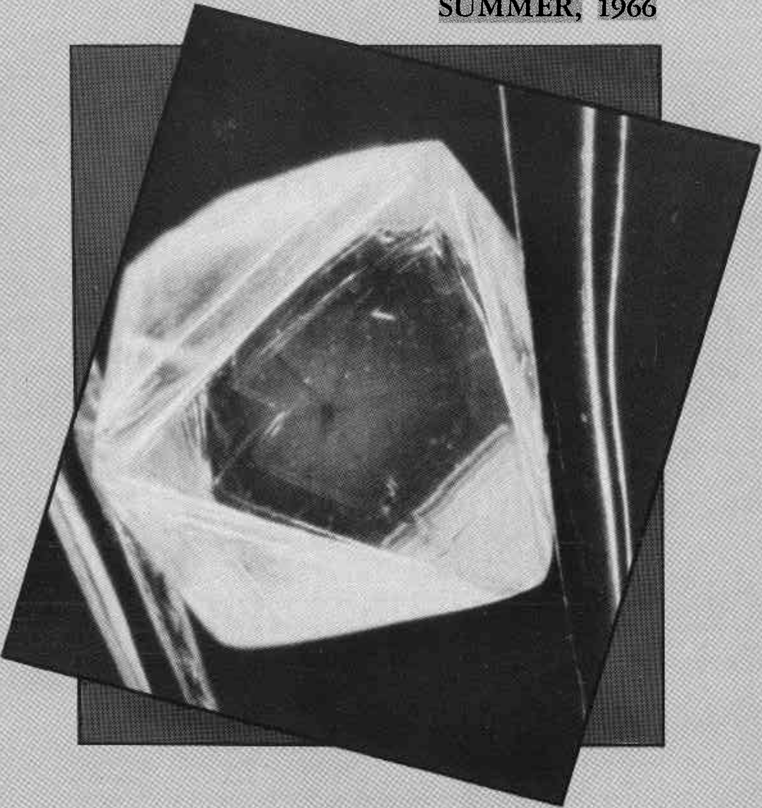
Gems and Gemology

SUMMER, 1966



Gems & Gemology

VOLUME XII SUMMER, 1966 **NUMBER 2**

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On the Cover

One of the 100 diamond crystals given to GIA by De Beers. This unusual inclusion of a six-rayed star was seen when the crystal was viewed through octahedral faces. See article this issue.

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De Beers & Kaplan Make Important Gift to GIA

by

Richard T. Liddicoat, Jr.
and
H. Lawrence McKague, Ph.D.

De Beers Consolidated Mines, Ltd., has given GIA a gift of 100 diamond crystals, and the well-known New York City diamond cutter, Lazare Kaplan & Sons, has offered to cut them without charge. This generous gift of fine cuttable rough is made up of 51 stones of approximately 1 carat and 49 of approximately 1½ carats. The total weight comes to over 126 carats. The purpose of the gift was to make it possible for the Institute to teach diamond grading and appraising to more jewelers and to provide its diamond training more expeditiously. In 1938, De Beers loaned GIA the important Oppenheimer Student Collection, which was given to the Institute some years later. A portion of this was cut, partially as a gift from the Kaplan firm and partially on contract. Many of the crystals in that Collection are still employed regularly for class purposes.

Although the Kaplan firm features cutting to nearly ideal proportions, the stones in this fine new gift collection will be cut in a variety of proportions to cover all makes now on the market. Some will be cut in the Kaplan's Puerto Rican plant and some in Belgium. Starting with crystals of 1 carat and 1½ carats, the finished stones will range in size from approximately 1/5 to ⅜ carat if most are sawed through the center. If the stones are sawed off-center, many of the 1½-carat crystals will yield a larger stone (one of about a ½ carat, and a smaller stone near a 1/5 carat, if ideally proportioned).

The Diamond Trading Company classifies the carat-size crystals as melee, and it grades them by a slightly different system than that they employ for larger stones. For 1½-carat stones, the color grades are *extra collection, collection extra special, blue, fine* and *white.*

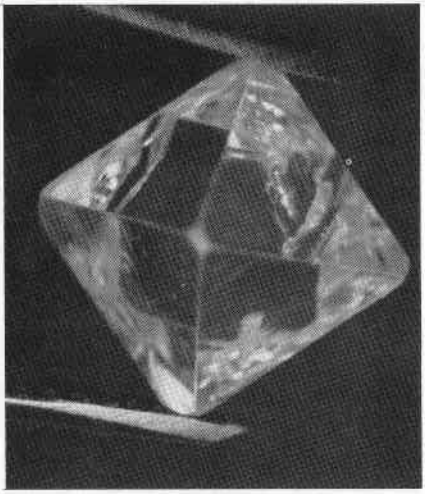


Figure 1

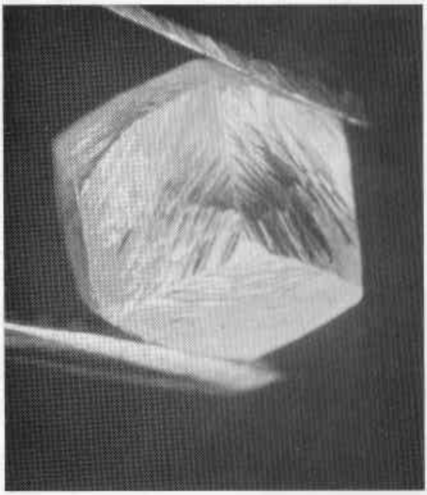


Figure 2

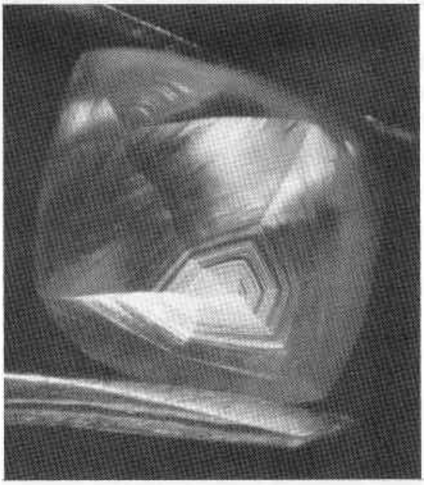


Figure 3

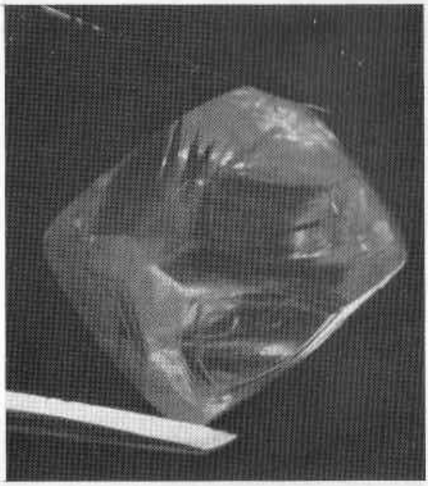


Figure 4

Among those given to the Institute, the first five grades were represented. Extra collection is about equivalent to the GIA D-E-F color grade; collection, approximately G to H-I; extra special usually cuts to H-I to I-J; blue, I-J to J-K; and fine, from J-K to about L. White would be from L to N. On a clarity scale, diamonds apparently without flaw are called *stones*. Those that are

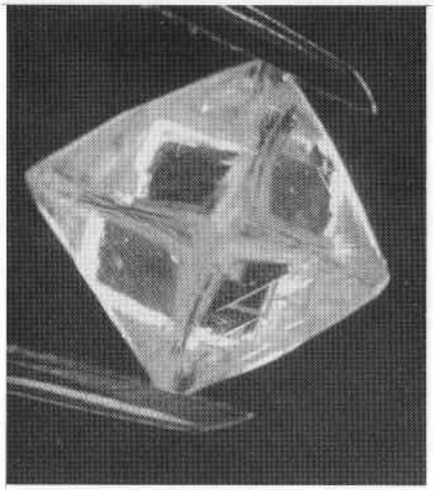


Figure 5

VVS are called *spotted. Speculative* is used for VS and SI, and *speculative spotted* would be on the VS side of this grade. *Dark* is SI to imperfect, and *black* is very imperfect.

The grades for melee are slightly simpler. The top color is *collection,* followed by *first, second* and *third.* In clarity, *finest* is the term for clean, or VVS stones and *fine, dark* and *black* are the other grades. Blacks are very imperfect.

