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IN THIS ISSUE

Ed. Note: A long delay in publication of the Spring, 1974 Gems & Gemology delayed the 1974 Summer and Fall issues. They were not published in calendar year 1974 but in January and February of 1975, respectively.

Natural, Treated, Synthetic And Imitation Gems

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INTRODUCTION

In an ideal world the distinctions among the four designations in the title could be determined easily and adhered to strictly. The distinctions, however, cannot always be made even with elaborate gemological testing,[1, 2, 4] and lack of understanding also adds confusion sometimes. The following is an outline of the distinguishing criteria; it recognizes, however, that there are some limitations inherent in current examination techniques. Also listed are those few cases where tradition permits a certain latitude.

1. Natural Gems

By itself this designation implies untreated material as found in nature and only improved by shaping.

Certain instances exist, however, where treatments used to improve the material cannot be detected with certainty. The following are typical examples: [1-4]

a) zircon does at times occur with a blue color, but most blue zircon has been heat-treated, as has much blue aquamarine (originally green) and most of the reddish pink topaz (originally yellow to orange);

b) the color of amethyst can sometimes be intensified by irradiation treatment;[5]

c) smoky quartz can be made by irradiation from most natural and synthetic colorless quartz;[5]

d) the deep blue color of zoisite (tanzanite) is developed by heating;

e) some rare colorless topaz can be turned blue by irradiation followed by heating.[5]

In most of these cases the color is indistinguishable from equivalent untreated material, and is just as stable to light, etc. Accordingly, the treatment is not customarily referred to and the simple designation "natural" is used. Although careful examination could sometimes disclose treatment, tradition does not seem to require such an attempt in these specific cases.

A recent addition to this list is synthetic amethyst and citrine, most of which is produced in the USSR. This is so far indistinguishable from the natural material and, since it is of comparable cost, the distinction is therefore of little significance.

2. Treated Gems

In addition to the "accepted" treatments mentioned above, there are a number of treatments which produce clearly identifiable changes, or

TREATED TOPAZ. The originally colorless specimen was treated with gamma rays and became dark reddish-brown. After treatment, half the specimen was covered with black tape and exposed to sunlight for two weeks. Note that the uncovered part faded.

changes which are not stable, so that the nature of the treatment used needs to be specified in the designation of the material. Examples of the first group include:[1-4]

a) heat treated or "greened" amethyst, particularly that from Rio Pardo, Minas Gerais, Brazil;
b) various materials dyed or bleached so as to improve or change the color, including turquoise, pearls, opal, agate, tiger-eye, and so on;
c) irradiated diamond of various colors;[4]
d) laser drilling to lighten dark inclusions in diamonds;
e) pearls turned "dark blue" or "black" by irradiation.

Such treated material can be highly satisfactory when the color is stable. The fact of treatment should be stated for materials in this group.

Examples of treated materials which are less satisfactory because the color or other effects disappear more or less rapidly include:

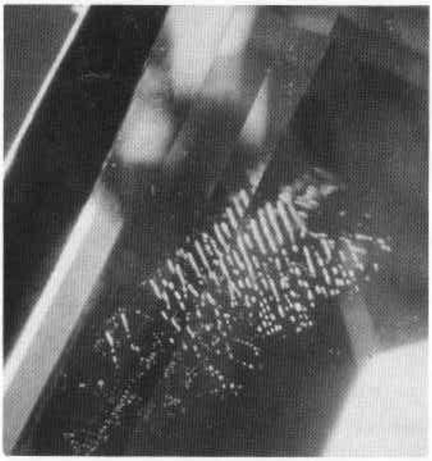
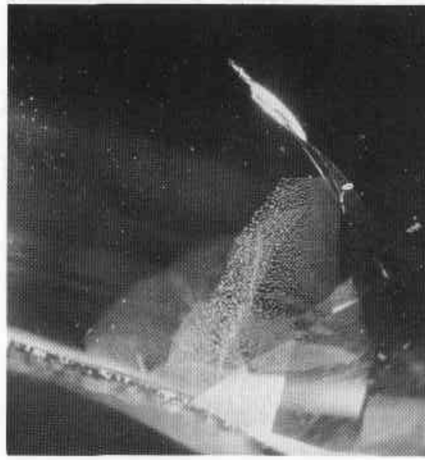
a) "Maxixe" type beryl[5, 7] turned deep blue by irradiation (this resembles aquamarine when it is partly faded);
b) brown irradiated topaz[5] (particularly cinnamon-colored material);
c) irradiated kunzite turned deep green;[5]
d) greenish-yellow quartz made by irradiation, followed by heat-treatment;[6]
e) yellow or orange irradiated sapphire;
f) "oiled" gems where the material used to hide flaws may also be colored to further improve the appearance.

The transitory nature of the effect of these treatments should probably be stated together with the fact of treatment so as to avoid later unpleasantness.

The only truly "reconstructed" gem also falls into this category; it is pressed amber, which softens at about 180°C when small pieces cohere under pressure.[4]

3. Synthetic Gems

To the scientist any substance made by man is "synthesized." To the gemologist the term "synthetic" has a more restricted sense, i.e., a man-made gem with essentially the same properties as the natural gem which it duplicates. Thus a synthetic ruby must have the same chemical composition (single crystal Al_2O_3 colored by chromium) and the same physical properties such as hardness, specific gravity, fracture, and optical properties including refractive index, dispersion, dichroism, birefringence.

SYNTHETIC RUBIES. Two examples of flux inclusions in flux grown synthetic ruby. The one on the right is deceptively like a "fingerprint" inclusion that typifies natural only.

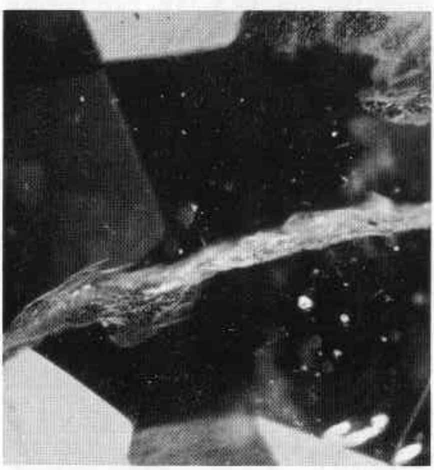
In fact, the only way the synthetic product may differ from the natural gem is in those properties in which the natural material itself shows a significant variation. This includes range of color, some compositional variation such as the alkali and water content in emeralds (producing some specific gravity and optical constant variability) and of course those imperfections by which synthetics can be best distinguished from the naturals. As synthesis techniques improve, such distinguishing tests must also change. An example is the "fingerprint" type of inclusion once considered to be indicative of natural ruby only, but now also recognized to occur in flux-grown synthetic ruby.(13)

One exception to the preceding rule (that the composition of the synthetic must be the same as the natural gem) is found in spinel. Natural spinel is $MgAl_2O_4$, but synthetic spinel, made by the Verneuil flame-fusion technique, can be grown with a wide compositional range, from the stoichiometric $MgO{\cdot}Al_2O_3$ to a very alumina-rich product $MgO{\cdot}5Al_2O_3$. Since it is easiest to grow intermediate material, this is usually done; traditionally the term synthetic spinel is accepted for this product.

The designations "man-made," "laboratory-made," "created," and "cultured" are at times used as synonyms for "synthetic." Note, however, that a cultured pearl is really a man-assisted natural gem.

