Gems & Gemology

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Gemstone Inclusions*

Photomicrographs arranged as an aid to identification of gem species and of the differences between genuine and synthetic sapphires, rubies and emeralds. All illustrations, except as indicated, from kodachrome transparencies by Dr. E. Gübelin, C.G., of Lucerne, Switzerland, Research Member, G.I.A.

While the feather-like and sea-weed-shaped inclusions, the bubbles, crack-like formations and indistinct inclusions within gemstones fire the imagination and stir one's curiosity, they have a practical value over and above their fanciful appeal.

The invaluable material included in Dr. E. Gübelin's lecture "The Inclusions in Gemstones," his recent

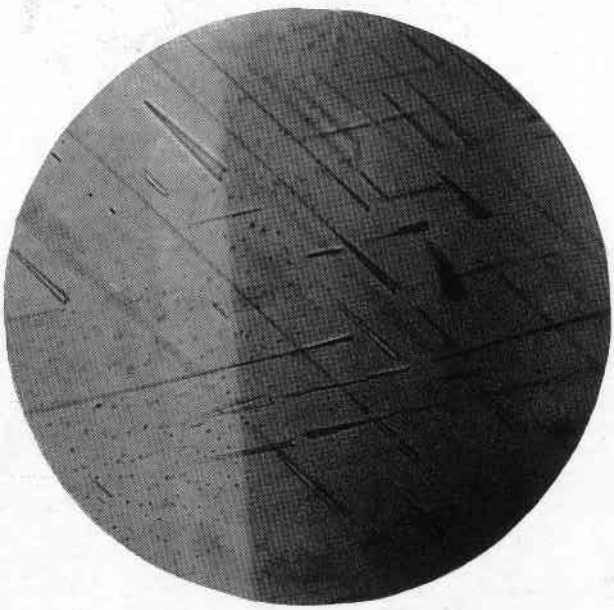

Figure 1

***Light blue Ceylon sapphire**, showing fine "silk", a proof of genuineness. In this instance the "silk" seems to consist of hexagonally oriented tubes filled with some unknown brown liquid which has probably replaced rutile needles. Gemological microscope.*

*A.G.S. Research Service.

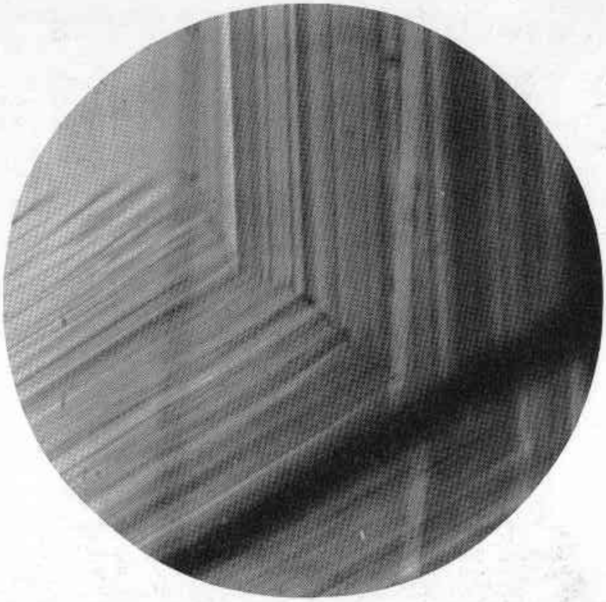

Figure 2
Cabochon-cut ***dark blue Australian sapphire*** *with zones marked by delicate variations of tones of blue, parallel to the faces of the hexagonal prism. Gemological Diamondscope.*

gift to the G.I.A., develops this theme and appeals not only to the sense of beauty and the imagination of the student and jeweler, but offers him as well two very interesting opportunities for practical application.

By the very wording of his lecture and by the findings of his own studies, he quickens the will to further the study of gemstones, particularily their inclusions.

"In their great durability, today as in the illustrious times when Egyptian kings flourished in splendor, precious stones are the eloquent witness of the earth's vital epochs of development," he states, as he likens the value of intensive study of gems and their inclusions to that of a knowledge of the cultural history of the Hellenes, the Egyptians, or the Inca tribes.

As the geologist or mineralogist will examine gem inclusions in minutest detail for their revelations of age-long development, the jeweler and gemologist will study them for their conclusive distinction between genuine stones, and between these and their reproductions, the synthetics.

From Dr. Gübelin's 129 beautiful kodachrome transparencies has been chosen a series to stress this practical phase of a fascinating study.

