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The First Two Taaffeites: An Historical Note

by

B. W. Anderson

The description of the fourth, and by far the largest, cut specimen of taaffeite, which was given by Richard Liddicoat in *Gems & Gemology,* made interesting reading for one such as myself who has been closely concerned with the mineral in its earlier history. The finding of this "monster" specimen of 5.34 carats levels the score at two-all, as between Britain and America, for the recovery of this very rare gemstone.

It seems important to me that exact records of how discoveries are made should be secured as soon as possible after the event, since these have both a human and a scientific interest and are all too easily lost forever, to be replaced later by apocryphal accounts. And, since details of the original discovery of taaffeite are already being not quite accurately rendered, I am venturing to give a summary of the events leading to the establishment of the first stone as a new mineral twenty-odd years ago, and the discovery of the second specimen some four years later.

Count Taaffe (who unfortunately died last year) was born in Bohemia in 1898. He was the only son of the 12th Viscount Taaffe of Corran, Baron of Ballymote, County Sligo. He was a keen amateur both of gemology and astronomy, and used his considerable knowledge of gemstones to do a certain amount of buying and selling to supplement a meager income. A resident of Dublin, he often went the rounds of friendly jewelers in search of interesting gems, which were occasionally to be found in their boxes of oddments. From the boxes of one such jeweler, a Mr. Robert Dobbie, Taaffe removed some hundreds of stones, mostly broken from old jewelry over a period of twenty years. This search occupied some days towards the end of October, 1945, and the agreed purchase money for the lot was £14.

Taaffe's methods of identification were remarkably effective, in view of the paucity of his equipment. He had no refractometer; refractive-index information was, where necessary, gleaned from a stone's relief in a few immersion fluids. His main instrument was a Bausch and Lomb Greenough binocular microscope without a stage, giving a magnification of some 21 di-

Count Taaffe with the setup he was using when he discovered the first taaffeite in October, 1945.

the stone weighed only 1.42 carats and, as measured by us later, had a double refraction of only 0.004, this argues for very acute powers of perception. When the stone was immersed in methylene iodide, the facet edges nearly disappeared, an effect similar to that seen with spinel. The density, also, carried out hydrostatically with a balance suspended by a tassel held by hand, was also near that for spinel, the mean of ten determinations being 3.62. That the stone really was doubly refracting was confirmed by observing clear 90° extinction between crossed nicols. No wonder that Taaffe was puzzled. On November 1, 1945, he posted the stone to me at the Laboratory with a covering letter: "This time a new riddle: what is this mauve stone? It seems to me to answer all the characteristics of spinel, yet it shows double refraction . . . could anomalous double refraction be so strong?"

We, of course, were equally puzzled. One does not lightly expect cut gemstones to be new minerals, but the properties of this one did not fit anything in the literature. Our refractometer showed the stone to have a birefringence of about 0.004, and it gave a clear uniaxial interference figure through the table facet. Our density figure corresponded closely with Taaffe's, and the hardness was near 8. Further, the weak absorption bands seen were very similar to those observed in spinel of similar color. Preliminary X-ray examination by Dr. G. F. Claringbull at the British Museum of Natural History confirmed that the stone was *not* spinel. To enable more detailed work to be carried out, Count Taaffe courageously gave per-

ameters. His first steps, however, to which he attached great importance, were to clean each stone meticulously and then to sort them into groups according to color. On this occasion, the taaffeite (as we now call it and that, incidentally, is pronounced tarf"-ite) was placed in a little box containing violet, mauve and lilac stones. Taaffe's habit was to hold each stone in tweezers and scrutinize it under the microscope from all angles over a sheet of white paper, the illumination being from a flexible desk lamp with a 100-watt bulb. Evidence of double refraction was one of the points particularly looked for. With the then unknown specimen he found that in a certain direction "every speck of dust on the back and every scratch appeared double, like on a badly wobbled snapshot." Considering that

mission for a small portion to be sawn from the culet region. The fragment removed was lightly crushed in a diamond mortar, enabling X-ray powder photographs, rotation, and also an oriented Laue photograph, to be obtained. The data tallied with no mineral on record. The stone was found to be hexagonal and its symmetry to be that of the rare hexagonal trapezohedral class, to which previously only "high" quartz had been known to belong. From one of the chips, a qualitative spectrum analysis showed the presence of magnesium, aluminum and beryllium. Hitherto no known mineral had beryllium and magnesium together as essential constituents.

The first operation on the stone had reduced its weight from 1.42 to 0.95 carat. Later, a further sacrifice was required for a complete chemical analysis, and this reduced the stone (after refaceting and polishing) to its present weight of 0.56 carat. Dr. Max Hey, the skilled analyst and mineralogist at the Museum, had only 12 milligrams at his disposal on which to do a preliminary analysis and the analysis proper, this last being carried out on only 6.16 milligrams of material. Hey's figures were Al_2O_3, 70.0% ; Fe_2O_3, 51.9% ; MgO, 13.4% ; BeO, 11.0%.

The final analysis was actually not carried out until 1951, and in this interval the Laboratory and Museum staff were keenly on the lookout for further specimens of the new mineral, attention being directed particularly to parcels of mauve spinels, among which it could so easily remain unnoticed. Nearly four years were to pass before success came, the happy discoverer being my colleague, C. J. Payne. He was working alone and rather late on an interesting collection of 104 stones (mostly from Ceylon) that had been sent in by a dealer for a routine test. This contained a number of green sapphires and pale spinels and one kornerupine, which served as a curtain raiser for the taaffeite No. 2 and that eventually turned up as a pale-mauve stone weighing only 0.86 carat, showing refractive indices near 1.72, a small double refraction, and a uniaxial interference figure.

Robert Webster and I were at a Gemological Exhibition at Goldsmiths' Hall in the city and it was there that Payne phoned me, in great excitement, at his discovery. There followed some tantalizing bargaining with the dealer before I could "land" this truly precious stone, together with the kornerupine (acting as a stalking horse) for a sum of twenty pounds. The identity of this second stone was confirmed by taking a randomly oriented rotation photograph through the tip of the pavilion, and superimposing it on the powder photograph of Taaffe's stone.

For the record, accurate data for the two specimens are as follows:

	e	w	w - e	d	H
No. 1	1.7182	1.7230	0.00475	3.613	8
No. 2	1.7167	1.7208	0.00412	3.60	8

The dispersion of the original stone was found to be 0.019 for the B - G range, comparing closely with the 0.0206 for spinel. Two weak absorption bands in the green at 5530 A.U. and 5580 A.U. are very near to those in blue spinel; also feeble bands in the blue at 4750 and 4600 A.U. A narrow and fairly strong band in the near ultraviolet at 3820 A.U. was recorded photographically in taaffeite but is missing in spinel. Both minerals show a green fluorescence under X-rays.

The original taaffeite remained in the Count's possession until his death, since he was naturally loath to part with the stone, unless for a substantial sum in the £1000 region. Following Taaffe's death in 1967, his collection of gemstones (mostly rather small in size) was purchased by Mr. R. K. Mitchell, and this included taaffeite No. 1. Taaffeite No. 2 is now appropriately in the collection at the Natural History Museum, South Kensington, London, where all the definitive work enabling the new mineral to be established was so skillfully carried out.

A paper on taaffeite was eventually read before the Mineralogical Society on June 7th, 1951, and published in the December issue of the *Mineralogical Magazine.* Preliminary notes had appeared earlier in the year in *Nature, The Gemmologist* and the *Journal of Gemmology.* Thereafter, the hunt for further specimens was worldwide among keen gemologists, yet it was not until Christmas Eve, 1957, that the first U.S.A. success came at the capable hands of Robert Crowningshield in the New York Laboratory of the GIA.

The original home of the four cut taaffeites so far recovered remains uncertain, though personally I have no doubt that they came from the gem gravels of Ceylon. Crystals of the mineral up to 1 cm. in length, but not of gem quality, have been found in the Hunnan Province of China (1963), and are to be seen in the Mineralogical Museum of the Academy of Sciences in Moscow. More recently, tiny transparent green crystals of what was thought to be a new mineral were found by Prof. A. F. Wilson and a research student from Queensland University in the Musgrave Ranges of Central Australia. Analysis of this material showed close similarity to taaffeite, but the X-ray patterns revealed threefold in place of sixfold symmetry. Patient work on the problem by Dr. I. M. Threadgold of Sydney University, however, has established that these Australian crystals are, in fact, a "polytype" of taaffeite, in which nine subcells, in place of four, make up the unit cell.

Count Taaffe was something of an eccentric, and not a very easy man to know. To me he was a good friend, and I respected him greatly as a dedicated and skilled gemologist. I am proud to have been a link in the chain that established his small and insignificant gemstone as one of the most interesting minerals known to science.

The Optics of Brilliant-Cut Diamonds

by

W. R. Eulitz

Editor's Note: Dr. W. R. Eulitz, a noted physicist and mathematician is a part of the United States space team at Huntsville, Alabama, that is led by Dr. Werner Von Braun. Dr. Eulitz's study of gemology is a hobby. The proportions of the round brilliant fascinated him and led into the extensive research that culminated in this paper.

The introduction of the triple-cut diamond by Peruzzi a few centuries ago caused a sensation in the diamond-cutting industry. The fashionable language of those days, French, called the appearance of Peruzzi diamonds "brilliant," which means excellent, superb, splendid, magnificent. Later, this attribute typified the stone itself: a diamond cut in Peruzzi style was simply a "brilliant."

The brilliant of today is, in principle, the same as the Peruzzi brilliant, with the only difference being that the squared format of the girdle has been rounded and the angles between the facets have been modified. The basic centro-symmetric design, crown and pavilion fashioned with a total of 58 facets, did not change.

During the centuries, the cutting in-dustry learned by experience that the beautiful effect of a brilliant depends primarily on the inclination of the main facets (bezels and pavilion) to the girdle plane. The optimum angles, how-ever, remained a puzzle. And even to-day, there is no general agreement about the proper angles. Commonly, it is con-sidered a delicate art to cut the stone in such a way that the result is optimum beauty.

