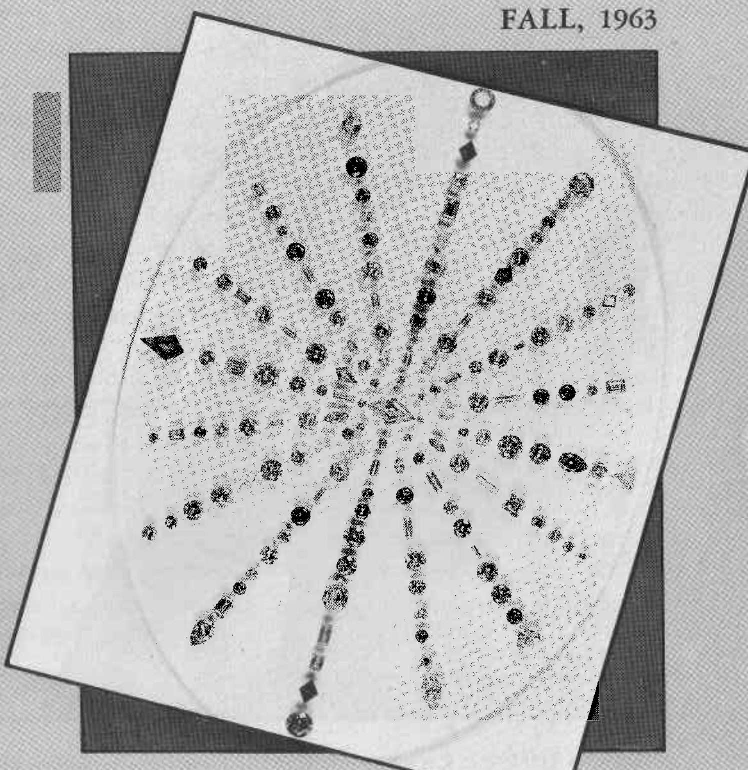
Gems and Gemology

FALL, 1963



See Inside Cover

Gems & Gemology

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On the Cover

De Beers Colored-Diamond Collection. Approximately one-third actual size. See N. Y. Lab Notes, page 80.

Photo Courtesy N. W. Ayer & Sons, Inc., New York City

Diamond Mining and Recovery Today

by

Gladys Babson Hannaford

No matter what product a retailer carries, a healthy respect for the people and methods behind its production gives him a greater sales enthusiasm. A visit to the diamond mines develops this respect to a point that borders on awe.

Last year, Elizabeth Henry and I spent five and a half weeks in Africa. This was no casual trip. We spent all day, every day, with diamonds. We returned home a little humble but very proud to be associated with diamonds.

We went by jet to London and then to Nairobi in Kenya also by jet. By then, we were almost halfway around the world. But actually we were just starting on our real trip.

The first mine we visited was Williamson Diamonds, Limited, in Mwadui (pronounced Muh-DOO-y), Tanganyika.

The township and mine, covering 10 square miles, are situated about 90 miles south of Lake Victoria on a high, grassy plain, 4000 feet above sea level. Dar es Salaam, the principal supply base and the capital of Tanganyika, is situated 620 miles away on the coast. Most of the heavy equipment is transported from this port city via railroad. The mine has its own landing strip and, to take care of urgent needs, operates cargo planes. From Nairobi, we traveled by cargo plane. We were part of the cargo!

Seeing the town as it is today, with paved streets, lovely homes, swimming pools, trees and gardens, it is hard to visualize Dr. Williamson in a sea of waving grass carrying out his private prospecting, which led to the discovery of this pipe mine.

A private company, Williamson Diamonds, Limited, was formed on March 19, 1942, and Dr. Williamson was faced with the heavy responsibility not only of establishing a mine in the wilderness in the face of great financial and technical difficulties, but of building a town to meet the varied needs of a large community.

He did more. He built great respect for himself and for his idea of human relationships. There are still many at the mine who worked for him, and they speak of him today with great respect and affection.

Mr. Harry Oppenheimer, Chairman of De Beers Consolidated Mines, Limited, said, "I am sure that Dr. Williamson will finally be recognized as the man who set going a process that will eventually, in its repercussions, raise the standards of living conditions generally throughout the territory."

After Dr. Williamson's death, the Government of Tanganyika and De Beers Consolidated Mines, Limited, became joint owners of the mine.

Although it is a generally accepted theory that diamonds were created in a volcanic action — the volcanic rock here being peridotite, kimberlite, or blueground—a very limited number of the ancient volcanoes, or *pipes,* have contained enough diamonds to be mined profitably. This volcanic rock is comparatively soft and contains varying amounts of clay. It early succumbed to nature's weathering process and, over the long years of geologic time, many of the world's diamonds were washed out of their volcanic beds and carried far from their sources. They came to rest in the alluvial fields, which will be discussed later.

All diamond pipes are weathered at the tops. With this weathering the bluish rock turns a yellowish brown, and some of it appears to be gravel. All the pipes have been mined first from the tops by the open-pit, or open-cast, method before a shaft is sunk for underground work. The Williamson Mine is in this stage of operation, and it will be operated in this manner for some time to come.

At its top, Williamson is the largest of all the pipe mines. It is eliptical in shape and roughly 3900 x 5000 feet in diameter; this would be about 347 acres.

Although it is believed that some of the African pipes have weathered down from the volcanic surface as much as 4000 feet, the mine at Mwadui has weathered very little — roughly, 100 to 200 feet. In the center, it has settled about 500 feet.

Drainage in Mwadui is not good, and this is probably the reason for the small amount of weathering. The first eruption is believed to have left a rim around the periphery of the mine. Small additional eruptions brought up the center. Finally, after weathering and settling lowered the center, shales were carried in.

The first two or three inches of the mine as it is today was covered with "black-cotton soil," found in nodules, probably once a lake bottom. It looks and feels like tar and is dirty, but it is

The author (left) and Elizabeth Henry in the sorting room at Williamson Diamonds, Ltd., Tanganyika.

easily washed away. One of the men said it was "oily, like graphite."

Beneath this there is a layer of *silcrete* (silicated kimberlite), which varies in depth from a few inches to as much as 40 feet.

Next comes a layer of gravels and shales two to four feet deep. In some sections of the mine, this layer holds the richest deposit of diamonds.

Below that is 200 feet of upper-bedded kimberlite; 300 feet of lower-bedded kimberlite and shale basin; and 400 feet of conglomerate, primary kimberlite, granite pieces, basal breccia and sedimentary material. Below this is the pipe of primary kimberlite.

Even though we are inclined to think of the weathered area at the top of the mine as being gravel, there are some hard-packed areas where blasting is done; drilling here goes to a depth of 25 feet. The explosive used is ammonium nitrate and 6% (maximum) diesel oil.

Then the earth-moving equipment takes over. The walking drag line, so called because it travels from one area to another on caterpillar treads, is a huge piece of equipment that is used in some of the excavation work. Its shovel can pick up six tons or more at one bite and swing around to load it into 35-ton trucks. Regular excavators or mechanical shovels are also used.

The trucks carry the ore to the field crushing plant, where the oversized pieces are reduced to a maximum of six inches. From the crushing plant, the ore travels two miles by conveyor belt to the treatment plant.

All gravels from the field pass first through barrel scrubbers, where they are given their first washing. As the name suggests, these look like large, straight-sided barrels laid horizontally; they are seven feet in diameter and 16 feet long. Water is added as the gravels enter the scrubbers, so that the barrels contain 50% gravels and 50% water. The washing operation takes place as the scrubbers revolve. Clay is suspended and carried off. The black-cotton soil is removed here.

After the washing operation, the gravels travel over screens. Here pieces up to 1½ inches in diameter are separated from the larger ones. The larger material travels to a crusher, where it is reduced in size and passed to washing screens.

All material from $\frac{1}{10}$ to 1½ inches in diameter is ready for heavy-media separation.

The diamond has a high specific gravity, higher than that of most of the other minerals found in the gravels. For this reason the heavy-media process is used.

To the layman this would appear to be another washing operation. Ferrosilicon (28%) is added to water, making a fairly thick liquid. The specific gravity of this "bath" is 2.85. When the crushed gravels pass through this operation at the Williamson mine, 99.5% of the minerals are floated off, because they have a lower specific gravity. The .5% of high-specific-gravity minerals, containing the diamonds, sink. This operation is commonly referred to by plant men as the "sink and float." It takes place in large cones that are 12 feet across the top and taper down to a narrow base.

Although some of the material is reduced in size when it is agitated in the heavy-media cones, some remains large enough to contain small embedded diamonds and is carried off as float. Therefore, all float materials pass over float screens after leaving the cones. Gravels over ⅜-inch in diameter go to "recrush"; i.e., crushers that reduce its size. Gravels over $\frac{1}{10}$ inch in size go through heavy media again. The slime, or thick mud, travels over magnetic rollers for the recovery of the ferrosilicon.