Most of the common crystal habits of diamonds are represented. Only a few of the crystals are sharp, well-formed octahedra of the type one expects from Sierra Leone *(Figure 1).* More common are the dodecahedral *(Figure 2)* and tetrahexahedral forms *(Figure 3).* Crystals with only one form, as illustrated above, are rare; most are modified by other forms. *Figure 4* shows an octahedron modified by a trapezohedron. Octahedrons modified by hexoctahedrons are shown in *Figures 5 and 6.*

Figure 6

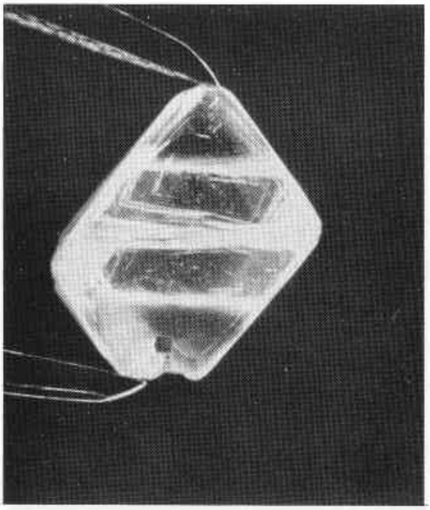


Figure 7

The only difference is in the relative development of the octahedron faces. Most of the crystals are well formed; however, a few are malformed, such as the octahedron in *Figure 7* and the hexoctahedron in *Figure 8.*

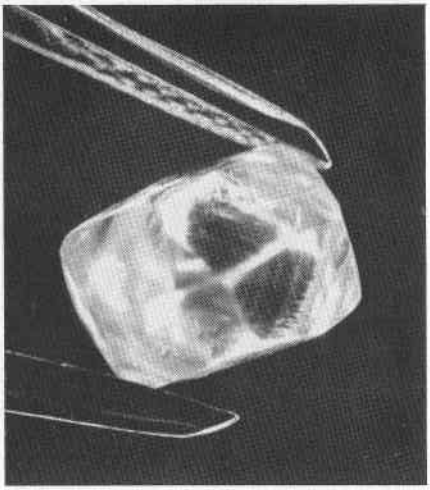


Figure 8

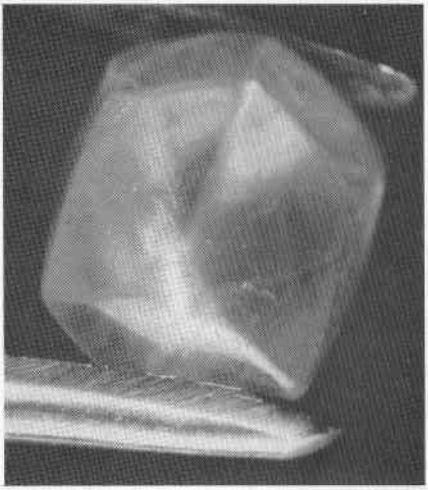


Figure 9

Nearly all of the stones show little sign of wear, other than small concussion marks and a few broken octahedron points. This damage probably occurred during the separation process. An exception to this is the diamond in *Figure 9,* which has slightly rounded edges and corners and a frosty coating, indicating it is waterworn and probably was mined from an alluvial deposit.

Many of the stones have relatively clear faces with only minor growth markings, such as *Figure 1*. Some stones contain numerous striations *(Figures 2 and 3)*, which make it difficult to observe the interior of the stone. This latter feature is more common on dodecahedra and hexoctahedra than on octahedra.

Several growth features are illustrated by these stones. The most common feature is the trigon, which occurs as depressions on octahedral faces *(Figures 5, 6 and 10)*. Trigons, which can be very shallow, occur on nearly all octahedral faces. Commonly, trigons form along lines that are parallel to the edges between the octahedral faces *(Figure 10)*. It should be noted that the points of a trigon are always toward octahedral edges, as indicated by the arrows in *Figure 10*. A related feature, found on cube faces, is shown in *Figure 11*. Although not clearly shown in this photograph, the edges of the square are parallel to the octahedral faces.

A third feature, illustrated in *Figures 12 and 13,* are growth plateaus. These are characterized by the steplike levels and many re-entrant angles, giving them the appearance of a penetration twin. Actually, this is just an unusual growth pattern in which the octahedral faces formed faster than the edges and corners. This is illustrated in *Figure 14,* also. The ragged appearance

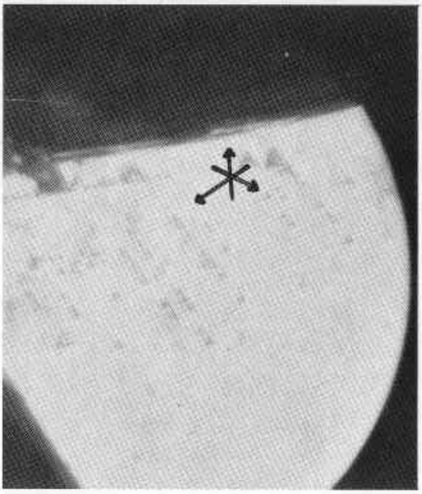


Figure 10

Figure 11

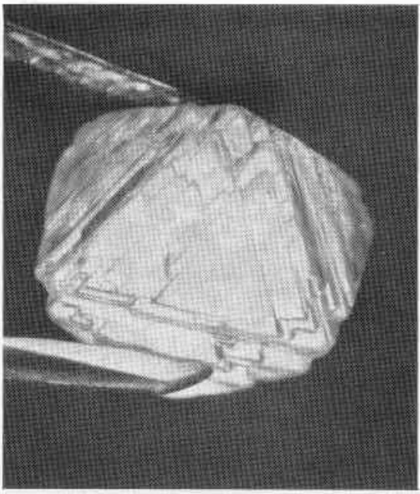


Figure 12

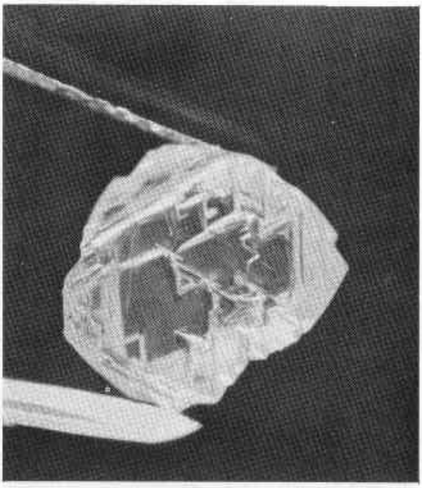


Figure 13

of the stones in *Figures 12 and 13* is similar to that of diamonds we have seen from Russia.

In *Figure 15,* a trigon occurs on a growth plateau. Note the points of the trigon (indicated by T) and the growth-plateau point in opposite directions.

These three growth features serve to

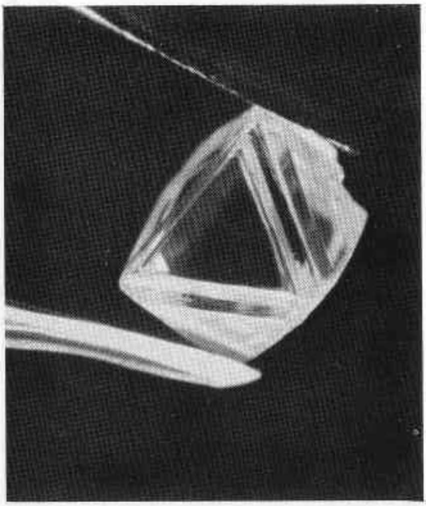


Figure 14

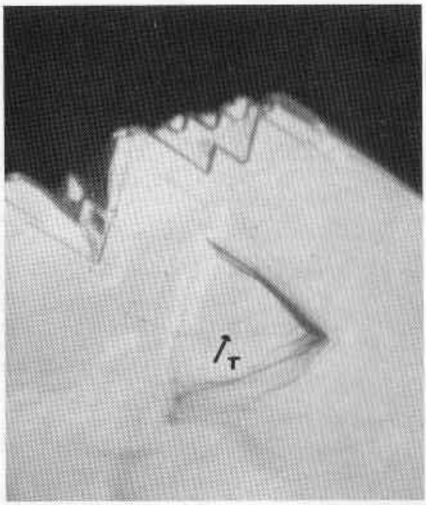


Figure 15

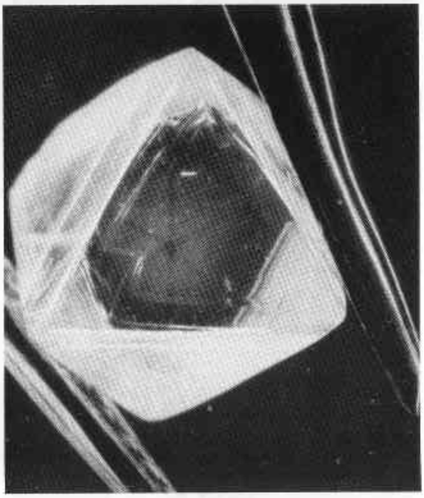


Figure 16

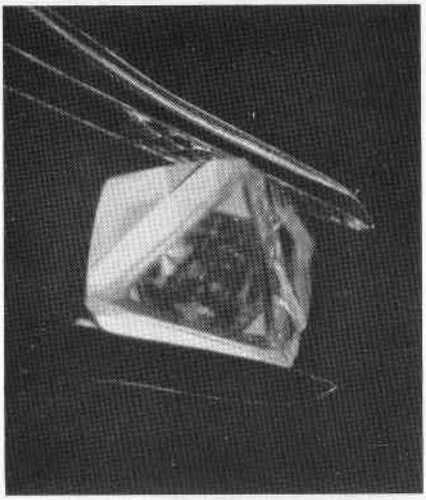


Figure 17

illustrate how diamonds grow by the addition of layers parallel to the octahedral faces.

