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and

PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN
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SYNTHETIC VANADIUM EMERALD

By A. M. TAYLOR, Ph.D., F.G.A.

A NEW and no doubt controversial emerald will shortly appear on the market; this time emanating from the Southern Hemisphere. The cut stones are a rich grass-green colour due to the presence of vanadium, without chromium. They are produced on a small scale by the Crystals Research Company of Melbourne, Victoria. A hydrothermal process is used to grow fully synthetic crystals weighing up to 10 cts, from which faceted stones of 0·5 to 2 ct. size are obtained. Besides presenting an interesting addition to the list of synthetic gemstones, the vanadium emerald does much to explain the intriguing variations in physical properties of natural emeralds.

The cut stones have refractive indices within the ranges $\omega = 1{\cdot}571\text{–}1{\cdot}575$ and $\varepsilon = 1{\cdot}566\text{–}1{\cdot}570$, with D.R. about 0·005. These values are normal for hydrothermally-grown beryl and emerald (excluding Cr-rich overlays), and they overlap the values recorded for natural emeralds from Brazil and Colombia(1). The small variations from one facet to another result from differences in vanadium content, which are apparent from the marked colour banding seen when the stones are immersed in a liquid of similar refractive index. This banding has been practically eliminated in the most recent productions.

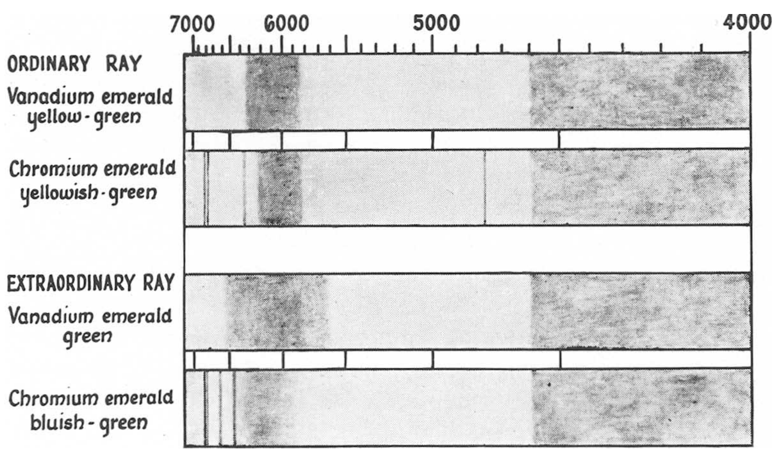
The specific gravity is 2·68, or within the range of 2·67–2·69 characteristic of fully synthetic hydrothermal emerald. The slightly higher figure compared to flux-grown emerald (2·65) is due to the small water content ($\sim 1\%$) of emerald grown from an aqueous solvent. No fluorescence could be detected when the crystals were tested with ultra-violet radiation or X-rays.

Vanadium produces an emerald with a warm grass-green colour, verging on yellowish-green, which is in contrast to the cooler bluish-green of most synthetic chromium emeralds. Dichroism is distinct, with O = yellow-green and E = green. Through the Chelsea filter, cut stones appear greyish-green to a very dull pink. Use of a polaroid plate in conjunction with the Chelsea filter, reveals that the O-ray is green and the E-ray pink.

The absorption spectrum due to vanadium is of considerable interest because of the common occurrence of this element in natural emeralds. The spectra over the range 1000–350mμ were recorded on a Beckman DK-2 spectrophotometer at the C.S.I.R.O. Polarized radiation was passed in the appropriate directions through a polished plate of vanadium emerald cut parallel to the optic axis. The absorption spectra are reproduced in Fig. 1, as seen through a prism-type spectroscope.

The dichroism of emerald is due to appreciable differences in absorption of the ordinary and extraordinary rays. The O-ray of both vanadium and chromium emerald is yellowish-green, with the

FIG. 1.



former being more yellowish—close to yellow-green. The vanadium O-ray is characterized by very strong absorption of the violet (absorption edge about 4600 Å) and by a weaker absorption band in the orange centred at 6100 Å; another weak band occurs in the near infra-red at 7640 Å. Maximum transmittance is at 5100 Å. The O-ray absorption for vanadium in beryl was first reported by Emel'yanova *et al.*[(2)] in 1965; they recorded absorption maxima at 4310 Å and 5950 Å. Their crystal plate was orientated perpendicular to the optic axis and still contained the natural beryl seed-plate. The presence of traces of iron in the latter produced a strong absorption peak at 8000 Å.