From the heavy-media cones the "sink," which contains the diamonds (now called concentrate), goes to the recovery house, approaching the end of its journey. There the concentrate passes through the ball mills; these, which look like smaller editions of the barrel scrubbers, are six feet long and four feet in diameter.

When the concentrate goes into a ball mill, 15% of water is added to make a thick mixture. Inside the mill are five tons of steel balls, each 1½ inch in diameter. When the mill revolves, the balls break up further the material holding the diamonds; this is done with attrition, not pounding, and the diamonds are not injured in the process.

From the ball mills the concentrate goes to the grease tables. Many jewelers tell their customers about the diamond's affinity for grease to emphasize the need for periodic cleaning of their diamond jewelry. All diamonds found underground in the pipe mines have a nonwettable surface that causes them to adhere to the grease tables.

But the diamonds found in weathered gravels at the top of a pipe, as are the diamonds in the Williamson Mine in this stage of its operation, and those found in alluvial fields have a thin surface deposit that makes them wettable; therefore, they will not adhere to grease.

This means that the concentrate must be preconditioned before the grease tables can be used for the recovery of the diamonds. Treating the concentrate with sodium-oleate acid (a fish-acid oil) and caustic soda produces a combination of both electrical and chemical forces. An absorption on the surfaces of the diamonds then make them water repellent, or nonwettable, and ready for the grease tables.

The grease tables used for treated concentrate are continuous moving belts. When the concentrate is passed over one of the belts, the diamonds stick to the grease and the waste material is sluiced off. The diamonds are scraped off at one end of the belt, and the belt is coated with new grease for a repeat performance.

(The grease table used in a pipe mine is a series of tilted, vibrating steps, rather than a continuous belt. As the steps take on the diamonds adhering to the grease, they are periodically scraped clean and then recoated with grease for the next batch of concentrate.)

After being scraped off the grease table, the diamonds are cleaned. Then they are ready for the sort house.

The above describes how diamonds are recovered from gravels over $\frac{1}{10}$ inch in diameter. Smaller stones (i.e., 2 mm. to .16 mm in size) are not cuttable, but industry has a ready use for them.

In every screening operation, the fine material is separated from coarser gravels and must be handled by a separate process; this goes to "cyclones," a combination of heavy media and centrifugal force. The medium here is magnetite. 60 to 70 tons go through the cyclones each hour, 99.5% of which is waste. Concentrate containing diamonds is .5%. The specific gravity in the cyclones ranges from 1.9 to 2.01, but it usually is 1.97.

The concentrate is dried by infrared light, and then it is passed through a four-stage electrostatic separator. Because diamonds are nonconductors of electricity, this operation separates the diamonds from the other materials.

(Grease tables cannot be used for these small diamonds, because their surfaces are too tiny to cling to the grease.)

From the separator these diamonds also go to the sort house.

At the Williamson Mine, the diamond yield at the 20- to 30-foot level averages nine carats per 100 tons. Some sections of the mine produce more; others, less.

About 45% of the total production is larger than a carat, and the remainder varies from one point to a carat. About 45% are of cuttable quality; the remainder, industrials.

The effort to improve recovery methods is continuous. When one considers that here only one part in 30 million is diamond, one cannot help but be impressed by the efficiency of the entire operation.

But there is the human side of the diamond-mining picture. Where diamonds are found in the wilderness, as they are in Tanganyika and in South West Africa, modern villages have been built; this alone seems like a modern miracle. Living conditions are comparable to our own small cities and towns.

The population of this mining town is being developed to provide integrated facilities for all to participate in social, cultural and religious activities of their choice. The homes, even the smallest, are attractive. Electricity is provided for all accommodations, as is chlorinated, filtered water. There are stores, clubs and community centers.

The hospital has unexcelled equipment. Each year 36,000 outpatients are treated, and 30,000 enter for hospital care. As of 1962, there were seven surgeons in Tanganyika to treat its nine million people, and one of the finest was in Mwadui.

With the independence of Tanganyika, new problems arose; this is understandable — we had them after 1776. But the capable hands of George Hunt, manager of Williamson Diamonds, backed by the liberal policies of Mr. Harry Oppenheimer and De Beers, steered Mwadui through these times with the minimum amount of confusion.

Elizabeth and I, and our wonderful memories of Mwadui, left by cargo plane for Nairobi; from there, a jet took us to Johannesburg.

Our next mining area was historic Kimberley, which is not far from Johannesburg.

Originally, there were five pipe mines here: De Beers, Kimberley, Dutoitspan, Bultfontein and Wesselton. The De Beers Mine was closed in 1908, when it was no longer considered payable, but it will be reopened in 1964 with a new shaft and headgear.

The "Big Hole," at Kimberley is completely mined out. The townspeople love to tell you that this is the largest manmade hole in the world.

The other three are in operation. In underground mining, a shaft is sunk through the rock surrounding the pipe, and tunnels are extended from the shaft into the blueground. Dutoitspan and Bultfontein are 300 feet apart and are connected by a tunnel at the 1900-foot level. The Bultfontein shaft is used for

The author (right) and Elizabeth Henry inspecting the underground workings of one of the Kimberley diamond mines.

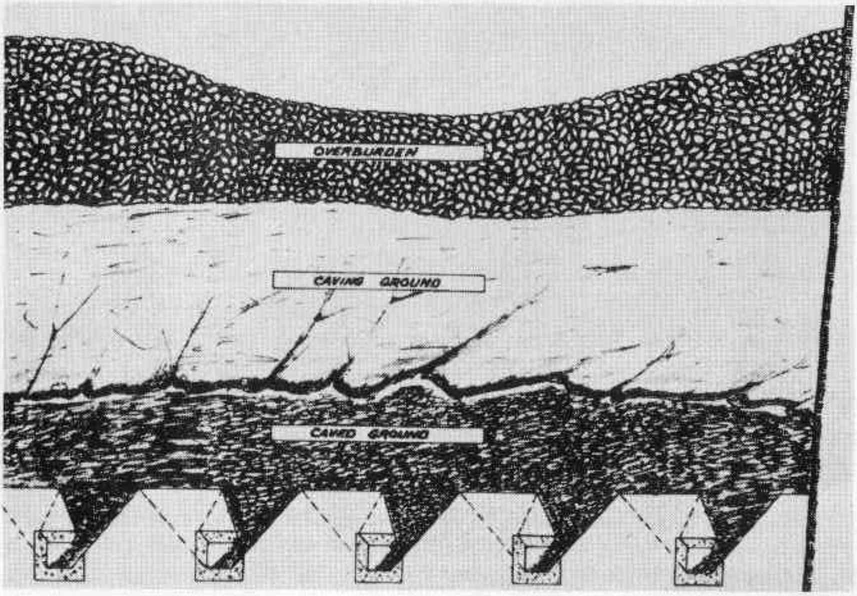
transporting workers and for rock haulage for both of these mines. Blueground from Dutoitspan, Bultfontein and Wesselton is combined at the surface for processing at one recovery plant.

These mines are being worked at different depths. As the mining goes deeper, fewer and smaller diamonds are found than were found in the upper levels. Each mine varies in production.

Block caving, which is done in both the Bultfontein and Dutoitspan Mines, is practical here, because of the physical characteristics of the wall rock and ore. Tunnellike, cement-lined scraper drifts are cut horizontally through the rock 45 feet apart. Along the drifts, 4- x 4-foot draw points, or openings, are staggered on opposite sides at about 11-foot intervals. Overhead, cone-shaped "raises" cover the lower wall of the undercut level, which is 19 to 29 feet above the scraper level.

The caved ore is drawn off by scrapers, dropped through ore passes, and picked up on the level beneath by a loco-drawn series of cars called Granbys. From this haulage level, the ore then is dumped to huge crushers on a lower level, where the material is reduced to about 6 inches in diameter. Now it is ready for its trip to the surface.

Wesselton has its own shaft, and is operated separately. The mining method here is chambering, which has been used with little change since 1890. Horizontal chamber levels are established 40 feet apart; then, 22-foot cuts are mined out across the pipe. Each 22-foot cut consists of a pillar and a chamber, each of which is 11 feet



Section across scraper drifts.

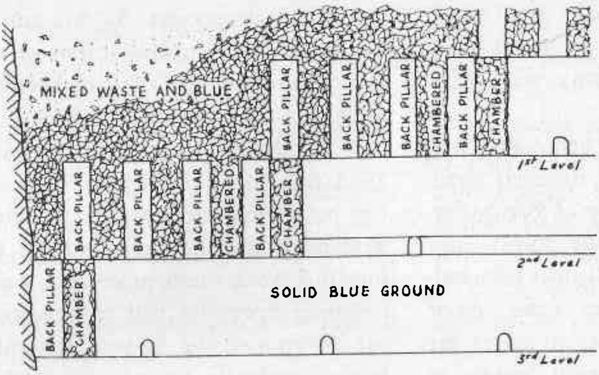
across. The chamber is mined by overhead-shrinkage stoping.