During the first three decades of this century, attempts have been made to calculate the proper proportions for the brilliant-cut diamond. But all these cal-culations did not provide any more brilliancy than a few practitioners ob-tained by intuition. Results obtained by different authors disagreed, partially because they judged brilliancy by differ-ent standards.

In 1919, Marcel Tolkowsky pub-lished a book, *Diamond Design* (out of print). By trial-and-error calcula-tions, considering the critical angle as the limit for refraction and reflection, Tolkowsky arrived at proportions that are very close to what is supposed to be the perfect brilliant cut by long-experi-

enced diamond cutters striving for maximum beauty, rather than maximum weight retention. His figures are accepted in this country by the GIA as the standard proportions of a perfect brilliant. They are, with the other suggestions in parenthesis for comparison: pavilion angle $\alpha = 40.75°$ (40.8); crown angle, $\beta = 34.5°$ (33.2); table diameter, 53% (56%); pavilion height, 43.1% (43.2%); crown height, 16.2% (14.4%); total depth, 60.3% (58.6%). Actually, all these figures vary widely, because almost every cutter claims his products are the ultimate of the art. This widespread disagreement stimulated a new study of the problem from another point of view.

It is well known that the beautiful appearance of a brilliant is the result of a special effect of light, or, more precisely, it is a combination of the quantity and quality of light reflected by the stone. A brilliant is irradiated in any imaginable direction from the outside and these light rays can enter the stone through the table as the main "window." It also is well known that all these rays change their direction when entering the stone: they are refracted.

So far, there is no particular phenomenon, because light penetrates a great number of materials and is thereby refracted. What the appearance of a brilliant-cut stone, especially diamond, makes so outstanding depends primarily on the form in which the stone is cut and in a secondary respect, on the high refractive index of diamond. A diamond cut as a flat plate with two parallel planes would never have the effect of a brilliant, although the high

refractive index exists.

Hence, the primary question is: what happens to the collected light inside the stone? What are the prerequisites for light rays to be reflected to the outside in the direction to the observer? Are there any general rules that govern such an optical system, and, if so, can such rules serve to tell the degree of brilliancy of a stone from its external shape?

To discern this, we will, in the first place, consider the paths of light rays inside the stone and, subsequently, the effect toward the outside. For better understanding, the important symbols used in the following discussion may be explained beforehand.

All angles are symbolized by Greek letters *(Figures 1)*: $\alpha =$ pavilion angle, $\beta =$ crown angle, $\alpha_c =$ angle between the pavilion facets at the culet. These angles characterize the given brilliant cut; they are, of course, supposed to be constant for an individual stone. Angle $\emptyset$ indicates the refractive angle at the table, whereby $\emptyset_1$, (index 1) stands for the refractive angle at the left half of the diagram, while $\emptyset_2$ (index 2) refers to the refractive angles at the right side. The angles of reflection at the pavilion facets are designated δ with indices of respective meaning.

The angles are always measured between the ray and the normal to the facet, not to the facet itself. The normals (lines vertical to the facet) are designated NT for the table, NP for the pavilion facets, and NB for the bezel facets.

In the first step of our investigation, we neglect the bezel facets and illustrate the profile of the stone by a simple
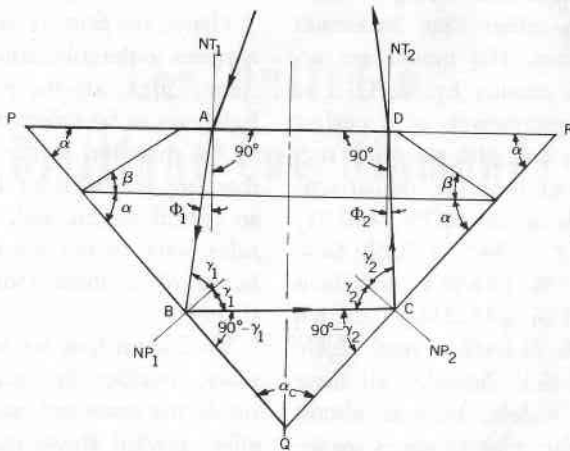
Figure 1

triangle PQR, as shown in *Figure 1*.

Suppose a ray from outside enters the table at point A and is going to point B at the pavilion facet. Then, $\emptyset_1$ is the refractive angle at the table, and δ_1 is the angle of incidence at the pavilion facet. The law of reflection requires that the angle of reflection is equal to the angle of incidence. Thus, the ray is reflected with angle δ_1 to the opposite pavilion facet at point C, being incident with angle δ_2. With the same angle δ_2, the ray is reflected back to the table entering with angle $\emptyset_2$ in point D. This incident angle $\emptyset_2$, actually, is the refractive angle for the ray leaving the stone to the outside.

Each of the three steps of the ray forms three triangles with the corners of the profile, triangles ABP, BCQ and CDR. The sum of the three angles within each triangle is 180 degrees. The angles of the normals to the facets are, of course, 90 degrees. Thus, considering triangle ABP, the angle inside the triangle at A is $(90 - \emptyset_1)$, and the

angle at B is $(90 - \delta_1)$. The total sum of all angles within triangle ABP is now:

$$\alpha + (90 - \emptyset_1) + (90 - \delta_1)$$
$$= 180°$$
or $\qquad \alpha = \emptyset_2 + \delta_1 \qquad (1a)$
or $\qquad \delta_2 = \alpha \pm \emptyset_1 \qquad (1b)$

The same situation exists for the other two triangles. In triangle CDR, we have

$$\alpha + (90 - \emptyset_2) + (90 - \delta_2)$$
$$= 180°$$
or $\qquad \alpha = \emptyset_2 + \delta_2 \qquad (2a)$
or $\qquad \delta_2 = \alpha \pm \emptyset_2 \qquad (2b)$

Triangle BCQ provides

$$\alpha_c + (90 - \delta_1) + (90 - \delta_2)$$
$$= 180°$$
or $\qquad \alpha_c = \delta_1 + \delta_2 \qquad (3a)$

The correlation between and in triangle PQR is

$$\alpha_c + 2\,\alpha = 180°$$
or $\qquad \alpha_c = 180 - 2\,\alpha \qquad (3b)$

Substituting (3b) into (3a)

$$\delta_1 + \delta_2 = 180 - 2\alpha \qquad (3c)$$
combining (1b) and (2b)
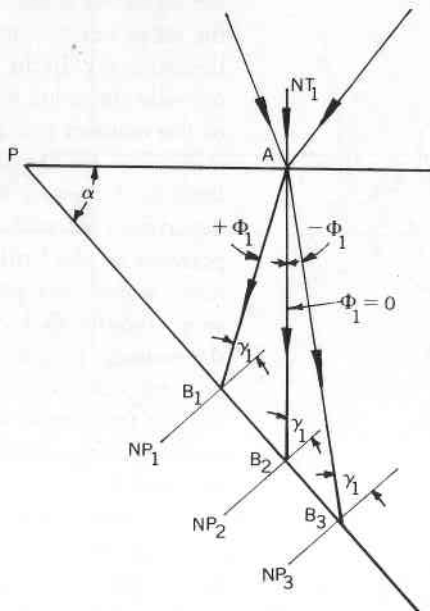
$$\delta_1 + \delta_2 = 2\alpha - \emptyset_1 - \emptyset_2$$

Figure 2

substituting (3c) for ( ) $(\delta_1 + \delta_2)$
$$180 - 2\alpha = 2\alpha - \emptyset_1 - \emptyset_2$$
and rearranging, we finally obtain
$$\emptyset_1 + \emptyset_2 = 4\alpha - 180° \quad (4a)$$
This means the sum of the angles at the table (incident refractive angle plus exit refractive angle) of any ray inside the stone that is reflected by the pavilion facets is constant and depends only on the size of the pavilion angle α. The two angles $(\emptyset_1 + \emptyset_2)$ combine behind the culet to one angle, $\emptyset_0$, which is a characteristic angle of the cut, and which is the same for all rays reflected inside the stone, as demonstrated in *Figure 3*. Equation (4a) can now be written:
$$\emptyset_0 = \emptyset_1 + \emptyset_2 = 4\alpha - 180° \quad (4b)$$
We conclude from equation (4b) that $\emptyset_0$ is zero if $\alpha = 45°$. In this case, $\emptyset_1$ and $\emptyset_2$ are always equal but they have opposite sign. This means if the pavilion angle is 45°, all rays leaving the stone are parallel to the originating incident rays. For α smaller than 45°, $\emptyset_0$ becomes negative; and for α larger than 45°, $\emptyset_0$ is positive. This inversion of sign is possible for the components of $\emptyset_0$ also; i.e., $\emptyset_1$ and $\emptyset_2$. Recalling equations (1b) and (2b), we find that the angle of reflection at the pavilion $\delta_1 = \alpha$ and $\delta_2 = \alpha$, if $\emptyset_1$ or $\emptyset_2$ is zero, respectively. If δ_1 or δ_2 is smaller than α, then, $\emptyset_1$ or $\emptyset_2$ is positive; if one of the two angles, δ_1 or δ_2, is larger than α, $\emptyset_1$ or $\emptyset_2$ is negative. For $\emptyset_1$ or $\emptyset_2$ equal to zero, the rays coincide with the normal.