The term "synthetic" is also applied frequently to materials not having a counterpart in nature; thus the use of this word in "synthetic YAG"(12) merely indicates that it is man-made. Here also the word "garnet" in "yttrium aluminum garnet" does not imply a synthetic garnet in the sense of a duplicate of one of the group of natural garnets, but only a material having the same atomic structural arrangement; although different elements are present, namely yttrium and aluminum, these substitutions are similiar to those occurring in nature.[12]

The use of natural material in ground-up form need not present any confusion. For example, if ground-up ruby or sapphire is used in flame-fusion apparatus, the result[9] is merely the synthetic gem, just as if purified reagent grade chemicals would have been used; every chemical substance ultimately traces its path back to nature. As another example, if ground-up turquoise is cemented together with some other materials,[8] e.g. some type of plastic, the result cannot be considered a "synthetic" turquoise – it does not have the same chemical composition, hardness, fracture, etc. as natural turquoise.[2] Such a bonded product is merely an imitation. (Ed. note: The so-called "synthetic turquoise" as manufactured by P. Gilson, France, may not be a true synthetic in the strictest sense because the microstructure is not the same as natural turquoise and there appears to be a bonding agent present. See *Gems & Gemology,* Winter 1973-1974, p. 226-229, by Dr. W. F. Eppler.) Were it possible, however, to use pressure and temperature to recombine natural turquoise powder (or a mixture of its chemical components) into a sinter-compact duplicating the natural material including its microstructure, then one could indeed speak of "reconstituted" (or "synthetic") turquoise. The latter was reported in 1927,[10] but lack of duplication appears to make this claim an improbable one.

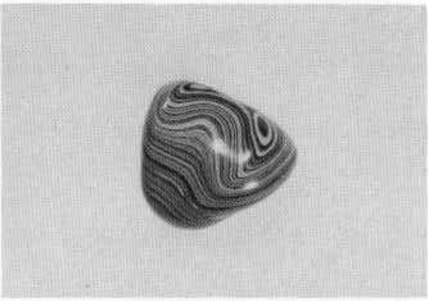


SYNTHETIC ALEXANDRITE. Coarse flux, hexagonal platelike inclusions, and wispy veil-like patterns are common.

As of the present, the list of synthetic gemstones includes diamond*, opal, ruby and sapphires (including stars), spinel, beryl*, aquamarine*, emerald, alexandrite, tourmaline*, zircon, and quartz (including colorless, citrine, amethyst, and smoky). Those marked with an *asterisk* are not commercially available at present. A number of others have been synthesized as powder only, including the occasionally mentioned topaz;[4, 11] nor have the natural silicate garnets been synthesized yet as crystals. Only synthetic gems large enough to be of actual use are listed above. Techniques of synthesis have been described elsewhere.[14-18]

4. Imitation Gems

Strictly speaking, an imitation is any substance used as a substitute for a natural gem that fails to duplicate its composition, structure, and properties.



IMITATION. Plastic imitation simulating agate.

This group includes everything that does not fall into the previous three groups. Here we find the many diamond imitations (simulations, fakes, substitutes) including natural zircon, synthetic sapphire and spinel, GGG (Gadolinium Gallium Garnet), YAG (Yttrium Aluminum Garnet), strontium titanate, synthetic rutile, doublets, and even glass and plastic imitations. Also in this group are substances such as the above mentioned turquoise powder cemented with plastic, foilbacked stars, and materials not having an exact counterpart in nature such as goldstone (copper crystals in glass) and the like.

SUMMARY

With certain exceptions mentioned, some sanctioned by tradition, others by the inability to distinguish them with any degree of certainty, the conceptional distinction between natural, treated, synthetic, and imitation gems is quite straightforward and should present no problems. What is then required is sufficient gemological knowledge to place any given gem into the correct group.

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Imitation Lapis-Lazuli

In a three-week period recently we were presented with 4 imitations of this popular gem material—only one of which was known previously to us. This, of course, is the classic glass imitation. Dark blue splotches in a lighter blue and white ground mass together with a brassy material resembling pyrite characterize this imitation. It is surprising, however, that it frequently fools the unwary. *Figure 1* illustrates one of 40 beads in a necklace submitted for identification.

Far more sophisticated were the large carved ring sets shown actual size in *Figure 2*. Cursory study under magnification indicated lapis with very uniform structure and a minimum of well distributed pyrite. A drop of hydrochloric acid quickly discolored the area turning it white *(Figure 3)*. Surprisingly, the odor of hydrogen sulphide was overpowering and far stronger than that produced from known natural lapis. When the white area produced by the acid was examined, dark blue fragments appeared like the fragments in a breccia. Until now, we were sure we had an unusual, but probably natural stone. However, the refractive index of 1.60 was not right and the complete lack of fluorescence under short-wave

Figure 1.

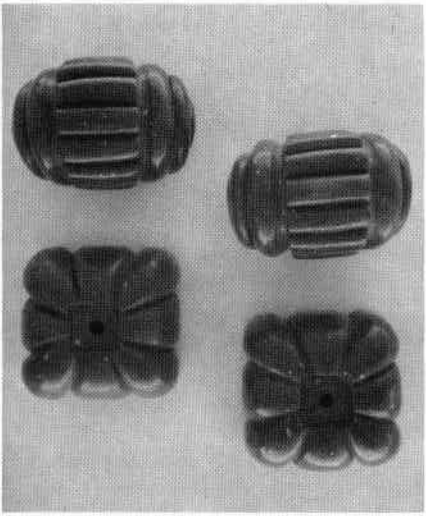

Figure 2.

Figure 3.

ultraviolet seemed strange. The client volunteered to submit more stones—part of a large lot he was contemplating. They were identical. Now we began tests in earnest. The stones are more opaque to x-rays than lapis of similar dimensions *(Figure 4).* The hardness is just slightly above 3, specific gravity approximately 2.35, streak medium blue (contrasting with the faint blue of natural lapis) and the hotpoint chars and decrepitates the area touched *(Figure 5).* We were not successful in securing one of the stones for x-ray diffraction and thin sectioning to determine the exact nature of this clever imitation. However, we have since received from New York dealer Max Stern a small sample for testing. In the course of pursuing our study of this material, we asked in the Trade if any dealers were familiar with any new imitations of lapis. We are indebted to GIA Graduate Melvin Strump for several small beads which were sold to a client of his recently as "reconstructed lapis." These are en-

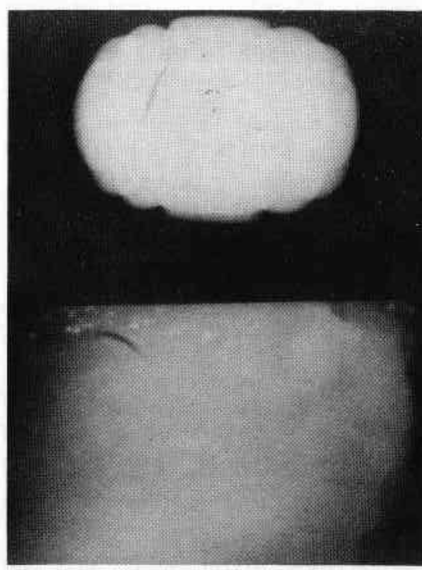

Figure 4

Figure 5.

Figure 6.

tirely different from the large stones and are apparently the same as those described by Mr. Alec Farn of the London Chamber of Commerce Laboratory in the April, 1974, issue of *The Journal of Gemmology.* A drop of acid reacted very slowly with this material yielding only a suggestion of rotten eggs. Like the London Lab staff, we could not secure a refractive index, although it appeared in the mid-1.50's. The specific gravity agrees with Mr. Farn's findings—approximately 2.20. At the moment x-ray diffraction and chemical tests are being carried out to determine if the supposition is correct that these beads may be crushed lapis bonded in plastic. The hardness appears close to 3.

The latest simulated lapis was submitted in the form of an elaborate necklace of ungraduated beads and gold spacers. In this case it was the lack of pyrite that prompted a jeweler to suggest that the owner bring the necklace to the Laboratory. Fortu-

Figure 7.

nately, the necklace was broken so that we had a loose bead to work with. The refractive index which we secured easily after polishing with cerium oxide on the palm of the hand was approximately 1.60. No color was indicated when acetone was used with a swab, but looking down the drill hole it was obvious that the color only penetrated for about one millimeter. The mass of the bead appeared a creamy white in color (*Figure 6*). A drop of acid attacked slowly, leaving an area of exposed "crystal ends" (*Figure 7*). With the specific gravity of 2.57, we were certain that we were testing a dyed howlite–a compact but soft calcium borosilicate hydroxide found principally in Southern California's playa lake deposits, such as at the Tick Canyon area in Los Angeles County and Death Valley.