The E-ray is an attractive grass-green colour. Its absorption is more interesting and has not previously been reported. Strong absorption of the violet occurs as before, the crystal plate being too thick to measure the full extent and position of this band. The central band in the orange-yellow is wider and asymmetrical. Its maximum is now at 6000 Å, with a shoulder at 5750 Å, and an overlapping band at 6320 Å. The band in the near infra-red is weaker than before and shifted to 8500 Å. Maximum transmittance is at 5200 Å and 7500 Å. The slightly greater absorption of the yellow-green and lesser absorption in the deep red (*cf.* O-ray) causes the E-ray to appear pink through the Chelsea filter.

Whether the weak band in the near infra-red is due to vanadium or iron is not known at present. The spectrum of a natural aquamarine plate gave an intense absorption peak at 8200 Å, the tail of which extends into the red, thus causing the pale blue colour of the crystal. The absorption spectrum of iron in natural beryls is being further investigated as suitable crystals come to hand.

When the spectrum of a cut stone is examined with a direct-vision spectroscope attached to a polarizing microscope, the central absorption band appears weaker than that seen in chromium emeralds of comparable depth of colour. This band is most noticeable in the E-ray spectrum and does not appear to extend as far towards the red as recorded by the spectrophotometer. This may possibly be due to the eye being more sensitive to the yellow than the red part of the visible spectrum.

It is now apparent that spectroscopic examination provides little chance of detecting vanadium in natural emeralds containing chromium. The visible absorption bands of both elements coincide rather nicely—vanadium simply lacks the frills, or fine lines in the red which are so noticeable in the chromium spectrum (see Fig. 1). The absorption of a natural emerald containing both elements can be simulated by correctly orientating crystal plates of the two synthetic emeralds on a polarizing microscope stage. A significant feature may be that the combined E-ray shows a greater overall absorption compared to the combined O-ray, which is opposite to that observed for chromium alone.

The crystals are grown on seed-plates sawn from earlier-grown crystals, hence the cut stones are fully synthetic. The plates are 1 mm or less thick, and inclined to the c-axis. The reason for this orientation is obvious if the habit of natural emerald is considered. Emerald is always found as somewhat elongated hexagonal prisms capped by the basal pinacoid. The largest faces on a crystal are always those having the slowest growth rates; conversely the smaller faces have faster growth rates and as a result often grow themselves out and disappear. The fastest growing direction for emerald is thus inclined to the c-axis. Use of seed-plates may be considered one characteristic of hydrothermal crystal growth. Although seeds have been used at times to grow emerald in anhydrous molten salts or fluxes, this technique has not been favoured by commercial producers. The best quality flux emeralds are apparently spontaneously nucleated crystals.

Immersion of cut stones in a liquid of similar refractive index will allow the interfaces of the seed-plate to be seen, more or less parallel to the plane of the girdle (Fig. 2). Stones of 1 ct. or larger may show further colour bands indicative of two or more growth periods. No banding is visible when the stones are viewed through the table (Fig. 3). Under high magnification the usual two-phase (aqueous liquid + vapour) inclusions may be seen concentrated as wisps and on new growth surfaces. No phenacite or other crystal inclusions have been observed. It would be premature to describe present inclusions and internal features as characteristic of vanadium emerald, since continuous efforts at quality improvement will before long result in macroscopically flawless stones.

Just what is an emerald? This question deserves some discussion now that we have new data concerning the role of vanadium. B. W. Anderson (3) has aptly stated "vanadium is the mystery element in the emerald story". The mystery is now beginning to unravel itself. I hope this report will cause renewed interest in natural emeralds that might contain this bashful colouring element.

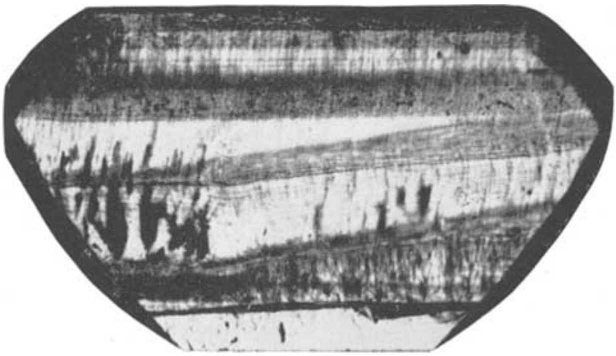


Fig. 2.