Chambering is done at the 1430-foot level and the haulage level is at 2160 feet. The blueground is loaded by workers into cars known as "co-co pans," a car carrying 4/5ths of a ton. The blueground travels to the haulage level through ore passes, goes through crushers to reduce the larger pieces and thence to the surface. There it joins with the ore from Dutoitspan and Bultfontein.

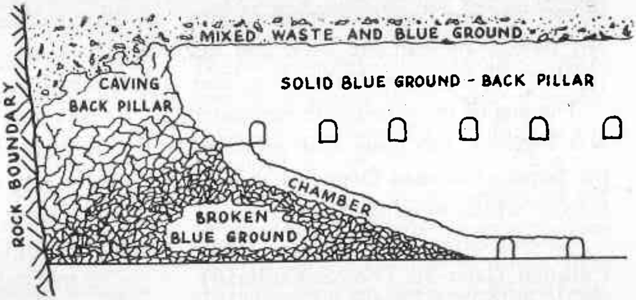
Unlike the ore from the Williamson Mine, the blueground here does not have to go through barrel scrubbers; however, it does have to travel over screens or classifiers to separate the fine material.

There is another major difference: rotary washers are used. These are 14 feet in diameter at the outer periphery and eight feet at the inner. Between the two, rakes revolving at eight rpm. stir up the broken blueground and water, a mixture of 2/3rds water and 1/3rd rock. Under agitation the blueground breaks down, and the clay becomes mixed with the water to create a slime that has a specific gravity of 1.25. Minerals with a lower specific gravity overflow into weirs. The heavier material is carried to the outer rim as a gravity concentration.

Overflow travels over a 3/8-inch screen. Smaller material goes to secondary washers and the larger to recrush. Overflow from secondary washers trav-



Cross section of chambering.



Longitudinal section of chamber.

els over a ⅛-inch screen. Minus ⅛ inch in size goes to cyclones. In this fashion, 97.5% of the worthless material is removed and the remaining 2.5% goes to heavy-media separation, where more is discarded, to leave .005% as diamond bearing. No preconditioner is needed before the concentrate goes to the grease tables.

An interesting fact is that 80% of the diamonds by weight are recovered after the first washing. This 80% is worth 99.5% of the total value.

The angles of the grease tables vary with the size of the concentrate. They vibrate, and the concentrate goes over tilted steps in water. Diamonds and other adhering minerals are scraped from the tables every 45 minutes. The old grease is used as a base to be covered with new grease.

The recovery plant for these three mines is a large and modern one. Electrostatic separation is used for the recovery of the smaller diamonds.

This plant can handle 18,000 tons of ore from the three mines a day. This tonnage produces an average of 4300 carats of diamonds, which is 55% industrial and 45% cuttable.

From Kimberley, Elizabeth and I went to Jagersfontein by car. It is a long and dusty journey and, I might add, a sentimental one. This mine has produced some beautiful diamonds in its long history. It has been mined since

1886, and it has reached a level where the yield is low and the diamonds small. The yield is decreasing with each month's production.

Block caving is done here, as in Bultfontein and Dutoitspan. Recovery methods are parallel to those of Kimberley.

When one visits the mines, one senses that each has a distinct personality. To me Jagersfontein is the lady of the group. Some of her treasures she has given us possess great beauty, as anyone who has handled fine Jagers knows. But she hasn't too much to give any more; she's an old lady, and her production days are almost at an end.

The last of the pipe mines we visited was Premier, the mine that produced the famous Cullinan Diamond, world's largest, which weighed 3106 carats.

An experienced prospector, Thomas Cullinan (later Sir Thomas Cullinan), after months of careful prospecting in 1902, became convinced that the source of diamondiferous river gravels originated in the area now known as the Premier Diamond Mine. After long and difficult negotiations with the farmer who owned the land, the purchase was made. In 1903, the Premier Diamond Mining Company was formed.

Excavations were begun in April of 1903 by the open-pit method. In 1905, the finding of the Cullinan Diamond brought fame to Premier.

The mine has been closed twice in its history. It ceased operations in 1914 with the advent of World War I. but it was reopened in January of 1916. In 1932, it was closed again during the worldwide depression. By this time, it had produced 30 million carats of diamonds, and the open mine had reached a depth of 610 feet.

It was decided to reopen the mine in 1944. Since open-pit mining below 610 feet was considered hazardous, plans were made to mine underground. Before this work could proceed, a major pumping operation had to be carried out, to remove the 12-year accumulation of water in the pit. It took ten months to empty the pit of some 900 million gallons of water. In 1945, work on the shaft was started, and this was followed by underground development.

It was here that the first pilot plant for heavy-media separation was set up.

At the top, Premier is roughly elliptical in shape; the long axis measures 2800 feet and the short axis, 1400 feet.

The method of getting the ore here is different from Kimberley; it is done by "slot" mining. A 45-foot wide slot, 300 feet in depth, is cut through the center of the long axis of the pipe. The walls of the slot are stepped back in benches; these are 50 feet apart vertically.

Tunnels, 90 feet apart horizontally, are constructed at right angles to the slot. In the tunnels, six feet back from the slot face, drilling is done in the shape of a fan (called "fan drilling"). Drill holes are from 45 feet to 50 feet in length, and they are half the distance between the tunnels horizontally. When blasting is done, each blast removes six feet of blueground to drop it into the slot.

68-foot-square cones are excavated in

the blueground throughout the length of the bottom of the slot. The blueground that has been blasted loose collects in these cones, gravitating to the level below.

Here it passes through grizzlies, which are iron bars set 23 inches apart; they act as a screen to prevent oversize pieces from reaching the lower haulageways. These large pieces are blasted at this level.

All the broken rock travels to the operational level and then to six-inch grizzlies, where ore larger than this is sent through a jaw crusher. Then all the blueground comes to the surface in skip loads.

Above ground, recovery methods are very similar to those in the Kimberley Mine, but the methods are adapted to slight differences in the blueground; for example, the water and ferro-silicon has a specific gravity of 3.0 in the heavy-media cones at Premier. About 95% of the blueground has a specific gravity below 3.0 and is floated off. The 5% that sinks contains the diamonds and other high-specific-gravity minerals. In some parts of the mine, gravels have a greater density, and a slightly higher percentage is "sink."

The "sink" is carried by airlift to washing screens for removal of the ferro-silicon. It then goes to a secondary heavy-media separator, where the specific gravity is 3.2; here, the concentrate is only about 1.5% of the original ore and contains the diamonds and high-specific-gravity minerals.

The concentrates are now ready for the grease tables. The tables are scraped regularly, to recover and clean the diamonds.

The grease and diamonds are placed in perforated pots and immersed in boiling water, to melt the grease. Still in these pots, they go to sorting. Hand sorting must still be done, because bits of metal, pyrite, garnet, dolerite and ackermanite travel along with the diamond. An acid treatment removes any remaining foreign material.

The new plant at the Premier Mine is one of the most modern in the world. There are eight complete units, from grizzly to grease table, each of which is capable of handling 120 tons of ore an hour.

Because of the greatly increased use of very small industrial diamonds, commonly called *grit*, four of these units are being used for the reworking of material now on the tailings dumps; the other four are used for underground ore. All eight can be used for either tailings or to new-mine material, depending on the current economic situation.

The diamonds from new blueground at Premier average 80% industrial and 20% cuttable. The industrials are considered excellent quality. Among the cuttable material, there are some diamonds of a beautiful blue color and top quality.

When Elizabeth and I visited South West Africa, we traveled by company plane again, this time up the Atlantic Coast from Cape Town. Shortly after leaving, the shoreline became desolate

The author (right) and Elizabeth Henry at one of the alluvial diggings of Consolidated Diamond Mines of South-West Africa, Ltd.

desert, with very little habitation.

Just north of the Orange River, the village of Oranjemund came into view; it seemed like a jewel in the desert. As our plane came in for a landing, the trees, gardens and well-laid-out streets seemed like a modern miracle. Consolidated Diamond Mines of South West Africa (commonly called CDM), which works one of the most productive areas, is located here. The Orange River separates Namaqualand (in the Republic of South Africa) from South West Africa.