One last confirming test on the bead of dyed howlite was the intense orange fluorescence of the exposed white area down the drill hole. Until now we had only encountered howlite in the form of rather unsuccessful turquoise imitations. The hardness of about 3½ is responsible for its failure as a gem material.

Surface Stained and Plastic Coated Turquoise

Although the use of completely white turquoise as the base for painting and plastic coating beads is not new, the use of a fracture sealer as a fortifying agent for extremely porous turquoise before staining is new. The claim that nuggets of turquoise offered to hobbyists "go through a fracture sealer to seal the dynamite fractures

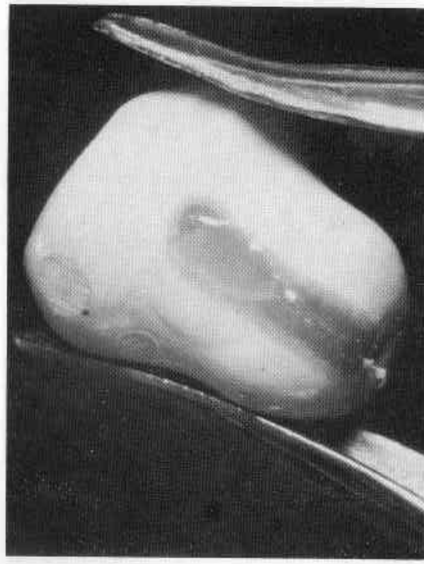

Figure 8.

from the mining operation but they are NOT dyed and are natural color" did not stand up in the Laboratory. However, the turquoise at the center of the nugget that we examined had a compact gray appearance evidently due to the fracture sealer. Specific gravity was under 2.57. When a drop

Figure 9.

of water was placed over a thin scratch that penetrated the protective plastic coating, the area discolored as shown in *Figure 8*.

Imitation Opal on Matrix

In the Winter 1973-1974 issue of *Gems & Gemology* we illustrated a clever opal on matrix imitation consisting of ground-up ironstone, some opal and plastic. *Figure 9* illustrates a refinement of this theme. The handsome stone consisted of low cabochon, probably Coober Pedy, with the back left just as it came from washing away the sandstone (instead of crudely cutting an irregular back as in the stone described in the Winter 1973-1974 issue). This rough but "natural back" was painted black and then cemented to a semi-polished cabochon of ironstone. The cement layer is relatively thick and contains gas bubbles as well as bits of opal and ground up ironstone. Under ultraviolet, the opal top fluoresces strongly while the cement layer fluoresces weakly and the ironstone back, not at all.

An Identifiable Natural Emerald

Rarely have we ever seen crystal inclusions in emerald as well formed and distinct as those we illustrate in *Figure 10.* They appeared darker green than the host stone and are presumably emerald crystal inclusions. *Figure 11* shows the largest crystal termination. We have been told that this stone is almost certainly from the mines at Lake Manyara, Tanzania.

Inside and Outside Diamonds

We could not resist photographing a bit of "flora" seen in a marquise brilliant recently. Nothing like the inclusions shown in *Figure 12* appears in Dr. Gübelin's monumental *Internal*

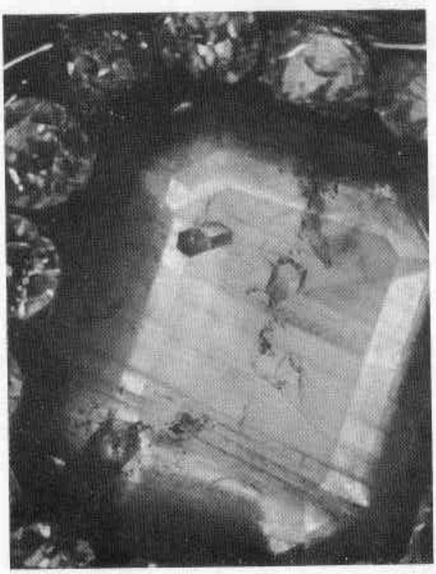

Figure 10.

Figure 11.

Figure 12.

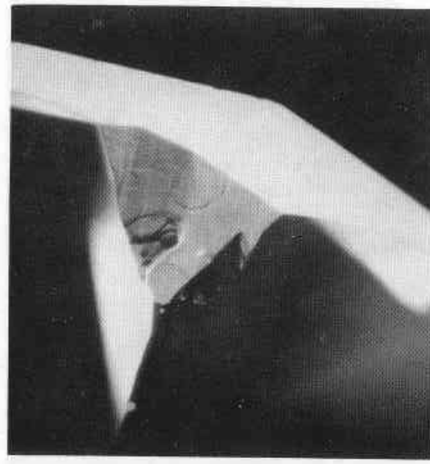

Figure 13.

World of Gemstones, although I am sure it is not an uncommon inclusion. Its nature is unknown to the writer. *Figure 13* shows a natural on a blocked diamond in which one can see circular etch or growth markings. These are new in our experience and difficult to explain. In *Figure 14* the camera has captured surface grain lines in an otherwise flawless diamond. Sometimes these lines appear on only one facet and at other times they run around the stone in circles. A 77-facet round diamond brilliant shown in *Figure 15* was admired in the Laboratory recently. The additional facets, or rather design difference, occur because instead of two upper halves between each main (and two lower halves between each pavilion) there are three. An attempt to illustrate this arrangement top and bottom is shown in *Figure 16*, while *Figure 17* shows that the star facet seems to "sit" on a smaller star coming up from the girdle. Unfortunately, as with most of these novelty cuts, the stones are not well proportioned and one cannot really appreciate what the potential of the

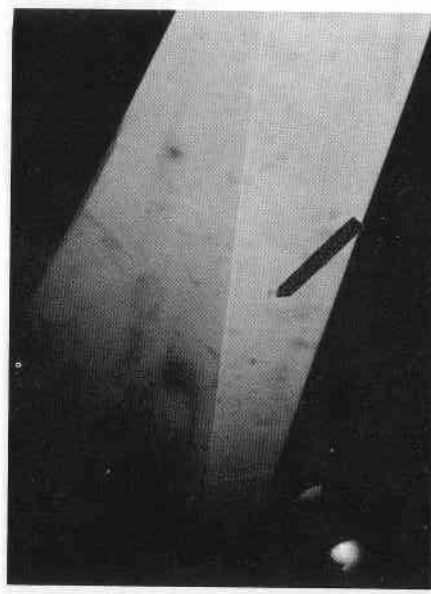

Figure 14.

Figure 15

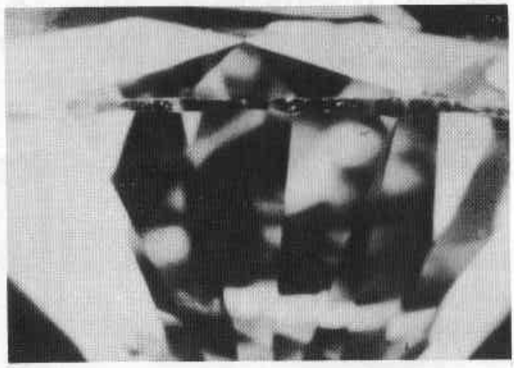

Figure 16

cut is. In this case, the table size is 68% and the pavilion angles are steep, resulting in a dark-centered stone with considerably diminished dispersion potential.

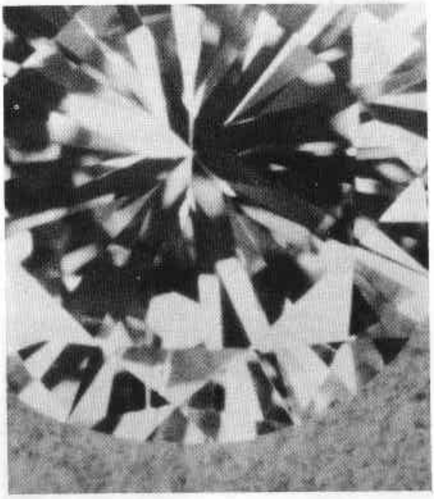

Figure 17

More Preventable Damage (or a Diamond Wears a Star)

In *Figure 18* we see a very large star sapphire being attacked by one of the side diamonds. The star cabochon was so steep that the prongs proved incapable of keeping the stone tight in its setting. As a result, it rocked back and forth during wear and the diamonds on each side had worn a considerable groove in the stone.