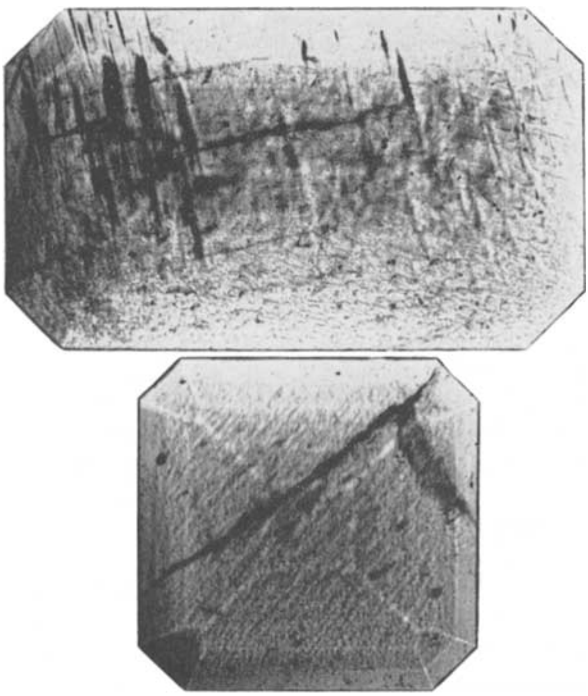


Fig. 3.

The presence of vanadium in natural emeralds was first investigated in 1919 by the renowned geochemist V. M. Goldschmidt(4). He found 0·9% V_2O_3 and only 0·1% Cr_2O_3 in emerald from Minne, at the southern end of Lake Mjösen, Norway. The yellowish-green Muzo emeralds are known to contain both vanadium and chromium to several tenths per cent (4). A recent Chivor emerald analysis(5) shows 0·05% V, 0·12% Fe and 0·14% Cr. Several Brazilian localities are known where green beryl and emerald are found to contain appreciable vanadium e.g., Ferros, Minas Geraes(3) and Salininha, Bahia(6). More detailed physical data and analyses of stones having various shades of green from these localities would be most interesting.

A problem that worries many gemmologists is where the dividing line should be drawn between emerald and green beryl. This necessarily depends on one's definition of emerald. There are two definitions commonly propounded. The one that I support, and which has held sway from ancient times, is simply that "emerald is a bright green variety of beryl". This is more in keeping with other varietal names used in gemmology e.g., heliodor is yellow beryl, morganite is pink beryl, etc.

The other definition is an extension of the first i.e., "emerald is a bright green variety of beryl coloured by chromium". This immediately raises the question of how much chromium is required to be present. It has been suggested that emerald should contain sufficient chromium for its absorption spectrum to be detectable with a hand-spectroscope(3). The new data presented here shows the extended definition to be unsatisfactory. Vanadium and chromium alone, or together, are able to produce the coveted emerald-green hue in beryl. It is quite possible for good natural (and synthetic) emeralds to have their colour predominantly due to vanadium, and yet still show a chromium absorption spectrum resulting from the presence of lesser amounts of this element. Clearly such stones should not be called emerald by reason of having detectable chromium. It is equally unsatisfactory to extend the definition to include vanadium, because there is still the problem of iron content, which has not yet been considered. Iron is the culprit responsible for spoiling the bright green hue of emerald, when present in excessive amounts. Synthetic crystals containing vanadium and iron are a sad olive-green colour. The only satisfactory solution to the problem is to return to the simpler definition which is non-commital regarding the colouring element.

The insistence that emerald is coloured by chromium dates back to the time of Vauquelin, who discovered the element in 1797, and was first to detect its presence in emerald. In 1830, Sefström isolated compounds of vanadium from iron ore slag and was impressed by the beautiful colours they displayed in solution. He called the new element vanadium, after Vanadis, one of the names of Freya, the Scandinavian goddess of beauty. As mentioned previously, its presence in emerald was not suspected until the work of Goldschmidt in 1919. It seems that we can blame the ostentatious nature of the chromium absorption spectrum for chromium's mysterious rival, vanadium, being ignored for so long.