Most of the stones whose interior can be viewed contain inclusions. Only one contains an unusual inclusion: a six-rayed star in the center of the crystal when viewed through different octahe-

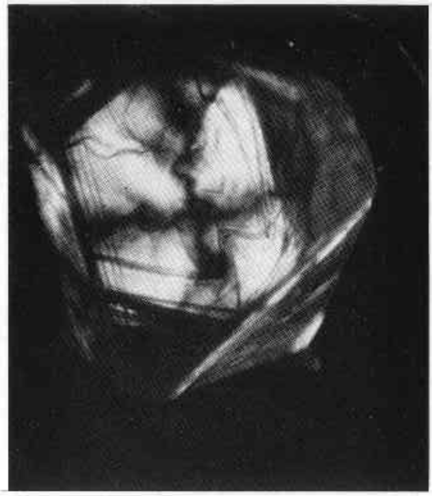


Figure 18

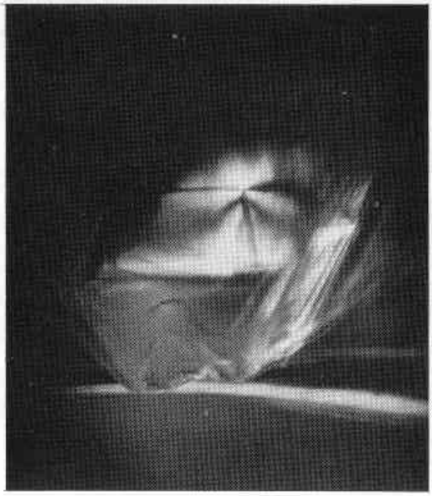


Figure 19

dral faces *(Figure 16)*. Actually, this is a large cottony cloud. Planes, with a dearth of inclusions extending from the center of the stone perpendicular to each face, form the rays of the star. Thus, the star is actually present because of the *absence* of inclusions.

All of the diamonds show some strain birefringence or, as it is more frequently termed in gem identification, anomalous double refraction. More and more diamond cutters are using polariscopes to determine the extent of the strain, and therefore the potential problems they might encounter in the cutting process.

Figure 17 shows a strain pattern that would not worry a cutter, because it is general and rather evenly spread throughout the stone. The strain pattern shown in *Figure 18* is common and would probably not worry a cutter, either. *Figure 19,* on the other hand, shows a strongly strained diamond with a very definite focal point of strain: an inclusion *(Figure 20)*. It should be noted that the presence of an inclusion

Figure 20

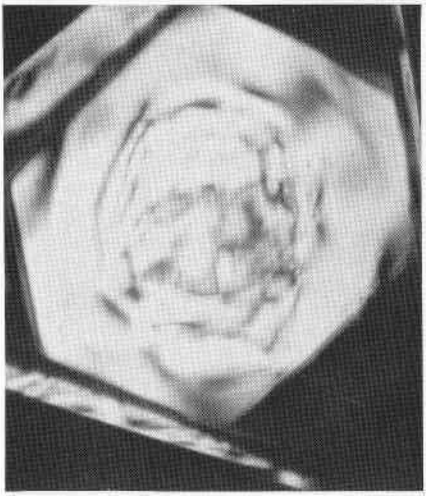


Figure 21

does not mean there will be strain associated with it. The annular pattern of strain shown in *Figure 21* is unusual and seen in only one stone. Although a few scattered inclusions are present, there is no obvious cause for this pattern.

A subjective evalution of the strain in these stones was made. The results were as follows: very strong strain, 22 diamonds; strong strain, 35; moderate strain, 16; weak strain, 13; and very weak strain, 14. The strain within a diamond can be quite variable. The stones were placed in each category on the basis of maximum amount of strain shown between crossed Polaroids.

The fluorescence under long-wave ultraviolet light was also examined. Thirty-one of the stones are inert or have a very weak glow. The fluorescence of the remainder was classified as follows: very strong, 1 diamond; strong, 21; moderate, 22; and weak, 25. Of the 69 stones that fluoresced, 59 fluoresced blue, 6 orange, 3 pink and 1 yellow.

Most commonly, the fluorescence is evenly distributed throughout the stone; however, there are a number of exceptions. There are several stones whose fluorescence is limited to areas in the center of the stone. One octahedron whose points fluoresce has an inert center. In several stones, the fluorescent areas have an irregular shape and distribution.

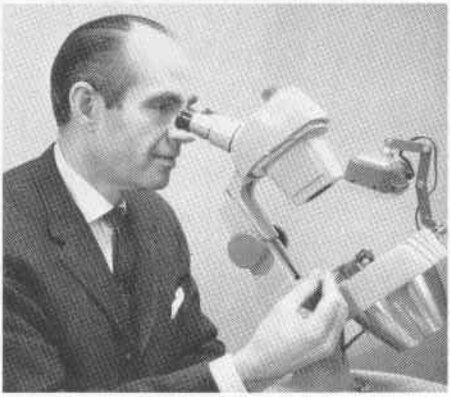
In the stone with the star *(Figure 16)*, the areas containing the cottony inclusions fluoresce pink, whereas the rays of the star are inert. Another stone, without similar inclusions, shows a pink fluorescent star; however, in this diamond the rays fluoresce and the areas between them are inert.

One diamond that fluoresces blue contains a yellow fluorescing inclusion. Another stone that fluoresced blue contains a small, irregularly shaped area that fluoresces yellow. And finally, the stone pictured in *Figure 21* contains a small spherical area of blue fluorescence in the center, surrounded by an inert zone and then a halo.

The diamonds in this gift collection will be of inestimable value to students and to the jewelry industry. The GIA Board of Governors and the faculty are deeply appreciative of this generous action by both De Beers and Kaplan.

* * *

Developments and Highlights



at the

GEM TRADE LAB

in New York

by

Robert Crowningshield

Diamond Enigma

On several occasions we have identified rings manufactured in the Middle East in which a very thin rose-cut diamond was placed over a bright metal back crimped or molded to appear like back facets, the whole hermetically sealed and placed in a closed setting. One ring of this kind was taken apart and pictured in the Fall, 1959, issue of *Gems & Gemology.* In that instance, the diamond was approximately 15 mm. in diameter and 2.1 mm. in depth. Before being removed from the ring it was very difficult to determine that it was not of normal depth. Recently, we examined a similar ring and the client returned the stone and its metallic backing for us to photograph after removing it from the mounting. The rose cut was the thinnest we have ever encountered. Although the diameter was 14.5 mm., the depth was only .6 mm. The rose cut and the cone-shaped metallic backing are shown in *Figures 1 and 2,* a top and side view, respectively.

Maine Tourmaline

Figure 3 illustrates, by reflected light and in actual size, a magnificent light blue-green tourmaline crystal found recently at Mt. Mica in Maine. The two sections of the crystal total 411.10 carats and should cut into very fine gems. We are indebted to Mr. Frank C. Perham of West Paris for allowing us to photograph the stone. We hope to be able to illustrate the stones cut from these pieces in an early issue. *Figure 4* shows the

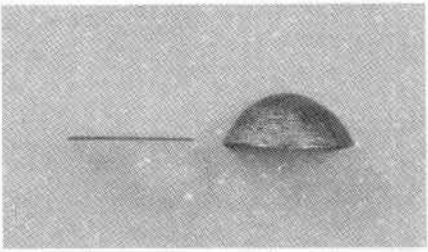


Figure 1

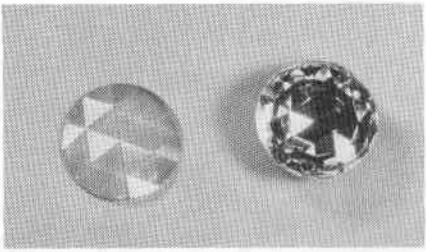


Figure 2

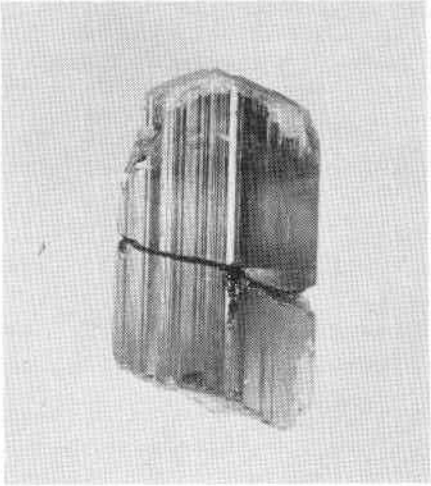


Figure 3

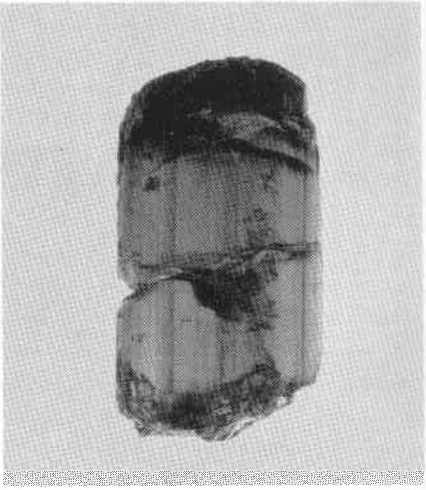


Figure 4

great transparency of the crystal and its potential as cutting material.