"Blue Morganite": Again

A call from good friend Melvin Strump of Superior Gem Co., with the tongue-in-cheek announcement that a dealer was in his office showing him a stone he called "blue morganite," reminded us of our experience with the fading of some of the Maxixe-type blue beryl last year. With moderate heat (and exposure to sunlight) they became pink. Our suspicion was correct when we examined the 40-carat, slightly grayish-blue stone. It had the typical absorption of Maxixe-type beryl colored by gamma radiation and could have probably profited from a slight heat treatment to produce a purer blue color. More calls requesting information about "blue morganite" surprised us since the term is ludicrous–like saying "pink emerald," "yellow amethyst" or "blue rubies" (the last, a term we once read in an advertisement by a fine jewelry firm).

More Preventable Damage

The old European brilliant shown in *Figure 19* was submitted for identification. The stone appeared quite milky and the jeweler suspected an imitation. Observation of the 4155Å line in the spectroscope together with the magnification and an x-radiograph for the record proved it to be a diamond. However, the milky appearance was due to a severely burned pavilion. The fact that the ring had enamel ornamentation completely across the top suggests that the enamelling was done after the diamond had been set.

A First Look at Rubies from Kenya

A few months ago we were asked to issue a report for a large and important ruby which at first glance appeared to be a fine, slightly light-colored Burma stone. Magnification immediately puzzled us. The stone had a few coarse needles intersecting, some unusual bread-crumb inclusions, coarse parallel striations, fingerprint inclusions that looked suspiciously like flux and a metallic crystal polished on the surface. These disturbing characteristics, plus a strong fluorescence under both long- and short-wave ultraviolet, prompted us to send the stone to the Los Angeles Laboratory. It was the consensus that it was a natural stone but from an unknown source.

Now, thanks to Mike and Tony Wolff of M. & A. Wolff, wholesale gem

Figure 18

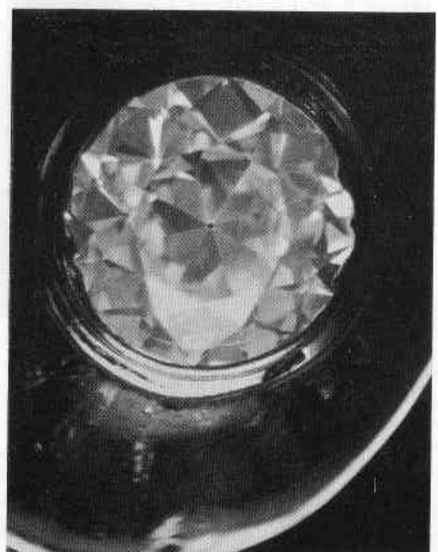

Figure 19

dealers of London, we can state with conviction that the stone represents one of the finest yet found in the newly discovered ruby mines in Tsavo National Park, Kenya. Messrs. Wolff kindly allowed us to examine parcels of small stones from these mines, and we were able to find all the characteristics noted above in addition to prominent "crackling" in the stones of lesser quality. In an effort to acquaint gemologists and jewelers with the diagnostic features of these new rubies, the following photographs are presented: *Figure 20* illustrates some coarse needles, a fingerprint inclusion made up of small black crystals of unknown nature, and general "crackling." *Figure 21* shows a larger black included crystal which, though not seen in the photo, was surrounded by a brownish stain—probably iron. In *Figure 22* we see the peculiar breadcrumb-like inclusions together with some bands of whitish silk which do not appear under high magnification to be rutile, but very fine liquid drops. With some

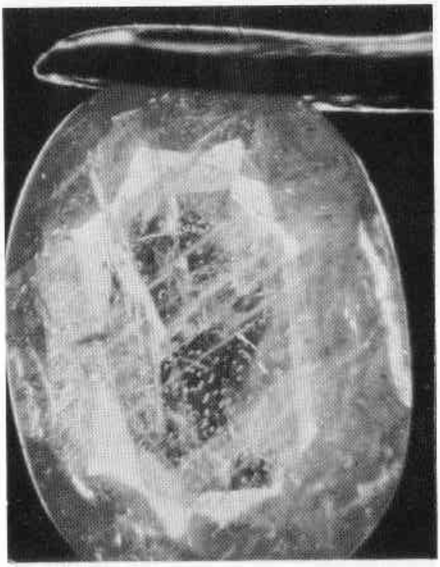

Figure 20.

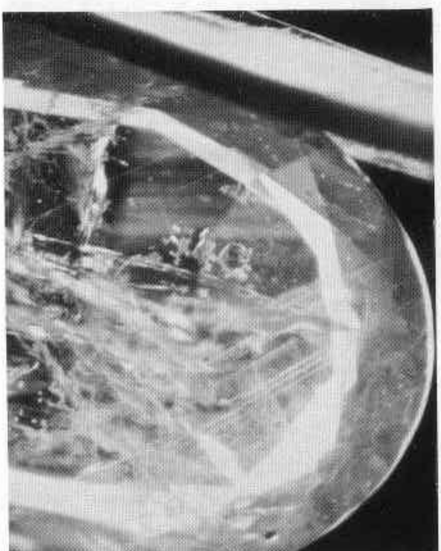

Figure 21.

Figure 22.

attention to these details and a keen eye for the particular nuance of color seen in these attractive rubies, a gemologist should soon be able to satisfy himself that a stone is A) natural; and B) probably from Kenya.

One dealer who had purchased a fine ruby in Europe was puzzled by some of the same things we noted and asked for an opinion about the stone. As is customary, the Laboratories do not include origin in reports of gem identification, but since we had Kenya rubies on hand for direct comparison the dealer was convinced that his stone was also Kenyan. He raised a question as to how the market for Burma stones would be affected–who would pay the top prices for Burma stones with African stones in competition? It was our feeling that, as with the new-found respect for the better Thai stones, the finer Kenya stones will soon be accepted on a par with similar quality Burma stones. The dealer illustrated his point with a lot of fine Burma stones recently broken from an old necklace. The price asked for them was considerably higher than he had paid for the African stone (which, incidentally, had been sold as Burma origin). By coincidence, one of the Burma stones had a metallic inclusion exposed at the surface–something we have rarely seen in a natural stone but frequently in flux-grown synthetic stones.

We are indebted to Scottish geologist and mine operator in Kenya, Campbell Bridges, for showing the staff some excellent slides of the mining areas around and in the Tsavo National Park including the disputed ruby mines, one of which was owned by Dr. John Saul, a frequent contributor to the GIA collection. Also, we had the chance to see the area where Mr. Bridges mines dark green vanadian grossularite which Tiffany and Co. has christened "Tsavorite." The latter stones, never large, are not found as good crystals but as nodules or fragmented inclusions in a contact gneiss from which fragments may be pried to yield truly beautiful stones rarely exceeding 3 carats when cut.

Inclusions of Albite and Phenakite in Gem Topaz From The Tarryall Mountains, Colo.

By PETE J. DUNN, M.A., F.G.A.
Smithsonian Institution

Fine crystals of blue topaz, $Al_2SiO_4(F, OH)_2$, have been recovered from weathered pegmatite dikes in the Tarryall Mountains, Park County, Colorado. The deposit was first worked about 1909 and later described by Wulff in 1934. Further mention of the deposit was made by Eckel (1961). Crystals occur loose in debris formed from the weathering of the pegmatites. The associated minerals are quartz, feldspar, muscovite, and biotite.

Topaz crystals collected (NMNH 117588, 177589) are stout, prismatic in habit, and euhedral. Forms present, on these exceptionally well-formed crystals, are the prisms {110}, {120}, {140}, {101}, {201}, {011}, the pinacoids {001}, {010}, and {100}, and the dipyramids {111}, and {112}.