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THE SIGNIFICANCE OF THE CULET OF OLD BRILLIANT-CUT DIAMONDS

By W. F. EPPLER

TODAY, we are often astonished when seeing the large culet of an old brilliant-cut diamond. The modern style prefers a shape of the brilliant-cut with a culet as small as possible or with no culet at all, and this particularly with small stones. The culet is often considered as a facet to prevent damage to the pointed part of the pavilion. If this facet is only a little larger than necessary, the brilliant-cut stone loses in brilliance, as the larger culet gives the impression of a "hole". It is a fact that the brilliancy of a modern brilliant-cut stone is reduced in the same proportion as the culet increases.

In former times, all well cut brilliants had a culet of considerable size and this was based on good reasons. In old books, like those of Jefferies(1) and Mawe(2), it is exactly described in what proportions a diamond in the form of a natural octahedron had to be cut to obtain a "perfect" brilliant. Jefferies(1), who must have had some forerunners more than a hundred years earlier, suggests the division of the diamond octahedron into eighteen parts (Fig. 1) and he recommends "to take off $\frac{5}{18}$ in the upper part and $\frac{1}{8}$ in the lower part" of the crystal. Then, the remaining stone has one third of its total thickness above the girdle and two thirds below it. And he adds (in translation):

"In this way, the table and the small lower facet (the culet) are made which always have these proportions, namely the small lower facet has the fifth part of the width of the table".

This means, in other words that the diameter of the culet is one fifth or 20% of the table diameter, measured between the opposite sides. At the same time, the culet is as large as 11% of the girdle diameter.

A cross-section of such a so-called "thickstone" is shown in Fig. 2 and it exhibits the paths of light when entering the stone in a direction perpendicular to the table or to the girdle plane. With this incidence of light, it can be observed that the culet is an important facet on the base of the stone as it reflects many rays which otherwise would have been lost for the brilliancy of the stone.

The presence of the culet enables an output of light* of 18·9%.

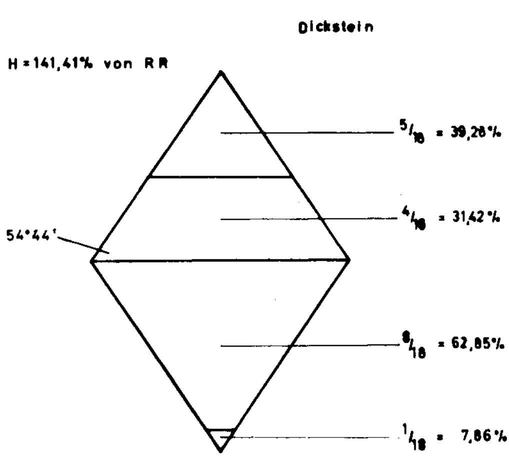

FIG. 1. *A natural diamond octahedron seen from the side, the length of which is divided in eighteen parts. After David Jefferies.*

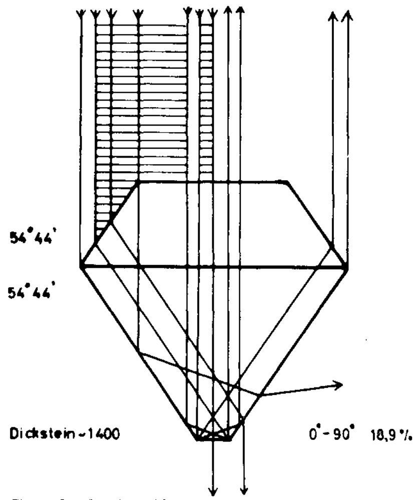

FIG. 2. *Paths of light in a so-called "thickstone" with the proportions recommended by David Jefferies and shown in Fig. 1.*

With an increase in the angles of incidence, the output rises at first until, at approximately 30°, a drastically sharp drop occurs. Further greater angles of incidence again cause a considerable peak in output at 45°, which is followed by further reduction until zero is reached at 90°. The calculation for the output of light* for seven angles gave the following results:

So-called "thickstone" (after Jefferies)

Angle of incidence	Output of light
0°	14·5%
15°	14·1%
30°	0·9%
45°	45·0%
60°	36·6%
75°	21·3%
90°	0·0%
0°–90°	18·9% as the mean value.

In detail, the efficiency of this cut is demonstrated by the diagram in Fig. 3. The first part of the curve, representing the output of light for the angles of incidence between 0° and 30°, is only caused by the culet.

