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IN THIS ISSUE

Formation of Precious Opal

by

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Precious opal is distinguishable from other opaline silicas by being essentially amorphous, as shown by J. B. Jones, J. V. Sanders and E. R. Segnit[1]. The relation between the remarkable particulate structure and the reflected colors of precious opal has been described by J. V. Sanders[2], who found that this mineral consists of regularly packed uniform spheres of amorphous silica a few tenths of a micron in diameter. From electron micrographs, Sanders concluded that the spheres must have grown in suspension by deposition of silica on to precipitated nuclei and then the spheres must have been later packed together, possibly during a filtration process.

The purpose of this article is to describe the spontaneous formation of brilliantly colored, opallike masses of 0.1μ spheres of colloidal amorphous silica by aggregation from a sol, and to point out the physical similarity between this and other types of similarly colored, regular aggregates formed from inorganic and organic colloidal particles in this range of particle size.

The preparation of sols of uniform spherical particles of amorphous silica by depositing soluble silica on preformed nuclei has been described by M. F. Bechtold and O. E. Snyder[3], and the characterization of such silica has been summarized by me[4].

In a 30 percent silica sol of particles about 100 mμ in diameter, prepared by George W. Sears of this laboratory, he and I observed that after two years in quiescent storage in a 1-gallon bottle an intermediate layer showing brilliant colors in reflected light had been formed at the boundary between a dense, white, concentrated layer of colloid at the bottom and a more dilute opalescent sol remaining above.

To investigate the effect of *p*H, a number of 4-oz. samples of colloidal silica were withdrawn from the intermediate colored layer, diluted with equal volumes of distilled water, adjusted with the hydrochloric acid and dilute ammonia to *p*H values ranging from 3 to 10, and then allowed to stand in sealed glass or polyethylene bottles for another two years. In samples at *p*H

5 and 7, colored layers formed within a period of 3 months; in all cases, colored layers appeared after two years. Above *p*H 7, the colored region consisted of a thin, dense intermediate layer of uniform thickness. Between *p*H 4 and 7 at the boundary between the concentrated and dilute regions, brilliant platelets were formed, growing upward into the supernatant liquid. These have the appearance of leaflike or bladelike crystals, and will be referred to as *pseudocrystals*. These objects have been found repeatedly in silica sols of relatively uniform particle size averaging about 100 mμ in diameter; in most cases, the initial silica concentration was 5 to 10 percent by weight of silica and the *p*H between 5 and 7. In these circumstances, the blade-shaped, colored pseudocrystals grew to a length of 2 mm., with relatively straight sides but with the upper edges less well defined.

The color of the pseudocrystals depends on the angle from which the light is reflected. As the bottle containing the specimen is carefully turned, new pseudocrystals of different colors come into view. It should be noted that a given pseudocrystal can be seen only by one eye at a time, since the other eye is usually not at the correct angle to see the reflected light. The colors range from brilliant yellow through yellow-green, orange, deep red, blue and violet. These pseudocrystals are extremely fragile and disappear if the container is jarred or slightly shaken, and are formed again only after the mixture has stood again for several months.

Unsuccessful attempts were made to produce pseudocrystals more rapidly by centrifuging sols to bring about settling in several hours, but the silica particles were packed into white, opaque layers, leaving a translucent, almost transparent supernatant liquid. It is apparent that time is necessary for the particles to attain the required perfection of packing.

The colored material has been isolated in dry form as chalky-white masses of silica gel, still showing weak interference colors, by permitting the sol containing the colored layer to evaporate very slowly over a period of two more years, so that the silica in the supernatant liquid is drawn down slowly on the colored masses without disturbing them. More rapid evaporation, which obviously must involve movement of water from the bottom to the top of the mass, disturbs the structure. The slowly dried, fragile, opaque material was heated to 900° C. over a period of 12 hours and then slowly cooled. When the mass was impregnated with water or preferably with benzene or alcohol, the interference colors were again observable. The refractive index of the impregnating liquid had a marked effect on the reflected colors. Water with a refractive index of 1.33, as compared with 1.46 for the amorphous silica, gave a white opaque mass in which green flecks of color could be seen. Normal butyl alcohol, refractive index 1.39, gave an almost transparent mass, showing green-blue flecks of color in reflected light. Carbon tetrachloride, refractive index 1.46, gave a perfectly transparent mass that, however, showed slight green reflexions. An oil with a refrac-

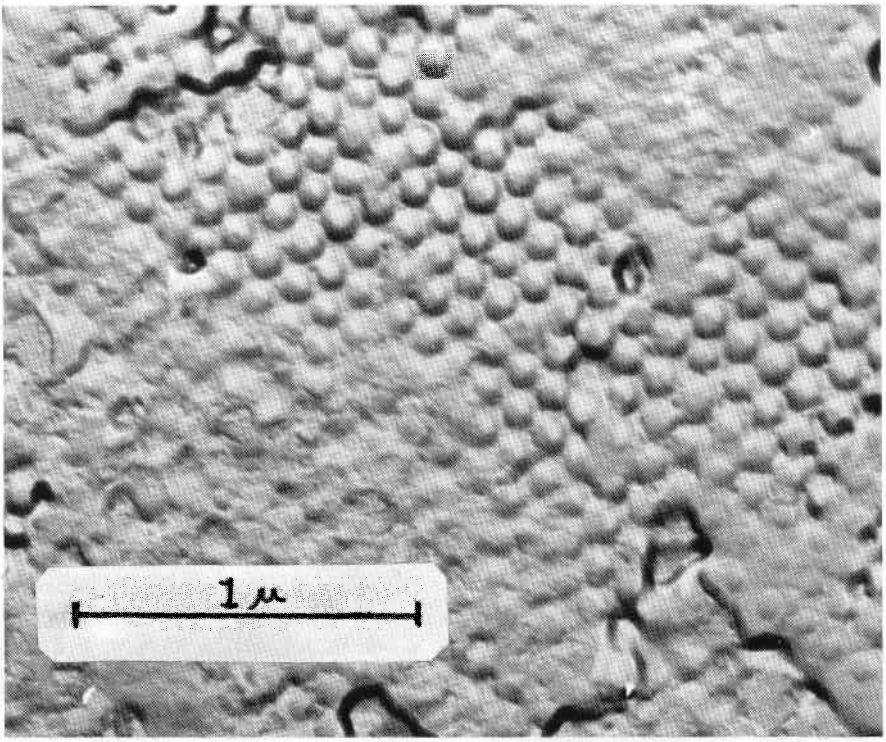


Figure 1
Electron micrograph of replica of polished section of close-packed spheres of colloidal silica showing reflected interference colors (x c. 25,000)

tive index of 1.6 gave deep-red reflexions, while liquids of still higher refractive index resulted in a white opaque mass with a brownish tinge.

The bulk density of solid pieces of the slowly dried silica, still showing interference colors, dried and fired to 1,000° C., was 1.53 g/c.c., corresponding to 69.6 percent by volume of amorphous silica. This approaches the value of 72 percent by volume, corresponding to close-packed, uniform spheres. An electron micrograph of a replica of a polished section is shown in *Figure 1.*

Formation of natural opal. The brilliantly colored but very fragile layers containing the pseudocrystals, viewed through the glass walls of the container, look exactly like natural precious opal. There is little doubt that the colors originate from uniform arrays of silica spheres, as Sanders[2] has described in the case of natural opal. However, in natural precious opal the spheres are larger, and the space between them is at least partially filled with hydrated amorphous silica, which serves to harden the mass. Such a cementing process probably occurred after the spheres were packed in regular array, by long-continued impregnation with soluble silica. Cementing or reinforcing of

suspended aggregates of silica particles has been carried out in the laboratory to produce mechanically strong silica gels[5]. Impregnation of dense-packed masses of opal may have occurred by a similar but far slower process in Nature, since the solution would have to pass through the mass in order to achieve such a uniform deposition of silica.

It is probable that a critical step in the formation of natural precious opal was the creation of spheres of amorphous silica in dilute suspension and subsequent slow settling in quiescent underground pools. Since geyser waters are often supersaturated with silica, it is conceivable that in some circumstances the rate of cooling might be such that relatively large uniform particles of colloidal silica were formed. In undisturbed subterranean pools such particles might have become concentrated, and uniformly packed aggregates may have been formed just as observed in the laboratory. Once such uniform aggregates had been formed, further hardening of the structure by deposition of silica within the interstices over thousands of years could result in the type of structures described by Sanders *et al.*

There remains the question as to why uniform spherical particles of amorphous silica should become packed together in regular arrays as pseudocrystals. In the silica-water system, the changes that occur spontaneously are those that lower the area of the silica-water interface, since there is an interfacial surface energy of about 80 ergs/cm^2 (ref. 6). Minimum interfacial area is achieved when the surfaces of such particles are brought together, excluding the water from the areas of contact. The formation of these points of contact represents the first stages in reducing the overall silica-water interfacial surface area. Greatest reduction in interfacial area is obtained with the closest packing of spheres in which each sphere makes the greatest number of contacts with surrounding spheres. In a sol containing charged particles of different sizes, particles that are either smaller or much larger than the average will not fit as perfectly into the growing uniform array of the pseudocrystals, and their inclusion is thus thermodynamically less favored. Unless the particle colliding with the surface is held with several points of attachment, it will be repelled by the surface of the pseudocrystal that is of like charge. This is analogous to the fact that a potassium ion does not fit into the lattice of a growing crystal of sodium chloride, and is thus excluded. Thus, spheres of like size tend to fit into a given growing pseudocrystal.

Analogous systems. Analogous aggregation of spherical particles of colloidal size to form highly colored masses has been observed with organic materials. N. Xeros[7] reported that a virus in an insect caused the formation of iridescent nodules that showed brilliant colors in reflected light; when the virus is purified it is obtained as a mass showing iridescent colors. The properties of this lattice, consisting of very uniform spherical particles, 130 mμ in diameter, is further described by Williams and Smith[8].

The close packing of uniform poly-

vinyl toluene latex particles in the size range of 100-1,000 mμ has been described by Alfrey, Bradford, Vanderhoff and Oster[9]. The spontaneously formed, close-packed, crystalline array acted as a diffraction grating and particle sizes in the range of 302-481 mμ were determined by the diffraction method.