The topaz is light blue in color. The refractive indices, determined on the Rayner Dialdex refractometer in sodium light, vary from α = 1.608 to 1.612, β = 1.610 to 1.614, and γ = 1.616 to 1.620. The optic sign is positive, and the birefringence is a constant 0.008. There is no discernible fluorescence with either long- or short-wave ultraviolet radiation. The specific gravity is 3.56.

Crystals darken to a rather unappealing murky brown after a ten-hour exposure to CuKα X-radiation. The brown color gradually fades after several days of exposure to sunlight.

The included crystals examined in this study were exposed by grinding down the host topaz. These exposed inclusions were then scratched with a diamond point and the resultant powder x-rayed utilizing CuKα X-radiation and a Gandolfi powder camera. Subsequently, the samples were returned to the polishing laboratory and prepared for microprobe analysis. Analyses were made with an ARL Electron

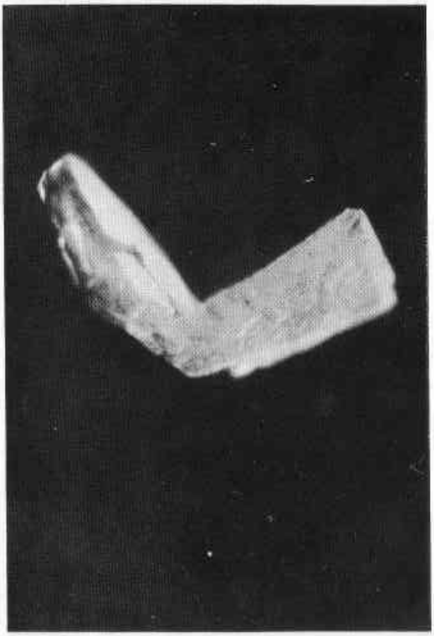

Figure 1. Twinned platy crystals of albite in topaz from the Tarryall Mountains of Colorado (original magnification 20X)

TABLE 1

ANALYSES OF ALBITE INCLUSIONS IN TARRYALL MOUNTAIN TOPAZ

Oxides	Weight Percentage	
	1	2
SiO_2	69.15	69.39
Al_2O_3	19.46	20.02
FeO	0.02	.02
MgO	0.00	0.00
CaO	0.03	0.10
K_2O	0.19	0.22
Na_2O	10.92	11.22
TOTAL	99.77%	100.97%

Microprobe using an operating voltage of 15 KV and a sample current of 0.15 μa. The standards used were National Museum of Natural History microprobe standards of high reliability.

Two types of inclusions were found. The broad platy crystals shown in *Figure 1* are albite, $NaAlSi_3O_8$, occurring both as single platelets and as twinned multiple crystals. Analyses of two albite crystal inclusions are given in *Table 1*.

The equant, rhombic crystals shown in *Figure 2* are phenakite, Be_2SiO_4. Since phenakite is frequently associated with topaz, and because Colorado pegmatites are noted for phenakite and other beryllium minerals, this occurrence of phenakite as an inclusion in topaz was anticipated. The phenakite crystals are clear and colorless, and have a textured surface. The fuzzy edges obvious in *Figure 2* are due to the birefringence of the host topaz.

The crystals were analyzed with a microprobe and analyses gave SiO_2 ~53%, which is in satisfactory agreement with the 54.40% SiO_2 content of pure phenakite. Since the microprobe cannot detect any element with an atomic number below 6, the beryllium (atomic number 4) content could not be determined. However, a scan did not indicate the presence of any other detectable elements.

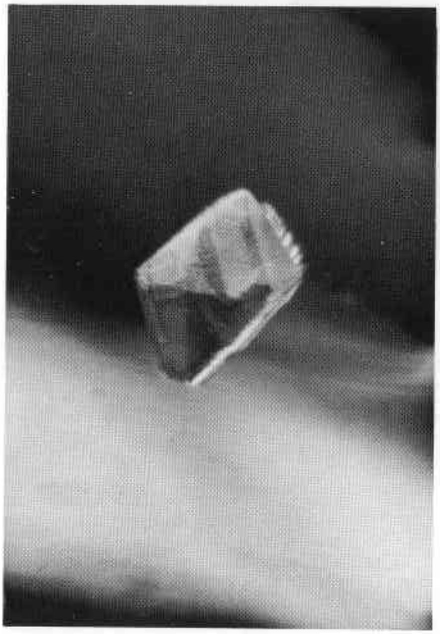

Figure 2. Equant rhombic crystal of phenakite in Tarryall Mountain topaz (original magnification 30X)

Also present as inclusions are planar, triangular cavities containing what appears to be two immiscible liquids.

The author is indebted to Mr. Richard Johnson of the thin section laboratory for his painstaking preparation of polished surfaces. Repeated, tedious efforts were required to expose the inclusions, and this study could not have been completed without his invaluable assistance. The author is also indebted to Dr. George Switzer and Mr. John S. White, Jr., for critical readings of the manuscript.

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Wulff, W. W., 1934, Topaz in the Tarryall Mountains of Colorado. *Rocks and Minerals* 9, 45-47.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Since our last report in *Gems & Gemology,* quite a number of very interesting gemstones and substitutes have been examined. The occurrences in the laboratory are a never ending source of delight and intrigue.

A Natural in the Table of a Diamond

We expect to find naturals on many diamonds; we do not expect, however, to find an indented natural in the table. Recently, we received a marquise blue diamond of under 1 carat that had a very interesting natural in the table which is shown quite clearly in *Figure 1.* You will note that the natural has a pattern that would enable one to work out easily the crystallographic orientation of the host diamond.

Naillike Inclusion in Diamond

Often we refer to the inclusions in hydrothermal synthetic emerald as being spikelike with a phenakite crystal at the head. The appearance of a naillike inclusion in a diamond startled us recently. A very good representation of the inclusion is captured in the photograph shown in *Figure 2.* A needlelike inclusion seems to start from a crystal shown at the bottom of the photograph. Needlelike inclusions are uncommon in diamond, and ones with a larger section at the head are particularly rare. This photograph is taken at 126X.

Diamond Reflection Pattern

For many years we have called attention to the manner in which various cutting angles reveal themselves in the pattern of reflections encountered in diamonds. In *Figure 3* we see a situation in which the bezels and stars appear dark, and the upper girdle facets bright. This is caused by the stars and bezels in this diamond being lower than the usual angles to the table or the girdle plane, which means

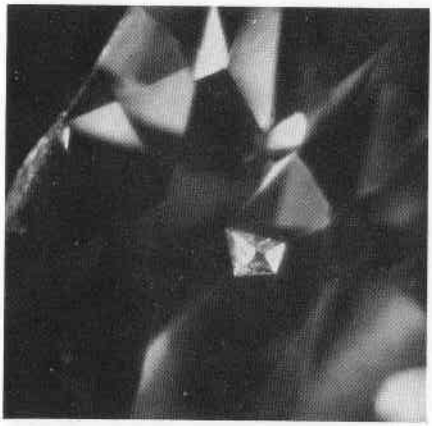

Figure 1

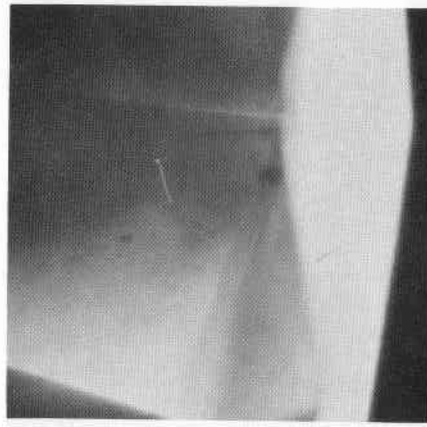

Figure 2

that the upper girdle facets are steeper than usual. As one looks through the stars and the bezel facets with side lighting, the result is that the upper girdle facets appear bright. In this dark field lighting condition the stars and bezel facets do not reflect the light to the eye as do the upper girdle facets.

Another Diamond of Interest

We received a diamond for a damage report in which there was a very serious cleavage across one end of the table of the diamond. This had resulted in an actual separation of the two parts of the stone. From the photograph *(Figure 4)* which shows a reflection of light from the table, it can be seen that the separation caused the stone to buckle; the smaller portion of the table has been displaced from the main portion of the table.