Treated Red-Brown Diamond

Students and faithful readers of the LOUPE may recall that in the March-April, 1958, issue we reported the unusual absorption and fluorescence spectrum of a tiny (.01 carat) red-brown treated diamond. *Figure 5* illustrates the absorption spectrum of this stone but with the positions of the absorption lines shown in their true positions, which were incorrectly stated in the LOUPE. Note that, in addition to the 5920 Å line expected in treated and annealed diamonds, it shows a strongly fluorescent line at approximately 5690 Å. Under ultraviolet the stone glows a bright orange-red color. No sign of the lines at approximately 5040 Å could be detected, though admittedly working with such a small stone has drawbacks. Over the intervening years we have seen several other treated stones with similar properties but always of melee size; hence, there was no observation of their properties before treatment. We have

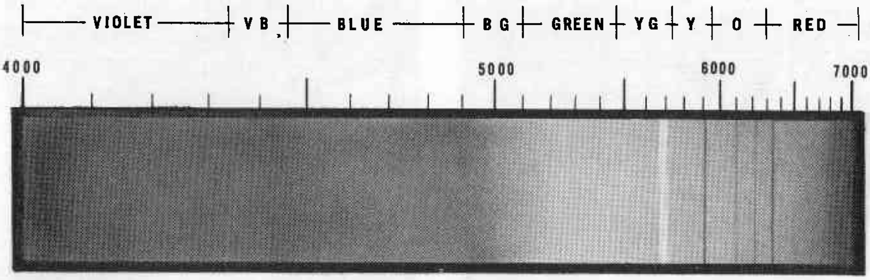


Figure 5

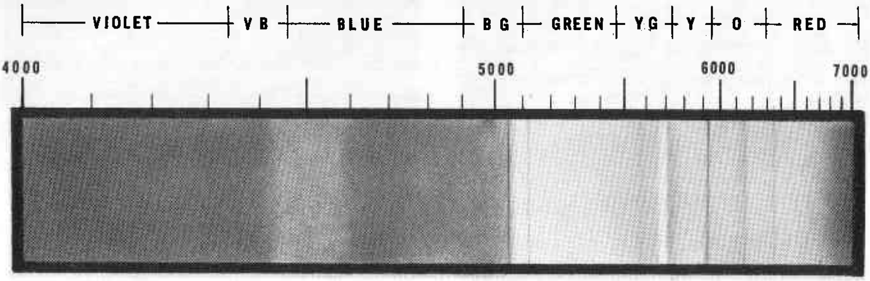


Figure 6

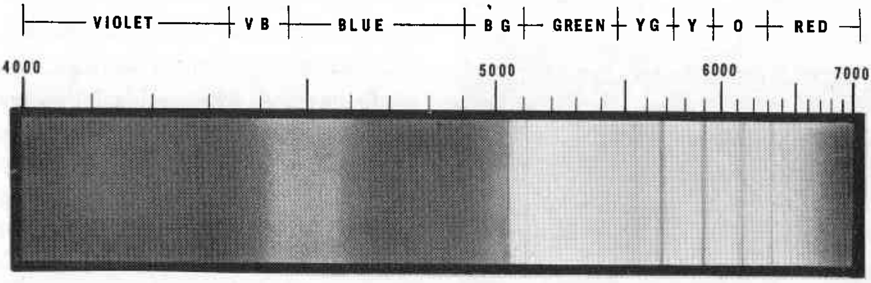


Figure 7

often wondered what type of stone would change to this pleasant color.

Recently, we were pleased to be able to examine a 1.05-carat red-orange treated diamond, and are again indebted to Mr. Theodore Moed and his son, Irwin. This stone was of sufficient size that before treatment it was studied for pertinent characteristics. It reportedly showed a distinct greenish-yellow fluorescence under long-wave ultraviolet, and it was decided that it would treat to a good "chartreuse" color. It was a surprise, therefore, when the stone was returned from treatment in the atomic pile and subsequently annealed, to find that it had become an attractive orange-red and that the fluorescence was a strong red-orange color. The absorption spectrum was very much like that of the small stones we had seen earlier; but with the larger size as the reason, perhaps, we were able to see the 5040 Å line and one at approximately 5120 Å. There is a slight difference in the position of the lines in the red and orange and the large stone has one less line above the 5920 Å "treated" line, although the fluorescent line is in the same position *(Figure 6)*. By positioning the stone over the light source so that the light was not scattered but directly transmitted, it was possible to see the fluorescent line as an absorption line *(Figure 7)*. The small size of the other stone prevented this "phenomenon" — a reaction that is expected, as mentioned by B. W. Anderson in his excellent article, *The Classification of Diamonds on the Basis of Their Absorption and Emission of Light (Journal of Gemmology*, Spring, 1963).

Blue-Enamel "Turquois"

An attractive necklace of blue beads sold as turquois proved to be blue enamel over heavy hollow gold spheres alternating with heavy melon-cut gold beads. The effect was most pleasing. We hope the client appreciates that this necklace will probably give much more satisfaction than if it had been turquois.

Cat's-Eye Apatite

An unset cat's-eye apatite of nearly 220 carats is the largest of this Indian material we have seen, although we understand museum specimens are larger. We have continued to see these stones set in jewelry showing fractures caused by damage, either in wear or in repair. Not only is apatite relatively soft (being #5 on Mohs' scale of hardness), but it is apparently also very susceptible to temperature changes. This latter unfortunate characteristic it shares with most crystalline quartz, peridot and large garnets.

Are They Pink Jade?

Reports of the existence of pink jade continue to come to our attention, and we are always interested to know if the stones are truly jade. Student Robert Dunnigan, Larter & Sons, sent us some very clear color slides of a jade crown in the Cleveland Museum of Art. The central section is definitely pink and other areas, gray to green. A bit of sleuthing disclosed that the area in the center of the crown is backed with red foil! We are currently trying to obtain information about pink stones in two other museums that are labeled jade.

A Diamond Re-Cutting Problem

Figure 8 shows the exceedingly thin girdle produced when an old-European-cut diamond was recut on the pavilion only without girdling, so that the resulting finished stone would weigh just over two carats. The edge of the stone appeared "nibbled" by damage, and it is amazing that it had been worn for nearly six months without greater damage. A knowledgeable jeweler would never accept such a stone for sale to a private customer. It was estimated that to girdle the stone for a safe edge the weight loss would have been approximately .06 carat, but it would then have been under two carats, unfortunately, a compelling reason not to girdle.

Acknowledgements

We are indebted to the firm of

Figure 8

Figure 9

Wm. V. Schmidt Co., Inc., for a gift of several round brilliant-cut strontium titanates (Fabulite). Three of the stones contained unexpected inclusions. The gas bubbles illustrated in *Figure 9* are not clear but cloudy and many have the shape of a golf tee. The lines of bubbles are essentially straight, even though the material is formed by the Verneuil process. In *Figure 10,* the inclusions do not appear to be gas bubbles at all, although where they reach the surface they are filled with foreign material, probably polishing powder. In *Figure 11 and 12* are two views of a "fingerprint" inclusion, resembling a healed fracture in a natural sapphire.

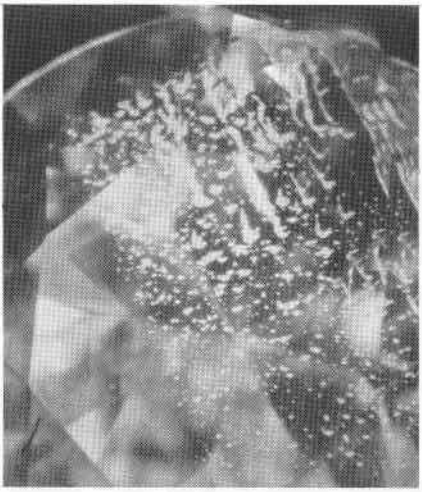


Figure 10

Thanks to graduate **Cal Smyth** of Albert Smyth & Sons, Baltimore, for the gift of carob pods and seeds *(Figure 13),* 20 of which weighed 19.52 carats but individuals ranged from .60 to 1.20 carats. Presumably, the seeds were found to be remarkably uniform in weight and were used as the basis for weighing gemstones in certain Middle Eastern centers. In other areas, other seeds were used, such as the barley grain