Another instance of uniformly arrayed colloidal particles showing brilliant interference colors is the formation of the so-called "schiller layers" from colloidal hydrated iron oxide. The structure and arrangement of regularly packed masses of uniform colloidal particles of this type have been described by Watson, Cardell and Heller[10].

In instances in which the spontaneous regular and uniform aggregation of charged colloidal particles occurs, it appears that at least one of the dimensions, whether the diameter of a sphere, or the width of a rodlike particle, is of the order of 100 mμ or more. Possibly this is because uniform arrays of colloidal particles are most easily recognized when the particles are in this size range and thus reflect monochromatic light of visible wavelength. However, this is also the size range in which slow sedimentation occurs. Particles larger than about 100 mμ in diameter or thickness tend to settle so that there is a gradual increase in concentration at the bottom of the container; conditions are thus favorable for the slow segregation of particles into regular aggregates or pseudocrystals, each consisting of particles of a particular uniform size.

On the other hand, in the case of smaller particles, the Brownian motion is so strong that the rate of sedimentation is negligible and the particles do not become concentrated by settling. If the concentration is increased rapidly by centrifugation, the particles become packed randomly, since there is no time for segregation and for ordered arrangements to be developed. However, if the size is extremely uniform, as with virus or certain latex particles, a relatively rapid increase in concentration can still result in the formation of a highly ordered array.

1 Jones, J. B., Sanders, J. V., and Segnit, E. R., *Nature,* 204, 990 (1964).
2 Sanders, J. V., *Nature,* 204, 1151 (1964).
3 Bechtold, M. F., and Snyder, O. E., U. S. Patent 2, 574, 902 (E. I. du Pont de Nemours and Co., 1951).
4 Iler, R. K., *The Colloid Chemistry of Silica and Silicates,* 90 (Cornell Univ. Press, Ithaca, N.Y., 1955).
5 Iler, R. K., *The Colloid Chemistry of Silica and Silicates,* 133 (Cornell Univ. Press, Ithaca, N.Y., 1955).
6 Iler, R. K., *The Colloid Chemistry of Silica and Silicates,* 10 (Cornell Univ. Press, Ithaca, N.Y., 1955).
7 Xeros, N., *Nature,* 174, 562 (1952).
8 Williams, Robley C., and Smith, Kenneth M., *Nature,* 179, 119 (1957).
9 Alfrey, jun., Turner, Bradford, E. B., Vanderhoff, J. W., and Oster, Gerald, *J. Opt. Soc. Amer.,* 44, 603 (1954).
10 Watson, John H. L., Cardell, jun., R. R., and Heller, Wilfried, *J. Phys. Chem.,* 66, 1757 (1962).

Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

"Oolitic Opal"

The natural-color opal described in last issue of *Gems and Gemology* as "oolitic opal" has been the subject of several conversations with clients who could not believe they were not treated. *Figure 1* shows even better than the illustration in *Gems and Gemology* the peculiar nature of the oolitic structure seen under 20x.

Black-Core Emerald Crystals

Through the good offices of our student Italo De Vivo we received from Antonio M. Barriga Del Diestro, lapidary, Bogota, Colombia, two emerald crystals that illustrate admirably two types of Muzo crystals having black central cores. These are diagrammed in a booklet entitled *Esmeraldas de Colombia,* published by the Banco de la Republica, Bogota, in 1948 *(Figure 2). Figure 3* is a photograph of the two crystals (approximately 1½ actual size) in the direction corresponding to the diagram, whereas *Figure 4* illustrates the opposite ends of the crystals.

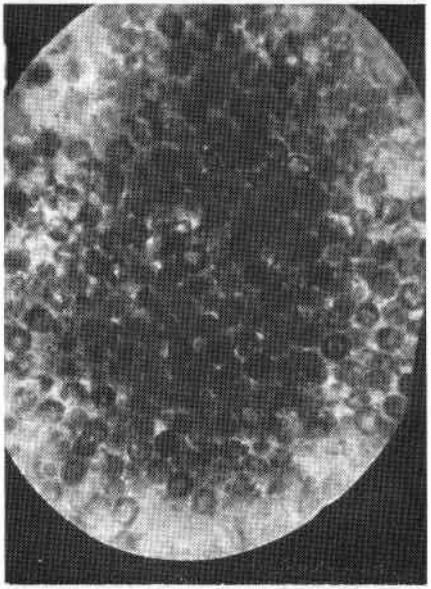


Figure 1

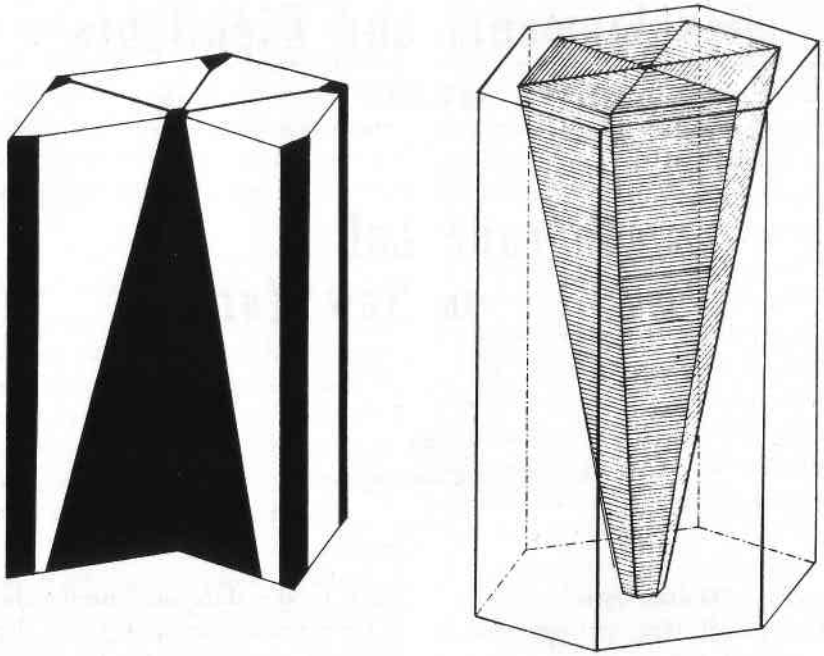


Figure 2

The precise nature of the black core is being determined. It is very soft and friable but interlaced with fragmentary emerald.

Star Enstatite

When the 4-rayed star diopside and cat's-eye diopside first made their appearance in the market they were imported from India as enstatite. X-ray diffraction and other tests proved conclusively that they are diopside. In the April, 1967, issue of *The Journal of Gemmology* an article by W. F. Eppler describes and pictures a 6-rayed star enstatite, black in color and somewhat like sapphire in appearance.

We are indebted to Graduate Gemologist Eli Corman, Canton, Mass., for the opportunity to study eight of these stones and for the gift of one for our collection. In appearance, the stones resemble medium-quality black star sapphires. However, on close inspection one difference was noted: the legs of the star did not cross with the symmetry of sapphire. Two pairs of legs appeared to be at a greater angle than the others. Several of the stones had a weak leg crossing in the wide area, giving the appearance of an 8-legged star; this is only suggested in *Figures 5* and *6*. For comparison purposes, *Figure 7* shows a nearly round Mysore star ruby with perhaps the sharpest star we have ever seen in this material. We are indebted to Mr. Corman for allow-

Figure 3

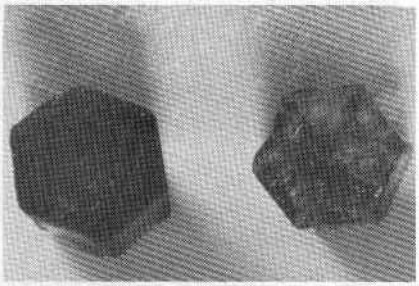


Figure 4

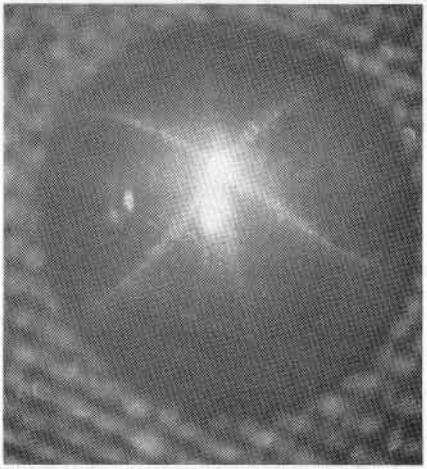


Figure 5

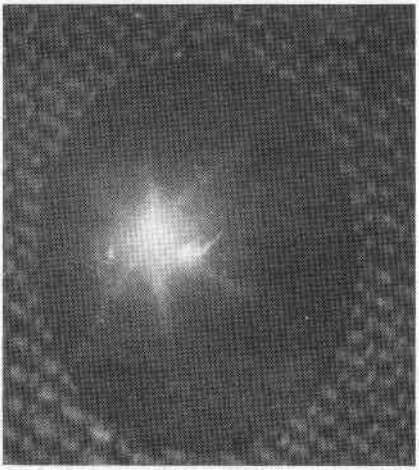


Figure 6

ing us to photograph this stone, too.

Since star enstatite is not mentioned in the literature, it is well to indicate the constants we determined on these stones. The specific gravity ranged from approximately 3.30 to 3.41, and the refractive index was about 1.68. Under magnification, the tiny needles that Eppler assumes are rutile may be seen, although not clearly, unless the magnification is higher than 100x.