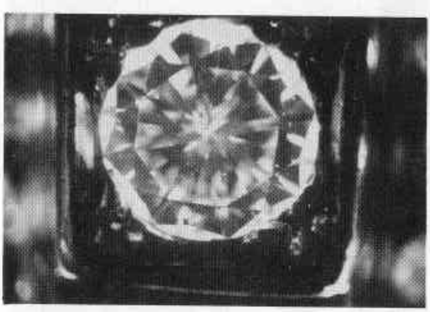

Figure 3

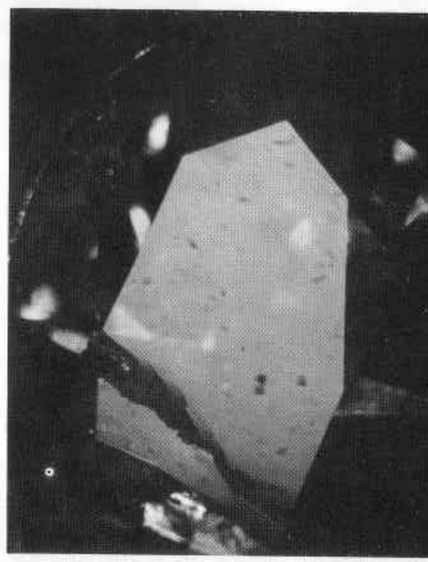

Figure 4

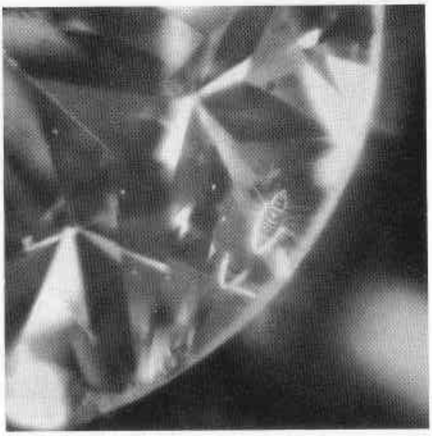

Figure 5.

This type of situation usually is best shown by reflected light, such as is used in this photograph.

An "Insect" in Diamond

One of the most remarkable inclusions we have ever encountered in a diamond is shown in *Figure 5.* In this photograph, taken at 63X, a large included crystal caused strain cracks in the diamond, which gave the appearance of legs extending from the ovate body. As a result, it looked like a sow bug or wood louse.

More Diamonds

In *Figure 6,* we see another inclusion in diamond taken at a magnification of 63X. Prior to the microprobe work on inclusions by Gübelin and others, we would have assumed the inclusion to be zircon. Now we can be quite certain that it is either diopside or peridot. It is interesting to know how much information can be gathered about the conditions of diamond growth from the nature of diamond inclusions.

Figure 6.

The Effect of the Use of Borax in Repairs of Corundum Jewelry

For some time we have called attention to the fact that when borax is used as a means of protecting gemstones in repair efforts, its harmful effect on corundum gems can be very serious. An example is very clearly shown in *Figure 7.* In this case, borax

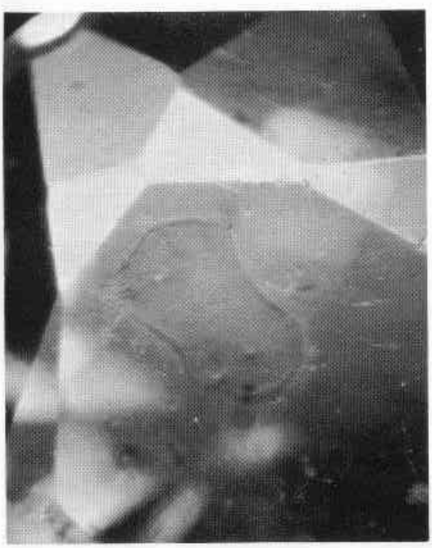

Figure 7.

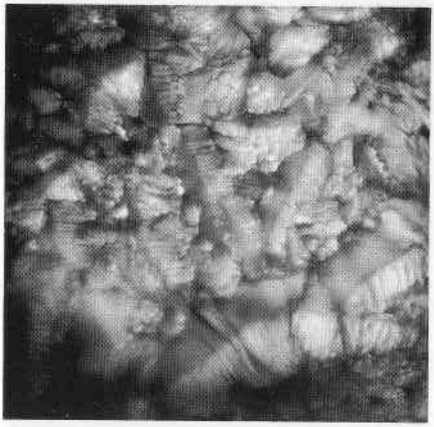

Figure 8.

flux was used to protect a sapphire; the manner in which the surface was attacked by the boron-containing flux is readily seen on the table. By experimentation we have proved conclusively that borax can be very damaging to corundum in situations where a high degree of heat is applied.

Synthetic Opal

In recent issues of *Gems & Gemology* we have mentioned that Gilson synthetic opals can be readily distinguished from natural black opals. Differentiation can be made by using a strong light coming through the stone with all extraneous light cut off by an opaque diaphragm placed behind the stone. Recently we were called upon to identify a black opal and found it to be synthetic. The reason for the synthetic opal identification is apparent from *Figure 8.* The appearance in the photograph is characteristic of Gilson synthetic black opal. We have examined a great number of natural black opals, many of which are opaque to transmitted light. When they are transparent to transmitted light, however, there is almost no resemblance between the pattern seen in natural black opals and the characteristic pattern in the Gilson synthetic black opal shown in *Figure 8.*

The Conqueror

One of the highly pleasant aspects of laboratory work is the frequency with which one encounters items that have no huge scientific importance, but which are intriguing or amusing. In *Figure 9*, we see a conquering hero from outer space striding into the heart of a pale emerald. The heavily garbed figure with a ghost hovering above his head is seen entering from lower center. Whatever this may prove scientifically is lost to us, but it is an intriguing figure.

Deceptive Inclusion

Recently we found in a natural sapphire an inclusion that looked very much like a bubble. Crystal inclusions in sapphires have much lower relief

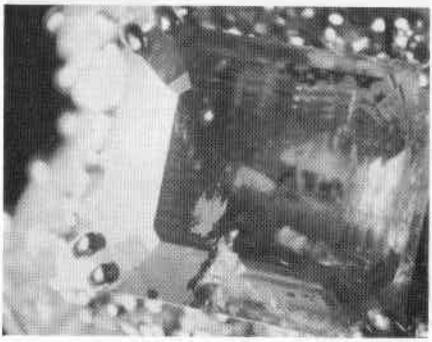

Figure 9.

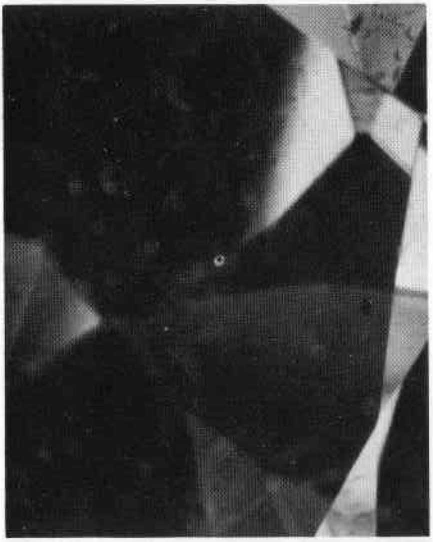

Figure 10.

than gas bubbles, since the refractive index of the solid inclusion, whatever it might be, is much closer to the refractive index of the sapphire than the gas is, gas having a refractive index of only about 1. The very round looking inclusion pictured in *Figure 10* is quite bubblelike, but it is a crystal inclusion.

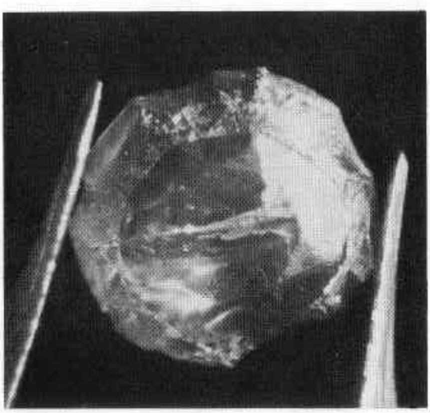

Figure 11.