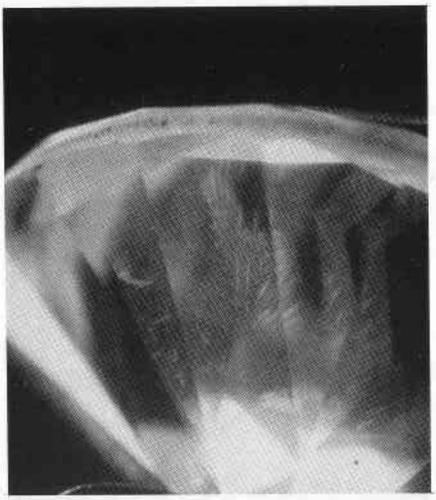


Figure 11

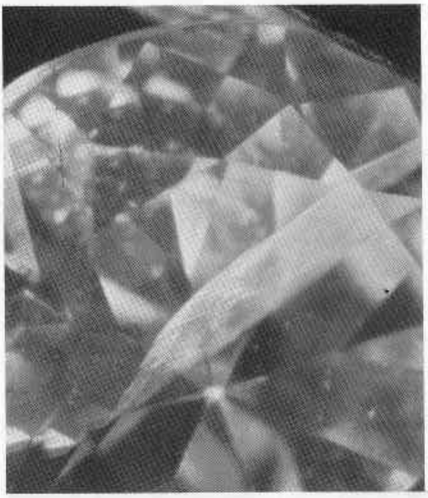


Figure 12

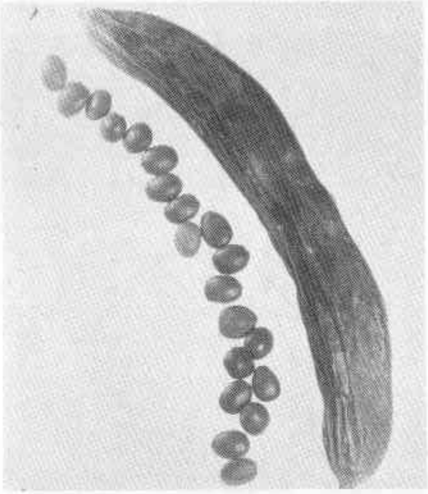


Figure 13

in Europe (hence our term *grain* for pearls). The carob tree *(Ceratonia Siliqua)* grows readily in counties bordering the Mediterranean and is a happy addition to the numerous introduced species in Southern California. Another very beautiful addition to the Southern California landscape is the coral tree *(Erythrina Corallodendron),* the dried seeds of which one writer states were used as the basis of weighing gold. The native name of the tree, *kuara,* presumably was the source of the term *carat.* The seeds have about the same weight and are about the size as those of the carob. A little investigation of the origin of the Latin names of the trees suggests that carob is the source of the name *carot. Ceratonia* is from the Greek weight, *ceratium,* whereas *siliqua* comes from the name of an old Roman weight. It would seem that the ancients appreciated the relative constance of the weight of the carob-tree seeds. The Latin names for the coral tree refer to the color of its blossoms.

From student **Walter Klinger,** Wm.

(continued on page 62)

Hydrogrossular — A Hydrogarnet from the Transvaal

by

H. Lawrence McKague, Ph.D.

Introduction

The first reported occurrence of "grossular" in the Province of the Transvaal, Republic of South Africa, was by Hall in 1908. This occurrence is in the eastern belt of the Bushveld Igneous Complex. In 1909, Kynaston noted grossular in the contact metamorphosed country rock surrounding the Complex. Later, Hall (1925) described in detail occurrences in the western belt near the small town of Brits. These deposits, approximately forty miles west of Pretoria, are the classic locality for the ornamental material misnamed "Transvaal jade," "African jade" and "South African jade." In studying the transmission spectrum of this material, van dèr Lingen (1928) detected the presence of OH-groups and concluded this material was not grossular. Tilly (1957) and Frankel (1959) determined it to be a member of the hydrogrossular series.

Hutton (1943) applied the name, hydrogrossular, to the members of the series $Ca_3Al_2(SiO_4)_3$—$Ca_3Al_2(OH)_{12}$, whose composition is between $Ca_3Al_2(SiO_4)_3$ (grossular) and $Ca_3Al_2(SiO_4)_2(OH)_4$ (hibschite). The terms hydrogarnet (Flint, McMurdie and Wells, 1941), grossularoid (Belyankin and Petrov, 1941), hydroxygarnet (Donnay and Allerhand, 1965), and garnetoid (McConnell, 1942) also have been used for this series. In addition to hydrogrossular, other known water-bearing garnets are synthetic hydropyrope (Christie, 1961) and a naturally occurring hydroandradite (Peters, 1965).

The source of the sixteen samples studied for this report was given only as the Transvaal. However, the presence of chromite indicates the source of the samples to be within the Bushveld Igneous Complex, rather than in the surrounding contact metamorphosed country rock.

Geology

If the samples used in this study did not originate in the Brits deposits, they are probably from a similar occurrence. For this reason a brief description of the geology of the Brits deposits, based on Hall's 1925 report, will be given.

The Bushveld Igneous Complex is a large pseudostratified lopolith of basic igneous rocks. The complex is generally divided into four zones: (1) upper zone, (2) main zone, (3) critical zone and (4) basal zone. Hydrogrossular occurs in the critical zone, which is characterized by chromite-rich bands in noritic rocks. Layers of hydrogrossular are parallel to the pseudostratification of the surrounding igneous rocks and may be up to 18 inches thick. The hydrogrossular is always in close association with chromite, although the converse may not be true. The enclosing rock is commonly anorthosite; however, in some areas this is replaced by a monoclinic pyroxene and garnet rock.

Hall suggests two modes of origin for the hydrogrossular bands: (1) a magmatic origin with the hydrogrossular bands formed in the same manner as the chromite bands, and (2) a metamorphic origin in which xenoliths of calcareous aluminous sediments were intensively altered, resulting in the hydrogrossular.

Tilley (1957) and Frankel (1959) suggest, on the basis of the observation of relict textures preserved from the original rock and the interbedding of the hydrogrossular bands with anorthosite, pyroxenite and chromite bands, that the hydrogrossular layers result from the metasomatic replacement of pre-existing layers of anorthosites and feldspar-rich pyroxenites. This would entail the loss of Na and Si and the gain of Ca and H_2O (Tilley, 1957).

Mineralogy

The hydrogrossular rocks from the Bushveld Igneous Complex are not truly monomineralic. Hall (1925) lists chromite and zoisite as occurring with the hydrogrossular. According to Hall (1925), most thin sections contained between 60 and 100 percent hydrogrossular. He also notes that those with 100 percent were not uncommon. Frankel (1959) lists enstenitic pyroxene and sussurite as occurring in these rocks, also. In thin section, these rocks are either isotropic or show anomalous birefringence (Frankel, 1959). In those sections with anomalous birefringence, a zoning and twinning effect similar to that in plagioclase feldspar is observed. This relict texture led Tilley (1957) and Frankel (1959) to conclude the hydrogrossular originated by replacement of feldspar. Thin sections of samples 8 and 15 were prepared for this study. The thin section of sample 8 shows this specimen to be approximately 95 percent isotropic garnet, 5 percent idocrase. The thin section of sample 15 is composed of anomalously birefringent garnet, showing relict albite twinning, isotropic garnet, and random irregular patches of small grains of idocrase, which show an anomalous brownish birefringence.

X-ray diffraction patterns of the 16

samples examined for the present study showed the presence of hydrogrossular, idocrase and chromite. In all patterns both idocrase and hydrogrossular lines are present, except that of number 4, which contained no idocrase lines. Zabinski (1965) also detected idocrase in association with hydrogrossular in material from the Transvaal. There is no indication of zoisite in any of the 16 diffraction patterns. In thin section, idocrase and zoisite are easily misidentified, since they both show anomalous birefringence.

It is not unexpected that idocrase and hydrogrossular should occur together. Their chemical formulae indicate their similar composition:

Idocrase
$Ca_{10}(Mg,Fe)_2Al_4(Si_2O_7)_2(SiO_4)_5(OH,F)_4$
Hydrogrossular
$Ca_3Al_2Si_2O_8\ (SiO_4)_{1-m}\ (OH)_{4-m}$

In addition, they have similar crystal structures. Warren and Modell (1931) noted the similarity in their unit cells. The *c*-axis of the idocrase unit cell is 11.85 Å (Warren and Modell, 1931), which is in very close agreement with 11.851 Å for the *a*-axis of grossular (Skinner, 1957). A slightly larger *c*-axis, 11.95 Å, was determined by Takane (1933); this is within the range shown by the hydrogrossular unit cell. In addition, Warren and Modell (1931) pointed out that certain parts of the idocrase structure are in common with certain parts of the hydrogrossular structure.

Chromite was definitely identified in only one specimen, number 4. This identification was obtained by limiting the X-ray powder sample to an opaque black equidimensional inclusion. Other specimens contained similar, though smaller, inclusions, which are assumed to be chromite.

Physical Properties

As indicated in the last section, the samples under consideration are not monomineralic. Thus, properties, such as specific gravity, are of bulk samples, rather than of individual minerals. There is an attempt to evaluate this effect on the physical properties in some of the following sections.

Color and Transparency

The sixteen samples are equally divided into a pink group and a green group. There are slight variations in shade, but, in general, the green group is a yellow-green, whereas the pink group is a brownish pink. All samples are translucent. On the basis of color and transparency, Hall (1925) divides the material from the Brits occurrences into twelve varieties: (1) massive, translucent deep sea green, (2) spotted, translucent, deep sea green, (3) opaque, vivid, pure dark green, (4) massive, translucent, dull sea green, (5) opaque, dull sea green, (6) bright apple green, (7) opaque, dull gray-green, (8) spotted, opaque, bright yellowish green, (9) translucent pink (rare), (10) dull pink, (11) mother-of-pearl to pale bluish, and (12) cream colored (rare). In addition to these colors, Webster (1963) lists yellow and

TABLE I

Semiquantitative Spectrographic Analysis of Two Hydrogrossular Samples

	#5 (Green)	#12 (Pink)
Silicon	18%	18%
Calcium	26	27
Magnesium	1.4	0.66
Aluminum	11.0	11.0
Iron	0.71	0.43
Boron	0.0063	0.0082
Manganese	0.42	0.80
Tungsten	0.14	nil
Chromium	0.066	0.0016
Copper	0.00095	0.00021
Titanium	0.016	0.012
Nickel	trace	nil
Other Elements	nil	nil

red. He also notes that the colors may grade into one another.