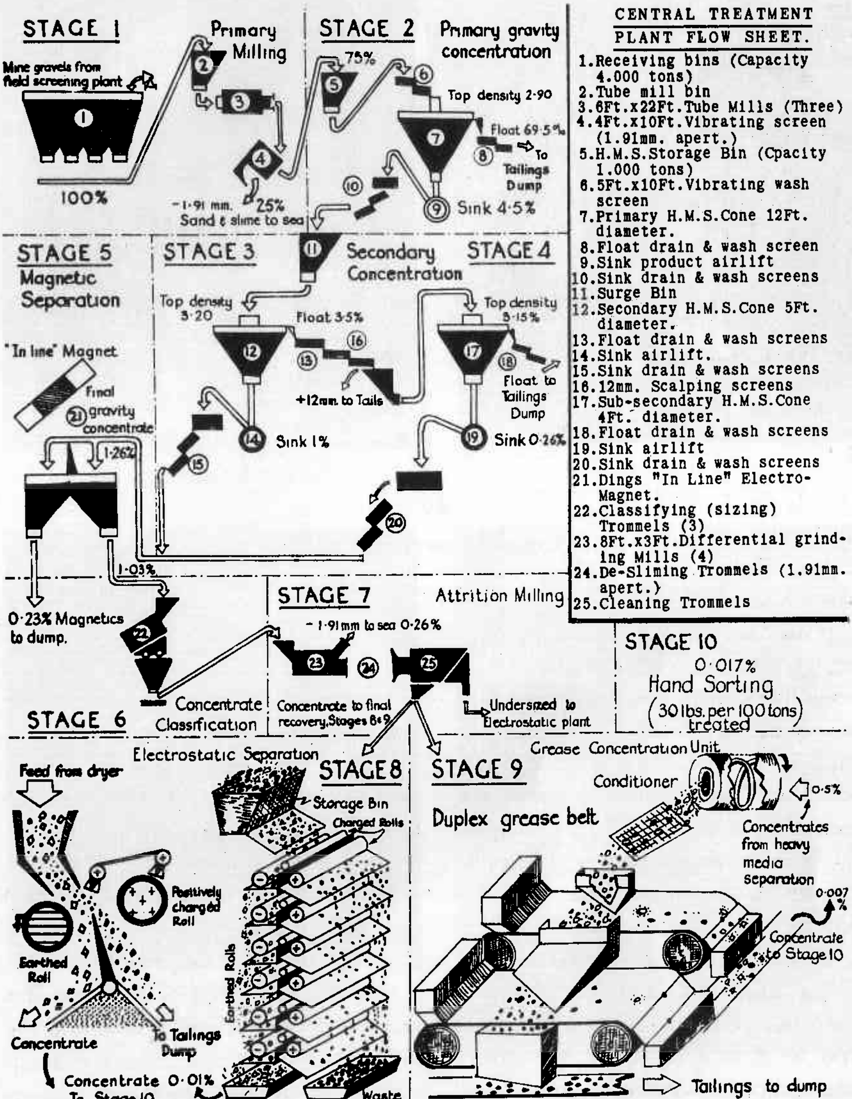
This is an alluvial field. It is believed that the Orange River, possibly with its tributaries the Vaal and Modder Rivers, over many centuries carried the diamonds to the sea and the sea washed them shoreward. Later, the land mass rose and the sea was pushed back.

The oldest shelf (wave-cut surface) is known as Shelf D. It rises about 77 feet above sea level near the river and the height diminishes as one goes north. Fifty miles up the Atlantic, it is less than nine feet above sea level.

Indications are that Shelf D is very old. Shelf C, too, is old. Shelf B and A are steeper, but apparently much younger. The marine deposits tell the history, in part.

The beach terraces are buried under sand overburden, referred to as unconsolidated windblown sand. Beneath the sand on Shelf D and part of Shelf C is calcrete, and beneath that is compacted red sand. A partly consolidated red sand is next. Shelves A, B and C have marine sand and sandstone. All have, below this, marine gravels and conglomerate, going down to the schist bedrock.

Payable mining areas are located by means of 39-inch trenches that have been cut through the terraces at about 1500-foot intervals, and the gravels are



processed on the spot. Diamonds recovered in each section are recorded and the ore reserves calculated. From the records obtained by this trenching, geologists say that mining operations can be plotted for the next 25 years.

There are no diamonds in the sand

Continued on page 94

Developments and Highlights

at the

GEM TRADE LAB

in New York

by

Robert Crowningshield

Blue Sapphire Intaglio

Figure 1 illustrates an intaglio-carved top, step-cut-back blue sapphire that was submitted because the client felt it was a doublet. The photograph shows the shadow of the figure cast on a plane of rutile needles approximately one millimeter below the surface; otherwise, the stone was free of inclusions.

De Beers Diamond Collection

We are indebted to Mr. Donald Thompson and Miss Loys Malmgren, of N. W. Ayer & Sons, Inc., the advertising agency for De Beers Consolidated Mines, Ltd., for the opportunity of examining the famous De Beers collection of 150 colored diamonds. With the spectroscope and the electroconductometer we detected no unusual reactions, but the examination helps confirm previous findings. *Figure 2* is a photograph of part of the collection, which was recently photographed in color by LIFE magazine.

Unusual Inclusion in Glass

Figure 3 illustrates a most unusual emerald-cut green glass that contained a gas bubble in the shape of a crystal – a most misleading bit of evidence, if a loupe only were used to examine the stone.

Diamonds Do Wear

Figure 4 is an illustration of a mistake that can be made by even an experienced jeweler. In this case, the jeweler advised a customer that her dia-

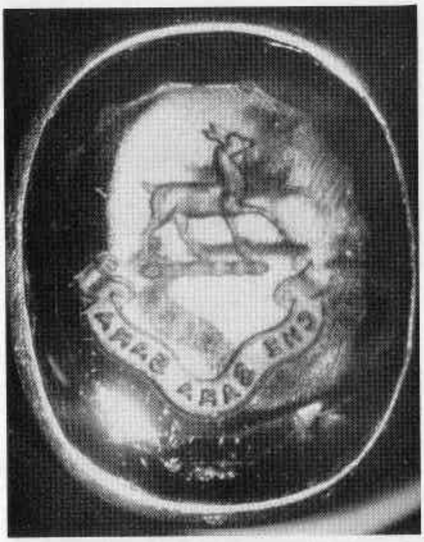


Figure 1

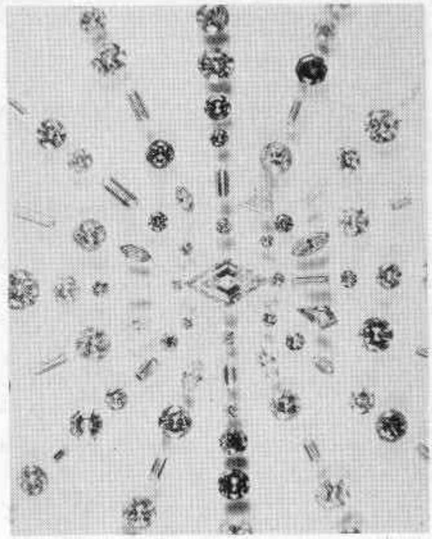


Figure 2

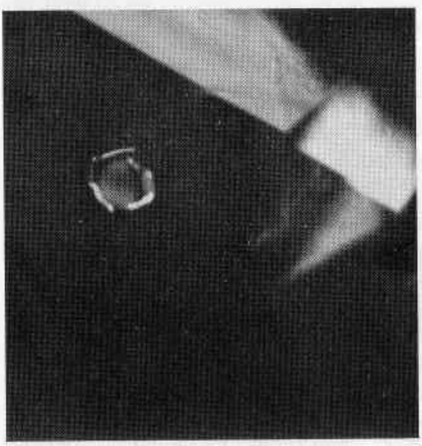


Figure 3

Figure 4

mond was not "genuine" because "diamonds don't wear like this"; however, it proved to be a fine $2\frac{1}{2}$-carat diamond. We were offered no explanation as to how an engagement stone could receive such treatment.

Diamond Growth Lines

We have seldom had the problem of interpreting the 1962 American Gem

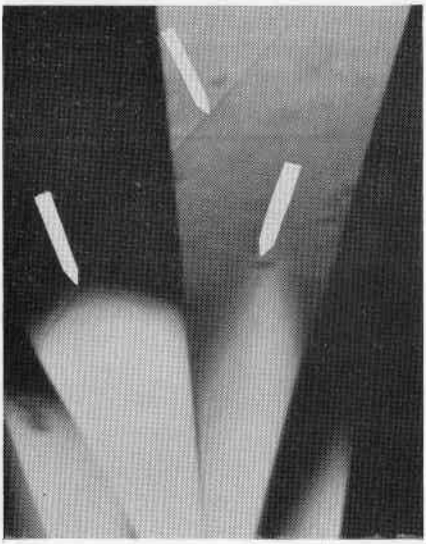


Figure 5

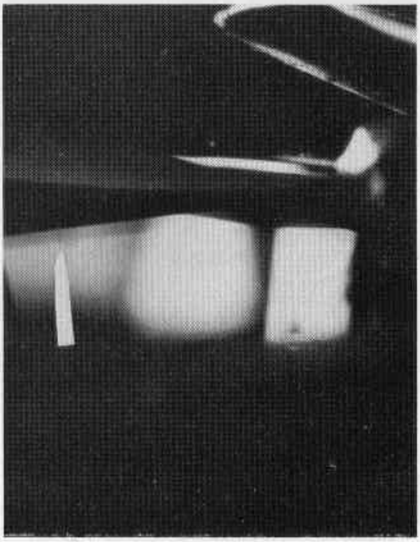


Figure 6

Society Ruling B-2, which states that "growth lines shall be considered flaws only if they exhibit color or break the surface." *Figure 5* illustrates growth lines that break the surface and are visible in reflected light. This fine diamond contained no other flaws but had to be graded VVS_2, because of the lines.