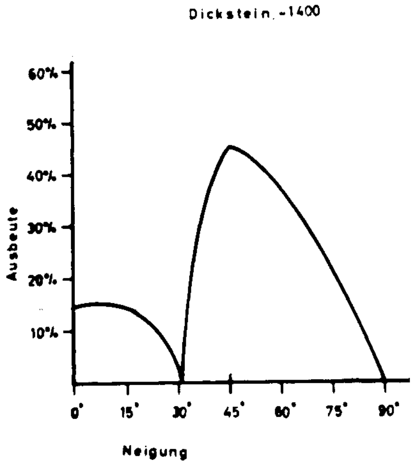

FIG. 3. *The output of light of a so-called "thick-stone" after Jefferies in percents of the incident light and in relation to the angles of incidence.*

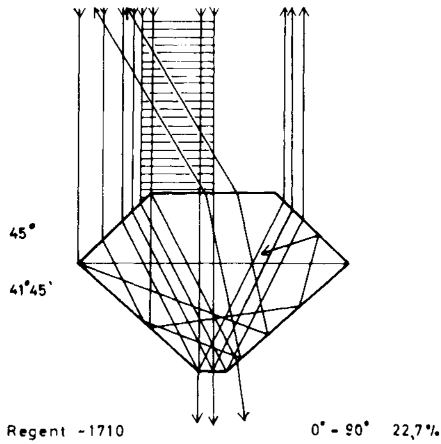

FIG. 4. *Cross-section of the brilliant-cut, after Mawe.*

Another reference about the importance of the culet is given by Mawe(2), but this author must have been the subject of a misunderstanding or, what seems more likely, he used former publications without having taken into consideration the proper correlations of the angles and the proportions. He repeats the recommendation of dividing the raw crystal, as already mentioned by Jefferies(1), with the following words:

> "The rule to be adopted in regulating the height of the brilliant is (supposing the stone to be a regular octahedron), to divide it into eighteen parts. Five-eighteenths are cut away to form the table, and one-eighteenth for the collet, which will reduce the height one-third, and the diameter of the collet will be one-fifth of the table".

But then he demands

> "The inclination of the facets to the girdle ought to be 45°, and the bizel should be inclined to the table at the supplement of the same angle".

This means that the angles of the main facets are altered. Formerly, the angles of the so-called "thickstone" were those of the natural octahedron, i.e. 54° 44′, and now they are reduced to 45°. Without any doubt, this reduction is a considerable development, as will be shown below. But there remains a contradiction between

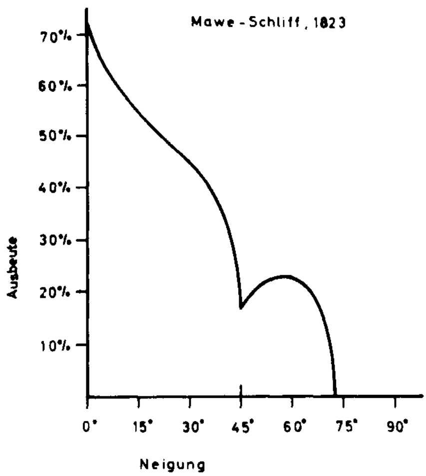

FIG. 5. *Diagram showing the output of light of a brilliant-cut after Mawe in relation to the angles of incidence.*

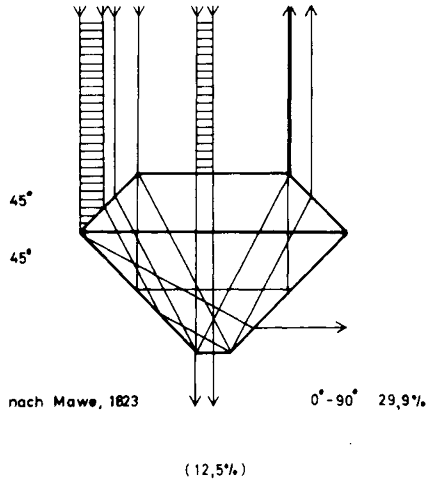

FIG. 6. *Cross-section of the old-cut Regent diamond.*

the rule of dividing a regular octahedron with its proper angles and the recommendation of 45° angles. However, considering the edges of an octahedron instead of the planes—which seems very unlikely to be the real meaning of the prescription mentioned in the text—both postulations can be combined.