For purposes of comparison, Figures 9 and 10 are reprinted from earlier published material. The major portion of Dr. Gübelin's 129 photomicrographs will be reproduced in our following issues.

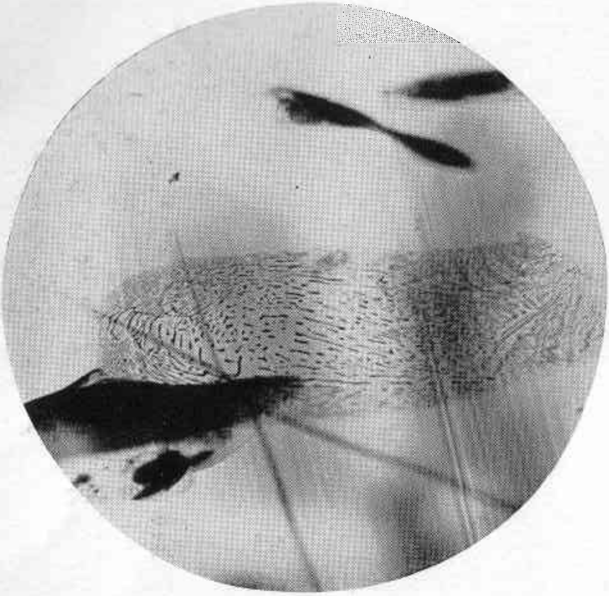

Figure 3
***Blue sapphire** with straight zoning structure. Compare with almost straight zoning structure of synthetic in Fig. 4. Also contains dark, wing-shaped inclusions and a liquid "feather" (large, dotted wing in the center). Gemological microscope.*

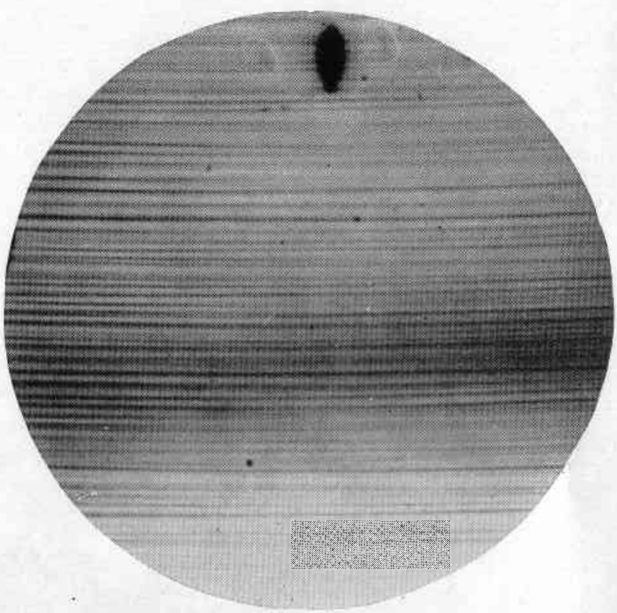

Figure 4
***Synthetic sapphire** with curved striae (color accretion lines). Could be mistaken by inexperienced jeweler using loupe to be straight lines which indicate genuine sapphire, as in Fig. 3.*

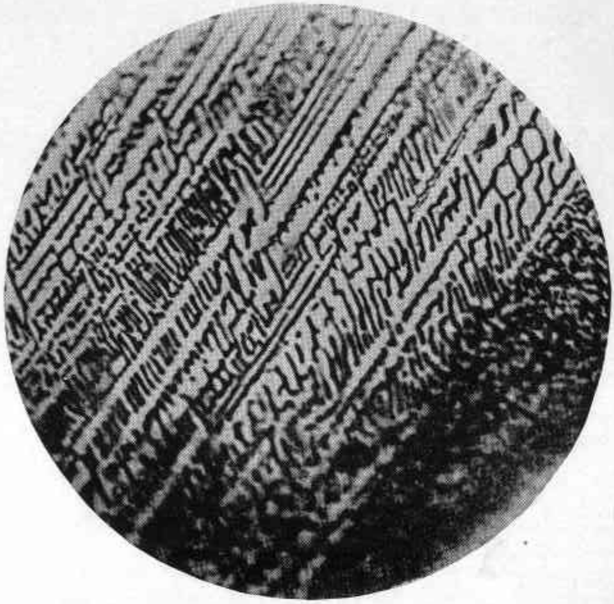

Figure 5
***Blue sapphire** exhibiting a wonderful "flag" or "feather" consisting of script-like liquid drops. Arrangement of drops in lines results in lighter and darker zones which might, under a jeweler's loupe, be mistaken for the almost straight lines of a synthetic. Gemological microscope.*