Angular color banding and a distinct 4500 A.U. absorption band showed the stone to be a natural sapphire rather than a synthetic. The bubblelike inclusion alone would have caused difficulty in the identification of the stone, but its relatively low relief and the other characteristics proved the stone to be a natural sapphire.

Damage in the Repair of Jewelry Set With Garnet-and-Glass Doublet

An unhappy result in an attempted resizing of a ring set with a garnet-and-glass doublet substitute for a ruby, left the substitute ruined. The damage is clearly evident in *Figure 11.* The gar-

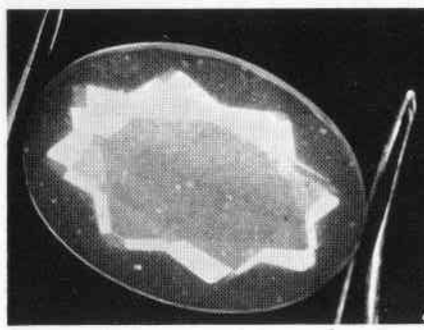

Figure 12.

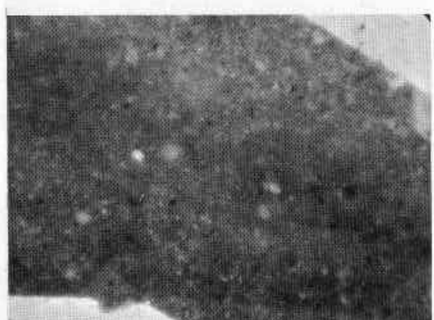

Figure 13

Figure 14

net cap can be distinguished from the glass back rather readily in the photograph. The garnet cap was damaged as well as the glass back which chipped out noticeably.

Transparent Sodalite

While in Idar-Oberstein in October, Prof. Hermann Bank, President of the German Gemmological Association, showed me some almost transparent sodalite that was very attractive. Charles Fryer took two photographs of the sodalite, one at a low magnification *(Figure 12)* and one at 63X *(Figure 13)*. Despite the multitude of tiny inclusions, the sodalite is almost transparent. Normally sodalite has so many inclusions that no light is transmitted. This material has a refractive index of 1.484 and a specific gravity of 2.31.

Black Spinel

Often we receive opaque black gem material for identification. When such material has a refractive index in the high 1.70's we can be almost certain that it is black spinel. Black spinel often shows a characteristic surface appearance which is unique in my experience. In *Figure 14,* this appearance is quite clearly shown in the photograph which was taken at 37X. The refractive index of this piece was 1.78.

Figure 15

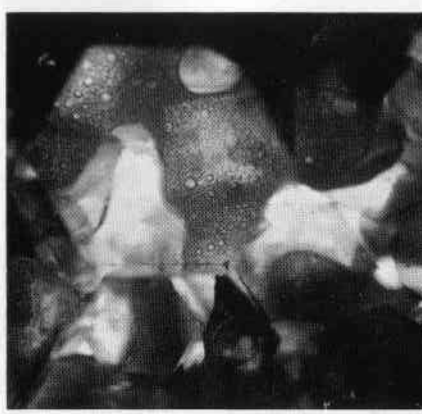

Figure 16

Cemented Crystals

Recently we have seen a number of imitations of clusters of crystals that resemble the growth-produced Chatham clusters of synthetic emerald or ruby crystals. The imitation clusters often are produced in other colors as well. *Figures 15* and *16* show a cemented imitation cluster. The cement was brightly colored and held synthetic rubies and sapphires which had been faceted to resemble hexagonal prisms. The result is rather realistic until closely examined.

Tortoise Shell

Another interesting identification was a snuff bottle which appeared to have been made of tortoise shell. It is obvious that something the size of a snuff bottle could not be carved from solid tortoise shell, because tortoise shell is not sufficiently thick. Examination showed that the snuff bottle had been assembled from pieces of tortoise shell. *Figure 17* shows a junction plane (see arrows) between the plate that covered one side of the bottle and the substrata on which the thin tortoise shell layers had been cemented.

Crystals and Glass

We seem to be caught up in the repetition of a number of subjects such as needlelike crystals in diamonds and crystals in glass. Each time we encounter crystal aggregates in glass they seem to be more intriguing than the last. *Figures 18* and *19* show a very interesting array of needlelike crystal groups in glass which appear to fan out from a central point like tight centrally bound sheaths. The first photo-

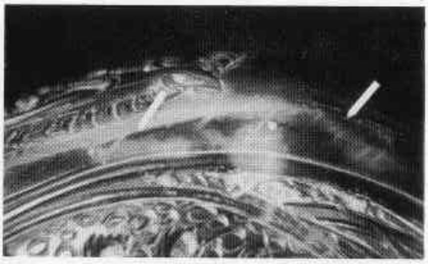

Figure 17

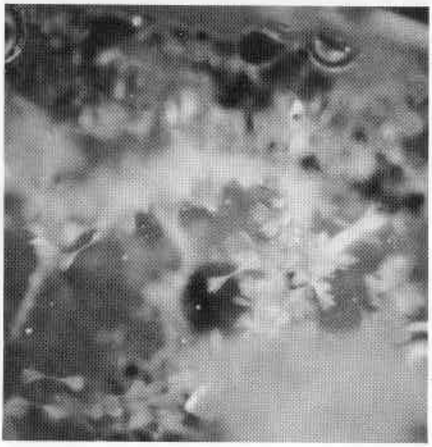

Figure 18

Figure 19

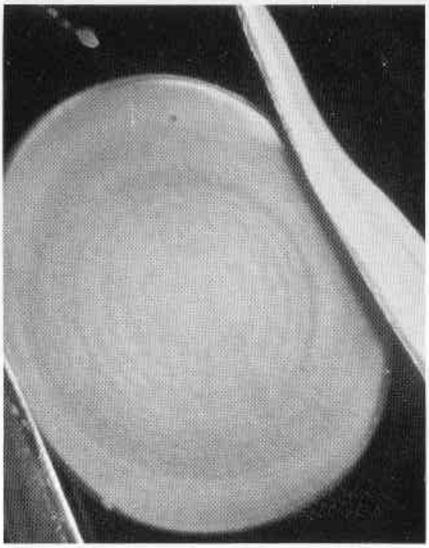

Figure 20.

graph was taken under approximately 15X and the last under about 50X. In the absence of a microprobe, we were unable to determine the nature of the inclusions.

Concentric Growth Lines

We were very much intrigued by the back of a synthetic star sapphire. Concentric growth lines were unusually strong. They are seen in *Figure 20.*

Interesting Diamonds

Recently we received a diamond for a quality analysis that had surface features unique in our experience. On the table of the diamond were two deep polished grooves, wider at one end than on the other, which are shown in *Figure 21.* There is no way we can account for their odd appearance, nor how they could have formed. It appears that they would have had to be cut into the table of the stone with a diamond-charged disc about the size of a dentist's polishing disc. How or why is a mystery.

A few times in the past we have encountered needle-like inclusions in diamonds. The photomicrograph of the diamond shown in *Figure 22* seemed to have more needle-like inclusions than any in memory.

Fairly well-formed diamond octahedra are common as inclusions. However, octahedra modified by cube faces are much less common. Such an inclusion is illustrated in *Figure 23.*

In *Figure 24* we see a laser drill hole in a diamond which is exceptionally long and narrow. It appears to have gone through one inclusion about half way down from the table and then, being aimed perfectly, reached a second at greater depth. The tube is almost entirely parallel-sided throughout its length, with but only a very

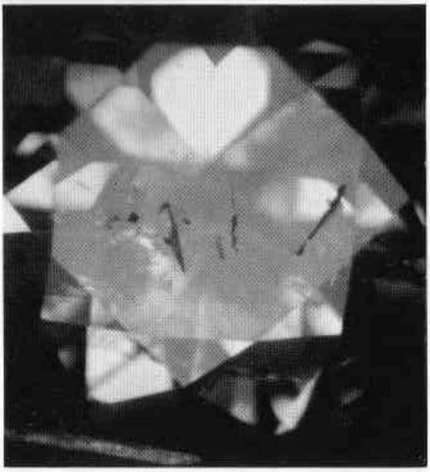

Figure 21.