The three typical cases are illustrated in *Figure 2*, where only the left corner of *Figure 1* is plotted. Positive $\emptyset_1$ is outside the corresponding triangle ABP; negative $\emptyset_1$ is inside the triangle AB_3P.
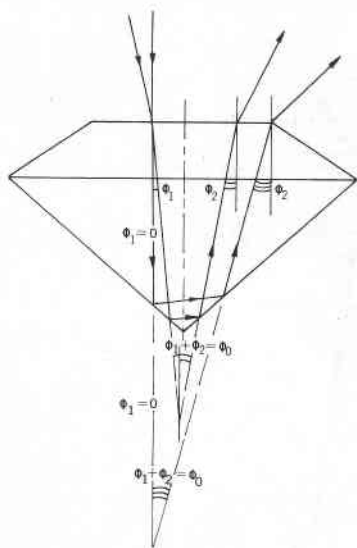
Figure 3

Incorporating now the crown angle β, *Figure 4*, it is evident that this angle has no influence on the angle $\emptyset_0$ at all. We can readily read from *Figure 4* that the refractive angle $\emptyset_{2}^{1}$ at the bezel facet has a very simple correlation to the corresponding angle $\emptyset_2$ at the table. It is,

$$\emptyset_{2}^{1} - \beta = \emptyset_2$$

and if we add the angle $\emptyset_1$ for the incident ray to both sides of the equation, we obtain

$$\emptyset_1 + \emptyset_{2}^{1} - \beta = \emptyset_1 + \emptyset_2 = \emptyset_0 \tag{5a}$$

Referring to equation (4b), we accordingly combine the two angles, $\emptyset_1$ and $\emptyset_1$ of the ray to one angle $\emptyset_{0}^{1}$, and equation (5a) becomes

$$\emptyset_{0}^{1} - \beta = \emptyset_1 + \emptyset_{2}^{1} - \beta = \emptyset_0 \tag{5b}$$

The two components $(\emptyset_1 + \emptyset_2)$ and $(\emptyset_1 + \emptyset_{2}^{1})$, of each of the total angles, $\emptyset_0$ and $\emptyset_{0}^{1}$ are of fundamental importance. One of them characterizes

the refractive angle of the incident ray; the other one characterizes that of the departing ray. In the following, we will consider the angle with index 1 as that of the incident ray, the other one with index 2 is for the departing ray. The latter is of primary interest because the departing (reflected) ray makes the appearance of the brilliant. We question now, which rays collected inside the stone (angles $\emptyset_1$) can be reflected to the outside (angles $\emptyset_2$) for a given brilliant cut, or, what is the angular margin (maximum and minimum) for rays departing from the table and from the bezel facets.

This means with reference to the formulae derived above, we have to find a correlation between the two refractive angles, $\emptyset_1$ and $\emptyset_2$, and the angles α and β, which characterize the geometric-optical quality of the cut. Then, the correlation has to be resolved for the exit refractive angle $\emptyset_2$. In other words, the problem is: which of all possible rays that enter the stone with refractive angle $\emptyset_1$ return to the table or bezel facet under such an angle $\emptyset_2$ that they can escape to the outside without being totally reflected to the inside of the stone?

We recall equation (4b), which states

$$\emptyset_1 + \emptyset_2 = 4\alpha - 180° = \emptyset_0$$

and from equation (5a) we have

$$\emptyset_1 + \emptyset_{2}^{1} = \emptyset_0 + \beta$$
$$= 4\alpha + \beta - 180°$$

The first of the two equations refers by definition to table reflections, the second one to bezel reflections. For an angle of $\beta = 0°$, the second equation is identical with the first one. Thus, the first equation can be considered a spe-
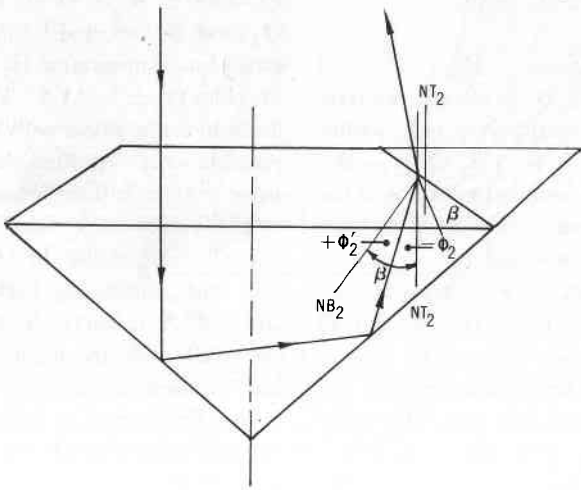
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Figure 4

cial case of the other equation; and β has the general meaning of the inclination angle, with reference to the girdle plane, of any facet (also star and upper-girdle facets), which is met by a ray from inside the stone. For a ray striking the table from inside, β is zero.

From this point of view, the left sides of the two equations above can be considered equal, and the two equations can be combined to one generally valid equation:

$$\emptyset_1 + \emptyset_2 = 4\alpha + \beta - 180°$$

Resolving for $\emptyset_2$:

$$\emptyset_2 = 4\alpha + \beta - 180° - \emptyset_1 \quad (6)$$

This is the final equation that describes completely and sufficiently the reflecting properties of a brilliant-cut diamond on the ground of the design angles α and β. For this reason, equation (6) may be designated the *brilliant equation*.

To discern the angular margin of all rays $\emptyset_2$, which can leave a stone of design (α, β) after internal reflection, it is important to know which rays can enter the stone, or, what is the possible maximum and minimum for the entering ray $\emptyset_1$. As a matter of fact, $\emptyset_1$ cannot be larger than the critical angle $\emptyset_{cr} = 24.5°$ for diamond. Thus, $\emptyset_1$ can, at first sight, vary within the interval $+24.5 \leq \emptyset_1 \geq -24.5$ (the symbol $\leq$ means *smaller or equal to;* $\geq$ means *larger or equal to*). The same, obviously, applies to ray $\emptyset_2$. If ray $\emptyset_2$ is supposed to leave the stone, it has to strike the facet from inside the stone within the same interval $+24.5 \leq \emptyset_2 \geq -24.5$. The transition of light at the crown from inside the stone to the outside is possible only if $\emptyset_2$ is smaller than the critical angle.

On the other hand, all light striking the pavilion facets has to be totally reflected by the pavilion facets. This means, angle δ in equation (1a) has to be larger than the critical angle, so that the minimum limit for δ_1 is: $\delta_1 = \emptyset_{cr} = 24.5°$. This limit substituted in equation (1a) gives:

$$\delta = \emptyset_1 + \emptyset_{cr}$$

and for $\emptyset_1$:

$$\emptyset_1 = \alpha - \emptyset_{cr}$$

Since $(\alpha - \emptyset_{cr})$ is always positive, angle $\emptyset$ can actually vary only within an interval $(\alpha - \emptyset_{cr}) \leq \emptyset \geq -\emptyset_{cr}$ in order to warrant total reflection at the pavilion and finally, departure through the crown to the outside.

For a brilliant cut with, say $\alpha = 35°$ and $\beta = 34°$, the maximum for $\emptyset$ will be: $\emptyset_1 = \alpha - \emptyset_{cr} = 35 - 24.5 = +10.5°$. This substituted into the brilliant equation (6) gives for table reflection $(\beta = 0°)$: $\emptyset_2 = -50.5°$, which exceeds the critical angle for $\emptyset_2$. The ray will certainly be reflected by the pavilion (no leakage on this part), but it will not go through the table facet to the outside: it is totally reflected back into the stone. Since the lower limit for $\emptyset_2 = -24.5$, it follows from equation (6) that only rays that enter with maximum $\emptyset_1 = -15.5$

$(-24.5 = 4 \times 35 + 0 - 180 - \emptyset_1)$ can be reflected by the table. The other limit, minimum $\emptyset_1 = -24.5$, provides $\emptyset_2 = -15.5°$. Thus, table reflection for a stone with $\alpha = 35°$ is possible only for rays that enter the stone with a refractive angle between •-15.5 and $-24.5°$, which, after internal reflection, strike the table from inside with angles $\emptyset_2$ between -24.5 and -15.5, respectively. All other rays are totally reflected inside the stone or leak through the pavilion.

In a similar way, it follows for table-to-bezel reflection: $\emptyset_2 = 4\alpha + \beta - 180 - \emptyset_1 = 4\alpha + \beta - 180 - (\alpha - \emptyset_{cr}) = -16.5°$. This maximum of $\emptyset_1$, $(\alpha - \emptyset_{cr}) = +10.5$, gives the minimum of $-16.5°$ for $\emptyset_2$ (negative sign). The minimum for $\emptyset_1$ is $\emptyset_1 = -24.5°$. In this case, $\emptyset_2$ results to: $\emptyset_2 = +18.5$. So, we have for this particular brilliant cut the following limitations:

Type of reflection	Incident ray $(\emptyset_1)$		Departing ray $(\emptyset_2)$	
	max.	min.	max.	min.
Table to Table	-15.5	-24.5	-15.5 (40)	-24.5 (90)
Table to Bezel Facet	$+10.5$	-24.5	$+18.5$ (50)	-16.5 (43)

With these figures the limitations for the ray departing the stone can be calculated by means of the sine law of refraction ($\sin \delta_2 = n.\sin \emptyset_2$) where δ_2 is the resultant angle for the direction of a ray outside the stone, which is originated by a ray striking the facet from inside with an angle $\emptyset_2$. The letter "n" stands for the refractive index of diamond, which is n $= 2.41$. The angles β_2 are given in parenthesis for

angles $\emptyset_2$ in the table above.

This calculation has been done for three different brilliant designs with $\alpha = 35°$, $41°$ and $48°$. The crown angle has been assumed the same in all three cases: $\beta = 34°$. The effect of possible reflection from each stone has been plotted in *Figure 5*.