Hall (1925) attributes the green color to the presence of chromium and the pink, to manganese. The semiquantative spectrographic data in Table I supports this theory. However, the color of the pink specimen may be a result of the smaller chromium content, as well as the increased manganese content.

Hardness

Hall (1925) gives the hardness of this material as 7, but commonly over 8. With the exception of sample numbers 5 and 15, the hardness is between 6 and 7. The hardness of number 5 is between 5 and 6, and that of number 15, between 7 and 8.

Refractive Index

The refractive index of the bulk samples was determined in sodium light with a refractometer. There is a question as to which refractive index was measured — hydrogrossular or idocrase. The refractive index of the hydrogrossular series ranges from 1.734 (Skinner, 1956) for grossularite, to 1.681 for hibschite (Belynakin and Petrov, 1941). For idocrase, it is possible for the ω refractive index to be as high as 1.752 and for the ε refractive index to be as low as 1.700 (Deer, Howie and Zussman, 1962). Thus, the indices of refraction overlap from 1.734 to 1.700, and within this range, the refractive indices obtained with a refractometer could be that of either mineral. However, in Hall's work, it was shown that hydrogrossular makes up from 66 to 100 percent of the slide. Although the effect on the index of refraction of an intimate mixture of two minerals has not been studied, it is tentatively assumed that the index of the predominant mineral will prevail. In addition, there was no detectable birefringence, which further indicates the measured refractive index is that of hydrogrossular, although the birefringence of

TABLE II

Physical Properties of Hydrogrossular Samples

Sample No.	Color	Refractive Index (±0.003)	Specific Gravity (±0.003)	Unit Cell (±0.003)
1	green	1.718	3.384	11.857
2	"	1.718	3.376	11.855
3	"	1.715	3.387	11.860
4	"	1.728	3.490	11.892
5	"	1.712	3.401	11.871
6	"	1.718	3.407	11.892
7	"	1.711	3.371	11.860
8	"	1.712	3.362	11.869
9	pink	1.702	3.342	11.912
10	"	1.699	3.338	11.925
11	"	1.700	3.342	11.893
12	"	1.700	3.338	11.912
13	"	1.702	3.330	11.904
14	"	1.702	3.336	11.901
15	"	1.705	3.341	11.901
16	"	1.690	3.298	11.925
$\bar{X}$ Total		1.708	3.365	11.889
$\bar{X}$ Green		1.717	3.397	11.869
$\bar{X}$ Pink		1.700	3.333	11.909
S Total		.010	.044	.024
S Green		.005	.040	.015
S Pink		.004	.015	.012

$\bar{X}$ = Sample Mean
S = Sample Standard Deviation

idocrase can be as small as .001 (Deer, Howie and Zussman, 1962). Thus, the R.I.'s in the overlapping range are assumed to be those of the hydrogrossular. Certainly those below 1.700 are of hydrogrossular. The indices of refraction of the sixteen samples is given in Table II and plotted graphically in *Figure 1.* The mean refractive index of all samples is 1.708. However, the means of the green and pink groups are 1.717 and 1.700, respectively.

Frankel (1959) showed that the index of refraction of hydrogrossular decreases with increasing water content. Thus, on the basis of refractive index, the pink samples have a higher water content than the green samples.

Specific Gravity

Hall (1925) lists the specific gravity

TABLE III

Chemical Analyses of Hydrogrossular-Rich Rock

	1	2	3	4	5	6	7
S_1O_2	35.53	36.4	36.65	34.40	37.60	34.46	36.55
T_1O_2		.1	.1	.5	.1	.14	.12
Al_2O_3	21.75	21.8	22.15	21.60	22.25	21.25	23.44
Fe_2O_3	nil	.8	1.9	.8	.5	.97	1.27
Cr_2O_3		nil	.02	nil	.10	.005	.25
FeO	5.00	.55	.5	.55	.55	.32	.52
MnO		.1	.45	.20	tr	.18	.04
MgO	1.82	.7	.9	tr	tr	1.13	.79
CaO	34.26	37.15	35.6	38.60	38.40	36.46	36.06
Na_2O				tr	tr	.05	
K_2O				tr	tr		
P_2O_5				.5	.5		
H_2O+	1.46	2.15	1.8	3.60	1.20	4.47	1.16
H_2O-		.25	.3	.70	.20	.65	none
Total	99.82	100.00	100.37	100.55	100.95	100.08	100.20
S.G.		3.47	3.44	3.335	3.52	3.27	3.488
R.I.						1.675-1.705	1.728
μ(Å)						11.90	11.859

1) Hall (1925). Gray material from Turffontein
2) Hall (1925). Gray material from Turffontein
3) Hall (1925). Pink material from Turffontein
4) Hall (1925). Pink material from Buffelsfontein
5) Hall (1925). Green material from Buffelsfontein
6) Tilley (1957). Pink material from Buffelsfontein
7) Frankel (1959). Material from Buffelsfontein

of the Brits material as ranging from 3.335 to 3.52 (Table II). Webster (1963) gives the range as from 3.06 to 3.66 for the forty-nine samples. The mean is 3.429. The mean specific gravity of thirty green samples is 3.464, whereas the mean of thirteen pink samples is 3.371. However, the ranges of the two colors overlap. The remaining six samples can be placed in either color group.

The range of the specific gravity of sixteen samples of this study is from 3.490 to 3.298 (Table II). The mean specific gravity of all samples is 3.365, whereas the mean for the green samples is 3.397 and for the pink, 3.333. This study, and that of Webster, shows that although there may be some overlap, the green material has the higher specific gravity. Again, the effects of other minerals must be considered. Two of Web-

TABLE IV

Molecular Composition of Transvaal Hydrogarnet

	Pink **Tilley (1957)**	**Green** **Frankel (1959)**
Almandite	0.7	1.1
Andradite	2.7	3.6
Grossular	92.2	91.7
Pyrope	4.1	2.9
Spessartite	.4	.1
Uvarovite	—	.7
	100.1	100.1

ster's samples and number 4 of this study contained enough chromite to cause the unusually high specific gravity of these samples. The specific gravity of idocrase and hydrogrossular overlap. Thus, the specific gravities listed in Table II are of bulk samples rather than of a single mineral. However, Frankel (1959) showed that increasing specific gravity of bulk samples is related to decreasing water content. With this in mind, it can be stated that the pink material commonly has a higher water content than the green.

X-Ray Diffraction

X-ray diffraction powder diagrams were prepared, using Ni filtered copper radiation ($\lambda = 1.5148$ Å). All the patterns contained diffraction lines characteristic of hydrogrossular, and all but the powder pattern of number 4 contained diffraction lines characteristic of idocrase.

The unit-cell size of the hydrogrossular was calculated, using the (642) reflection. This is a strong reflection, and there are no overlapping idocrase lines. Pure grossularite has a unit-cell size of 11.851 Å (Skinner, 1956), whereas that of hibschite is 12.0 Å (Pabst, 1942). The unit-cell sizes of the samples studied ranges from 11.857 Å to 11.925 Å, with a mean of 11.889 Å (Table II). The mean unit-cell size of the pink samples is 11.909 Å, as compared to 11.869 Å for the green. The unit-cell size of Tilley's pink sample and Frankel's sample are 11.90 Å and 11.859 Å, respectively. Flint, McMurdie and Wells (1941) showed that the unit-cell size increases with increasing OH content. The unit-cell size can also change as the result of increased amounts of the other garnet molecules. Treating the analyses of Tilley and Frankel (Table III) as anhydrous garnets, the grossular molecule comprises more than 91 percent in both analyses (Table IV). Because of the high and similar grossular content in both samples, and the probable close similarity in composition of the sixteen samples in