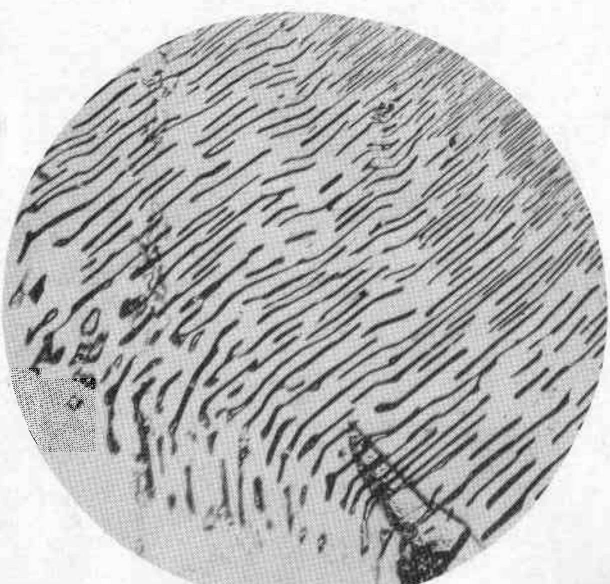

Figure 6
***Pale grayish-blue Ceylon sapphire** containing a "flag", which consists of many hose-like liquid channels.*

Figure 7
***Yellow sapphire** from Ceylon, containing group of distinctly outlined tabular hematite crystals. Included crystals of other minerals are never present in synthetics. Gemological microscope.*

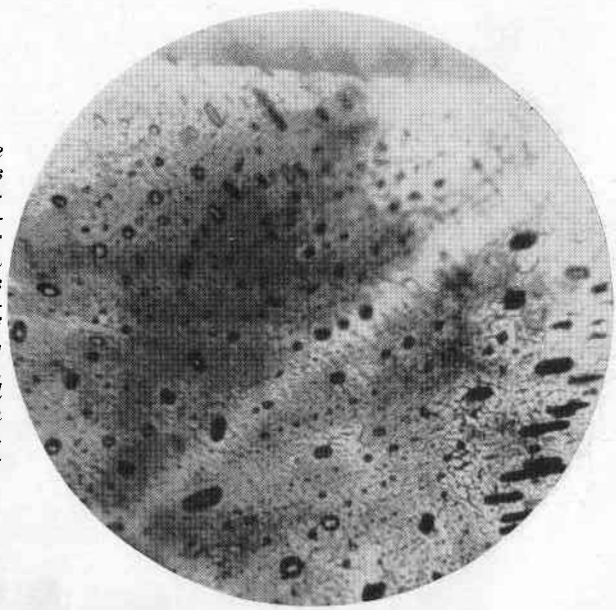

Figure 8
***Genuine sapphire** with liquid inclusions and newly precipitated mineral substance. Under lower magnification, such as with jeweler's loupe, the liquid inclusions, most of which are obviously hexagonal in shape, might be confused with the bubbles in synthetic sapphire. Gemological microscope.*

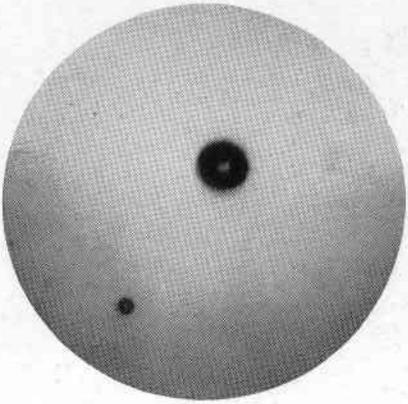

Figure 9

***Synthetic sapphire** showing included bubbles. Magnified somewhat over 100 times. Gemological microscope. G.I.A. photo.*

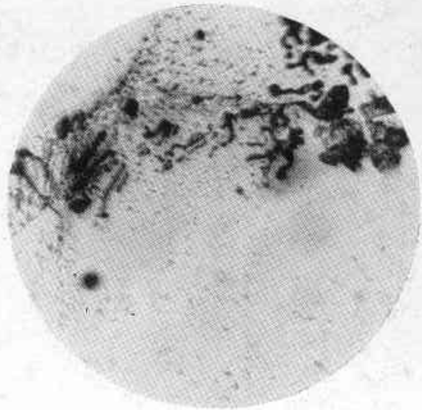

Figure 10

***Synthetic sapphire** of newer type containing spherical gas bubbles and unusual irregularly shaped gaseous inclusions.*