The result, certainly, is very interesting. *Figure 5a* illustrates a typical fish-eye effect with the center of the stone
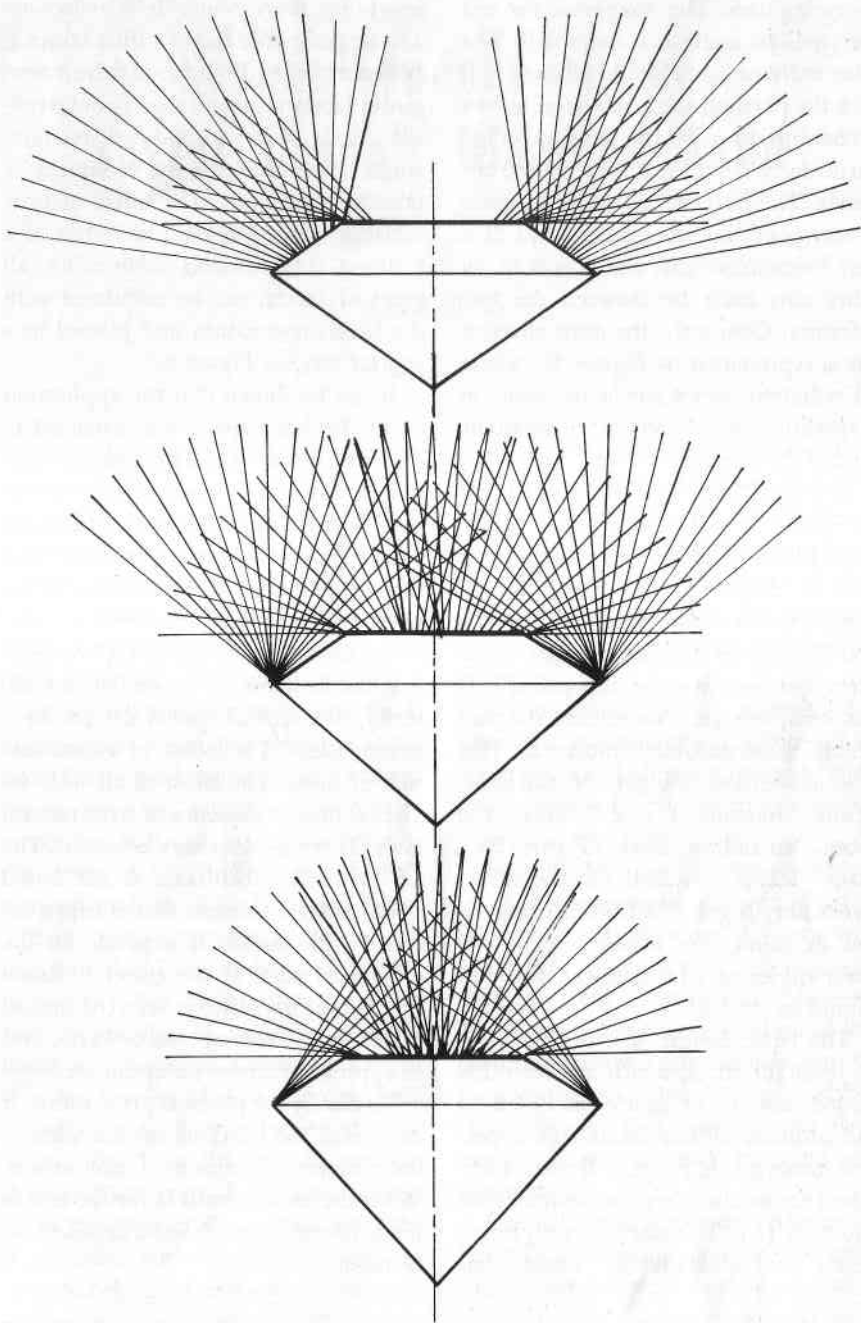
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Figure 5

appearing dark. The stone is too flat and the pavilion angle α is too small. The other extreme ($\alpha = 48°$), *(Figure 5c)*, with the pavilion angle too large, shows a concentration of the reflected rays, particularly from the bezels toward the center. The bezel reflection in this case is very poor; the stone has no fire. It is easy to conceive that the effects of all other cuts must be between the two extremes. Obviously, the most effective cut is represented by *Figure 5b*, where all radiation comes out of the stone in a sparkling way directed substantially toward the observer.

The transition from the brilliant cut in *Figure 5c* to that of *Figure 5a* appears like the unfolding of a rose blossom. In *Figure 5c* the "rose" is still closed; we have the "rose bud." Such a "bud" certainly has some attractive features, but we have the impression it is not complete yet; we expect the full beauty of the unfolded "blossom." This is what we have in *Figure 5b*, the beautifully "blossomed rose." Then, the "rose" is fading away *(Figure 5a)*, many "leaves" are lost, and the attractive beauty is gone. With this comparison in mind, the importance of the main angles of a brilliant-cut diamond should be evident.

The basic design of a brilliant and its resultant effect, which has been discussed here, is, of course, modified by the addition of star facets and upper- and lower-girdle facets. All these additional facets also obey the brilliant law, equation (6). The star facets represent bezels with a smaller β - angle, thus providing more white-light reflection. The upper-girdle facets with a larger β add more fire to the stone and the lower-girdle facets represent additional pavilion facets with a modified pavilion angle, thus enhancing the variability of possible reflections. The effect of each variation, and thus the total effect of a brilliant-cut diamond comprising all types of facets, can be calculated with the brilliant equation and plotted in a similar way, as *Figure 5*.

It can be shown that the application of the brilliant law is not restricted to diamond alone; it can be applied to all other transparent gemstones, even to glass and plastics. This law is of general validity, and what we call the degree of brilliancy of a gemstone can also be derived from the brilliant law.

In any case, it should be kept in mind that the brilliant cut of a diamond, actually, is a special optical device like a prism, a lens, a reflector, or a combination of them. The effect of all such devices is the consequence of strict natural laws. There is no mystery behind it. The art of cutting brilliants is not based upon a magic formula that is kept a secret by the cutter. It depends on the individual skill of the cutter to know the natural laws that govern the optical system he is creating, the brilliant, and to approach them to an optimum.

To clarify the physical principles that determine the effect of any cut stone is the foremost intention of this article. What the lens formula is for the lens is the brilliant equation for a brilliant-cut diamond.

Seven Wonders of the
Soviet Union's Diamond Fund

by

Lev Kolodny

Seven legendary stones form the famous Ursa Major constellation of the Soviet Union's Diamond Fund. Underground, where neither the sun nor the moon send their rays, one can see a rainbow and aurora borealis sparkling with every shade of light: lustrous diamonds — the earth's stars.

In depositories that make one think of a celestial realm, everything is itemized. The larger luminaries have names; the smaller ones, numbers. The former are in the stellar catalogue; the latter in the inventory list. Both large and small stones form the USSR's Diamond Fund.

Being not a specialist, it was for the first time that I saw authentic brilliants in quantity. But one need not be an expert to perceive at once the colorful music of the diamond treasure.

It has been in Moscow for over half a century now. Soon after the start of World War I, in 1914, it was brought there in haste from the Winter Palace. From the time of Peter the Great, the large coffin with three locks keeping "things belonging to the state" (crown, scepter and orb), transformed into a fabulous wealth, being carefully guarded in the Winter Palace's Brilliant Room for centuries. Now and again the members of the royal family would appear at the balls and masquerades wearing crowns, diadems and brooches that were afterwards put away again, giving rise to the Brilliant-Room legends and mysteries.

Legends gave place to scientific descriptions only after the Revolution had taken place and all those in the Winter Palace who tried reinstating its former rulers had met with defeat.

In cold Moscow in the spring of 1922, a commission appointed by the Workers' and Peasants' Government opened the boxes that were brought in disorder from Petrograd to Moscow. The temperature in the nonheated depository was five degrees below zero C. Fingers that were numb with cold became alive at the touch of the fiery stones: diamonds, emeralds, gold and platinum.

Headed by academician Alexander Fersman, the commission's report after four months of work read like a list of trophies in a combat message from a battlefield: 3 crowns, 9 regalia (chain,
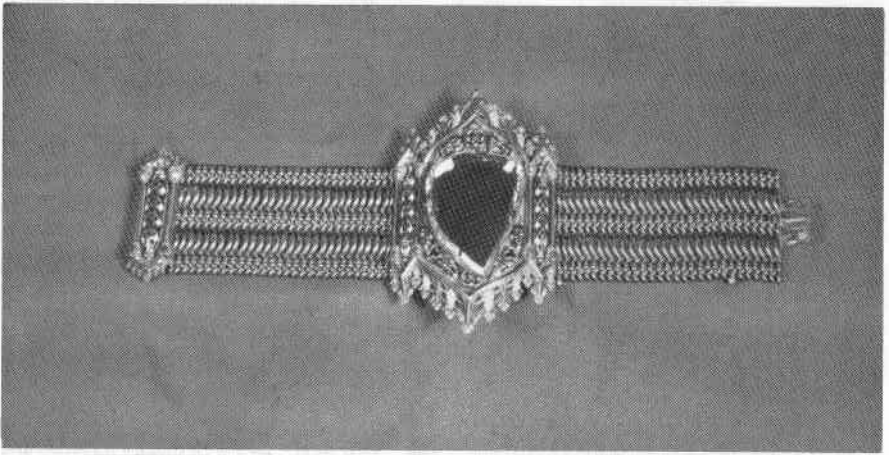
Early 19th century, 20-cm. long enamelled gold bracelet inset in pseudo-Gothic style with emeralds and world's largest-known, 25-carat, framed diamond.

orb, scepter), 23 stars and crosses, total weight of diamonds, 25,300 carats. This put an end to the mystery of the Brilliant Room and opened up the history of the Soviet Union's Diamond Fund.

The largest diamond weighs 196 carats. The smallest ones are light enough to be moved by a man's breathing.

There in the depository of the Soviet Union's Diamond Fund are the seven wonders. They are not very impressive in size: all seven can be held in the palm.

The *Orlov,* a magnificent gem born in India. It weighs 196 carats. The weight was taken in 1914 quite by chance when it had fallen out of its brilliant setting at the top of the scepter.

The *Orlov* was found in Golconda 350 years ago. Its cold transparent facets retain nobody's traces, except that of a skillful craftsman who shaped the stone into a tall rose with hexahedral honeycomb edges.

Originally, the diamond was named after the ruler *The Great Mogul.* Its light instilled fear, as if emanating from the throne.

Renamed, it became known as the *Sea of Light,* in contrast to a similar diamond, *Mountain of Light.* Both were shining in the throne of the Persian, Nadir Shah, who had taken control of Delhi and *The Great Mogul,* but not for long. Captured by Britishers, the *Mountain of Light* was recut so as to lose its original shape, while the *Sea of Light* was deposited by the tradesmen into steel-clad vaults in Amsterdam, from whence an Armenian merchant, Lazarev, sold it for 400,000 rubles to Count Orlov. Since then, about 1773, the gem has been called after him.