Zoisite Crystals

One of the most intriguing identifications we have been asked to do in recent years involved a strikingly beautiful blue crystal, nearly flawless, and

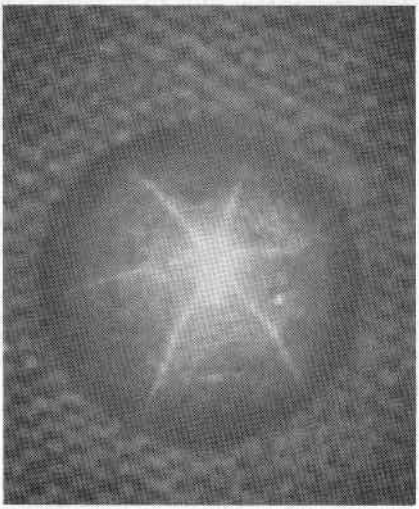


Figure 7

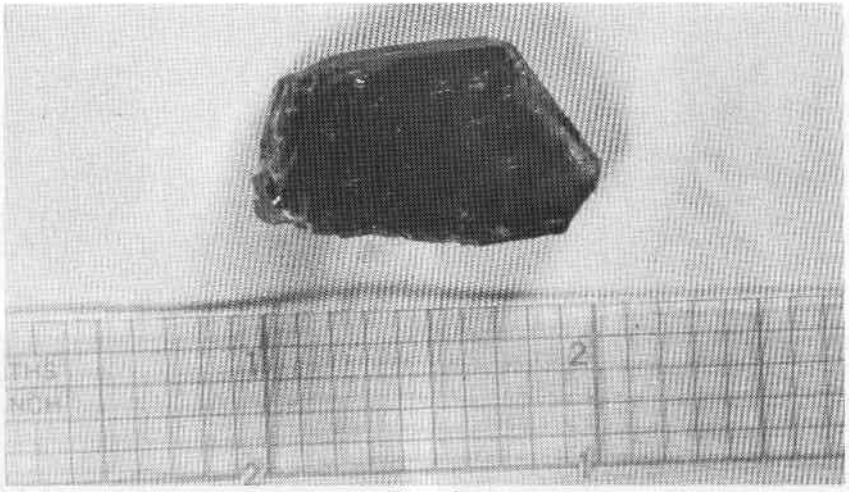


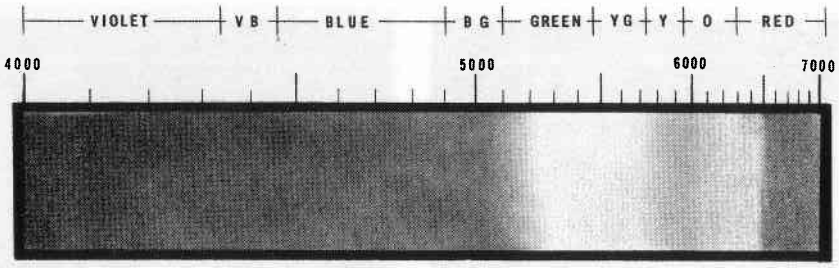
Figure 8

more than an inch in length. Its most striking feature was its phenomenal trichroism: fine sapphire blue, strong red-purple and yellow to deep orange-yellow. *Figure 8* shows the crystal in approximately 1½x actual size looking in the blue direction. Initial gemological tests gave us a refractive index of 1.69-1.70, a specific gravity of 3.36, and a hardness of 6½ to 7. There was no fluorescence under either long or short wavelength or X-rays and there were no inclusions. In the purple-red direction a residual red color could be seen with the color filter.

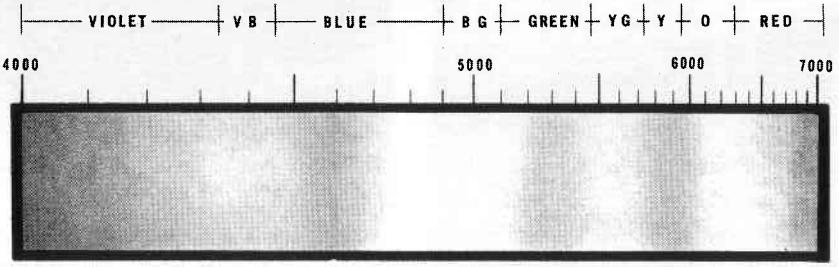
Since these properties did not precisely match any of the common gem materials, we sent the crystal to the Los Angeles Laboratory for X-ray diffraction. The pattern obtained indicated that the material was a new variety of naturally occurring zoisite, heretofore undescribed. Subsequently, chemical analysis, carried out through the good offices of Dr. Kurt Nassau, Bell Laboratories, showed the major components to be calcium, aluminum and silica. Vanadium as a major impurity was also present, with smaller amounts of chromium, iron, magnesium and strontium. The chemical analysis supported the identification of the material as zoisite.

Further work is being carried out on other crystals and rolled pebbles that have come into this country within the space of less than a month. The possibility of the beautiful crystals being a new mineral exists, although at the moment all clues point to a new variety of zoisite. The absorption spectrum, although not spectacular on the large crystal (it weighed more than 40 carats) did show a definite directional difference *(Figure 9)*. *Figures 10* and *11* show peculiar surface growth marks under different illuminations; they may be seen on only one face.

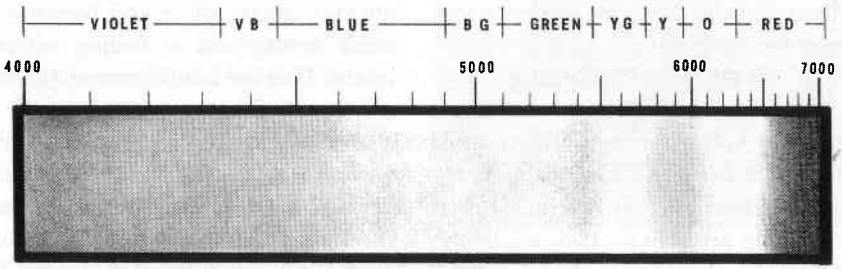
The fact that a number of these crystals have come into the country indicates that cut stones may soon be seen, and we anticipate with pleasure seeing



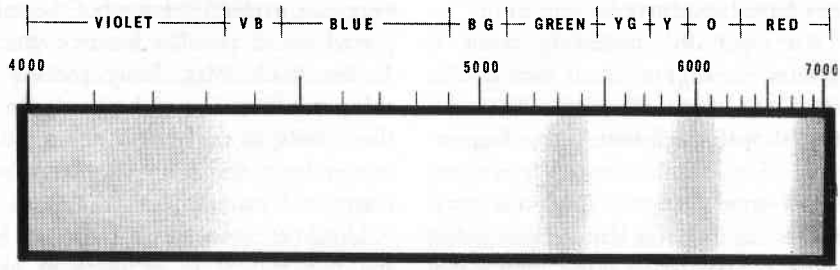
Yellow Direction



Purple Direction



Blue Direction



Nondirectional

Figure 9

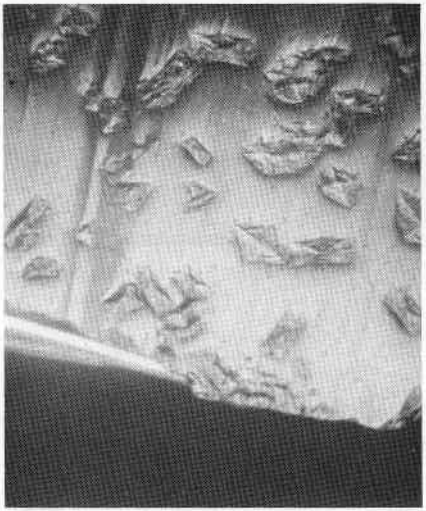


Figure 10

Figure 11

what an accomplished lapidary may be able to do with the material. We wish to thank Mr. Lou Ardbaum and Oriental Lapidaries Agency, Inc., for permission to carry out the necessary tests described above.

Snuff-Bottle Collecting

Snuff-bottle collecting seems to be a growing hobby, to judge from books that have been published and the increasing activity in the testing of these intriguing art objects. They are doubly intriguing when one studies the shapes and forms and carvings, as well as the great variety of materials from which they have been carved.

An especially interesting bottle is pictured in *Figure 12.* It is a double bottle, the larger of which is fine amethyst shot through with tufts of cacoxenite. The smaller bottle is a clear yellow-brown citrine. The artist cleverly chose material that naturally had a clear-cut separation at the joining area of the two bottles.

Two very beautiful bottles are shown in *Figure 13.* They have a very fine polish. The one on the left is a rich yellow with brown veining, whereas the one on the right is white and brown with black veining and a "feeling" of porcelain. They are both common (uncommon?) opal.

According to collectors with whom we have spoken and Mrs. Lila Perry in her book *Chinese Snuff Bottles,* perhaps the rarest highly prized bottle is one made of crested hornbill ivory. The crested hornbill is a large bird that lives high in trees in Malaya and is becoming very rare, probably because of the value placed on its peculiar head ornament. In her book, Mrs. Perry pictures in color the "horn" and beak of one of these birds, as well as two snuff bottles carved from the attractive yellow and orange-red material.

Until very recently we had never had the opportunity to examine at close hand anything made from hornbill

Figure 12

ivory, having only seen items in museum cases. *Figure 14* is a photograph of a snuff bottle that we feel quite sure is hornbill ivory. Properties for this material are not to be found in literature, however. We found a banded structure under magnification. The sides of the bottle are an intense orange-red, whereas the body is a rich grayish-yellow. The odor produced by touching the inside of the bottle with the tip of a hot needle resembled burning hair or feathers. The R.I. by the spot method was 1.54. Under long ultraviolet the yellow part fluoresced a strong whitish yellow; short ultraviolet produced a similar but weaker fluorescence.

Crystal Inclusions in Jadeite

An unusually translucent green jadeite cabochon tested recently had a number of sharply defined crystal inclusions that appeared to be nearly colorless. They are shown in *Figure 15* under

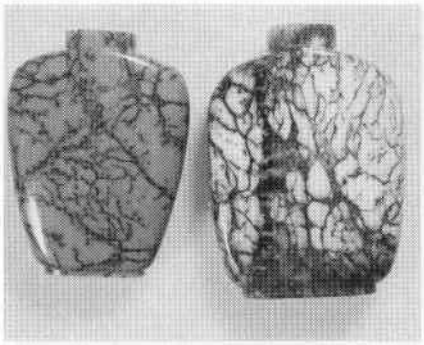


Figure 13

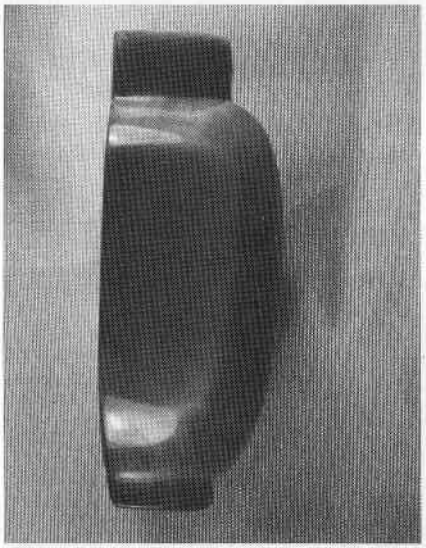


Figure 14

45x. No conclusion was reached as to their identity.