Orange, Cyclotron-Bombarded Diamond

Some of the loveliest colors produced by atomically bombarding diamonds are the orange colors, which we have encountered most frequently in table-up cyclotron-bombarded stones. *Figure 6* is a photograph taken through the pavilion, to show the slight penetration of color paralleling the table and adjoining the crown facets of a large orange, pear-shape stone. Because the penetration is so shallow, the absorption lines are not usually apparent in the spectroscope; and if the diamond is mounted, as this one was in a handsome ballerina setting, the need for magnification can be appreciated. This applies to any surface-irradiated cyclotron-treated diamond, whether the normal culet-up- or table-up type.

Lavender-Dyed Jadeite

Although we were aware that lavender-dyed jadeite is on the market, because we have purchased some for our collection, we have rarely been asked to identify it. Recently, we examined a bead necklace that proved to be pink-fluorescing, lavender-dyed jadeite showing a distinctive spectrum *(Figure 7)*. The dyed stones in our collection do not show either reaction.

Blue-Green Treated Diamond

In spite of the fact that the limits of

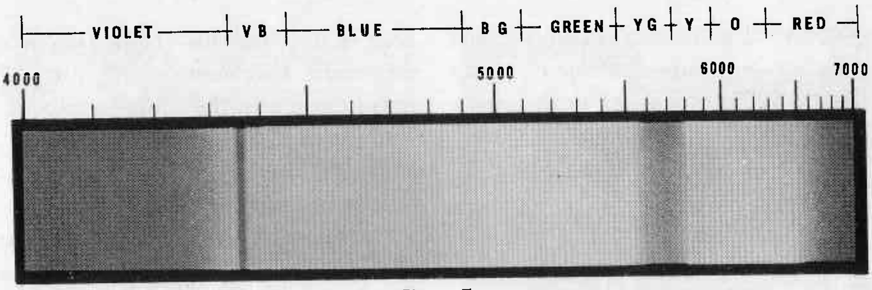


Figure 7

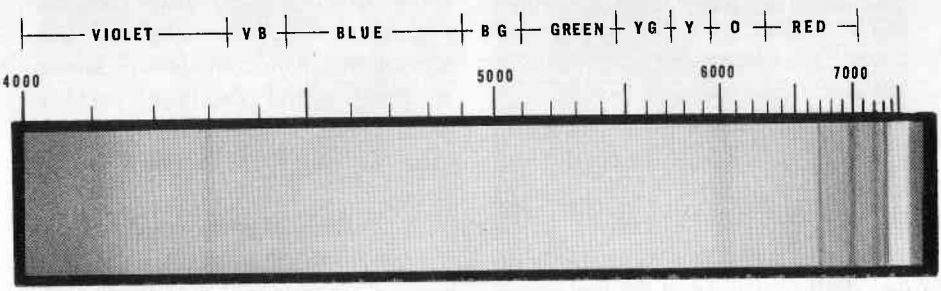


Figure 8

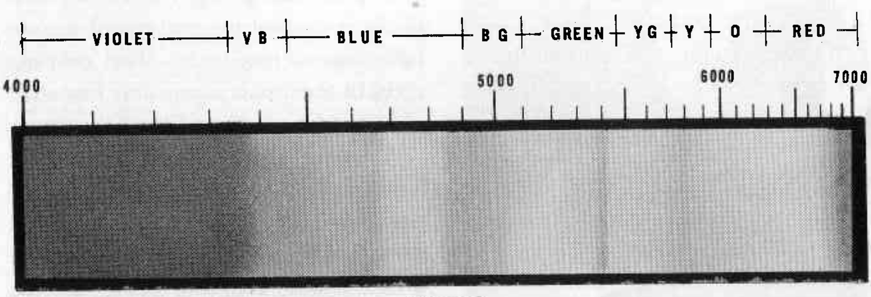


Figure 9

human visibility are usually given as 4000 Å and 7000 Å, we occasionally encounter a stone under spectroscopic examination that transmits beyond the 7000 Å region in the red. Such a stone was a blue-green treated diamond that showed clearly the lines first observed in a treated diamond and published in 1953 in the British Journal of Applied Physics, by R. A. Dugdale. The unusual absorption lines appeared at approximately, 7350, 7230, 7000 and 6700 Å. The stone we observed also showed an unexpected moderately strong line at approximately 4300 Å *(Figure 8).*

Light-Yellow Willemite

Figure 9 illustrates the absorption

spectrum of a transparent light-yellow willemite, which is different from the absorption spectrum of dark-brown willemite, illustrated in the Summer, 1960, issue of *Gems & Gemology.*

Need for Fair-Labeling Law

The desirability of an eventual fair-labeling law for gemstones and their substitutes, such as the fur and textile industries now have, is becoming ever clearer. The blatant advertising of colorless synthetic sapphire and spinel (as if it were some new creation of man), the deceptive advertising of imitation turquois as "pressed or molded turquois," and the more than 25 fanciful names under which synthetic rutile was ballyhooed all contribute to the low esteem in which the jewelry industry is regarded by the consumer. Now comes "Zenithite"! In the past few months we have been asked by at least six different clients in the trade to test some near-colorless material, and by normal gem-testing methods it has proven to be ordinary strontium titanate. It was only at the end of September, however, that some literature and the name "Zenithite" were shown to us. In the literature, the formula of strontium titanate was given chemically instead of mineralogically, and it was called "strontium meso-tri-titanate." There were slight differences in the printed figures from those published elsewhere earlier for the dispersion and refractive index. As a result, our clients concluded that the material is new to science. Most serious, however, is the insistence that the hardness is 6½ and the implication that diamond's toughness is inferior. All tests have shown the hardness to be no better than 6 and usually between 5½ and 6. In order to be sure that the material has the crystal structure of strontium titanate (first described in *Gems & Gemology, Winter, '57-'58*), we asked Professor Ralph J. Holmes, of Columbia University, to make comparative X-ray diffractions. By this test, strontium titanate, commercially known as "Fabulite" and "Zenithite," are identical, although "Zenithite" is from a manufacturing source unknown to us.

Red-Brown Quartz

Figure 10 illustrates a section of a bracelet containing 12 rounded, red-brown crystal groups of ferruginous quartz — a most unusual use of beautiful mineral specimens. The coloring agent of the quartz is probably hematite.

Highly Conductive Blue Diamond

A very brilliant old-European-cut, light-blue diamond in a platinum solitare ring gave surprising results when tested with the electroconductometer. When tested with the probe on the table, the needle registers as high as if the probe had touched the contact of the instrument directly *(Figure 11).* At the moment the reading was highest, brilliant-blue arcing could be seen within the diamond. If the probe touched the metal of the ring while the table touched the contact rod, a reverse reading was obtained and the needle went to a reading below zero *(Figure 12)* for an unknown reason. The stone

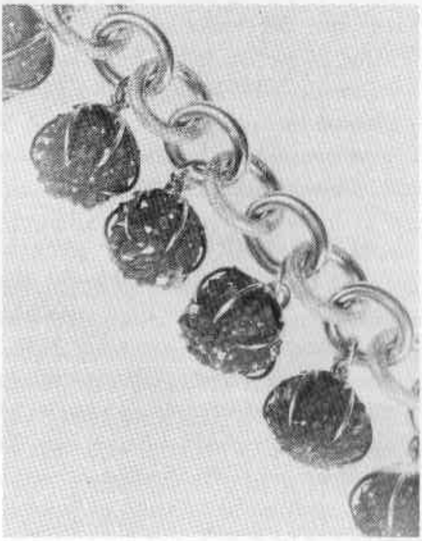


Figure 10

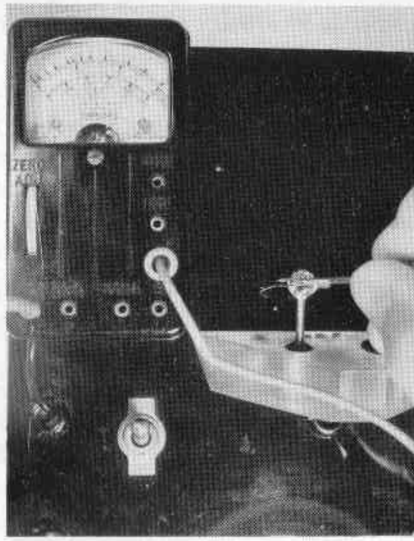


Figure 11

was the most highly conductive blue diamond we have ever encountered. In addition, it phosphoresced strongly after exposure to X-rays, but only slightly after exposure to short-wave ultraviolet.