The *Shah Diamond* was paid for in blood. A lustrous and elongated octahedron, it was apparently found, like the *Orlov,* in Golconda four hundred years ago. Originally, it was in the possession of the ruler of India's province Ahmednagar. It is no legend: The *Shah*
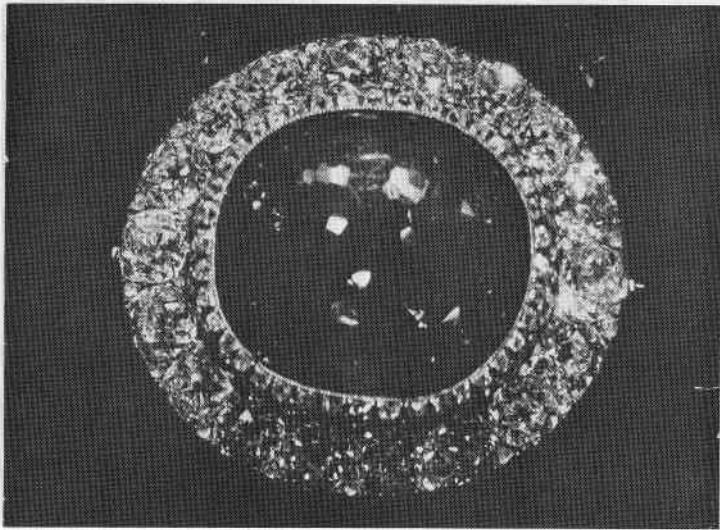
A brooch of gold, silver, sapphire, diamonds and roses. The center Ceylonese sapphire is the largest and most beautiful in the world.

is the only gem with a four-century chronology. On its transparent walls one can see, without a magnifying glass, three minute inscriptions of dates and names. The first date is 1591, with the name of Ahmednagar's ruler. The second is 1641. The gem was then already in the hands of the Great Mogul.

The third inscription refers to 1824, when the stone was in Persia's possession. In 1829, the Persian shah sent it to Petersburg in retribution for his guilt in the murder of the Russian ambassador Alexander Griboyedov.

One more rarity is the *Russian Table Portrait Diamond*. One can see one's own reflection in the flat mirrorlike stone. It is measured in square centimeters, rather than carats. The gem's area is 7.5 square centimeters. Its history is obscure. The only thing known about it is that it must have been found somewhere in India. It is set in a beautiful

gold bracelet. But bracelet or not, it is known that no other such large, beautiful, flat diamond is to be found anywhere in the world.

The spinel was mined from the Badakhshan mountains or, possibly, from Ceylon's sands. Not a diamond, this red-colored gem was known to our ancestors as *lal*. It mounts the Great Crown, which was made by the famous 18th century jeweler, Posiet. Four thousand diamonds that form oak leaves, crosses and a laurel wreath cover the Great Crown on all sides. At its top is the red gem.

Among the great variety of gems from the Brilliant Room very few are red. But the unique spinel is worthy of many. It has no equal. Its weight is quite colossal: 412.25 carats.

They used to refer to the spinel in past centuries as "a lal of no small size and of insuperable quality." In the 20th
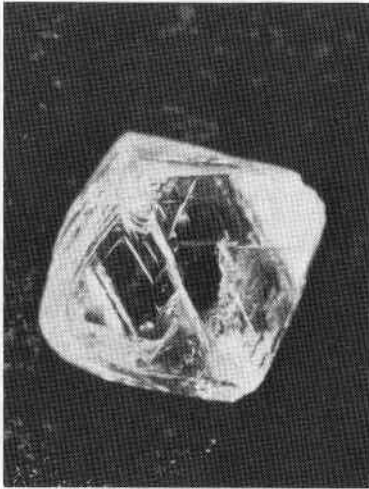
The Valentina Tereshkova Diamond.
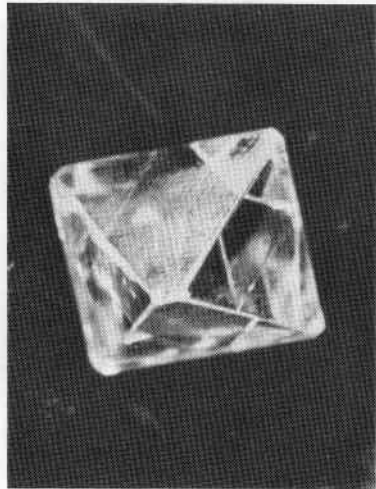
The Gornyak Diamond.

century it is called "the world's most beautiful spinel."

Not many persons would recognize the seemingly modest flat stone for what it really is: the mysterious chrysolite, the precious trophy brought from Palestine by the Crusaders, the very gem that was stored amidst most precious things in the Cologne Cathedral. None in Europe knew where chrysolite was being mined. Only at the turn of the century, in 1900, were the forsaken deposits of this stone found in the Red Sea on Zeberget Island. As the planet's biggest and purest chrysolite (7.0 centimeters by 4.7 centimeters) it is another wonder of the Diamond Fund. Pliny wrote that this stone produced by nature was superior to all earthly blessing, its beauty surpassing the fragrance of a spring flower, and that no cutter should be allowed to touch its virgin outlines.

Emerald comes from the Western Hemisphere, notably from Colombia,

where it was looked upon as an emblem of deity put up as temple decoration. It was from the ransacked temples that the invaders brought these greenish stones to Europe. From Europe they found their way to the East, to India. And in this way also traveled our flat square-shaped emerald, which impresses one not so much by its size (136 carats) as by its beauty of color. The scientists noticed some tiny cracks on it. But like solar spots, they only set off its purity, an evergreen blossoming and perennial youth.

No matter how many centuries pass away, the purity and bottomless depth of the diamond and emerald will remain in still another gem, the world's biggest sapphire.

It has absorbed the color of the sky and the brilliance of the Indian Ocean washing the shores of Ceylon, the island that produced this gem. It was bought a hundred years ago at a London auction from a rajah. It is all we know

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The Cosmos Ring.

about it. We know nothing about the skillful craftsman who cut in it over a hundred facets. Stones keep silent.

In 1967, the Diamond Fund received a stone 106 carats in weight. Its name, *Maria,* is in honor of Maria Konenkina, who found this Siberian gem in Mirny, the center of Soviet diamonds.

No additions were made to the treasure on the eve of the October Revolution. The last tsarina's whim brought beautiful Russian gems onto the auction block. They were pitilessly sold for a total of one million rubles. The tsar sold Russian gems. The people added new ones to the treasure.

After the Revolution, mineral exploration was stepped up and diamonds were found in Siberia. The news became a sensation and spread all over the world, but not with full acceptance. "Russian diamonds are not likely to find their way to the world market before the 21st century . . . Yakut diamonds lie in absolutely inaccessible places. Neither animal nor bird can go

as far as these kimberlite pipes in winter or summer," prophesied foreign specialists. They had a fairly good knowledge of Siberia's geography. But they knew neither the Soviet Union nor its people.

Close to the Mir kimberlite pipe, the town of Mirny was built in record time and Soviet diamonds streamed riverlike from Siberia.

The diamond river that took root in Mirny sent its branches into Moscow and enriched the USSR Diamond Fund.

Along with the Diamond Fund's seven historic gems, there are hundreds and thousands of new precious crystals. Virtually mountains of light have been erected by the labor of the Soviet people. The kilogram rather than the carat is now the appropriate unit for measuring their weight. To the historic gem collection new classics have been added: *Oktyabrksy, Pionersky, Stroitel* and *Gornyak. The Gornyak* is a beautiful first-water gem of 44 carats. It alone is valued at 100,000 rubles on the world diamond market. The ones that have "landed" in the storeroom's coffers are *Voskhod-2, Valery Bykovsky, Valentina Tereshkova* and many others.

In the words of academician Fersman, who was appointed to inventory the diamonds after the October Revolution:

"Such are the Diamond Fund's diamonds. They defy description. My cursory and brief enumeration is just a pale image of the world's wealthiest collection of wonderful gems . . ."

Photographs courtesy of
Soviet Life *magazine.*

Developments and Highlights
at the

Gem Trade Lab
in New York

by
Robert Crowningshield

Blue Zoisite

We have had the opportunity to examine several more of the new blue zoisite crystals and fragments described in the Fall issue of *Gems & Gemology*. One specimen weighing more than 1100 carats displayed breathtaking pleochroism. The colors were intense sapphire blue, an almost ruby red and intense greenish yellow. With a Polaroid plate and use of both incandescent and fluorescent lighting, it was possible to see all the spectral colors. An anonymous donor provided us with four very fine fragments from one of which, through the good offices of Mr. Allan Caplan, we had a flawless, five carat, square-antique mixed-cut stone made. This stone looks for all the world like a fine Ceylon sapphire with only a hint of change to purple when viewed in incandescent light — as long as the viewer is looking directly into the stone. It was cut with the table at right angles to the blue direction (which is also the direction of perfect cleavage). When viewed at an angle, a definite purple color is seen and the knowledgeable dealer will be on guard, since in sapphire the color seen at an angle should be a greenish blue. We have been told that the cut stones profit from a heat treatment that diminishes the effects of the yellow-green and purple, providing a better blue color. To date, we have not proved to ourselves the need for heat treatment in the cut stone. Other points that will have to be determined when thinking of this beautiful mineral as a potential commercial jewelry stone are its ultimate availability, its reaction to wear in jewelry, the best shapes and orientation for the cut stone, and the range of colors it produces.
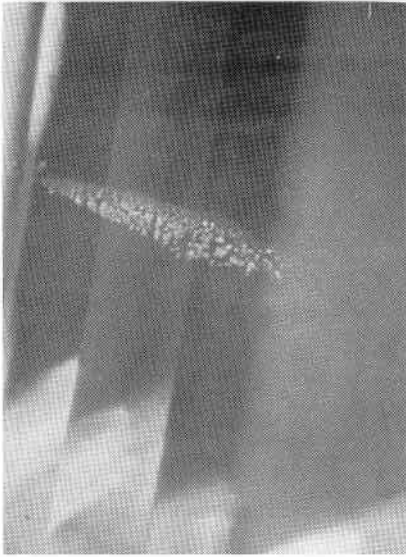
Figure 1

Figure 2

Lapis-Lazuli Mystery Solved?