The result of calculating a brilliant-cut diamond according to these conceptions is shown in Fig. 4, including a still larger culet of 12·5% of the girdle diameter. The height of the crown is again one-third of the total height and the pavilion two-thirds. For this particular cut, the output of light is surprisingly high. It was calculated as already mentioned, and it results in a mean value of 29·9%. A general view is given in Fig. 5. The great output of light with relatively small angles of incidence depends mostly on the large culet, which therefore has a great importance. This old brilliant-cut must have had a great brilliancy, not too far below that of our modern brilliant-cut stones and with by far a greater effect on the dispersion, i.e. the play of the rainbow colours or the fire.

A good example for stones cut in, or nearly in these proportions is the famous "Regent diamond", which recently has been described by Tillander (3). This author mentions about this very interesting old brilliant-cut diamond, among others:

"There is an exceptionally even distribution of fire all over the surface of the crown. Not one of the main facets in the pavilion can be seen through the stone. This is due to an ideal pavilion angle of some $41\frac{3}{4}°$".

The crown angle is 45°, and the culet 10·35% of the girdle diameter. It seemed to be worthwhile to examine this particular form in a cross-section. Fig. 6 and Fig. 7 give the results. The mean output of light is 22·7% of the incident light. This is less than the real Mawe cut. The reason is, with respect to the pavilion angle of 41·75°, that the culet is a little bit too large. On the other hand, even this too large a culet increases the brilliancy more than not having a culet at all, and the peak of the curve in Fig. 7 is for the most part due to the presence of the culet.

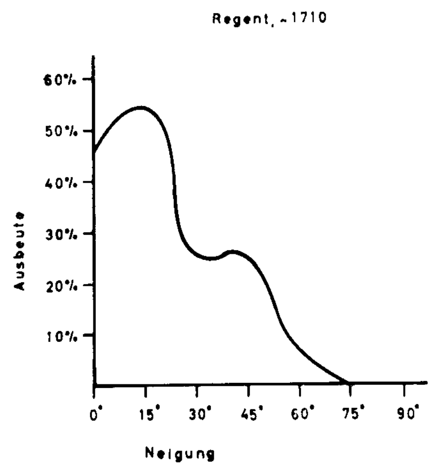

FIG. 7. *Diagram exhibiting the output of light of the old cut Regent diamond.*

In summarizing it can be said, that in old brilliant-cut diamonds, with steep facets or great angles of the main facets in the crown and in the pavilion, a culet of adequate size is necessary to gain a maximum of brilliancy. It is astonishing that the diamond cutters of former time found an improvement in the brilliancy by applying a culet not by calculation but by practice only. In reducing the angles in crown and pavilion, the culet has less importance, and in the modern "fine cut", with angles of only 33·2° and 40·8° in crown and pavilion respectively, the absence of the culet is an absolute necessity, if it is not applied to minimise damage.

*The "output of light" is the amount of light which leaves a cut stone on the crown in an efficient direction. It is given as a percentage of the incident light.

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SOLID INCLUSIONS IN CORUNDUM AND ALMANDINE GARNET FROM CEYLON, IDENTIFIED BY X-RAY POWDER PHOTOGRAPHS

By P. C. ZWAAN, Ph.D., F.G.A.

INTRODUCTION

THE identification of inclusions in gemstones has been a difficult matter for years because the optical method was the only one which could be used, often giving a more or less doubtful result.

Recently much work has been done by several gemmologists with the aid of other methods, as for instance X-rays. In 1965 I(1) gave the results of an investigation of crystal inclusions in a Ceylon spinel, identified as apatite by the X-ray powder method. Although the optical data were valuable, they could not give definite results. Developments in the technique make it possible nowadays to take X-ray powder photographs when only very small amounts of material are available.

In the present paper results will be given of an examination of inclusions in corundums and almandine garnets from the same gem gravel from which the spinel mentioned was selected. It is important to note that I collected all these stones myself in the Ratnapura district of Sabaragamuwa Province in Ceylon. Therefore we can be certain about their origin, however secondary it may be.