Weakly Conductive Diamond

A weakly conductive diamond was submitted to determine if it had been coated. It, too, was an older cut and was flanked by two blue synthetic sapphires. When an attempt was made to grade the stone in the Diamondlite, it appeared grayish, but we assumed it was drawing color from the sapphires. Out of the mounting, it appeared to be a very light grayish brown and showed a quite variable conductivity, as if it were perhaps a laminated stone with the II_b components, conducting only when the probe was positioned properly.

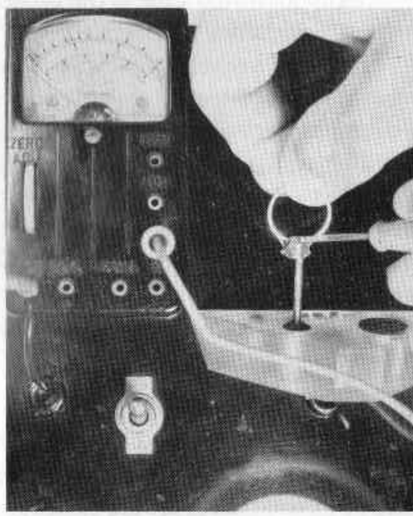


Figure 12

A New Synthetic Emerald

At no time since the World War II has interest in developing synthetic emerald by so many different people and firms come to our attention. In the past few months, we have been shown three different materials purported to be synthetic emerald. Only one of the stones, a 3½-carat emerald cut, closely resembled the Chatham synthetic, varying as it did only in the fluorescent color under long-wave ultraviolet. The stone appeared to be of commercial quality, and certainly of commercial size.

The other two materials submitted bore evidence of a considerably different technique of growth from the Chatham product. One of them was neither of commercial size nor quality but showed great promise. This client, as well as the first, wished to withhold publicity until such time as the product would be available commercially.

The most recent material we have examined was presented to our client as a sample, with the information that it will be available shortly in commercial quantities and in sizes up to two carats. At the moment, we are waiting permission from overseas to publish our findings of a most unusual product; if permission is granted, we hope to describe it in full in an early issue.

Eight-Foot Necklace of Jet

We were surprised to find that an eight-foot-long rope of highly polished, black, opaque beads proved to be jet – a material that is seldom presented for testing.

Dyed Lapis-Lazuli

A necklace of graduated, very uniform dark-blue lapis-lazuli was tested for dye. There was good evidence that some of the beads had been stained to obliterate white spots, although most showed no evidence of the dye. We have noted a similar selective use of dye in a carved lapis-lazuli figurine.

Pink Diamonds

We had the unusual pleasure of examining before and after repolishing two beautiful pink diamonds that, by coincidence, were both flawless after recutting and of precisely the same weight, although of entirely different cuts. One of them was the orange-fluorescing kind, such as the famous *"Princie" diamond,* which was auctioned at Sotheby's, in London, in 1960. It is the first of this kind we have examined.

Unusual Gemstones

Unusual cut stones that we have examined since the last issue include pink apatite, probably San Diego County material; brown danburite; red sphalerite; chondrodite; a true hiddenite; an unusually fine and large axinite; the very rare mineral, rhodizite; transparent sodalite; near-transparent willemite; colemanite; barite; boracite; colorless natrolite; transparent rhodonite; wulfenite; anhydrite; thulite; and pink epidote.

Surface-Stained Limestone Beads

The continuing effort to supply the demand for dark-blue turquois has reached somewhat of a nadir with the appearance on the market of blue, surface-stained limestone beads! Some we identified were being offered at a price that could not be considered inexpensive.

Treated Opal

Several dealers and at least one manufacturer have mentioned to members of the staff that they intend to handle the treated opal that was reported in the Fall '62, issue of *Gems & Gemology.* All mentioned, too, that they intend to sell it for what it is. Recent examples that we have seen have been strikingly beautiful stones. We have carried out no controlled testing as to the permanence of the color, but indications are that about the only trouble that might be experienced would be loss of some of the black color, if the stone ever had to be repolished. Because the few stones that we have polished down showed a penetration of the black color for varying depths, it is quite possible that stones could be repolished without altering of appearance and could thus give a long measure of enjoyment to the wearer.

Tinted Amber

A beautifully carved, dark-red-brown statue of amberlike appearance failed to fluoresce, as one expects amber to do, except in a few places that when examined in the light, proved to be either worn or broken areas. We were then able to determine that the material was, in fact, pale-yellow amber, but had been carefully painted.

Acknowledgements

We are indebted to **Dr. Donald Spaulding,** Omaha, for showing us several unusual colors of quartz, including a striking yellow-green stone produced by atomically bombarding smoky quartz and subsequently heat treating it. We are further indebted to him for a gift of Burma gem gravel.

From New York gem dealer, **Joe Smith,** we received a welcome selection of aquamarines, tourmalines and zircons.

From **Mr. Richard Hahn,** Juergens & Andersen Co., Chicago, we received a selection of natural and cultured pearls that have helped greatly to improve our display of these important items.

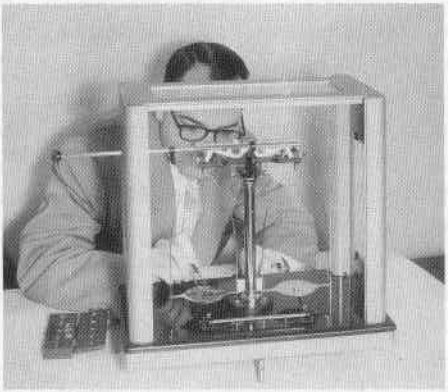
From **Mr. Roger E. Hunt,** Ocala Jewelers, Ocala, Florida, we received a rhodolite-garnet cluster ring, which we are very pleased to have both for display and for sneaking into stone sets for identification during resident classes.

From graduate **Andy Heinzman,** H. R. Benedict Co., we received a most unusual faceted glass piece containing crystals and needles.

We are greatly indebted to **Mr. Vladimir Lachowich,** of Regent Lapidaries, New York, for a fine selection of synthetic rutile for use in our expanding correspondence course in gem identification.

The writer enjoyed a visit with **Mr. Maxwell Perry,** of Imperial Jade, Ltd., Freehold, N. J., during which we saw one of the most advanced tumbling operations in existence. We are indebted to Mr. Perry for samples of tumbled nephrite, thulite, pink epidote, sodalite, natural-colored carnelian and rhodochrosite.

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by

Richard T. Liddicoat, Jr.

"Black Pearls"

We continue to test many "black pearls" that are materials without orient or pearly luster and therefore fail to qualify as pearls by our definition. Most frequently, these are the smooth, purplish-brown concretions found in cherrystone clams, but occasionally other materials are encountered. We examined a light-weight black sphere with a rather high luster that seemed almost metallic. By the spot method, the refractive index was difficult to pinpoint, but it was on the order of 1.70 to 1.75 and the specific gravity was approximately 1.30. There was no immediate reaction to the hot point, no reaction to HCl, and the material was obviously very soft. Since the client was in a hurry and was interested only in whether or not he had a black pearl, it was not necessary to make a positive identification. To reach a satisfactory conclusion would have required destructive tests, so we are still wondering about it.

Green Tourmaline

Not long ago, we saw a green tourmaline that had been purchased in Brazil for three times its retail value. The stone was mounted, so we estimated its weight at approximately 9½ carats. The client said that it had been represented to her as slightly under 10. Since the stone was loose in the mounting, we recommended that it be tightened by her jeweler. She said later that the jeweler had informed her the stone weighed not 9½ carats, but 19 or 20 carats. His reasoning was that a tourmaline he had purchased as a 10-carat stone was much shorter than hers. He paid no attention to the much greater depth of his stone. When we had an opportunity two or three weeks later to weigh both the jeweler's and his customer's stone, we found that his weighed slightly over 10 carats and the customer's less than 9½. With good intentions, he had mislead her (and himself) seriously with respect to the weight, and thus the value of the stone.

Synthetic-Emerald Necklace

We examined a necklace that was not at all remarkable, except that five reasonably large Chatham synthetic emeralds were accompanied by synthetic spinel single cuts. The cost of the synthetic emeralds seemed sufficient to justify the use of diamonds as side stones.