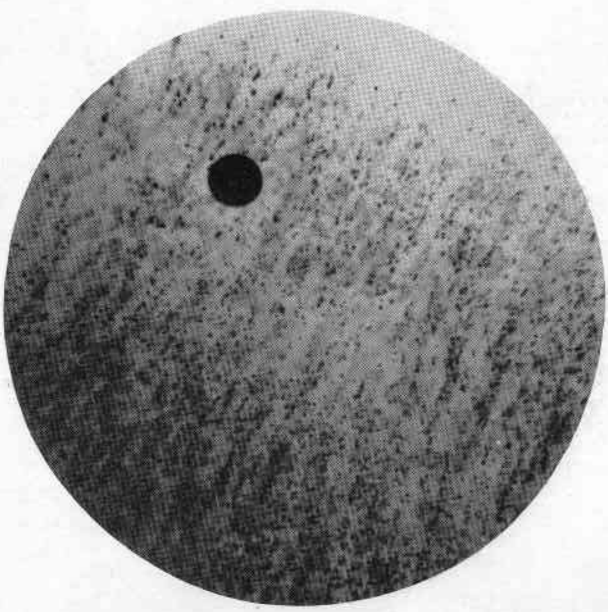

Figure 11

***Blue synthetic sapphire** containing innumerable air bubbles and one large individual air bubble. Under high magnification these round bubbles cannot be mistaken for the differently shaped liquid inclusions such as seen in Fig. 6. Gemological microscope.*

Figure 12
***Pink sapphire** from Ceylon with inclusions of rounded grains of corundum. Obviously these never occur in synthetics. Gemological microscope.*

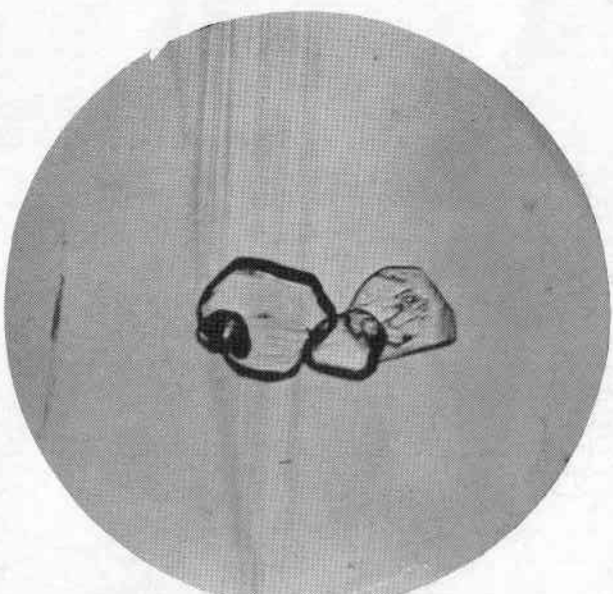

Figure 13
***Pale blue Ceylon sapphire** with small group of three flat hexagonally shaped, liquid-filled cavities (the one on the left containing a gas bubble). Such inclusions have not been noted in synthetics. Gemological microscope.*

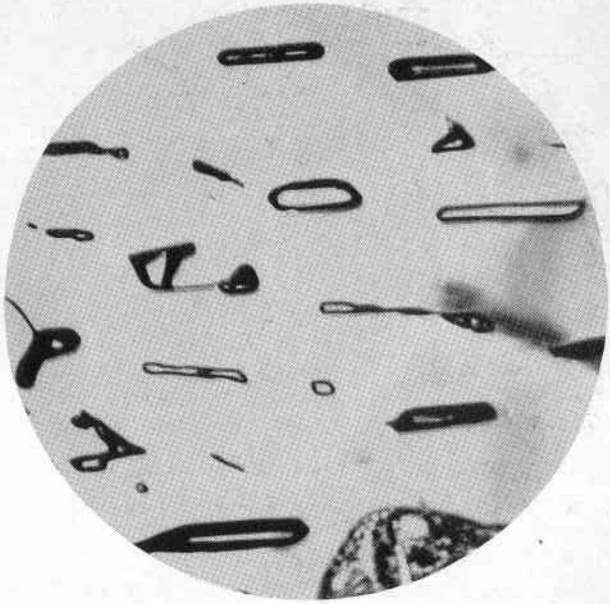

Figure 14
***Sapphire** from Ceylon containing large liquid drops of various forms; as a whole they build a "feather". Gemological microscope.*