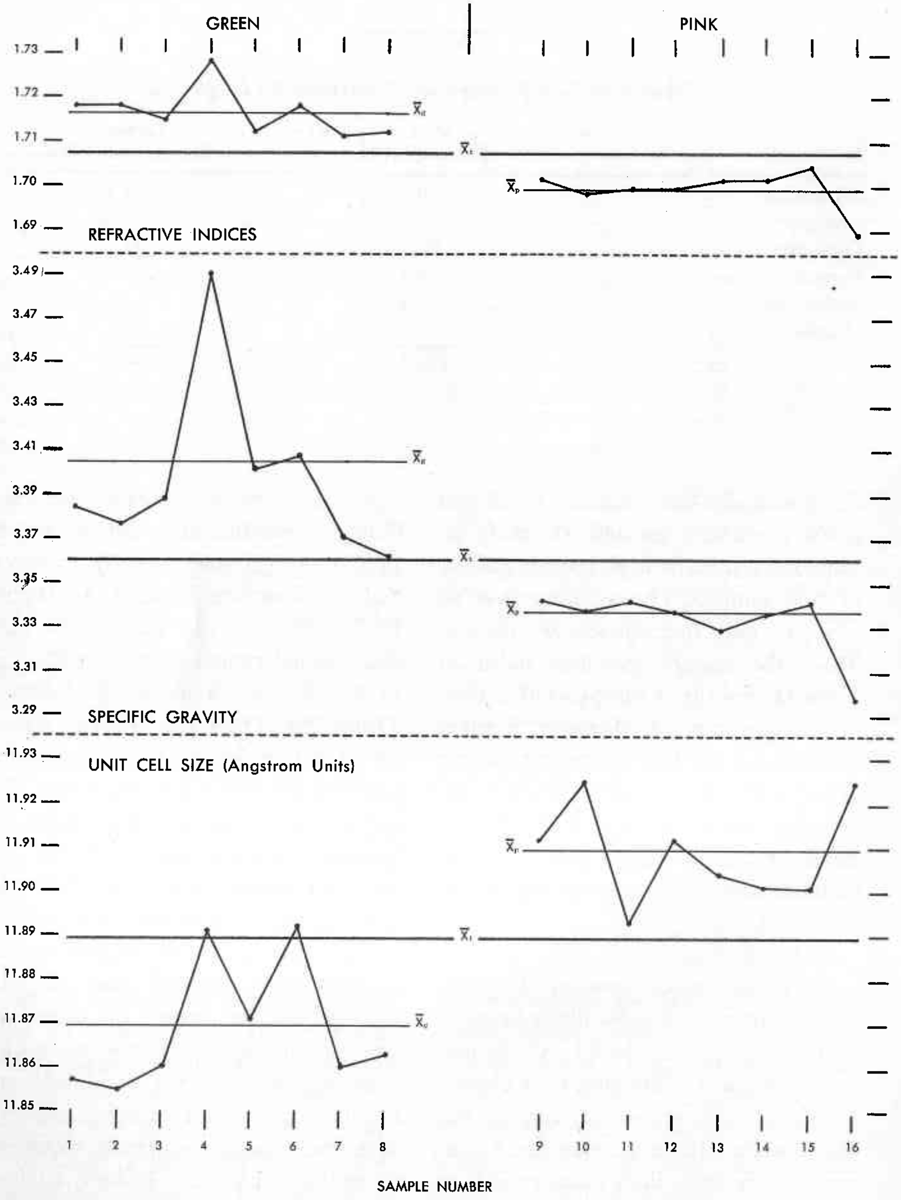


Figure 1

Graph Showing Variations of Refractive Index, Specific Gravity and Unit-Cell Size

this study, it is relatively safe to assume that the consistent variation in unit-cell size is a result of variations in water content. This assumption is supported by the fact that the variations in cell size indicate the same relative variation in water content as the refractive-index and specific-gravity data; i.e., a higher water content in the pink samples.

Fluorescence

All sixteen samples remained inert under both long- and short-wave ultraviolet light. However, when irradiated with X-rays, they all fluoresced yellow. In general, the pink samples have a stronger fluorescence than the green. The exception is specimen number 4, which exhibits the strongest fluorescence.

For years, both GIA and the London Laboratories (Webster, 1962) have considered visible X-ray fluorescence a diagnostic characteristic of massive hydrogrossular, not shown by either of the jades or any jade substitute, including idocrase. Crowningshield (1966) noted that translucent samples of idocrase from Pakistan fluoresce. However, X-ray diffraction patterns of similar Pakistanian material indicate that they are almost entirely hydrogrossular. The most intense idocrase line is very weak and barely detectable in the two samples of Pakistanian material that were examined.

Absorption Spectra

Eleven of the specimens have an absorption line at 4635 Å. Three green samples, numbers 6, 7 and 9, have absorption edges above 4635 Å. Samples 4 and 16 have absorption cut off below 4635 Å, but show no absorption line in the 4635 Å region.

(to be continued)

Book Reviews

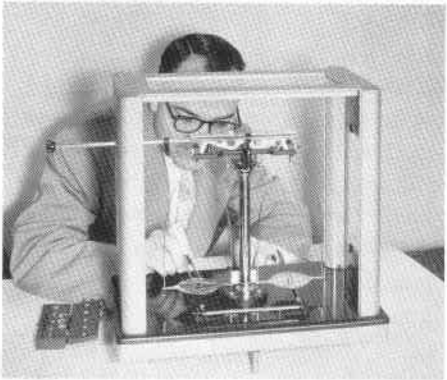
GEMS IN THE SMITHSONIAN INSTITUTION, by Paul E. Desautels, Associate Curator, Division of Mineralogy, Smithsonian Institution, Washington, D.C., 1965. 74 pages. Paperbound. Illustrated in color and black and white. Price: $1.25.

The primary purpose of this excellent little book is to acquaint the Smithsonian visitor with the beauties of the National Gem Collection, one of the outstanding in the world, and also to present a brief introduction to the study of gemstones. The author has accomplished this with commendable results.

Enhanced by 41 attractive color plates and 19 black-and-white photographs and line drawings, the book begins with a short history of this magnificent Collection, from its inception in 1884. Chapters two through five discuss briefly but lucidly the important subjects comprising the study of gemology, including physical and optical properties, cutting and polishing, substitutes, lore and legend, and birthstones. The following section, which constitutes the bulk of the text, describes and illustrates in color the principal gem species and varieties, all of which

(continued on page 62)

Developments and Highlights



at the GEM TRADE LAB in Los Angeles

by
Richard T. Liddicoat, Jr.

Crystal Growth Lines

The definition of *flawless* used by the American Gem Society accepts diamonds showing crystal growth lines that have no surface manifestations of the slightly banded appearance seen in the interior of the stone. This is an effect caused by light passing through the slight irregularities.

Figure 1 shows a diamond with very prominent growth lines for which there was no surface evidence. Such lines are very difficult to photograph; they are difficult to see through one eyepiece only. The stereoscopic effect of a binocular microscope makes them more readily visible. In this stone they were sufficiently prominent that we decided to make an attempt to photograph them. It can be seen that they are indeed growth lines and not polishing marks, by the fact that they continue across facet junctions without interruption or change of angle.

Fisheye Diamonds

From time to time we encounter fisheyes that are almost without brilliant reflections near the center. The diamond brilliant pictured in *Figure 2* was singularly "dead" in the center. The pavilion angle was so exceedingly flat that the girdle reflection reached almost to the huge culet. The ideal proportions for crown height and pavilion depth are, respectively, 16.2% and 43.1% of the girdle diameter. On this stone, the crown height was 16%, but the pavilion depth only 32%. Any figure less than 39% or 40% for the pavilion pro-

Figure 1

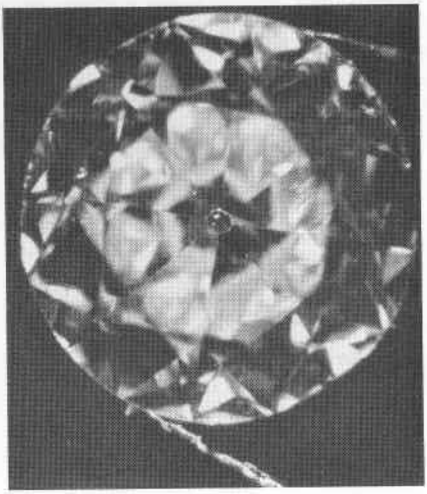


Figure 2

duces a reflection of the girdle that is visible through the table. This one approaches an extreme for a brilliant. Often the pattern seen when looking through the crown of a transparent stone discloses a great deal of its nature, as we have pointed out in previous articles in *Gems & Gemology.*

Because of the recent rapid increase in the price of single cuts, more and more single-cut diamonds are showing obvious effects of poor cutting, such as pavilion angles that are too flat or too steep. Another revealing sign is seen when the crown is exceedingly flat; in other words, when, instead of 34° or 34½°, the crown angles are on the order of 20° or 25°, or even flatter. This is apparent as an eight-sided pattern completely around the crown, as shown in *Figure 3.* This pattern is seen whenever the crown is exceedingly flat and the pavilion not too far away from the normal angle. This same stone is shown in cross-section in *Figure 4.*

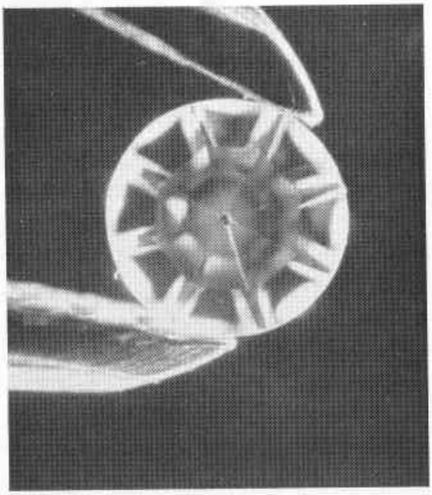


Figure 3

Indian-Cut Diamond

There are some diamond-cutting styles that are rarely encountered today.