Biwa Pearl Necklace

The progress in Biwa fresh-water, non-nucleated cultured-pearl production was never more apparent than in a necklace we tested recently. A few of the pearls were perfectly spherical to the eye and most of the strand nearly so. Although the average pearl was slightly baroque, it was not enough to be obvious.

Not Broken, Only Flawed

An indignant jeweler came in with a diamond that had been called broken by another jeweler to whom it had been taken by the first jeweler's customer to have a prong tightened. The purpose for bringing it to the Lab was to have it graded against the Institute's system and to have a written confirmation that the stone was not broken. The Lab was happy to confirm that the stone was not broken, but the jeweler found a fresh source of indignation when an SI_2 grade was assigned to the stone. Rather prominent inclusions under the table and several small cleavages near the girdle put it just one step above an imperfect rating; but to the jeweler, VVS_2 was the proper grade, or at the very worst, VS_1. The jeweler was convinced that the grading would bring criticism on him from the customer. Had a diamond of that cut, color and weight been a VVS_2, it would have cost him approximately the retail price he had put on the stone.

Tridacna Pearl

We were confronted with a huge white concretion that was believed to be a valuable pearl by its owner. The most interesting feature of the object was the irregular "flame" structure that may be seen in certain lights on the surface of a conch pearl. The only other material to our knowledge that shows this structure is this material, which we identified as a Tridacna pearl. Tridacna is better known as the giant clam. Although it lacks nacre and a pearly luster, concretions from this mollusc are interesting for their unusual flame-reflection effect, which is also apparent on the shell *(Figure 1)*.

Green Jadeite

We recently received a ring contain-

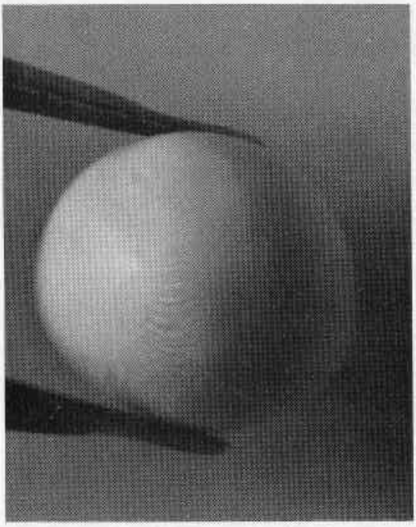


Figure 1

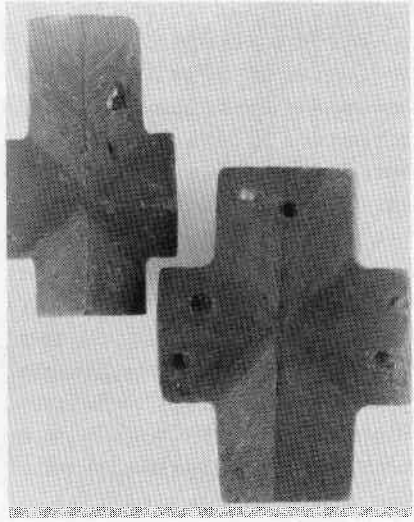


Figure 2

ing green jadeite in an attractive quality. It was sent by a jeweler who said that his customer claimed the color of the stone was fading. Examination by spectroscope disclosed no evidence of dye. Although it is possible for jadeite to be dyed and for the dye to fade away over a period of time, leaving no trace strong enough to be detected by the spectroscope method, truly green jadeite does not need to be dyed. If it has an appealing color, it is likely too valuable to be subjected to the value loss that is inevitable when dye is detected. In other words, it is only practical to dye inferior colors of jadeite. In view of the complete lack of evidence of dye and in view of its very attractive present color, we could only conclude that the customer must have imagined a change.

Quartz Chandelier

Although there was nothing unique about the material, we recently had a somewhat unusual identification. An antique dealer submitted a number of huge chandelier drops and a large colorless transparent ashtray, all of which were identified as rock-crystal quartz. In view of the tremendous size of the drops in the chandelier, it would have been interesting to see the whole piece.

Staurolite Imitation

Figure 2 shows a material that appears to be staurolite. It seems strange that it is necessary to make substitutes for such an inexpensive stone. However, in the areas in which these remarkable twin crystals are found, the demand is evidently too great to be easily filled by the right sizes and shapes. In its unaltered form, staurolite has a hardness in excess of 7 and not all of the twins are crosses; many are X-shapes. To improve on nature, often a soft talcose material is filed into the appropriate shape and then dipped in a substance such as paraffin to darken the tan material. Occasionally, soft mica-schists are used in place of talcose rocks, and sometimes staurolite that has altered almost all of the way through is used. In general, the imitators start with something that bears no resemblance to the staurolite until it has been shaped. Such materials are easily scratched with a knife blade, in contrast to hard staurolite. The file marks are readily apparent on the imitations shown in *Figure 2*.

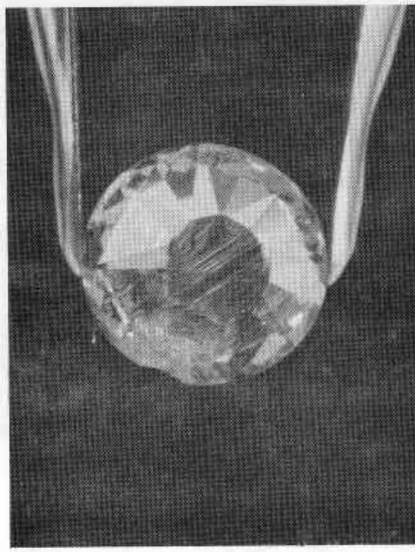


Figure 3

Synthetic Emerald versus Natural

On a number of occasions, it has been pointed out that natural emeralds, particularly in fine color, may fluoresce to some extent under long-wave ultraviolet. Another test that has been reported on several occasions for distinguishing synthetic from natural emeralds is transparency to short-wave ultraviolet. Because of its fluorescence to short- but not to long-wave ultraviolet, the mineral scheelite is often used to test this property. A short-wave ultraviolet unit is placed over an unknown stone, which in turn has been placed over a hole in an opaque shield. Below the opening, the scheelite is placed. If the scheelite fluoresces, it is clear that the unknown stone is transparent to short-wave ultraviolet. Transparency to short-wave ultraviolet light has been recognized as a means of detecting synthetic emerald.

On several occasions, natural emeralds that fluoresced slightly showed themselves to be transparent to short-wave ultraviolet, in that scheelite placed beneath them fluoresced to short-wave ultraviolet passing through the natural stones. Thus, this is similar to the fluorescence test – of value when the results are negative.

Three-Point Diamond

Figure 3 shows a three-point diamond; i.e., a diamond with its table almost parallel to an octahedral face. This orientation is clear from the fact that when the stone cleaved from a point near the girdle, a large piece of the pavilion cleaved away parallel to the table. Three-point diamonds are

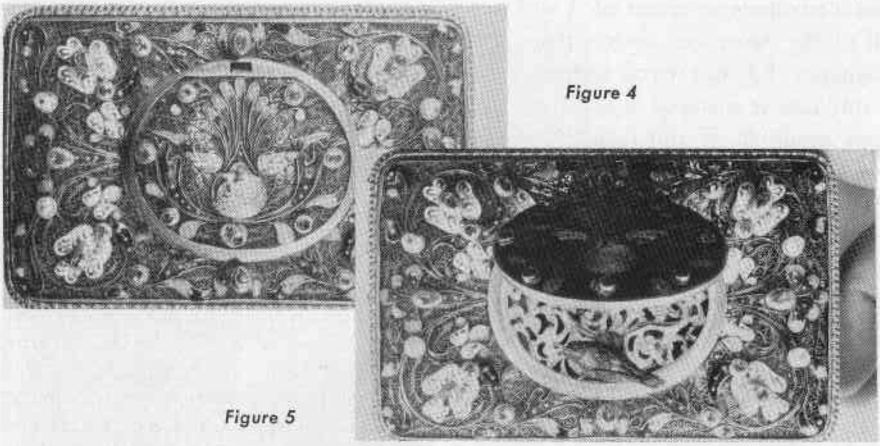


Figure 4

Figure 5

common but less commonly encountered than four-point stones, because the octahedron and modified octahedra, when sawed, yield four-point stones. Three-point stones are likely to be cut from macles, flats, or stones that must be cleaved in fashioning.

Unique Jeweled Music Box

Figures 4 and 5 are two views of one of the most interesting jeweled music boxes we have encountered. When a switch was pressed, a door opened and a tiny bird sprang into view to sing a many-noted song. As can be seen in the photograph, the box was made of filigreed gold and set with many colored stones and diamonds. The bird was covered by iridescent hummingbird feathers. The box had been brought to this country to be exhibited at a world's fair many years ago.