Frequently, the Laboratory is asked to determine if lapis-lazuli articles have been dyed. Just as frequently, a swab test using fingernail-polish remover produces a blue stain on the cotton, indicating the presence of dye. Recently, we tested some beveled tablet ring-stones in which this stain was produced only when we tested the beveled edge. On a hunch, we immersed the stone in acetone and the beveled area became frosted. Obviously, a blue wax had been used to disguise the lack of polish on the bevel. Because the stones were evidently immersed in (hot?) wax, other porous areas or cracks not on the bevel took up some of the color. Since seeing these stones, we have noted similar effects in round bead necklaces. The wax evens out the color in and near the drill holes, with adjacent porous or cracked areas also showing some color. We have rarely seen lapis in which the overall appearance has been improved (unlike turquois).

Speaking of lapis-lazuli, the writer is indebted to Mr. Alfred Engel of Brazilian Trading Company, New York City, for specimens of rough lapis and the opportunity to examine a large original shipment of fine rough. Included in the shipment was a strikingly beautiful specimen weighing more than 40 pounds. This piece deserves a museum setting or carving at the hands of a Donal Hord or other master carver.

Unusual Diamond Inclusions

Figure #1 illustrates a most unusual fingerprint inclusion in a diamond. By itself as an identifying clue, one would be tempted to call the stone a natural sapphire. *Figure #2* is a photograph of another diamond in which needlelike
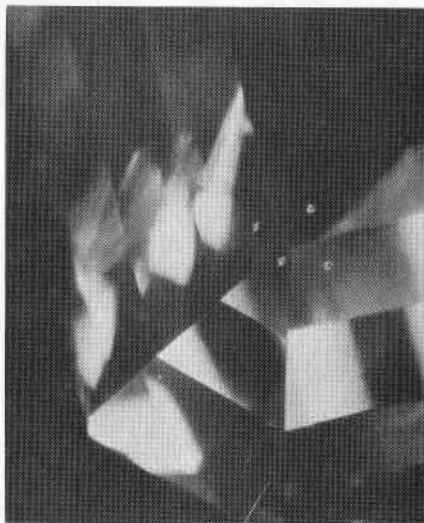
Figure 3

Figure 4

inclusions in three directions remind one of those in garnet. Both types of inclusions were "firsts" in our experience.

Unusual Identifications

Two unexpected reactions in otherwise easily identified stones tested recently were a very chrome-rich specimen of "Yunnan" jadeite that showed red through the color filter when an intense incandescent light was passed through a thin edge. Ordinarily, a red reaction in the filter is indicative of treated jadeite. Another "bad actor" with the color filter was a blue synthetic spinel that did not show red through the filter. It was with several natural stones in an old private collection and may represent an experimental lot. The absorption spectrum, although weak, was normal for blue synthetic spinel.

Reflecting Inclusion

Figure #3 illustrates a small included crystal in an emerald-cut diamond in a position precisely right for being reflected in three adjacent facets. Occasionally, such reflecting inclusions, although small, will cause the stone to be graded considerably lower than size alone suggests.
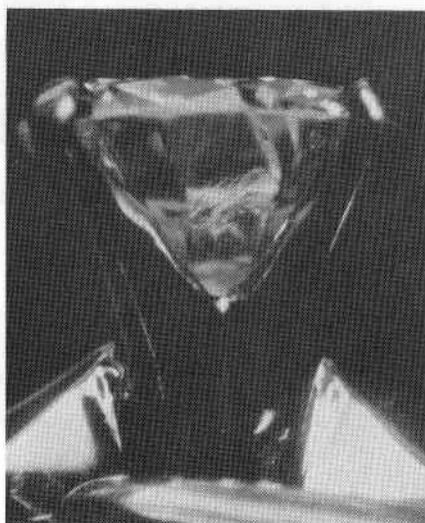
Chrome-Pyrope Garnet

The largest chrome pyrope — and the handsomest we have ever examined — weighed 4.27 carats. The refractive index was 1.73. It had been submitted to the Laboratory as a "fine ruby," but the identity was doubted by someone who had used an ultraviolet lamp and seen no reaction. We have heard of a chrome-pyrope garnet weighing more than 11 carats that was sold to a private collector for $100 a carat 15 years ago. It would appear impossible that such a stone could have been brought to the surface by Arizona ants, the "miners" usually given credit for bringing chrome pyropes to light.

Buried Culet

Figure #4 shows a solitaire engagement ring of *avant garde* design in
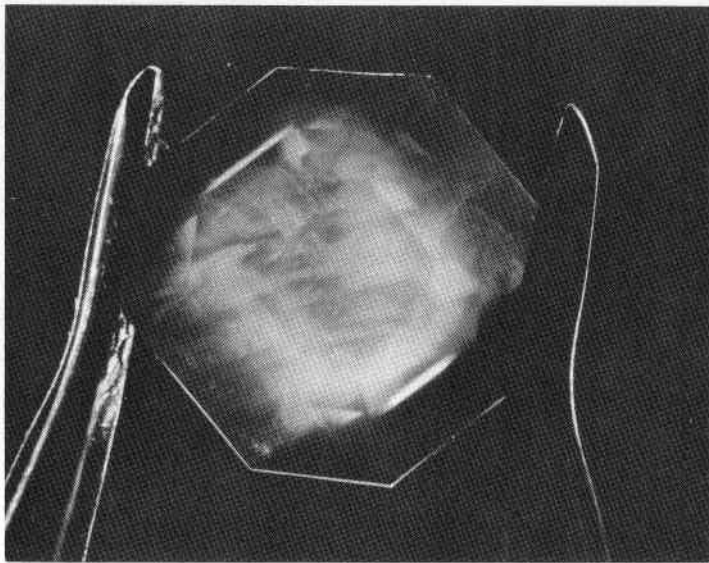
Figure 5

which the culet of the stone is buried in solid metal. The ring supposedly had never been worn, being still in a wholesaler's stock. However, a large cleavage flake from the culet to the girdle was missing, suggesting that such a style with the culet buried in the shank should be avoided.

We have identified several items of jewelry set with Trapiche emeralds. In at least two instances, the owners had been advised that their stones were not emeralds but dyed chalcedony, or "green onyx." *Figure #5* illustrates a 2-carat Trapiche in which the mossy or foggy texture characteristic of these stones is clearly seen. It is surely understandable that a jeweler might mistake this appearance for that of chalcedony.

Acknowledgements

Developments and Highlights
at the

Gem Trade Lab
in Los Angeles

by
Richard T. Liddicoat, Jr.

In the period covered by these notes, we have seen some exceptionally interesting stones and substitutes. Either because of curiosity or necessity, we have resorted to X-ray diffraction on numerous occasions.

An Emerald Natural

A cushion-octagon-cut emerald was sent in for testing. During routine examination we noted that there was a protrusion on one of the girdle facets *(Figure 1)*. Examining it under higher magnification, we were able to see that it was a crystal protruding from what had appeared to be a girdle facet. Since such a protrusion is not possible on a polished facet, this face, of course, had not been polished during the cutting operation; otherwise, the protrusion would have been removed. The girdle facet was actually the remnant of one

of the prism faces of the original emerald crystal. The protrusion was an inclusion that protruded at least one millimeter from the face. It was particularly interesting, because we have never encountered this condition in the past.
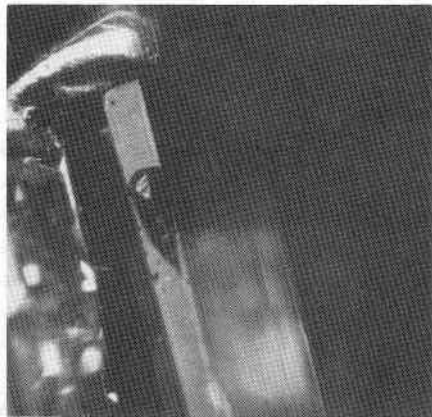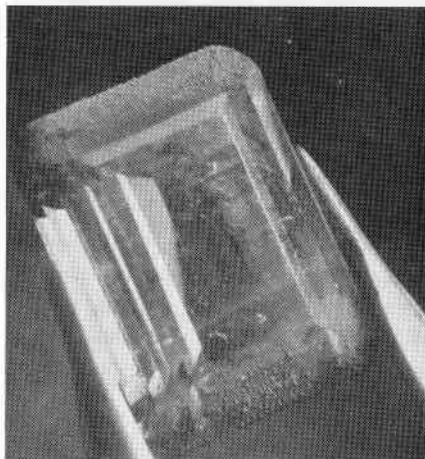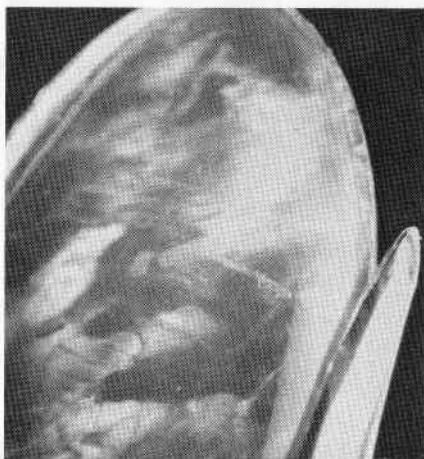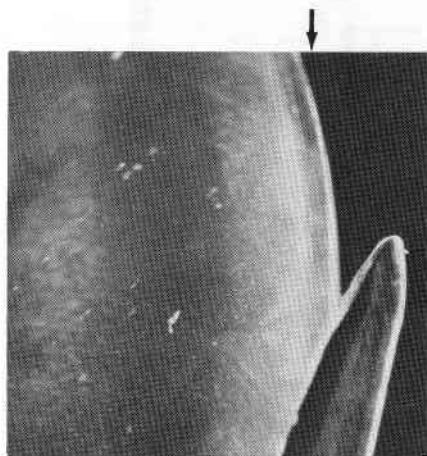

Figure 1

Figure 2
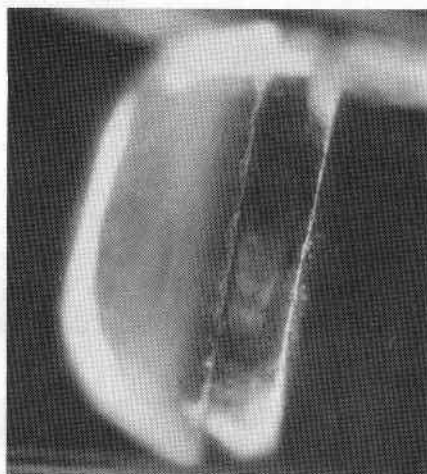

Figure 3

Figure 4

Figure 5

Grime Accumulation by Tourmaline

In one of our display cabinets, there was an opening between glass sections through which dust and grime could pass all too readily. The polarity of tourmaline was beautifully evidenced, in that most of the faceted stones on display picked up an accumulation of grimy material on the ends of the emerald-cut stones *(Figure 2)*.