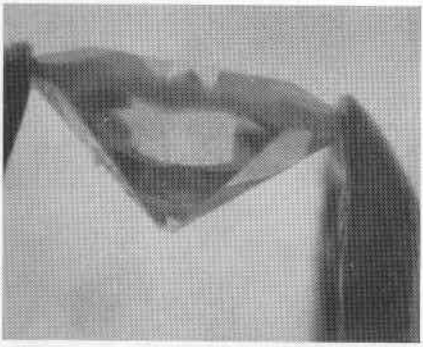


Figure 4

One of these is the so-called Indian cut. A short time ago, a diamond cut in this style was submitted for grading. It is pictured in *Figure 5.*

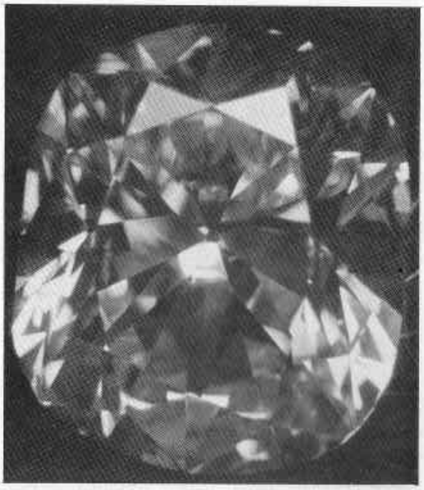


Figure 5

Cat's-Eye Opal

While in Atlanta at the Conclave of the American Gem Society, we talked with William Collison, a colored-stone dealer and former instructor on the staff of the GIA in Los Angeles. Bill had an interesting stone that he permitted us to photograph. It is not particularly rare to see a section of play of color in an opal that is distinctly banded similar to a cat's-eye, but it is very unusual to encounter an opal cut in such a way that a distinct cat's-eye effect is visible across the entire stone. Mr. Collison had such a stone, and *Figure 6* shows the clearly defined eye. It was rather small – only about 5 mm. in diameter.

Coated Amber

We received two large pieces of what appeared to be amber on cursory inspection. It had the strain cracks often seen as discs and in other respects appeared to be natural. However, it had a refractive index of 1.56 (about .02 higher than usual) and when touched lightly by the hotpoint, the resulting odor had a slightly oily quality – not quite right for amber. When we put the material under a fluorescent lamp, it fluoresced much too little for amber. One interesting aspect was a slightly stronger fluorescence on edges and points. By scraping a corner slightly, we were able to get strong fluorescence from the interior. It was clear that the material had been given some kind of thin coating, probably to protect it from crazing. By getting through the coating, the normal amber characteristics were readily apparent.

* * *

A star sapphire was submitted for identification with the claim that it had been in possession of the owner for over 30 years. However, it was an obvious synthetic, with all the characteristics of very early production by the Linde Company. Since their product reached the market less than 20 years ago, we assume that the man's memory was something less than exact.

Some Lapidaries Would Rather Switch

In the past, we have encountered frequent situations in which a layman has found a piece of rough gem material and taken it to a lapidary for fashioning. Occasionally, a cut stone of the same material is substituted for the rough and recut. Often the substituted stone is more satisfactory than the original rough and the lapidary presumably salves his conscience with this thought. The most startling switch that has come to our attention was an extrusive igneous rock containing a cavity filled with yellow transparent opal. Sent with it was a stone purported to have been cut from a similar piece of rough by a lapidary in the region where the material had been found. The interesting fact was that the rather large faceted stone was a synthetic yellow sapphire — not opal.

Quartz/Diamond Delusions

Gemologists are plagued by persons who find quartz and *know* they have discovered diamond. They usually seem to share a second delusion: that whoever says the material is "just quartz" is either mistaken or dishonest. This gives rise to unusual and humorous situations. Recently, a woman sent us two quartzite pebbles, each of which had been broken into two pieces. She wrote that she trusted us, but she had photographed the pieces to be sure they weren't replaced! After the stones were identified and returned, we received a letter asking, "Was your conclusion based on the behavior of the specimens in parallel polarized light between crossed Nicols, or was it simply based on the strength of double refraction of both specimens?" A second question: "Was the crystal structure taken into consideration?" Before the woman was prepared to believe the conclusion, she indicated that she wanted a complete breakdown of all the properties of the specimens.

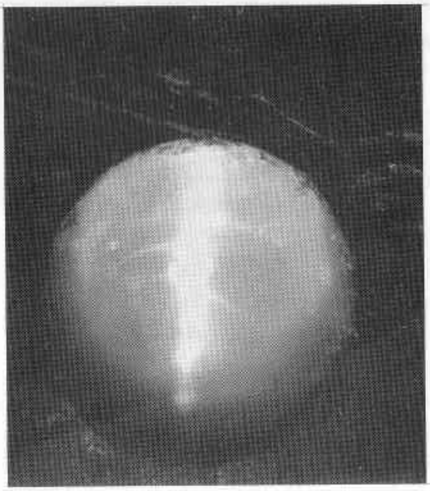


Figure 6

New Sphene Source

Two sources of very nice sphene have been discovered in Brazil within the last few months. An American importer has arranged for the entire output of gem-quality material. This may make it possible to re-establish the popularity of greenish-yellow or yellowish-green sphene. In the meantime, the Institute has received a substantial supply of gem sphene crystals from the importer.

Taiwan Nephrite Jade

Not long ago we received some very attractive nephrite that was labeled "genuine oriental jade." The importer who sent it to us for testing assured us that it had been mined in Taiwan. It was nephrite of a quality reminiscent of medium-grade material from Wyoming. It was characterized by a somewhat flaky appearance on the surface. In addition, feathers apparently extended into the stone, giving the impression that it was rather strongly layered. However, it seemed to be very tough and to have all the merits of attractive nephrite. In view of the quality of the material examined to date, it would appear that Taiwan is going to offer a new source of good nephrite jade.

We Appreciate

The GIA has often been in need of cut demantoids for gem-testing sets. Whenever this need has become apparent, **David Widess** of I. Widess & Sons, Los Angeles, has given us a supply of attractive stones that will last for a year or more in making up practice sets for students. His generosity is sincerely appreciated.

We appreciate the gift of 15 Mexican opals from student **Lawrence Reiner,** Phoenix, Arizona.

Doublets and miscellaneous stones for practice sets received from **Dick Patterson,** Garden City, Kansas, will be used to good advantage.

We are grateful to **Lazare Kaplan & Sons,** New York City, for pink, blue and yellowish diamonds. They now grace a prominent place in our display cases.

John H. Erle presented us with a nephrite jade cabochon when he attended a recent residence class.

(continued from page 48)

V. Schmidt Co., we received specimens of purple and yellow fluorite from Ohio.

From student **Jim Garriti,** James Garriti, Lapidary, we received a handsome synthetic-spinel triplet colored to resemble peridot.

From **Herb Walters,** Craftstones, Ramona, California, the writer received a handsome tumbled-polished agate nodule measuring nearly six inches across — surely one of the largest tumbled specimens one would expect to see.

Book Reviews

(continued from page 57)

are represented in the Collection. Notable among the celebrated stones in the Museum are the 44.50-carat *Hope Diamond,* the 127-carat *Portuguese Diamond,* and the 330-carat *Star of Asia,* a superb blue star sapphire. The *Maharani Cat's-eye,* weighing 58 carats, is one of the finest of its kind in existence. Significant because of record-breaking size, as well as fine quality, is a 66-carat alexandrite, a peridot of 310 carats, an 880-carat kunzite, and a benitoite weighing 7.60 carats. These and many other gems, including a wide variety of collector's items, are on view. The final chapter lists some of the larger and more interesting stones on display, including catalog number and name of donor.

Book Reviews

Reading the book prior to visiting the Museum will increase one's understanding and appreciation of gems when he tours the exhibit. Even if this opportunity never presents itself, *Gems in the Smithsonian Institution* is a worthwhile acquisition.
LLC

JEWELRY — PLEASURES & TREASURES, by Claude Fregnac. Published by G. P. Putnam's Sons, New York City, 1965. 128 pages. Clothbound. Illustrated in color and black and white. Price: $4.94.

This is one of a uniform series of attractively designed, beautifully illustrated books dealing with various categories of art objects and other subjects. (Another book in the series, entitled *Ivory — Pleasures & Treasures,* is an absorbing account of the history of ivory carving from prehistoric times through the 18th century. Written by Dr. O. Biegbeder, a leading French authority in the field, it will be particularly appealing to those gemologists and art lovers who appreciate the beauty of this material and the exquisite craftsmanship of the ivory carver, shown in black and white and high-quality color. It is available from the same publisher at the same price.)

Translated from the French by Donald Law de Lauriston, *Jewelry* is the always-fascinating story of the art of the Jeweler from Renaissance to the end of the 19th century — from the time of Benvenuto Cellini to that of Georges Fouquet, who designed fabulous pieces for the celebrated Sarah Bernhardt. With 32 excellent color photographs, 100 black-and-white pictures, and a well-written text, M. Frégnac describes many of the historic jewels and gems that gained fame or notoriety during this 400-year period, many of which were owned by such royal personages as Mary Stuart, Marie Antoinette, Empress Eugénie and Queen Victoria. In addition, the reproduced paintings depict the manner in which the jewels were worn, thus showing them not merely as isolated objects but as integral parts of the costume.

This book not only presents a rich and varied panorama of Europe's finest jewelry creations, but it is also a revealing commentary on the social history of the most extravagant period of European civilization. It (as well as *Ivory*) offers a great deal of enjoyment for so modest a price.
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THE FASCINATION OF DIAMONDS, by Victor Argenzio. Published by David McKay Co., Inc., New York City, 1966. 184 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: $4.50.

For the person who has read and studied other popular books on this subject, this one will add little or nothing to his fund of diamond knowledge. To the uninitiated, however, it presents the diamond story in an easy-to-read, entertaining style. Covered rather briefly but adequately are the usual topics to be found in a book of this kind, including history, lore, formation, sources, mining, cutting and marketing. Also included are tips on buying and a discussion of investment value, subjects of particular interest to the lay person contemplating the purchase of a diamond. Mr. Argenzio is a long-time jeweler and diamond dealer of Denver, Colorado.
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