We Appreciate

From GIA student, **Maurice C. Correia,** Bridgetown, Barbados, West Indies, we received six diamonds of various natural colors. These will be of great value to the Institute, particularly for spectroscopic analysis.

When **Doug Robinson,** gem merchant from Brisbane, Australia, visited the GIA recently, he donated specimens of nephrite, agate and chrysoprase.

Thanks to **Richard T. Pattie,** Hillsboro, Illinois, for the opal ring that he donated to the GIA. It will make a fine stone for class use.

The gift of library copies of the book, *The Great Blue Diamond,* by the author, **J. Komkommer,** Antwerp, Belgium, were greatly appreciated.

From **Bill Rowbury,** GIA student and hobbyist, San Francisco, we received a synthetic spinel, an amethyst and a topaz cut in his original design, that he named the Triumph *(Figure 6).*

We appreciate the andalusite crystals, enstatite cat's-eye cabochons and a number of faceted garnets that **Martin Ehrmann,** gemstone dealer of Los Angeles, recently donated to the GIA's collection.

Book Reviews

THE BOOK OF AGATES & OTHER QUARTZ GEMS, by Lelande Quick. Published by Chilton Books, Philadelphia, 1963. 232 pages, well illustrated with black-and-white photographs and two color plates. Price: $9.95.

Mr. Quick has written a highly readable, comprehensive, practical manual that is concerned primarily with the rockhound's favorite gem — the agate. One of the most immediate apparent and refreshing features of the book is its nontechnical approach to the subject. In the author's words: "This is not a scientific textbook. It tells all about agates but does not tell, except in a general way, exactly how agates were formed, because the details would be boring to many and really useful to none. These details are available in many other books."

The book begins with a definition and description of agate and proceeds to a complete account of the history of this desirable and long-cherished gem, tracing it from prehistoric times to the present. In this connection, the author discusses the evolution and development of the more than nine hundred gem, mineral and lapidary clubs now organized in America. Subsequent chapters are devoted to the details of agate collecting and to the varieties of quartz gems other than agate, including helpful glossaries.

Later sections discuss the sources of quartz gems throughout the world and gives thorough coverage to actual collecting localities in the United States, Canada and Mexico. This compilation of collecting areas is one of the best that has been written.

Later, there is a brief introduction to the art of cutting and polishing agates, together with descriptions and illustrations of lapidary equipment. Following this is a chapter devoted to inspiring photographs of the numerous jewelry, novelty, ornamental and utilitarian uses for which agate and other quartz varieties are particularly suited. Shown are outstanding examples of bookends, ashtrays, carvings, agate-handled tableware, bowls, paperweights, spheres, penholders, and faceted stones set in rings. Illustrations of great variety of cabochons, slabs and tumbled stones are to be found throughout the book, showing the endless combinations of colors and patterns that occur. It is regrettable that a greater number of color plates could not have been used.

In conclusion, there is a selected bibliography of currently available books on agate collecting, gem-mineral locations, gem cutting, gemology, mineralogy, geology, jewelry making and related subjects. Also included is a list of periodicals of interest and value to the hobbyist-craftsman. The concise index utilizes boldface type to refer to illustrations in the text.

The Book of Agates should prove to be a valuable addition to the libraries of the hundreds of thousands of persons who pursue the fascinating and absorbing avocation of rock and mineral collecting and gem cutting — America's fastest growing hobby.

(Editor's note: The late Lelande Quick, long a recognized authority on the amateur lapidary movement in the United States, was one of the founders and the first president of the Los Angeles Lapidary Society. He also founded similar societies in Michigan and New York, and assisted in organizing the Hollywood Lapidary Society and other groups throughout the country.

In 1947, he began publication of the *Lapidary Journal,* a monthly magazine devoted to gem cutters, collectors and jewelers. During his thirteen years as editor and publisher, Mr. Quick traveled widely and lectured on gem cutting at universities and museums from coast to coast. In 1959, he coauthored *Gemcraft,* a book on lapidary techniques. He retired in 1960 to continue his writing in the field of gems, minerals and the lapidary hobby. *The Book of Agates* was completed shortly before his death, in February of 1963.)

GEM-HUNTER'S GUIDE, by Russell P. MacFall. Published by Thomas Y. Crowell Co., New York. 3rd edition, 1963. 278 pages, numerous maps and eight color plates. Price: $4.95.

In this revised edition of a book that has met with success since it first appeared in 1951, Mr. MacFall has compiled comprehensive, up-to-date, verified information on the locations of gem minerals in the United States, Canada and Mexico. The author has been an amateur lapidary and gem enthusiast for more than forty years, has written many articles for *Science & Mechanics Magazine,* and is presently night editor of the *Chicago Tribune.*

Since the principal purpose of the book is to tell the reader exactly where to go to find gem materials and what to look for when he gets there, the main feature is a 150-page chapter entitled, "Directory and Maps of Gem-Hunting Locations." In this section, more than a thousand tested digging sites are described and organized by states, counties and the nearest towns. The directions and maps give such specific details as secondary and unimproved roads, mountain and desert trails, and sections of stream beds.

One of the early chapters discusses briefly but clearly some of the more useful clues for identifying gem minerals: hardness, crystal structure, cleavage and fracture, luster, transparency, color and pattern, and specific gravity. Following this is a brief description of the three major rock types (igneous, sedimentary and metamorphic), emphasizing that igneous rocks are the most prolific producer of gem materials. A subsequent section gives helpful suggestions for a gem-collecting trip. Another chapter is devoted to a simplified identification table of gem varieties found in the United States that are generally considered to be worth collecting and cutting. The remaining chapters deal with fluorescence, judging quality and value, collectors and collections, and diamonds and pearls in the United States. A short but helpful glossary, sources for maps and printed material on state mineral resources and the location of gem and mineral displays, and a bibliography are included. The book is enhanced by eight attractive color plates.

Gem-Hunter's Guide is a useful, practical, easy-to-understand book for the amateur gem collector.

Continued from page 79

overburden, so the primary and secondary sand and soil overburden is stripped off by a number of different types of earth-moving equipment and dumped into mined-out areas. The gravel of the exposed terrace is loaded into trucks by excavators and taken to field screening plants.

Where hard-packed diamondiferous conglomerate occurs on the bed rock, it must be blasted. The bedrock, which is very uneven, is handswept by wire brooms. More recently, a piece of equipment called a vacuveyor was developed. It is adapted from a large vacuum unit that was originally designed to clean the holds of ships. It works on a blower system and is sometimes referred to as a *vacublast.* Elizabeth and I were told that eventually they would probably replace the sweepers.

There are 13 field screening plants, each serving an area being mined, and these are models of efficiency. Here, approximately 85% of the sand and gravel is eliminated and dumped as waste. The remaining 15% is carried by diesel or electric trains to the central recovery plant.

The accompanying flowsheet traces the steps in the recovery of diamonds at CDM; most of these processes have been mentioned earlier. Here, as the first step, is a primary milling to remove magnetite, clay nodules and sand. About 25% of the valueless material is eliminated at this point.

There are three steps in heavy-media separation at CDM. The specific gravity in the first operation is 2.90. The smaller secondary cone, where the sink from the first separation is treated, has a density of 3.20. The float from the second stage travels through the third separation, where the specific gravity is 3.15, and the sink here joins that from the previous stage. In this third stage, the newer spherical ferro-silicon is used.

This concentrate contains a high proportion of minerals that are susceptible to magnetism, so magnetic separation is used. The magnetic field alters the course of these minerals. The diamonds, unaffected by the magnet, fall vertically.

The concentrates here must be treated in a preconditioner before being sent to the grease tables. They are alluvials and, as such, have a wettable surface before treatment.

To test the efficiency of the operations at most of the mines, including CDM, optical separators are used. Tailings travel through the separator. Its function depends on the ability of most diamonds to transmit a beam of reflected light. By means of a photomultiplier circuit, a gateway is momentarily opened and a stream of gravel with the diamond drops through whenever a diamond appears. This interesting piece of equipment was developed at the Diamond Research Laboratory, in Johannesburg.

Today, all the mines are recovering diamonds as small as .01 carat, which have become increasingly important in industry. It never ceased to amaze us that anything this small could be recovered from the mountains of waste material.

But what of the people back of this enormous operation of providing the world with diamonds? If possible, more impressive than diamond recovery is the caliber of the men one meets everywhere at the mines. Elizabeth and I spoke of this so often.

Each mining area has not only its individual mining problems but its social problems as well. At each new place we visited, we were again impressed by the fact that the men at the top were so peculiarly fitted for the problems of their area; this was true at all levels. The combination of one of our most exciting natural resources with the finest in human resources is hard to beat.

It is hoped that, in bringing you this brief outline of the mining and recovery of diamond deposits in southern Africa that you, too, may feel some of the pride in your diamonds that Elizabeth and I feel as a result of our visit.