Odd Assembled Stones

During the period since the last report, we have had a number of rather odd assembled stones, one of which was a quartz-topped opal doublet. In *Figure 3*, the thin opal lower portion is seen through the clear quartz cap. *Figure 4* shows the joining plane between the high rock-crystal cap and the thin opal base.

Another doublet was a thin piece of treated opal with a glass top *(Figure 5)*. Actually, this made a rather effective assembled stone, but one in which the nature of the assembly was quite obvious.

A third unusual assembled stone combined two synthetics: synthetic sapphire and synthetic spinel. The top was a synthetic-sapphire cabochon and the bottom, synthetic spinel. This was something unique in our experience and one,

therefore, worthy of note.

Taiwan Student

A very active student, Felix Chang in Taipei, Taiwan, has set up a laboratory bench, of which he has sent us pictures. *Figure 6* shows Mr. Chang sitting in his chair in front of the new laboratory bench. *Figure 7* shows a better detail of the laboratory itself. The instrument on the right side to the right of the *GIA Spectroscope Unit* is an ultrasonic cleaning unit. Sets of heavy
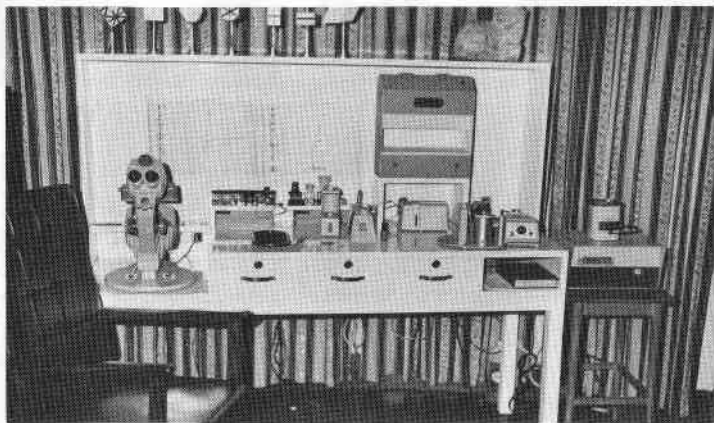

Figure 6

Figure 7

liquids and an overhead magnifier can be seen at the left of the photograph. GIA A and B charts are mounted on the wall behind the *Gemolite* and heavy liquids, above which are models of the crystal systems. The *Illuminator Polariscope* and *Duplex Refractometer* are between the heavy liquids and the *Diamondlite*, which is sitting high to the right of the A and B charts. Below the *Diamondlite* is a sodium lamp; to the right of that, the spectroscope and ultrasonic units. It certainly appears to be a very well arranged and equipped laboratory, of which Mr. Chang can well be proud.

Odd Intaglio

The easy method of distinguishing hematite and its substitutes is by the nature of the "carving." If it is actually a stamped impression in a piece of material that resembles hematite, it must be a substitute. Recently, we were asked to identify a piece that the sender felt was hematite, but the impression on the stone did not seem to be carved. The "carving" had apparently been done by normal methods, but afterwards the impression had been sandblasted *(Figure 8)*. The result was something that resembled a stamped impression more than a carving. The carving itself looked very grainy; we were startled to realize that the material was actually hematite. It had a fractured surface that was definitely splintery; the other properties also checked. However, the carving itself did not appear to be the normal carving in hematite; thus, our surprise.

Bill Culver Has Done It Again

Our old friend, Graduate Gemologist William W. Culver of Monterey,

Figure 8

California, sent us a specimen of a new material unlike anything we had encountered before. He called it pink benitoite. Since we had never heard of benitoite in other than a blue to nearly colorless condition, we were in some doubt about it. But we scraped the specimen with a diamond point, to get a good X-ray diffraction photograph and to get a small amount of powder analyzed. *Figure 9* is the new material and *Figure 10*, a standard benitoite shot.

At about the same time we were working on this, Paul Desautels of the U.S. National Museum happened to visit us. In the absence of complete data at that time, he suggested that we investigate the possibility that pabstite, a tin-bearing, isostructural analogue of benitoite, a mineral described a year or two ago in the *American Mineralogist*, was a possibility. However, our chemical analysis of Culver's material
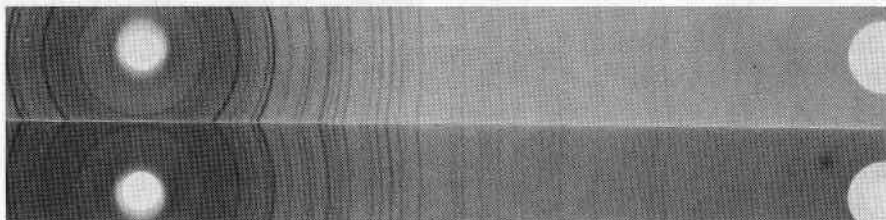
Figure 9

Figure 10

disclosed no tin whatever, and the lines (as seen by the two powder photographs) show that this is definitely benitoite and not a tin-rich isostructural material. Thus, Bill Culver has come up with another unusual material in his prospecting in central California.

Unusual Glass

We received a brooch for identification that had several small natural sapphires set in it, but the largest piece was an oval cabochon of blue glass. There was nothing particularly startling about the glass other than its appearance under crossed polarized light. The areas of anomalous birefringence were confined to the swirls that could be seen looking through the flat back of the stone. This is rather well shown in *Figure 11*.

Benitoite Inclusions

Student Bus Gray, of the Benitoite Mine Co., sent us as a gift a sample of a beautiful dark-blue brilliant-cut benitoite from his mine in Fresno County, California. In it there were some rather unusual inclusions: they resembled closely the radiating fibers peculiar to demantoid garnet. These are illustrated in *Figure 12*. In addition, Gray sent us
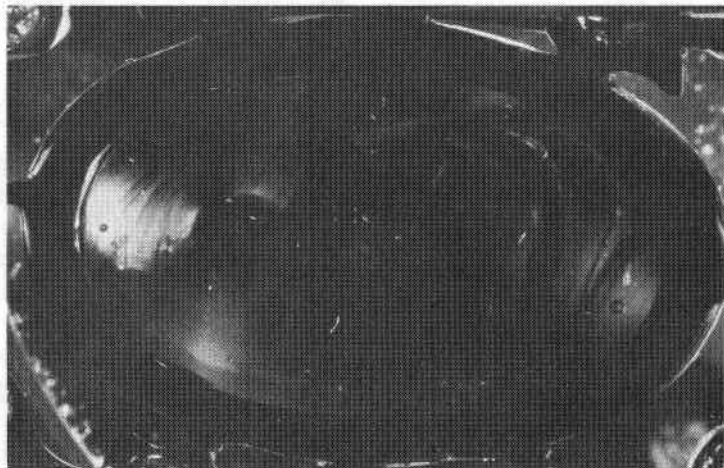

Figure 11

Figure 12

an emerald-cut, bicolored tourmaline that had a fracture between the red and green portions. It showed a very interesting structural condition, in which what appeared to be a rhomb was very clearly evident in the green end of the stone. This proved exceedingly difficult to portray in a photograph, but it is shown in *Figure 13* by the arrows.

Odd Table Reflection In Diamond

Figure 14 shows an unusual table reflection in diamond. The reflection is the black area in the center, surrounded by the very bright area under the table. The brightness is caused by the crown angles being unusually steep. In this stone, the pavilion angle was approximately correct, but the crown angles were so steep that this odd brightness under the table was evident.

Unusual Gem Materials

Unusual gem materials seen recently included a cat's-eye that was actually andesine-labradorite in composition. The eye was quite sharp, as is often true with feldspar cat's-eyes. For our
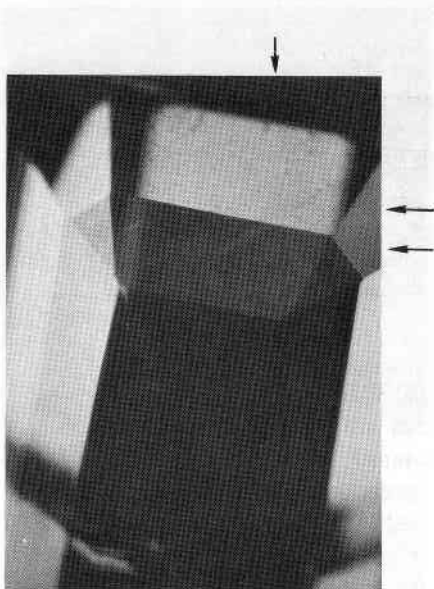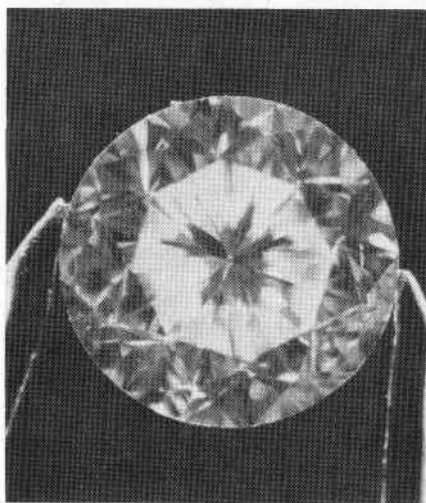

Figure 13

Figure 14

display, we bought an 1100-carat quartz cat's-eye and a beautiful 33-carat yellow orthoclase in an antique cushion cut.