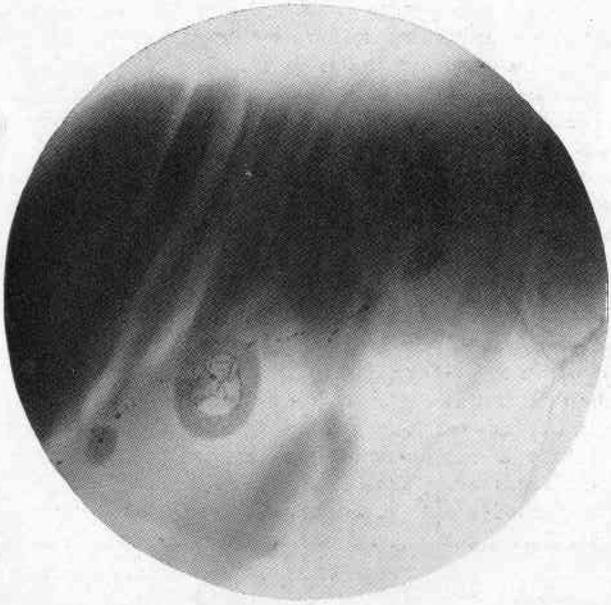

Figure 15
***Blue sapphire** containing irregular patch of unevenly distributed colloidal coloring substance. Rather easily mistaken for similarly appearing color striae of color sometimes seen in synthetic sapphire and indicating the necessary observation of other inclusions as a determining factor. Gemological microscope.*

Black Star Spinel*

by
E. P. HENDERSON,
Associate Curator,
Division of Mineralogy and Petrology,
U. S. National Museum

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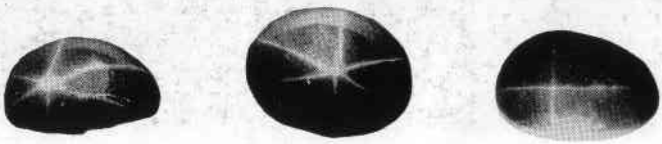

Figure 1
These three stars occur as the path of one light band is followed from the girdle to the opposite side of the stone.

Recently the United States National Museum acquired a black star spinel as an addition to the Roebling collection. When this stone was first submitted for identification, the owner reported it to be a black star sapphire, but the dealer questioned this determination since the stone displayed more than one set of stars (Figure 1).

This gem is cut in cabochon style, measured 12.2 mm. parallel to the long axis and 9.7 mm. parallel to the short axis. When received it weighed 8.35 carats, but as a section was removed from the base of the stone for study, the present weight is 6.61 carats. There is a well-developed 6-rayed star on the crown of the cabochon and 6 additional stars around the girdle. Following around the girdle of the stone the 6-rayed and 4-rayed stars alternate in occurrence. If any one of the light bands of the star on the crown is followed from one edge of the stone to the opposite edge, 3 distinct stars are noticed. Since the stars around the girdle alternate, each band of light in the main star on the crown will display one 4-rayed star and two 6-rayed stars. The reason for this is explained further on and the distribution of the stars can be understood by studying figures a and b taken from Walcott's paper.** (Figure 2.)

The specific gravity of this gem was found to be 3.665 and the hardness between that of topaz and sapphire. Topaz failed to scratch it, while corundum just did mark it, however, since each face was polished and curved it was not easy to apply the necessary pressure to make a satisfactory test of the hardness. On the basis of hardness and specific gravity it appeared to be a black spinel. To confirm this, a portion of the stone below the girdle was removed by cutting with a wire saw, fed with fine carborundum powder, and the X-ray examination by J. M. Axelrod of the Geological Survey was made on a small portion broken from this plate (Figure 3).

The above pattern shows that the star spinel (a) has the same struc-

*G.I.A. Research Service.