Flux-Fusion Synthetic Rubies

Figure 16 illustrates three flux-fusion-grown synthetic rubies, the largest of which was more than 8 carats in weight and nearly flawless. Several dealers who had seen them but had not been advised as to their identity readily offered to buy them as "Siam" rubies. Since they did not have seeds, nor contain many inclusions, it is assumed they

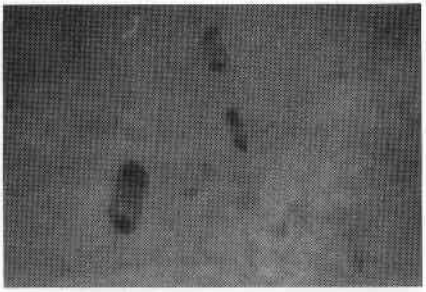


Figure 15

were not Chatham synthetics, the only flux-fusion synthetic currently being marketed.

Figure 17 is a short-wave transparency test with natural rubies, chosen for having the same color and dimensional depth, and three Verneuil synthetics. The flux-grown stones are the center row and the natural stones are the three that appear white in the photo. *Figures 18* and *19* show two types of fingerprint inclusions seen under 45x by *Photoscope*. The coarse inclusions are similar to those of known flux-grown synthetics. The finer fingerprint is very much like that seen in natural rubies.

More New Synthetic Corundum

Another flux-grown synthetic corundum we examined was unusual on two accounts: it weighed more that 40 carats and was a standard round brilliant cut. The color was light red (the optic axis ran through the girdle). *Figure 20* illustrates how a small group of (flux?) inclusions, strategically located, reflected throughout the stone. *Figure 21* shows an enlarged view of these inclusions, some of which appear to be elongated bubbles, others snakelike, and others like the negative crystals in some natural sapphires.

Figure 22 is a short ultraviolet transparency of this stone, together with a boule of similar color Verneuil-grown synthetic and a large red Verneuil synthetic. Under short ultraviolet, the stone had a pink glow with a whitish overtone, whereas the red stone glowed

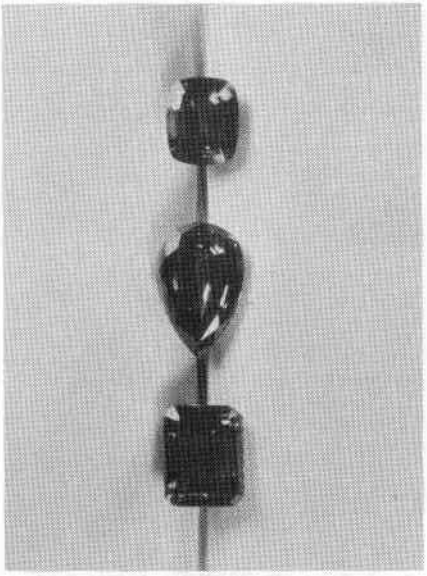


Figure 16

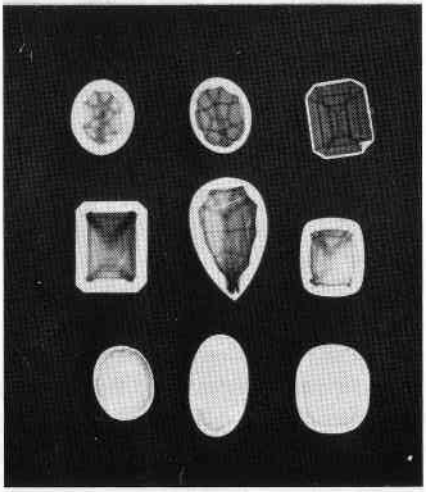


Figure 17

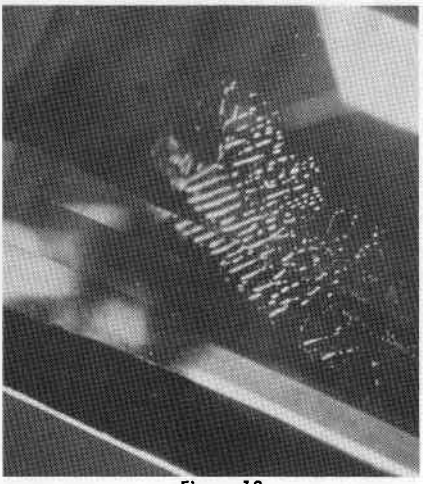


Figure 18

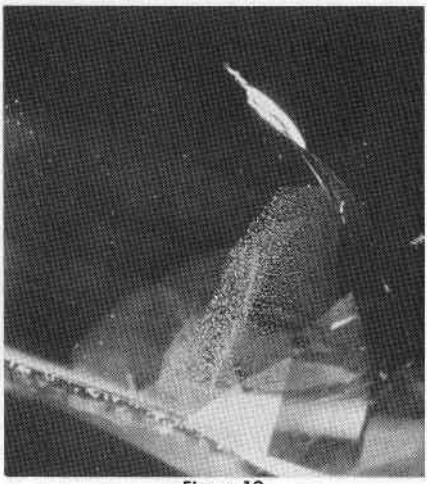


Figure 19

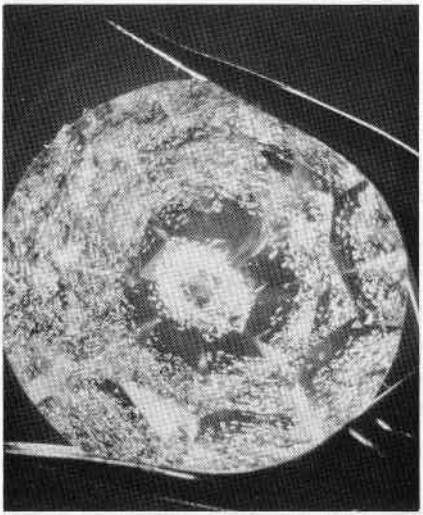


Figure 20

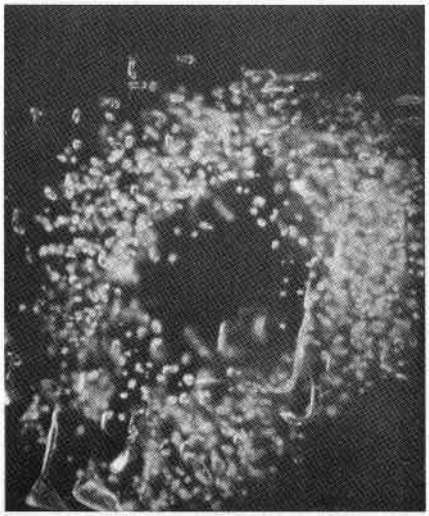


Figure 21

the expected dark red. A smaller stone presented as a solution-grown synthetic showed a definite color zoning but no flaws whatsoever. The lighter pink area fluoresced with this whitish overtone, whereas the dark-red area fluoresced dark red. We have noted this whitish fluorescence in other synthetics produced by other methods, as well as some Verneuil stones, but so far not in natural rubies.

Fine Opal Doublet

Ordinarily when opal doublets are manufactured, an opaque or, at best, a semitranslucent material is used for the back and frequently a black cement is used to join the two parts. We were intrigued by a beautiful black-opal

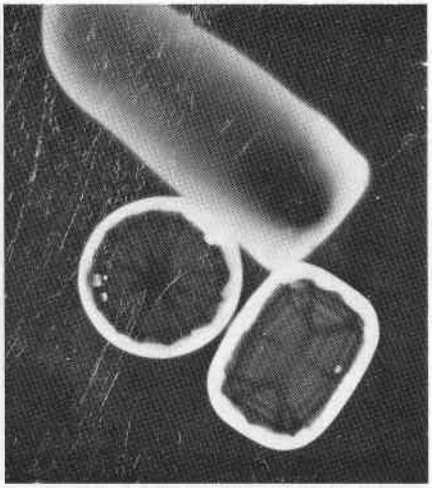


Figure 22

doublet in which a nearly transparent back was used with a colorless cement to join them. *Figure 23* shows the myriad of tiny gas bubbles in the cement layer looking for all the world (or beyond) like the milky way.

Imitation Emerald

One of the best imitation emeralds we have ever seen is shown in *Figure 24*. Set in platinum with two old-mine-cut diamonds, the stone had an excellent emerald color and numerous very natural-appearing inclusions, many dark in color and others in planes. No gas bubbles could be seen under 30x but under 60x small gas bubbles and wispy swirls identified it as glass.

Faulty Setting

Since the Gemological Institute has added Diamond Setting to its curriculum, most staff members have become very aware of the way stones are set and the care with which setting is done. Therefore, it was not difficult to determine why a large colorless and nearly flawless marquise diamond had broken

Figure 23

near one end during wear when it was noted that there was no seat prepared in the four center prongs. *Figure 25* shows the broken stone with the arrow pointing to the break. *Figure 26* shows that when the stone was given a sharp blow it merely spread open the four central prongs and snapped, because it was securely held only by the end caps, there being no true bearing in the other prongs.

Low-Specific-Gravity Plastic

Most of the time the Laboratory staff uses pure methylene iodide for taking the refractive index on stones below 1.70 in index. Such was the case when we were determining the index of a strand of transparent amberlike beads that floated in salt solution. When the bead was first placed on the prism a fairly clear index of 1.57 was obtained. But as we watched, the green line started to rise, finally coming to rest at 1.63, but the 1.57 was still faintly

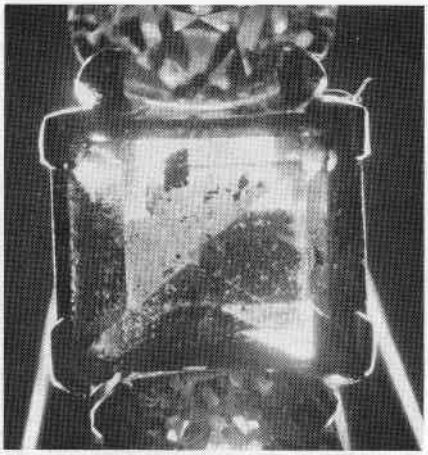


Figure 24

visible.

It was a few minutes before we realized that the bead was a rare low-specific-gravity plastic that was being slowly dissolved by the methylene iodide, thus raising the refractive index. *Figure 27* is a photograph of one of the beads showing a large (and suspicious) gas bubble. The patch affected by the liquid and to the left of the bubble is an area of crazing that closely resembles the crazing seen on the surface of old amber.