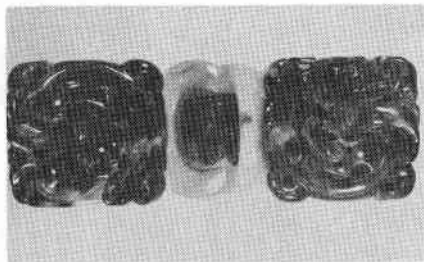One of the unusual items we saw recently was a jadeite belt buckle, shown

Figure 15

Figure 16

closed in *Figure 15* and open in *Figure 16*. This was a rather attractive green-and-white material, with most of the white in the closed area and the green in the area that is visible when the buckle is in place. We found it a very attractive piece.

We also saw some exceedingly attractive imperial jade ringstones. In addition, we saw a large number of dyed pieces that had been confiscated by our Customs Department and were imported as natural jadeite.

Natural Emerald Crystals

Not long ago we received an unusual emerald crystal from our New York office with the request that we identify the black material that showed a pattern somewhat similar to the white Trapiche inclusions, but in this case in black. The total pattern is shown in *Figure 17* and a magnification of one of the "arms" in *Figure 18*. We attempted to identify only the black material by X-ray, and then sent the specimen to the U.S. National Museum for their opinion. Their results, as ours, were negative. We all concluded that the black material was largely organic, but were unable to identify it.

Backyard Treasure
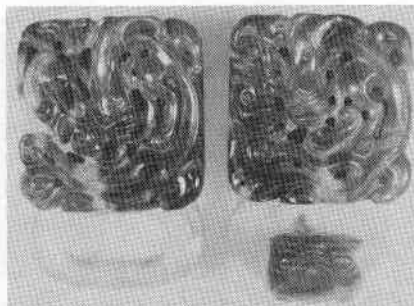
A man wrote us a letter describing materials he had found while digging a deep hole in his backyard. He wrote in such a glowing fashion that we offered to identify them for him. Most of the pieces were glass, but some were very interesting because they contained large and small crystal inclusions. In *Figure 19*, it can be seen that one of the pieces contained bladed white crystals of rather low relief and patches of minute crystals radiating from a center. There were also some black bladed crystals, plus typical gas bubbles (center of photograph), as well as the very large one at the center top.

A Fish Story

We received from a student an almost spherical glass piece that was said to have been removed from a fish. It was of particular interest, since the absorption of light was in the entire area from 4200 A.U. to 7000 A.U.; i.e., the absorption covered almost the entire visible spectrum. Transmission occurred only from 4000 A.U. to 4200 A.U. It was also partially transparent to X-rays.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

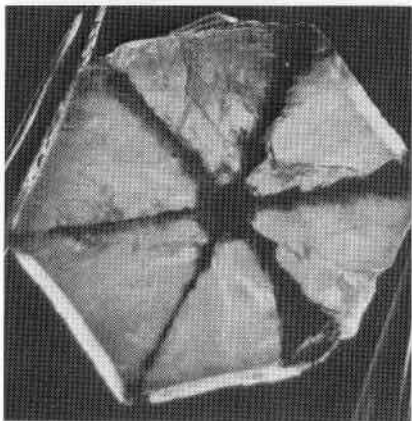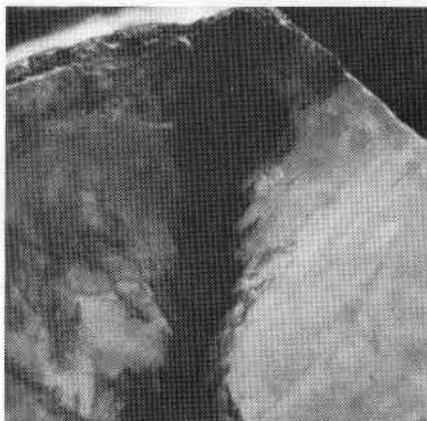To Abdul Ameer, Colombo, Ceylon, for three faceted sapphires.

Figure 17

Figure 18

Figure 19

To **Ralph Braun,** Braun's Jewelers, Zenia, Ohio, for a selection of stones for our practice sets.

To **Josephine Morrison,** the Candlestick Antique Shop, Los Angeles, for a carved jadeite plaque, imitation lapis-lazuli and imitation bloodstone.

To **Melvin Strump** of Superior Gem Co., New York City, for 21 faceted iolites.

To **Russell Lipscomb,** Graduate of Columbia, South Carolina, for faceted glass and amethysts.

To **C. D. Parsons,** cutter of Burbank, California, for a faceted, treated blue-green spodumene and a faceted golden calcite.

To **Graduate Ben Gordon** of Houston, Texas, for an assortment of opal, quartz, emerald, synthetic spinel, glass and nephrite.

To **William F. Kraemer,** jeweler of San Marino, California, for a faceted green glass.
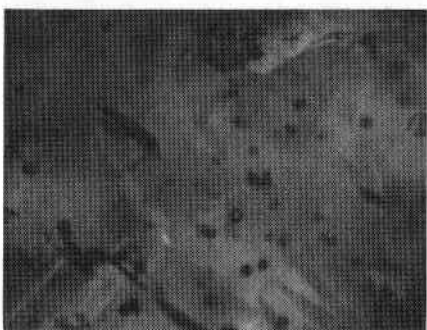
To **Jerry Call,** student of Hickory, North Carolina, for a specimen of hyalite opal.

To **Charles L. Wells, Jr.,** from Charles L. Wells Jewelers, 220 W. Adams St., Jacksonville, Florida, for the 20 assorted stones to be used in test sets.

To **Mr. C. Richard Patterson, CG,** of Garden City, Kansas, for 12 purple garnet-and-glass doublets.

Book Reviews

DIAMONDS IN PICTURES, by George Switzer, Ph.D. Published by Sterling Publishing Co., Inc., New York City, 1967. 80 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: $3.95.

This is the second book of interest to jewelers to be published by Sterling for its Visual Industry Series. (The first, entitled Pearls in Pictures, was reviewed in the Winter, 1967-1968, issue of Gems & Gemology.)

Dr. Switzer is eminently qualified to write a book of this kind. He is a recognized mineral authority and for a time was an instructor at GIA. For many years he has been Chairman of the Department of Mineralogy at the Smithsonian Institution, Washington, D.C. His writing style — lucid, nontechnical — is aimed at either the juvenile or novice audience, which is in keeping with the publishers intention for the Series.

In the opening paragraphs, the author describes the paradoxical qualities of this pre-eminent gem: "Diamond is not invincible. It will cut any other substance and will remain unaffected by the strongest acids, but heat a diamond hot enough and it will disappear as an invisible gas, carbon dioxide. Or, tap it in just the right spot, and it will shatter."

Succeeding chapters discuss the source and occurrence of diamonds, how they are mined, method of cutting, how they are marketed, and brief stories of a number of famous diamonds, including the Hope, Cullinan, Koh-i-Noor and others. In conclusion, the dependence of industry on diamonds is emphasized, pointing out that more than 32 million carats of industrial stones were used for this purpose in a recent year. The author says, "Without diamonds, most machine-age mass-production processes would come to a stop, just as surely as if their power were shut off."

One of the outstanding features of the book is the many well-chosen illustrations: 97 black-and-white pictures and line drawings. We were somewhat disturbed, however, since a number of illustrations prepared by GIA, on pages 38, 39, 40, and 41, were not credited to this organization. But that does not detract from the fact that the book is well written and illustrated. It is particularly good in the synthetic-diamond and industrial-diamond sections.

AUSTRALIAN ROCKS, MINERALS & GEMSTONES, by R. O. Chalmers. Published by Angus & Robertson, Sydney, New South Wales, Australia. Illustrated with black-and-white photographs and line drawings and 8 color plates. Price: $10.75.

Australian Rocks, Minerals & Gemstones is an authoritative and comprehensive treatment of the geological occurrences of these materials and the localities in which they are found. Meteorites and tektites are also discussed. It is well illustrated with 34

black-and-white photographs of rock and mineral specimens, 32 showing the development of Australian mining, and 45 color photographs of individual gems and ornamental stones.

The crystallographic, physical and chemical properties of minerals are given, together with simple but effective tests for their identification. In two chapters, special attention is given to the occurrence of gems, pearls and ornamental materials. A set of crystallographic diagrams is included, and a chapter is devoted to the procedure for performing field work and how to collect, catalog and care for minerals. In addition to a complete subject index, a locality index provides easy reference to places of geological interest in the text.

Although primarily a field guide to Australia for the mineralogically minded layman, serious students should find the book an invaluable reference.

Mr. Chalmers is Curator of Minerals at the Australian Museum, Sydney, and Associate of the Sydney Technical College in Geology. He is also Chairman of the Board of Studies and Examinations and Senior Lecturer to the Gemmological Association of Australia.

EXPLORING & MINING FOR GEMS & GOLD IN THE WEST, by Fred J. Rynerson.

Published by Naturegraph Co., Healdsburg, California, 1967. 204 pages. Softbound. Illustrated with black-and-white photographs. Price: $3.75.

This is an interesting and often amusing account of the experiences of Fred J. Rynerson during his fifty-four years of gem mining, prospecting and lapidary work in Southern California. The story is concerned primarily with the well-known gem deposits—tourmaline, spodumene, beryl, etc.—of San Diego Co., California, and, to a lesser extent, of Imperial and Riverside Counties in the same state. It will be of more interest to those who are already familiar with this famous gem-producing area.

Mr. Rynerson begins the book in 1895, when he was thirteen years of age and when gem mining was in its early stages in the San Diego Co. region. His stories relate the discovery of fabulous deposits of kunzite, tourmaline, morganite and other gem materials, and tells of his experiences as a mine owner and cutter of the beautiful gems. Much of the early history of the mines, many of which are still productive, is revealed for the first time. All of the stories, according to the author, are true, except for the "lost-mine" stories he interjects in the book.

The author wrote the manuscript before his death, after which his wife, Beulah Rynerson, arranged to have it published.