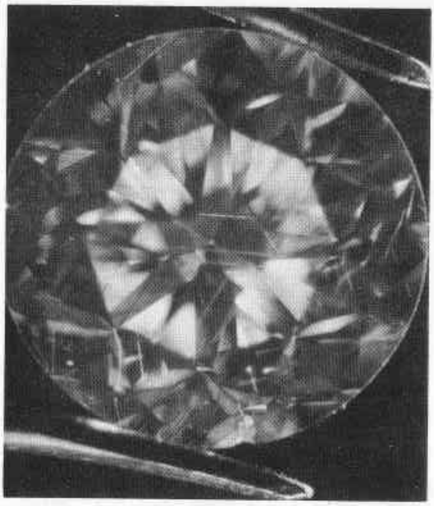

Figure 22.

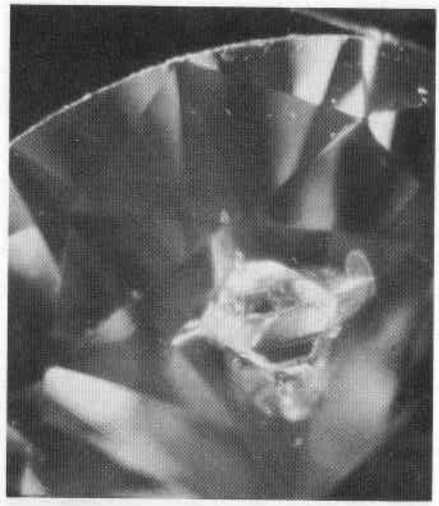

Figure 23.

slight tendency toward the usual funnel shape, as shown in the reflection from the table at the very top of the photograph. The drill hole appears quite rough-walled, particularly in its lower portion.

Odd Glass

A pink emerald-cut stone sent in for identification appeared under magnification as shown in *Figure 25.* There were a number of very large and very elongated gas bubbles visible through the table. Of course, this is not unique—only the size and length of the bubbles were worthy of comment. Interestingly, however, when the stone was examined through the end, it had a definitely cylindrical outline as shown in the central portion of *Figure 26*. There were successive layers more or less concentrically arranged around a central core. One of the elongated bubbles emerged at the pavilion surface and is seen in the left hand side of the central cylinder. It is difficult to visualize how this glass was manufactured.

Figure 24.

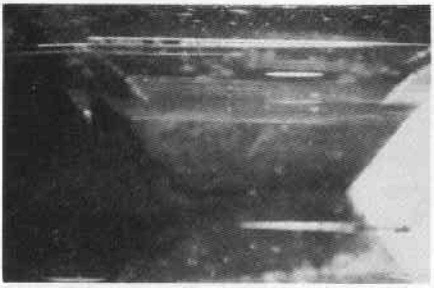

Figure 25.

Light Blue Synthetic Spinel

A synthetic spinel with a color reminiscent of pale aquamarine was tested and, surprisingly, showed a fluorescent line near 6900Å, suggesting the presence of chromium. Under long-wave ultraviolet, it showed a strong red fluorescence, but under short wave it showed an unusual bright reddish-orange fluorescence. The anomalous double refraction was exceedingly strong, showing some anomalous interference colors. Refractive index was the typical 1.73 and the synthetic spinel contained tiny gas bubbles.

Unusual Inclusions

A hessonite garnet which was identified by the Laboratory was photographed by Charles Fryer because of the presence of what apparently are long diopside crystals; some of them were described by Fryer as "ladder-like." These inclusions are seen in *Figure 27.*

Another group of inclusions caught Mr. Fryer's fancy and he photographed them as shown in *Figure 28.* This was a group of crystal rods in the form of a star. Certainly rod-like inclusions are not uncommon in sapphire, but it is rather unusual to have them radiate in effect from a single point.

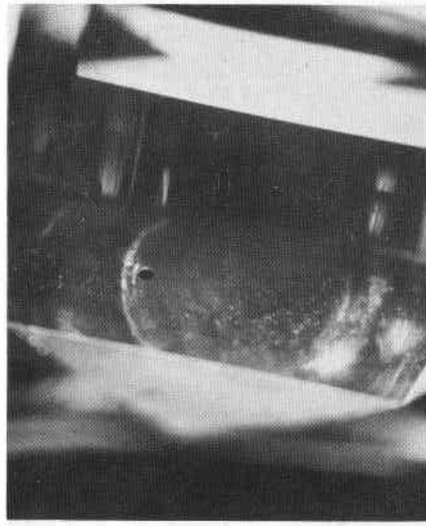

Figure 26.

Figure 27.

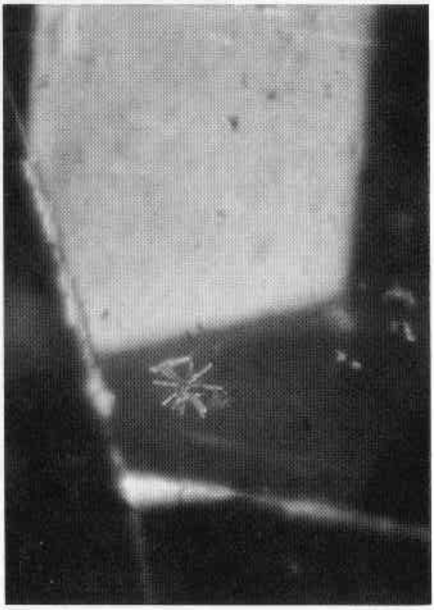

Figure 28.

Some inclusions of an unknown nature were photographed in a rhodolite garnet. They resembled thorns or icicles, as can be seen in *Figure 29.*

Figure 29.

Unevenly Dyed Jadeite

Several large jadeite carved objects were submitted for identification. They were all green and white jadeite, but in each case they had been dyed. One, shown in *Figure 30,* possibly could have been dyed by treating the two ends separately. Another showed a rather random distribution, except in the one crack at the left end of *Figure 31.* This suggests that only the areas that were sufficiently porous to take the dye became green. There is a distinct concentration of dye along the separation running from the wide end of the piece diagonally toward one side.

Acknowledgements (Fall 1974)

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To *Arnold A. Baron,* G. G., of Barton Distributing, Inc., Billings, Montana, for two garnets from Tanzania and 20 synthetic (Chatham) emeralds for classroom use.

To *Lowy Breckenridge,* Anaheim, California, for an interesting hematite

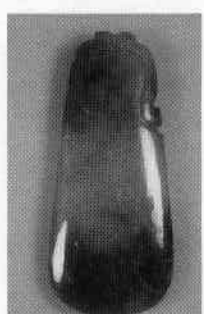

Figure 30.

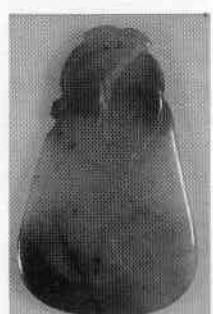

Figure 31.

and tiger's-eye quartz cabochon to be added to our reference collection.

To *Ben Gordon,* G. G., of Gordon Jewelry Corp., Houston, Texas, for three generous packets of miscellaneous stones for use in our gem identification classes.

To *Mr. Yukio Fugisaki,* Fugisaki Gemological Laboratory, Fukuoka, Japan, for a welcome donation of four books to our library. They will be well read by our students.

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Two late Graduates, *Jeanne G. M. Martin* and *Maurine Price Harvey,* bequeathed their gem collections to G.I.A. Jeanne Martin, G. G., who retired in 1968 after many years as an instructor and publications manager for G.I.A., had an extensive collection of both rough and cut gemstones. Jeanne's family also gave G.I.A. her instruments and lapidary equipment. The late Mrs. Erwin Harvey left G.I.A. two diamond rings plus diamond earrings as well as her collection of colored stones.