Dyed Angels'-Skin Coral

We have seen several examples of dyed coral in which the color has been applied only in selected areas in an attempt to imitate the rare pink angels' skin (a pink with no hint of orange). In one case, a swab test using fingernail-polish remover removed some color.

Rare Light-Blue Diamonds

We have no explanation why we have seen four very fine, Type II_B, very light-blue diamonds recently, when

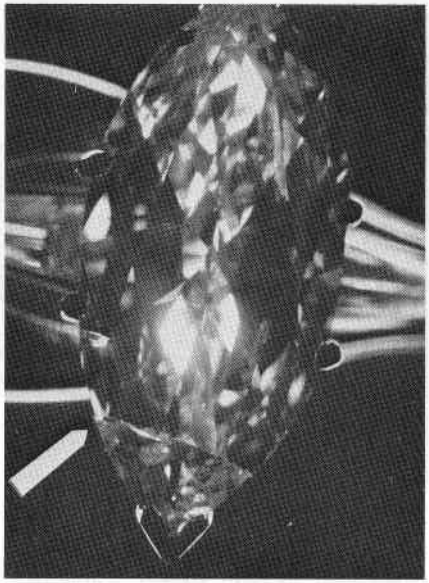


Figure 25

we have only seen three others in more than 15 years of looking for them. These four stones, when graded against out best color master stone (E color on the GIA scale), appear a decided very light blue, but not grayish or leaden in color. They would be undoubtedly accepted by most people as truly "blue-white." We do fairly commonly test dark-blue and gray diamonds that are found to be the Type II_B. It is interesting to note that the four stones mentioned above were also flawless!

Garnet-Structured Synthetics

The New York Guild of the American Gem Society was privileged to hear Dr. Kurt Nassau of Bell Laboratories give an illuminating lecture about garnet-structured synthetics. After hearing his talk, it was much easier to understand why we have encountered such widely varying absorption spectra for green "YAGs" — yttrium aluminum

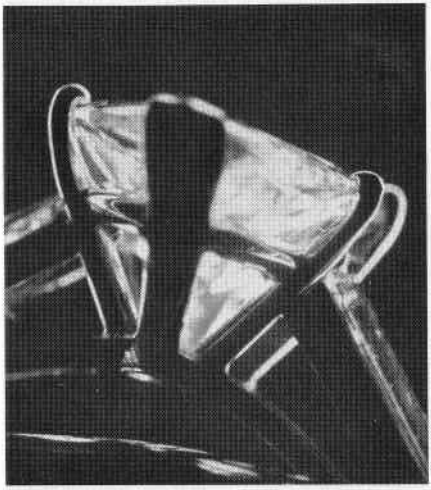


Figure 26

garnets. By replacement and addition of various metallic elements and rare-earth elements, almost any color may be produced. During the lecture he showed crystals and cut stones of many colors, some strikingly beautiful.

We have had several very attractive cut stones submitted for identification, some resembling fine demantoid garnet but with red overtones, if one can imagine that. The stones show intense red in the color filter or when a strong, narrow beam of light is passed through them. The spectacular absorption spectrum of these stones, to which the color is ascribed to chromium and neodymium, was illustrated on page 365 of the Winter 1965-66 issue of *Gems and Gemology*.

Among stones seen recently that we have identified as green-garnet-structured synthetic are two that have different spectra. *Figure 28* is the absorption spectrum of an intense-green crystal with intense red in the color filter, whereas *Figure 29* is the spectrum

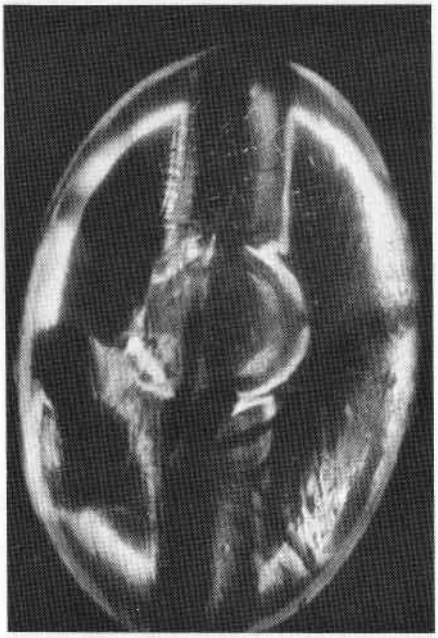


Figure 27

of a lighter bluish-green crystal that shows no red in the filter. The lines in *Figure 28* suggest chromium alone as the coloring agent; at least, rare-earth elements seem not to be present. The cause of color in *Figure 29* is not known.

Refractive Index of Gilson Synthetic Emerald

We encountered a Gilson synthetic emerald with an oddly banded structure too faint to photograph. The reason for mentioning the stone is that on either side of the main band the refractive index was different. On one side it read 1.560-1.564 and on the other, 1.57-1.574. We have mentioned before that the Gilson material may vary in properties.

Acknowledgements

We are again indebted to **Dr. Kurt**

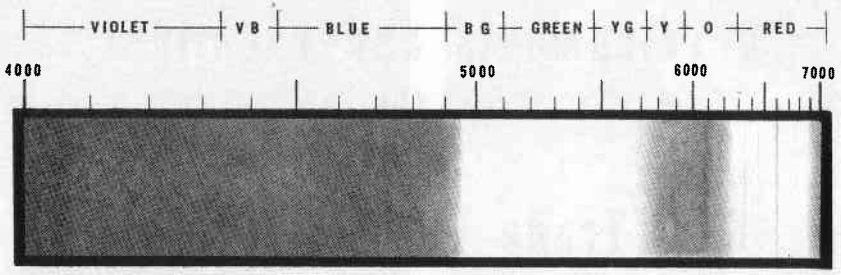


Figure 28

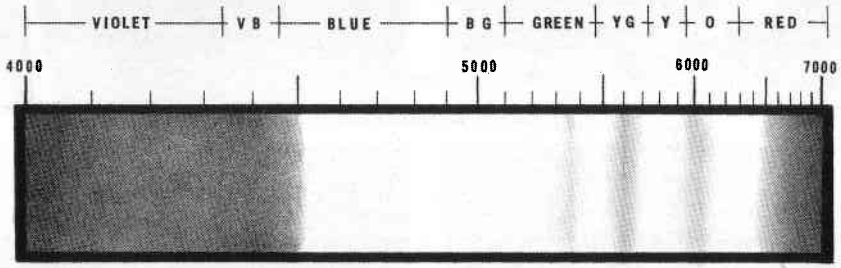


Figure 29

Nassau for a gift of several new colors of synthetic garnets, as well as other experimental crystals.

We thank **Mr. George Schuetz,** Larter and Sons, Newark, New Jersey, for a gift of fine lapis-lazuli for our collection and student study.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

Taaffeite Proves Largest

In a recent issue of *Modern Jeweler,* columnist George Bruce, owner of International Gem Import of Stone Mountain, Georgia, wrote an article on spinel. In it he retold the story of the remarkable discovery of taaffeite, a new mineral, a decade or so ago. Count Taaffe, an Irish nobleman, found a faceted gemstone in a paper of Ceylon stones using only a loupe. Taaffeite has physical properties almost identical to spinel, with the exception that it is weakly doubly refracting, in contrast to spinel's isotropic character (it is a beryllium-magnesium aluminate, whereas spinel is a magnesium aluminate). That Count Taaffe noticed the weak birefringence (.004) in a small stone with a loupe is proof of keen eyesight.

The Bruce article led one of his readers to check into a parcel of Ceylon sapphires that he had bought ten years ago in which he remembered that some of the stones had the properties of spinel. While checking the parcel he found one 5.34-carat dark-brownish-purple stone that had an index in the 1.72 area and that to him appeared to be doubly refractive. He immediately called Bruce and sent him the stone. Bruce, in turn, forwarded it to the GIA Laboratory, where it was found to be uniaxial with refractive indices just less than 1.720 and just over 1.724. The specific gravity was 3.608. The indices were just slightly higher than those reported earlier and the S.G. was approximately .01 lower. Since the stone weighs 5.34 carats, the S.G. determination should be quite accurate. This is the second taaffeite that has turned up in America (the first was identified in our New York Laboratory), and the same collector has been able to obtain

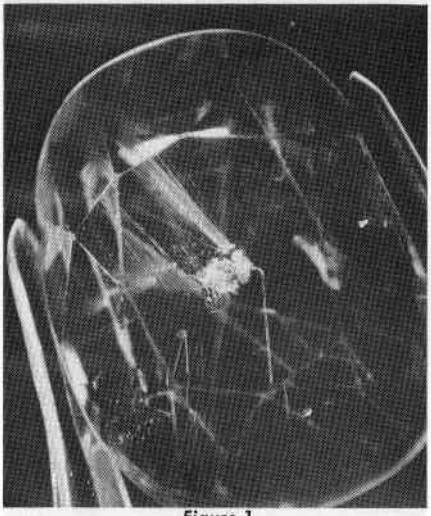


Figure 1

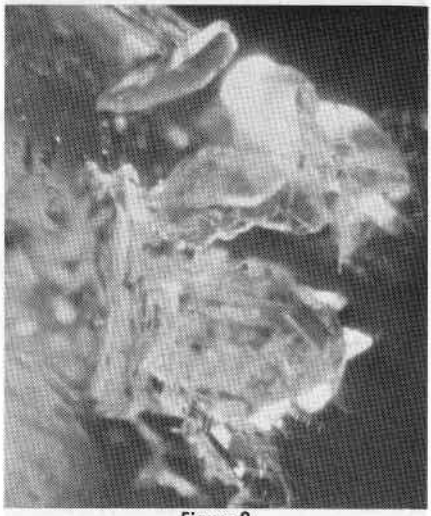


Figure 2

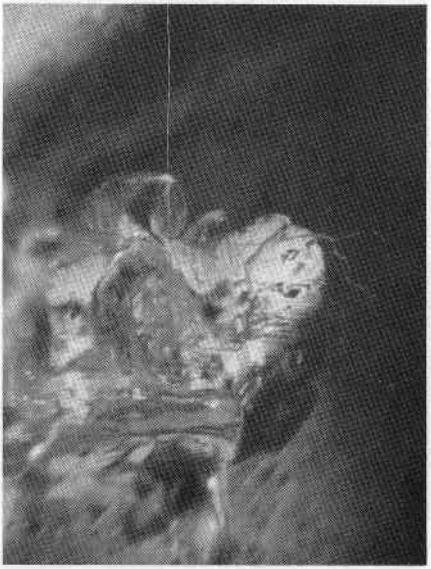


Figure 3

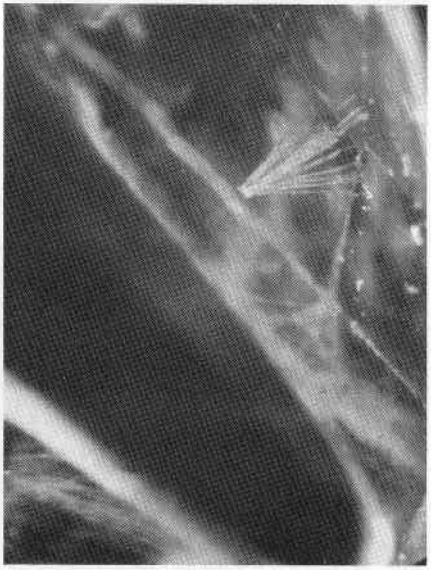


Figure 4

both. One was on loan to the Smithsonian Institute for over a year.

