.—R. M. S.

NEW FIGURES GIVEN ON DIAMOND RECOVERY

New figures obtained from private correspondence with the De Beers organization state that it requires twenty-three tons of blue ground on the average to produce one carat of cuttable rough—of which approximately fifty per cent is lost in cutting. These figures are based on production from five active De Beers pipe mines and replace those previously given as thirty-five tons of blue ground to one carat of cuttable rough.

HISTORY GIVEN FOR STAR OF THE EAST

ACCORDING to Harry Winston, present owner of "The Star of the East," the 94.80 carat, pear-shaped diamond was known by that name when it appeared in Paris early in this century.

The present owner further states that

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although its early history is not known, it was owned by Abdul Hamid II, Sultan of Turkey, and during the period of unrest shortly before the Young Turk's revolt, was sent to Paris to be sold.

Evalyn Walsh McLean who purchased it from Cartier in 1908 usually wore it, along with the famous Hope, suspended fróm a magnificent diamond necklace.

REVIEW

"Pearl Culture in Japan," by *A. R. Cahn, published by General Headquarters, Supreme Commander for the Allied Powers, Natural Resources Section, Report No. 122, Tokyo, 1949.*

THIS REPORT of the Natural Resources Section of SCAP is one of a series dealing with the resources and economy of Japan. It is the first work appearing in the English language that covers completely and in detail all phases of the pearl culture industry, and, as such, should be of interest to the gemologist.

The essential elements of the pearl culture industry have recently appeared in *Gems and Gemology* (Vol. 5, No. 10, pp. 417-20, 1947). The work under review gives, in its 91 pages, the details of the industry, including its history, production statistics, biology of the pearl oyster and of pearl formation, and a list of Japanese patents pertaining to the industry.

Dr. Cahn considers the disputed honor of first producing completely round pearls, and concludes that Tatsuhei Mise, a carpenter by trade, first developed the method now in use, and produced the first round pearls. Mise's application for a patent on May 13, 1907, however, was not granted. Tokichi Nishikawa's application for a patent was submitted on October 23, 1907, and was granted. Documents that have recently come to light apparently confirm that Mise was, indeed, the discoverer of the commercial method for producing pearls.

The question is frequently asked, "How thick is the pearl nacre on the nucleus?" Cahn includes a table showing the rate of deposition of the nacre on a nucleus. The thickness of the nacre depends primarily upon the period of growth, but is also influenced by the size of the nucleus. Thus, a pearl with a nucleus of about two millimeters will, after one and one-half years, have a nacre thickness of about one-fourth millimeter; a nucleus of about seven millimeters, after three years growth, will have a nacre thickness of almost one-half millimeter. An ordinarily good sized pearl, say three millimeters in diameter, will be about four-fifths nucleus and one-fifth pearl nacre.

The production statistics in the report are an interesting indication of the greatly depressed state of the industry. In 1938 a total of 10,883,512 pearls were produced. In 1946 the number dropped to 387,596 pearls. Material shortages, especially of wire for rearing cages, together with lack of capital, have prevented the small farms from resuming operations. A shortage of brood stock also exists. It is Dr. Cahn's opinion that it will be some years before pearl production can be resumed on a normal basis. The stocks made available during the last few years by SCAP undoubtedly were largely drawn from reserves, and it appears likely, therefore, that high quality strands will become scarcer before full production is again attained.

Unfortunately, this report has been issued in a very limited edition. Photostats or microfilm can, however, be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.—W. F. Foshag.

Contributors in this Issue

EDWARD J. GUBELIN, Ph.D., C.G., F.G.A., of the Editorial Board of *Gems & Gemology* and only Research Member of the Gemological Institute of America, is the founder of the Gemological Institute of Switzerland. Born in 1912, Dr. Gubelin's interest in gemological research started in 1925 when his father provided a gemological laboratory for his use. Edward Gubelin has been conducting experiments and research ever since. Dr. Gubelin studied mineralogy at the University of Zurich. In 1936 he was sent into the Campolungo Domomite region to prospect for minerals occurring there. Following this, he spent a winter term with Prof. H. Michel in Vienna, and in 1937 he attended a special course with Prof. Dr. K. Schlossmacher in Koenigsberg. Receiving his doctorate in 1938, he began his studies with the Gemological Institute of America, becoming a Certified Gemologist in 1939. In 1946 he received a fellowship from the Gemmological Association of Great Britain. He lectures yearly on gemology in both Britain and Sweden. He has done outstanding work with photomicrography and his recently completed book *Inclusions as a Means of Identification* is now being published by the Gemological Institute of America.

THOMAS DRAPER, born in the Transvaal in 1876, gained his early geological and mining experience with his father, Dr. David Draper—a pioneer in the Kimberley diamond fields and in the first discoveries of gold mines in South Africa. He worked with his father in mapping out the geology of the Witwatersrand around Johannesburg and then went to London to complete his studies. From there he went to Baja California to prospect for the extension of the copper deposits of the Boleo Copper Mining Company and to test the gold reefs at Calamalli. Later he went to Borneo for the Shell Oil Company where, as its pioneer geologist, he was responsible for defining the oil belt between Sanga Sanga and Balik Pappan. After a visit to China, he returned to South Africa via Ceylon. Later he was again sent to Mexico a number of times and twice to Brazil, then to Madagascar to examine the oil seepages of the Sakalava valley. After a short time tin mining in Cornwall he spent three years in Cuba mining for asphalt and prospecting for oil. In 1921 he made his third trip to Brazil and since then has been engaged in diamond mining as manager of various companies and in partnership with his brother Edward, whose photographs illustrate *Diamind Mining in Brazil* in this issue of *Gems & Gemology*.

FRANK B. WADE pioneered in the introduction of gemological science to the diamond and gem trade through his books *A Text Book of Precious Stones* and *Diamonds, A Study of the Factors that Govern Their Value,* appearing first in the *Jewelers Circular*. Born in New Bedford, Massachusetts, he was a member of the faculty of the Shortridge High School in Indianapolis for forty-six years and head of the Chemistry Department since 1910. In 1938 he was awarded an Honorary Master's Degree in Chemistry from his alma mater, Wesleyan. He received an Honorary Doctor of Science degree from Wabash. Although now retired, Frank B. Wade continues his research, writing for publication on chemistry education and his hobby of cutting and polishing practically every kind of genuine and imitation stone, except the diamond.