**"Asterism in Garnet, Spinel, Quartz and Sapphire." A. J. Walcott. Geol. Series, Field Museum, Vol. VII, No. 3, 1937.

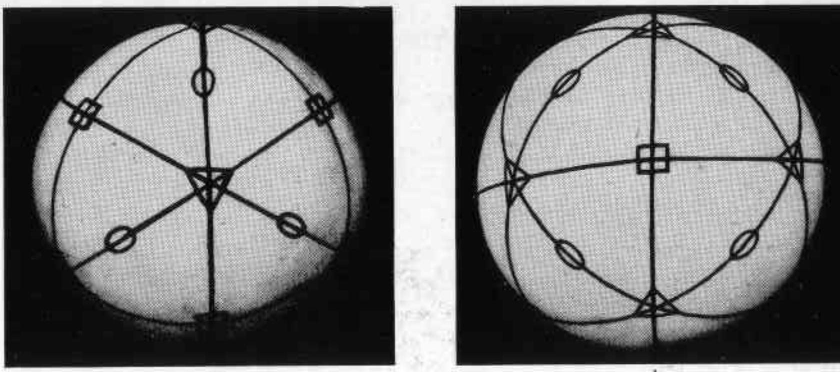

Figure 2

□ *Position of the cube face and a 3 fold star.*
△ *Position of the octahedron and a 6 fold star.*
○ *Position of the band of light.*
These positions correspond to the normal symmetry of the isometric cubic crystal. Fig. "a" corresponds to the orientation of this black spinel. Fig. "b" shows the possible distribution of stars if a 4 fold star (or the cubic face) is located on the crown of the cut.

ture as the spinel from Mt. Francisco, Western Australia; (b) the analysis of which was published in the *American Mineralogist*, v. 13, p. 461, 1928.

The only other described star spinel was a dark-red stone weighing a trifle over 3 carats which was submitted to Albert J. Walcott of the Field Museum who determined it to be a spinel.

The following quotation taken from Walcott's report explains in detail the asterism of the black spinel which is the subject of this paper.

"An examination of the spinel stone with a microscope under strong illumination reveals an inclusion system of a large number of very fine elongated crystals. Around the center of each 'six-rayed star' over an appreciable area, there are three sets of included crystals whose elongations extend in three directions at angles of 60° to each other. The value of this angle was determined with a polarizing microscope, using the method for determining crystal angles or cleavage angles. It is quite evident that the system of included crystals produces the asterism in the spinel gem.

"The relations of the chatoyant bands to symmetry directions may be visualized by assuming a spherical projection of an octahedron oriented so that a trigonal axis of symmetry is in a vertical position. Three binary axes of symmetry, intersecting at angles of 60° lie in a plane perpendicular to the trigonal axis of symmetry. Three sets of included crystals are parallel to the pair of octahedron faces which intercept the vertical trigonal axis at 90° and are respectively parallel to the three binary axes referred to above. This accounts for the 60° angles formed by the included crystals. Three chatoyant bands produced by the included crystals intersect at 60° on the octahedron faces at the terminations of the trigonal axis of symmetry.

"The same condition with its resulting phenomenon prevails for each pair of parallel octahedron faces. If a chatoyant band is traced on an octahedron, it will be found that the plane of this is perpendicular to a binary axis of symmetry and is axes of symmetry and, therefore, produce six 'four-rayed stars.'"

A slice roughly parallel to the six-rayed star on the crown of this black spinel was removed from below the girdle. After it was ground thin enough to transmit light, numerous needle-like inclusions were found all

a

b

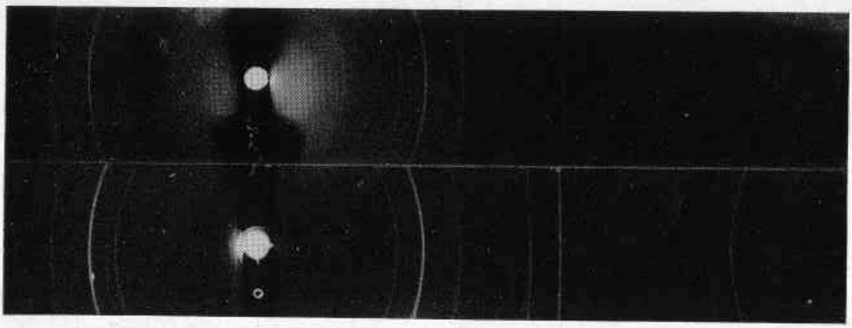

Figure 3

a—Black star spinel. *b—Spinel from Mt. Francisco, Western Australia.*

parallel to a diagonal plane of symmetry. The plane of the band, therefore, includes one tetragonal axis of symmetry, one binary axis of symmetry, and two trigonal axes of symmetry. It will readily be seen that for the whole crystal there are six chatoyant bands.