Inclusions in the new stone were interesting; they are pictured in *Figures 1* through *7*. The needlelike inclusions and many of the other inclusions were negative crystals. In addition, there were crystals of other substances. The whole stone is shown in *Figure 1;* the closeup of the large group of inclusions under the center of the table is pictured in *Figure 2*. In the latter a large negative crystal is near the top of the photograph. *Figure 3,* a photograph taken

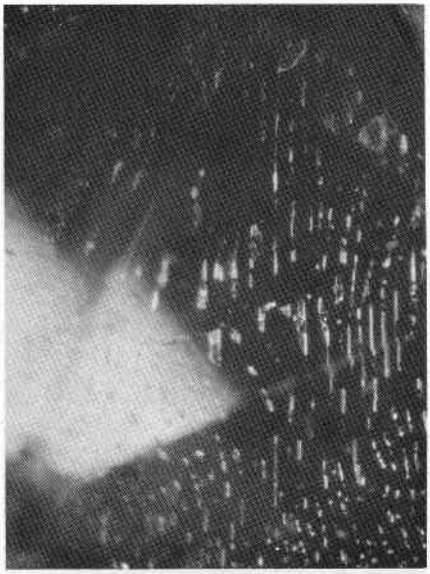


Figure 5

Figure 6

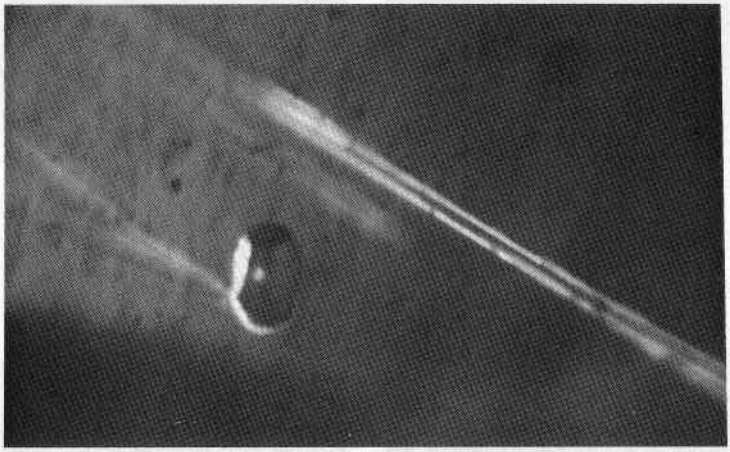


Figure 7

at 122½x, shows a general hexagonal pattern visible especially in the lighter portion. A number of 2-phase inclusions were visible in various parts of the stone; some are shown in *Figures 5* and *6*. *Figure 4* shows a fan-shaped group of inclusions we were unable to identify; they were confined to a single plane and appeared to be negative crystals, but this configuration belies such an interpretation. A large crystal, shown in *Figure 7*, had all of the characteristics of a barrel-shaped striated sapphire crystal, but we believed it to

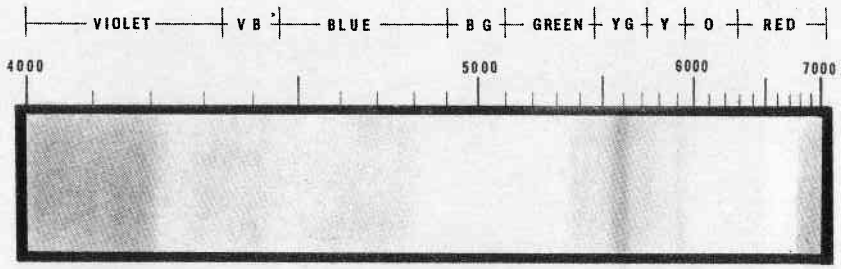


Figure 8

be a negative crystal. Doubling is apparent in the two long needlelike inclusions to the upper right. *Figure 8* shows the absorption spectrum observed for this stone.

Cat's-Eye Doublet

George Bruce also sent us a chrysoberyl that is shown under a single light source in *Figure 9*. When the stone was examined from the side, its appearance was startling. In *Figure 10,* the side view, the reason we were surprised becomes obvious: there is a distinct joining plane between the chrysoberyl top and the back of the stone. This is a very unusual substitute — a cat's-eye doublet. Although the material in the upper portion was exceedingly transparent, the stone looked very real. The reason it had been made into a doublet was that the chrysoberyl top was too transparent to make a good cat's-eye. By adding a more opaque back, a better eye was formed. There were almost no

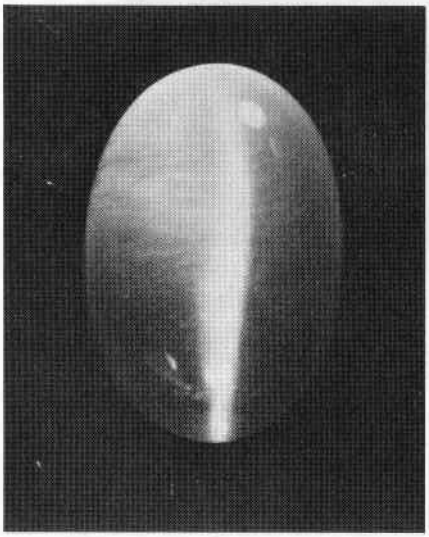


Figure 9

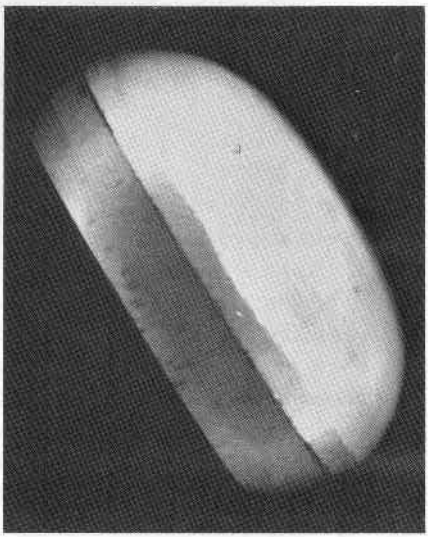


Figure 10

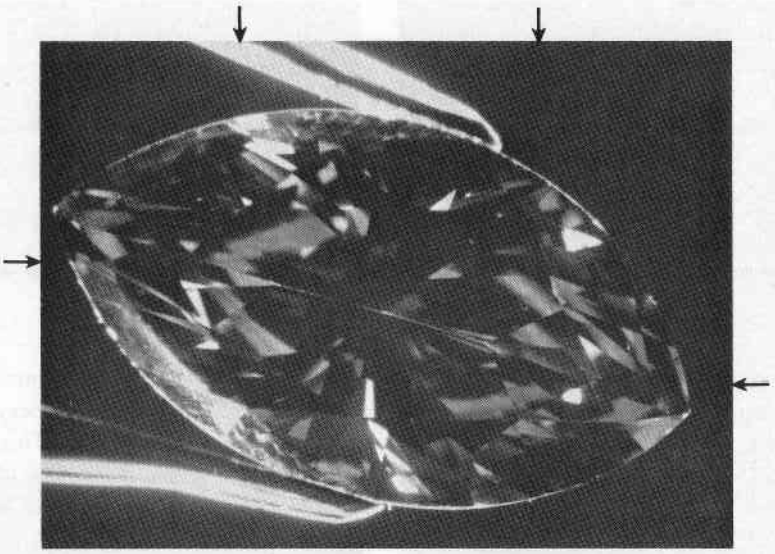


Figure 11

bubbles in the cement layer.

Marquises With Unpolished Girdles

The cutting angles of a marquise-cut diamond are such that the girdle must reflect into the table over a good part of the length of the stone, because the angles are so flat, except in the narrow cross section. To make the effect less obvious, the girdle is usually faceted. This has the advantage of removing the contrast between clear facet reflections and the gray streak of the girdle. The girdle becomes so much less noticeable that the stone's appearance is improved.

We recently received a marquise for quality grading that had only the points faceted; most of the expanse of the girdle was left unfaceted. This showed up so strongly as a girdle reflection in the table beyond the center section toward both points that it was very obvious from above, even to the unaided eye. A photograph was taken under low magnification to illustrate this point; it is shown in *Figure 11.* The girdle reflections show as arcs, two to the right and two to the left of the center of the stone. In addition, there are more gray reflections at the points.

This marquise had an unusual cutting in that there were two main pavilion facets, instead of the usual one, on both sides at the belly of the stone. The main girdle reflections are shown by arrows in the illustration.