"The interesting asterism phenomenon described above may be visualized more clearly if the octahedron is projected on a sphere. A sphere of spinel with inclusions like the stone here investigated will show six great circle chatoyant bands. Three bands will intersect, forming angles of 60°, at each of the poles of the four trigonal axes of symmetry thus producing eight 'six-rayed stars.' Two bands will intersect at 90° at each of the poles of the three tetragonal

of which are arranged in a trigonal pattern. Since the mechanical control in the grinding of the section was not accurate enough to produce a face parallel to the octahedron the needles in the section are not absolutely horizontal.

The fully developed star is visible in one place and each star holds its fixed position as the stone is rotated. If the rotation is along a plane parallel to one of the light bands a new star will appear when the rotation has been sufficient to bring the stone into the proper alignment between the source of light and the observer's eye. As Walcott so clearly described above, the asterism definitely follows the symmetry of an isometric crystal. This requires that the needles which produce the diffraction grating to be orientated parallel to the edges of the octahedron face. No other arrangement would produce this effect. Since the normal habit of spinels is to form octahedrons it is logical to expect the inclusions to be orientated along the sides of this face.

The author hopes that some day a cutter will have a sizable specimen of spinel which shows asterism and that he will fashion it into a sphere. This should have display value and perhaps the public would enjoy having a stone which will effectively display this interesting effect.

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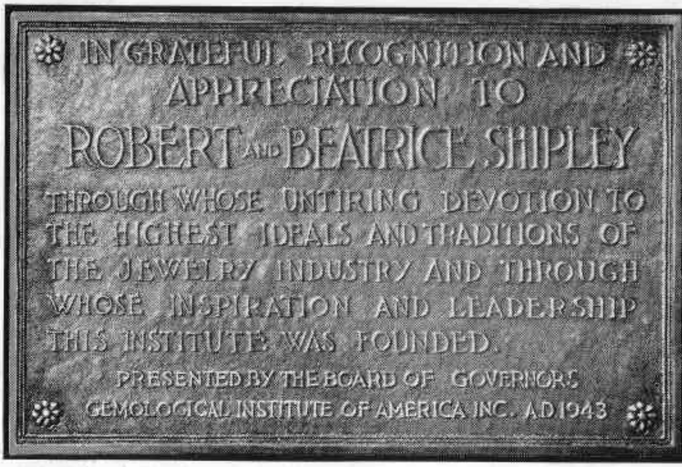

National Jeweler

G.I.A. BOARD OF GOVERNORS HONORS SHIPLEYS BY PLAQUE PRESENTATION

At the Retail Jewelers Research Group luncheon for the Board of Governors of the Gemological Institute, at Westchester Country Club, Rye, N.Y., April 27, Robert and Beatrice Shipley were honored in a ceremony in which a bronze plaque was presented to them in recognition of their far-reaching contribution to the jewelry industry.

The secretary-treasurer of the Institute, Percy K. Loud, acting for the Board of Governors, made the presentation.

Commenting on the success with which the Shipleys had transformed "a purely ephemeral plan into the reality of an institution known and respected throughout the civilized world," Mr. Loud concluded:

"The Board of Governors decided that even as Robert Shipley and his wife, Beatrice, have taken the highest ideals of the jewelry industry and moulded them into a great educational institution, so the Board should express in simple words the loyalty and admiration which the Shipleys have inspired, and mould them in deathless bronze that for all time our gratitude and affection may be cherished and remembered."

Mr. Shipley, in the East for the Board of Governors' meeting and the American Gem Society Wartime Conference, accepted for the Shipleys, remarking in part:

"The success of which Mr. Loud speaks could not have been accomplished without the self-sacrifice and wise collaboration of you Governors, and those many members of the A.G.S. who have built, and are still building, in the now strongly entrenched gemological profession, a monument to their own business and personal ideals."

DIAMOND GLOSSARY

(Continued from p. 140, last issue)

Miller indices. Mathematical symbols denoting the face of a crystal. These symbols indicate the distance from the crystal's center at which the face intersects each crystal axis. The symbols for the faces of the octahedron are 111, $\bar{1}11$, $1\bar{1}1$, etc., the first letter indicating the *a* axis, the second the *b* axis, and the third, *c;* the negative sign, that the intersection occurs behind, to the left, or below the center.

millimeter screw micrometer. A precision caliper gauge especially useful for accurately measuring the depth and girdle width of diamonds. See also **Leveridge gauge; Moe gauge.**

milling of blue ground. See **mill.**

Millionaire Diamond. Same as **Regent Diamond.**

mimicry. Imitations of crystal form of higher symmetry by those of lower grade of symmetry, usually the result of twinning.