Different Kinds of Anomalous Double Refraction

Reference is made frequently to the appearance of anomalous synthetic spinel under crossed Polaroid plates; we usually refer to it as *cross hatched.* In glass, on the other hand, anomalous double refraction usually takes the form of a black cross. There is nothing new about *Figure 12,* but it shows the difference between the two kinds of anomalous double refraction. Glass is on the left and synthetic spinel on the

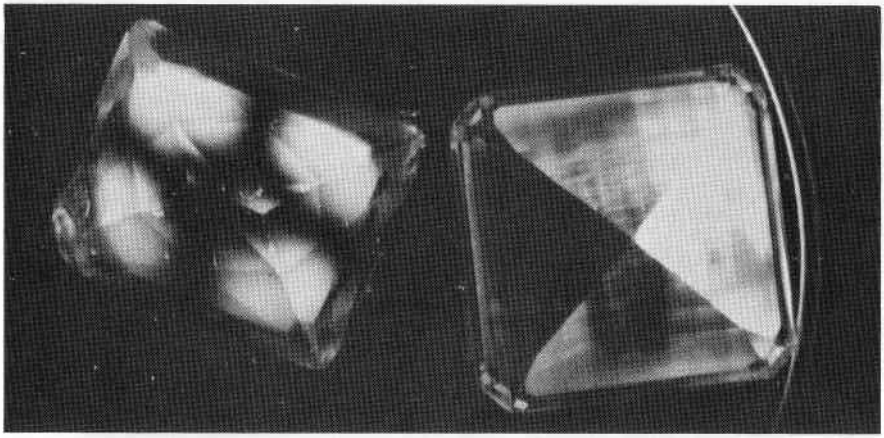


Figure 12

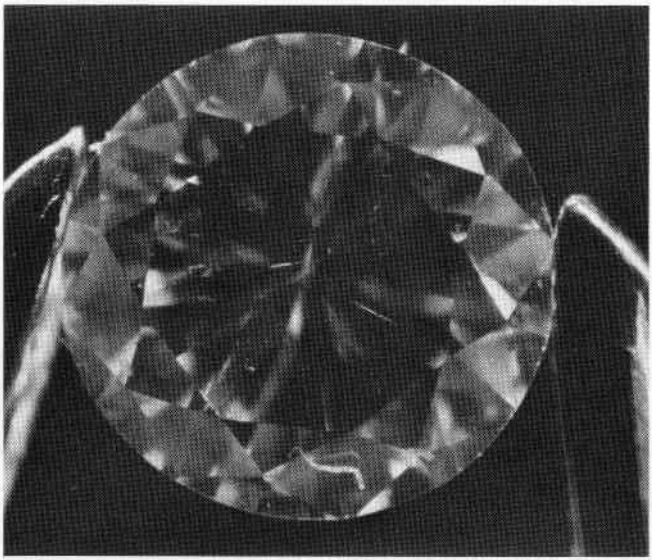


Figure 13

right.

Scratches on a Freshly Cut Diamond

Quite often one sees scratches on the surface of a diamond, but they are not frequently seen in new merchandise offered for sale as loose goods. They show up best when the diamond has such a deep pavilion that the whole table of the stone has a black background, as in *Figure 13*. In this round brilliant, a number of scratches were noted on the table surface. We don't know whether this was a paper-worn stone or whether the scratches were incurred during fashioning. If it had all been done during polishing, the

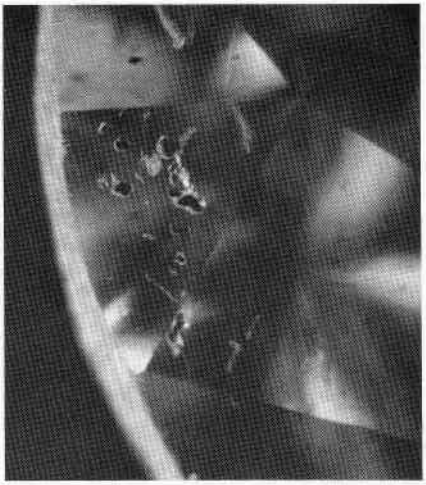


Figure 14

scratches would have been parallel to one another. These are not, as is obvious in the illustration.

Odd Negative Crystals in Diamond

Negative crystals in diamonds are common, but to find a large number of them in the same area in a brilliant cut, all of which have been filled in by a black material during polishing or earlier, is unusual. The diamond brilliant shown in *Figure 14* was encountered recently. The large number of negative crystals, most of which reach the surface, is well illustrated in this photograph.

Andesine Feldspar

We received some rough stones for identification that the miner had assumed must be some kind of jade. He sent us two different pieces. These were quite obviously not completely homogeneous, but they were largely one mineral, so we X-rayed them to arrive at a positive identification.

The properties were those of a feldspar, but we felt that X-ray diffraction was necessary to give us an unquestionable answer. Each of the pieces showed some of the characteristics of labrado-

Figure 15

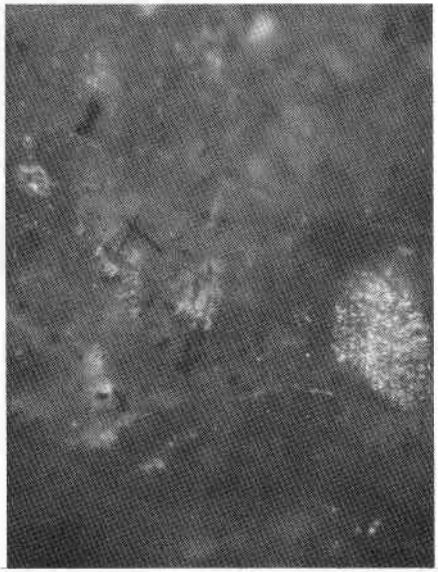


Figure 16

rite in various directions, but analysis proved them to be andesine feldspar. *Figures 15* and *16* are two illustrations of the same section of one of the pieces. In *Figure 15,* the section at right center shows little reflection, but in *Figure 16* a bright reflection can be seen from the same section in the andesine aggregate. This piece and its accompanying one were not spectacular, nor did they resemble jade closely, but they were rather attractive.

that were spectacular. One of the drill holes is shown in *Figure 17,* with arms reminiscent of saguaro cactus quite apparent in the photograph.

Unpolished Facets

In haste to turn out the finished product today, diamonds whose facets are nearly parallel to octahedral faces sometimes are very poorly polished, because too much time is required to realize a fully acceptable product. In *Figure 18* we see a diamond with a bezel

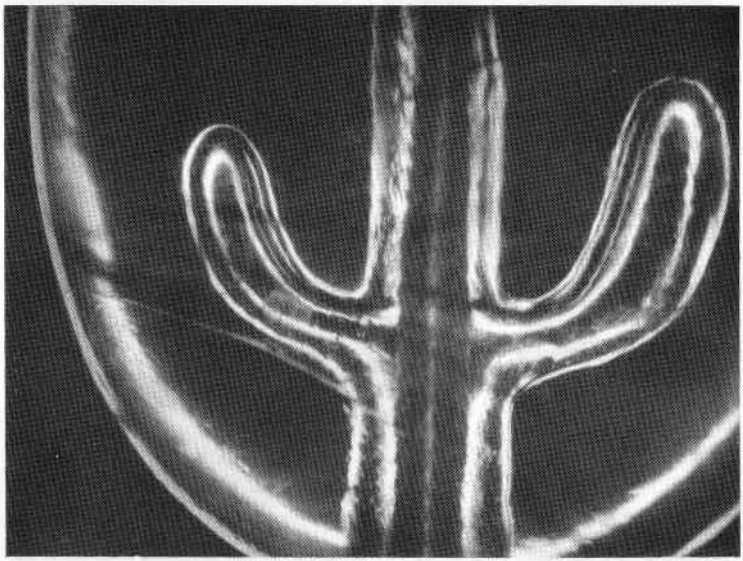


Figure 17

Amber Substitute

We received a strand of material that was represented as amber, but that on examination proved to be a plastic. The pieces were of interest because the drill holes had obviously been formed when the pieces were cast, rather than having been drilled later. Air trapped at the time of molding brought about results

facet at 12 o'clock that was not finished properly. This one was so bad that it was very obvious to the unaided eye. The one at 9 o'clock also shows deep grooves.

Opal Substitute

George Bruce was responsible for another specimen that was sent to us recently for identification and comment.

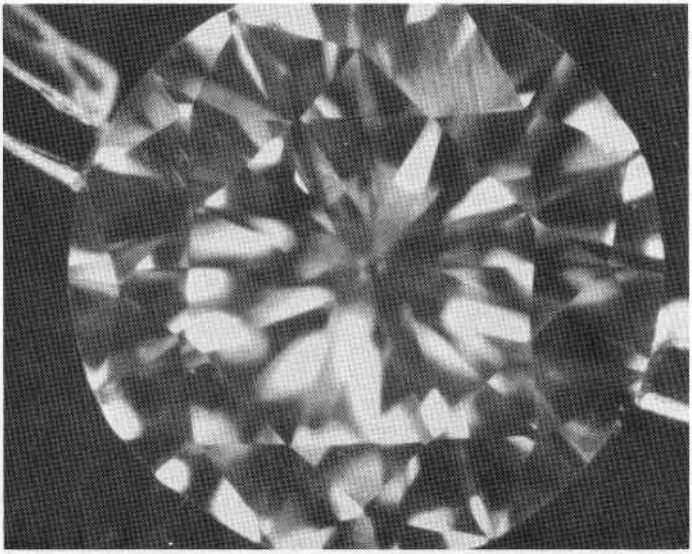


Figure 18

Received in a paper of opals from Australia was a stone that was a kind of imitation that is seldom encountered; that is, one made up of tiny fragments of opal embedded in a resin matrix. The resin is very soft and reacts quickly to a hotpoint. Embedded in it were numerous fragments of natural opal. The specimen is shown in *Figure 19*. At a distance from the unaided eye it appeared to be a natural opal, but under magnification its true nature was obvious.

A New Australian Emerald Source

Recently the Institute had the opportunity to examine a number of emeralds from a new source in Western Australia. Clem S. Cook, one of the operators of The Poona Mining Co., showed us a large number of specimens of both rough and cut emeralds from the new source. The mine is located about 500 miles north of Perth and about 450 miles east of the coastline. It is desert country with midday temperatures of 125° F. common. The operators have sunk a shaft to a depth of approximately 170 ft. and have extracted some rather attractive emeralds.

The stones have properties comparable to those of Colombian emeralds, but since they are found in a mica schist, they are typical of the emerald occurring in such rocks: full of inclusions and somewhat less clear than the finer Colombian product. A group of the crystals, ranging in size from less than a carat to nearly 6 carats, is shown in *Figure 20*. They showed a very strong chromium spectrum (so they can happily be called emeralds on both sides of the Atlantic), had a specific gravity on the order of 2.695, indices close to 1.572 - 1.579, and a birefringence of about .007.

The crystals were pink under the emerald filter, showed no fluorescence under long, short or X-ray exitation,

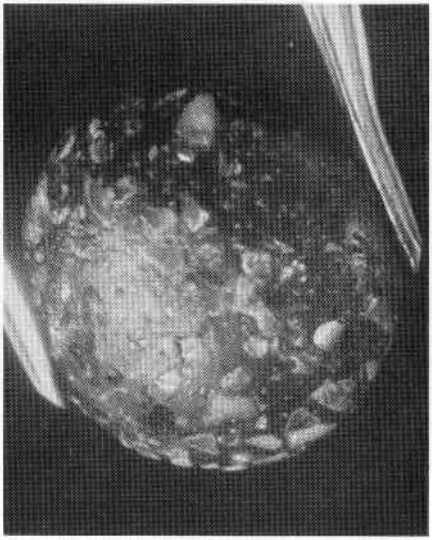


Figure 19

and the inclusions were heavily inclined toward the biotite mica that is very evident in the schist, according to Cook.

There were inclusions in the crystals that suggested calcite and actinolite, as well as some that were black and opaque and seemed relatively formless. The biotite flakes were evident in almost every stone (*Figure 21* — see arrows.) In *Figure 22* are three crystals that look as if they could possibly be calcite. Many of the cut stones showed black inclusions, quite a number of which are evident in *Figure 23.*

All in all, these were very interesting emeralds to examine. This new source would seem to add materially to emerald's availability in the world today. The Poona material will not compete with the finer product of Colombia, but it is more attractive than most of the product of emerald sources available in the world today, with the exception of Colombia and Sandawana.

The emeralds we examined were represented by Mr. Cook to be mine-

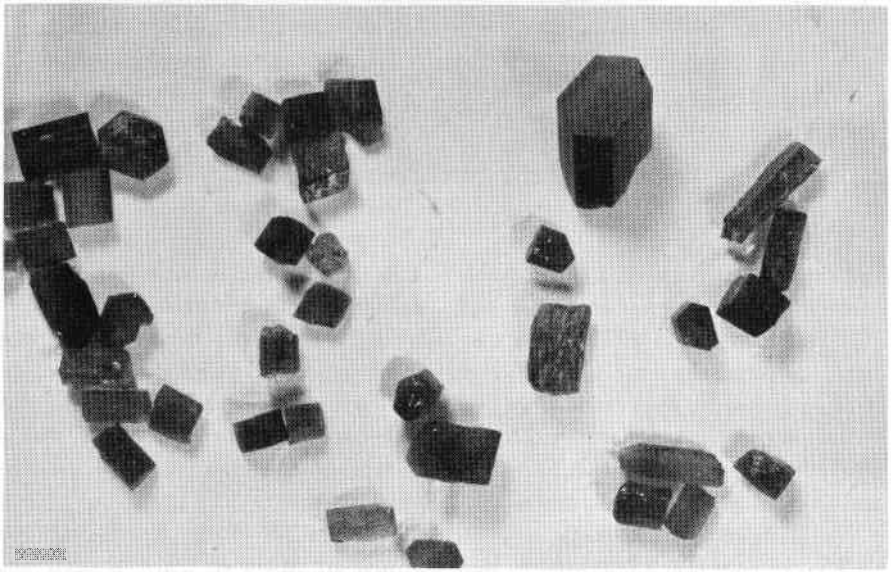


Figure 20

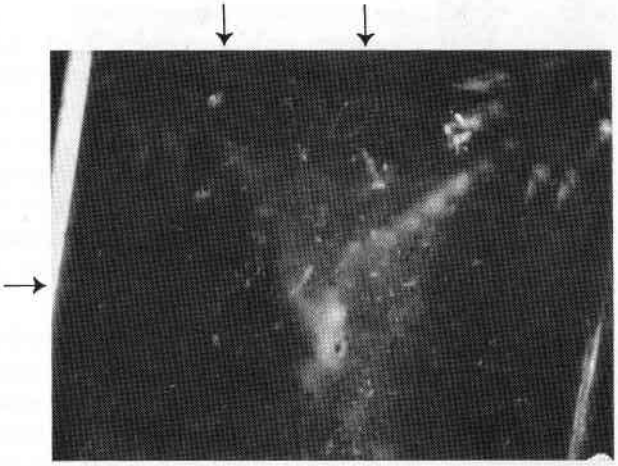


Figure 21

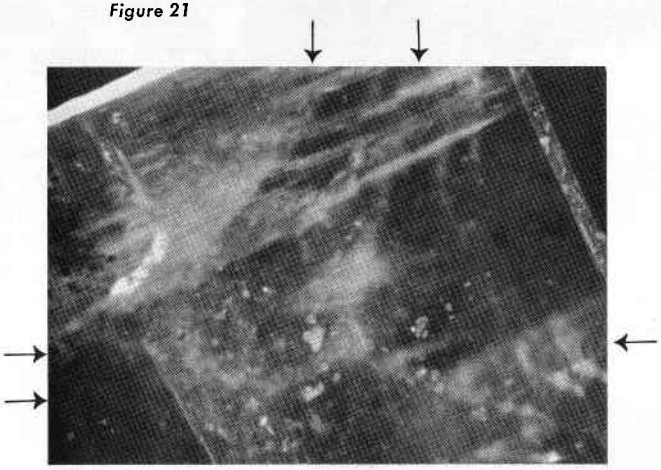


Figure 22

run material. In view of a considerable interest in the material in Jaipur and Idar-Oberstein, it is planned to continue to operate the mine and to enlarge it as an open-pit operation. Thus, we will soon be able to add emerald to the opal, sapphire and chrysoprase we recognize as products of Australia.

Acknowledgements

We are very much indebted to **Ben Gordon** of Gordon Jewelry Co., Houston, Texas, for donation of a large number of cut gemstones. We also recorded from Ben a cabochon that is a combination of jadeite and feldspar.

We would also like to thank **John Fuhrbach** of Amarillo, Texas, for a nice group of stones donated for use in our tests sets.

Andre's of Hong Kong and the **House of Ming** in Taiwan each donated to the GIA a sample of the new

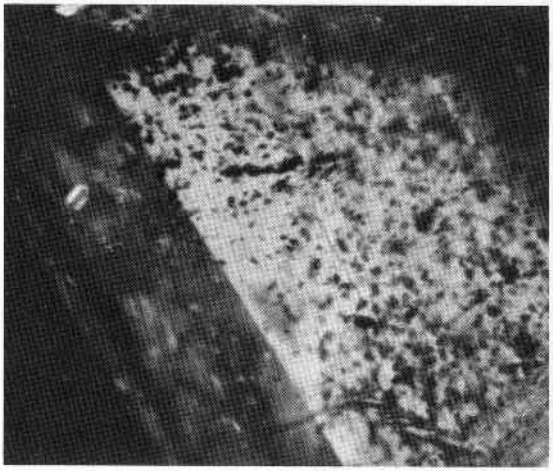


Figure 23

green chalcedonic quartz, the first discovered that has been colored green by chromium. It makes a very fine substitute for green jadeite.

Our thanks also to **Marvin Smoot** of Goldsboro, North Carolina, for a nice group of stones that will prove very useful for correspondence and class students of Gem Identification.

Bill Ilfeld of Gems and Turquois, Ltd., of Montezuma, New Mexico, for two fine specimens of turquois from mines that he identified for us. It is very helpful to be able to pinpoint the sources on stones of this type.

Also received with appreciation from **Hy Klein** of Los Angeles was a star garnet and two nephrite cabochons; and from **C. D. Parsons** of Burbank, California, a gift of faceted rhodonite, apophyllite and siderite. Also, our sincere thanks to the **New York State Retail Jewelers' Association** for a $100 donation.

(NOTE: In the Los Angeles Lab Column in the Summer issue of ***Gems & Gemology****, Figures 16 and 17 were reversed.)*

Book Reviews

EUROPEAN REGALIA, by Lord Twining. Published by B. T. Batsford, Ltd., London, England, 1967. 334 pages. 9" x 12" format. Clothbound. Lavishly illustrated with 420 black-and-white photographs and 20 line drawings. Price: approximately $35.

This monumental writing effort, like Lord Twining's 1960 masterwork, *A History of the Crown Jewels of Europe,* considers jewelry on a grand scale. In fact, it is even wider in its scope, covering the political as well as the cultural and symbolic histories of regalia.

Lord Twining has divided his work into eleven chapters, each of which is subdivided into several sections. The chapters are as follows: *Crown and Empire, Crown and the West, Church and Crown, Crowns of Princes and Sovereign Dukes, Crown Miscellany, Scepters, Orbs, Swords, The Lesser Ornaments, Anointing Vessels* and *Royal Obsequies.* The book concludes with a selected bibliography and a comprehensive index.

Any jeweler who is a sincere student of his art should be absorbed and fascinated by the multitude of facts in this impressive book. For example, what is the history of the orb? Why does it only give precedence to crown and scepter? Despite its original relationship to the celestial sphere, it has in its history been called a "ball" and an "apple."

"Royal ornaments," says the author, "are not just expensive baubles, but are symbols that have been consecrated for a special and unique purpose." The British jeweler should be particularly interested: only in England and the Vatican in the entire world have the ancient rites of coronation survived.

There can be no doubt that *European Regalia* will take its place beside Twining's earlier work, and that, together, they will become recognized as a complementary and standard opus.

SEVEN PRECIOUS GEMS, by William Elder Marcus. Published by Carlton Press, New York City, 1967. 80 pages. Clothbound. Black-and-white line drawings. Price: $3.50.

This little book, authored by a former New York City jeweler, was written to offer in nontechnical and concise form the essential facts and lore concerning diamond, emerald, ruby, sapphire, star stones, opal and pearl. It is intended as a guide and reference tool for students of gemology, for reference departments of libraries, for jewelry stores and gemstone dealers and for general lay persons who wish to be reasonably informed about these gems without reading extensively on the subject. *Seven Precious Gems* should please the general reader and prove to be a source of information to the connoisseur as well as to the prospective purchaser of gemstones. The book contains original drawings by Rockwell Kent, the eminent American artist.

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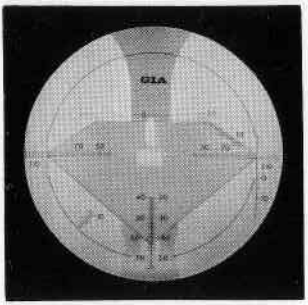

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