Minas Geraes. A state of Brazil, north and east of Rio de Janeiro; first important Brazilian diamond deposits were discovered near Diamantina and later near Bagagem.

Minas Geraes Diamond. An alluvial diamond of 172½ metric carats found in Minas Geraes about 1937.

mineral classification (of diamond). Diamond is of the normal (hexahedral or holohedral) class of the isometric crystal system, and therefore belongs to the most symmetrical class of the most symmetrical system.

mine run. Unassorted product of a mine. (R. Webster).

mine salting. See **salting.**

Mirror of Naples. A fine large diamond valued at 30,000 crowns (approximately $37,500) that belonged to Mary, sister of Henry VIII, who had married Louis XII of France. "What this diamond really was and its subsequent history is still a matter of conjecture." (Hamlin).

Mirror of Portugal. See **Mazarin.**

Modder River. A tributary of the Vaal River between Kimberley and Bloemfontein. An important alluvial diamond mining district.

moderne cut or modern cut. Any modification, or combination, of table cut, step cut or brilliant used especially in connection with diamond. Includes baguette, triangle, keystones, half moon, etc.

Moe gauge. A caliper gauge which, with accompanying table, estimates to within a few hundredths the weights of brilliant-cut diamonds only, by measurements of width and depth of either set or unset diamonds. Not a precision instrument. See **Leveridge gauge.**

Mogul, Moghal or Mughal Dynasty (1526-1857). Founded by Baber the Mongol. The greatest of his descendants were Akbar, Shah Jehan and Aurangzeb. After the death of Aurangzeb (1707) the empire declined rapidly. In 1739 Nadir Shah of Persia sacked Delhi, the capital of the empire and the title "Great Mogul" given the Emperors became but a name. The Mogul emperors had vast stores of gems, especially diamonds. Tavernier, "the father of the diamond trade," traveled in India and at the court of Aurangzeb saw a diamond sometimes known as the Great Mogul, and many other gems. See **Great Mogul Diamond; Tavernier.**

Mogul, Great. See **Great Mogul Diamond.**

Moh's scale. The most commonly used scale of hardness: diamond 10, corundum 9, topaz 8, quartz 7, orthoclase feldspar 6, apatite 5, fluorite 4, calcite 3, gypsum 2, talc 1. Divisions are arbitrary, not equal. Diamond is perhaps about 100 times harder than corundum.

Moissan, Henri (1852-1907). French chemist who, until adequate gemological tests were developed, was credited with having made synthetic diamonds in 1893.

molecule. The smallest unit of a substance in which the chemical properties of that substance are entirely retained; may consist of one or more elements, and therefore of more than one atom.

Monastery mine. Diamond pipe in Winburg area of South Africa. See also **Kimberley mines.**

monazite. A mineral associated with diamond in Minas Geraes. Essentially (Ce, La, D) PO_4; H. 5-5½; S.G. 4.9-5.3; R. I. 1.78-1.83; monoclinic.

Monteleo mine. Diamond pipe in Winburg area, South Africa. See also **Kimberley mines.**

Moon Diamond. A diamond identified by this name, weighing 183 carats, possibly the largest ever to have been sold under the hammer, was auctioned at Sotheby's salerooms, London, Aug. 20, 1942. The stone was purchased by H. W. Thorne for the low figure of £5,200, then passed into the hands of a foreign potentate, whose name was not divulged. Described by an eyewitness as a well-cut brilliant, almost circular, rather thick, but with good fire and a faint tinge of yellow. Almost certainly not an Indian stone, more probably South African, which would account for its lack of history. Weighed 183 carats and the drawing shows a stone of 1¼″ diameter, a crown of 41 facets, the bezel facets being divided into two parts. Publicized (but not represented) by Sotheby's, to be the Moon of the Mountains.

Moon of Baroda Diamond. Name probably given about 1926 to a 24.95 carat, pear-shaped yellow diamond by one of its East Indian owners, Prince Ramachandra, who had acquired it after its return to India from Austria to whose Empress Maria Theresa it has been given by the Gaekwar of Baroda.

Moon of the Mountains Diamond. An ancient Indian diamond said to weigh 120 carats, the description of which by earlier chroniclers may have been faulty, and which Smith, Schlossmacher and other authorities believe to have been confused with the names Great Mogul, Orloff and Derya-i-nur, all of which may refer to the same stone which was taken from Delhi in 1749 by Nadir Shah, and eventually given to Catherine the Great by Prince Orloff. See also **Moon Diamond.**

(To Be Continued)