To identify the nature of the inclusions in the stones, being all pebbles, they were partly faceted. Before scraping down part of an inclusion touching the surface microphotographs were taken. Moreover the facets made it also possible to measure the refractive indices of the pebbles on a refractometer and to examine the inner part of them by microscope. The specific gravity of the pebbles was measured using a hydrostatic balance and ethylene dibromide. All X-ray powder photographs were made using Fe-radiation and a camera with a diameter of 114·6 millimeters.

Results of the Investigation

Specimen 81721-1[a] Corundum with included spinel.

This large part of a colourless corundum crystal, weighing 46·39 carats, actually being a thick slab, has refractive indices 1·760 and 1·768, measured on one of the cut prism faces, and a specific gravity of 3·953. It contains a dark reddish-brown inclusion (Fig. 1). The irregular shape of this inclusion prevents an indication about its crystal habit or even its crystal system. Moreover the low degree of transparency makes it impossible to obtain optical data. The X-ray powder photograph (No. mm 1135), taken from this inclusion, gives a pattern of diffraction lines, characteristic for spinel. The X-ray data for some of the strongest lines are as follows:

d (in Å)	Intensity (estimated)	hkl	d (in Å)	Intensity (estimated)	hkl
4·64	7	111	1·276	2	620
2·84	6	220	1·231	3	533
2·42	10	311	1·166	2	444
2·01	7	400	1·131	1	711
1·640	3	422	1·080	4	642
1·548	6	511	1·052	6	731
1·423	9	440	1·011	4	800

By comparison of these data with those stated in the index to the X-ray powder data file of The American Society for Testing Materials (No. 5-0672), it turns out that they agree well with the corresponding data of common Mg-spinel.

Specimen 81721-2 Corundum with included pyrrhotite, apatite and phlogopite.

The stone has a violet-blue colour, and its weight is 9·04 carats. Refractive indices measured are 1·761–1·769. Its S.G. is 3·939. This low value is probably due to the great number of included apatite crystals. Beside silk three different kinds of inclusions may be seen with the naked eye (Fig. 2).

First bronzy-yellow grains with a metallic lustre occur. From the X-ray photograph (No. mm 1136) it is seen that these inclusions may be classified as pyrrhotite. The pattern has been compared

(*a*) *Registration number of the Rijksmuseum van Geologie en Mineralogie, Leiden, Holland.*

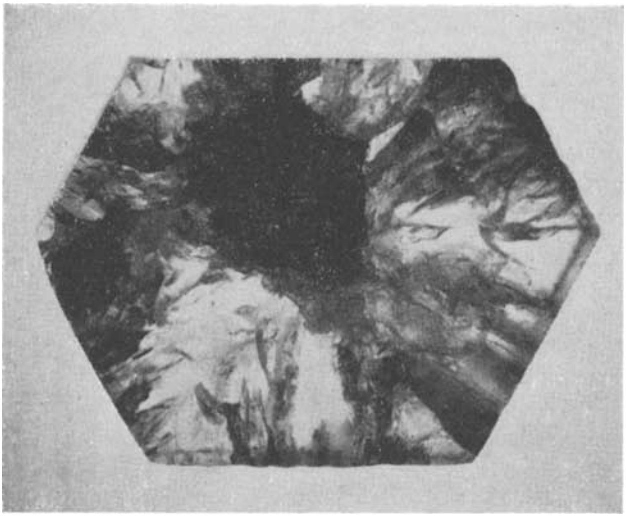

FIG. 1. *Dark reddish-brown spinel in corundum specimen 81721-1 (3 ×).*

FIG. 2. *Pyrrhotite with phlogopite and apatite in corundum. Specimen 81721-2, in both reflected and transmitted light (20 ×).*

with the X-ray powder photographs of other pyrrhotites in the collection of the Museum. The d-values of the strongest lines are 2·97 (Intensity 6), 2·64 (Int. 8), 2·06 (Int. 10), 1·719 (Int. 7), and 1·627 (Int. 3). In addition the material is strongly magnetic.

Secondly colourless to white crystals with a hexagonal prism habit are to be seen. They have a parallel extinction and rather high interference colours due to their thickness. Examination of a powder preparate of one of the crystals gave a refractive index of about 1·632, very weak double refraction and a uniaxial negative interference figure. The X-ray powder photograph (No. mm 1137) turned out to be characteristic for apatite. This pattern was compared with those of other apatite photographs in the collection.

Finally brownish platy crystals are present. They are strongly dichroic in tones of deep reddish-brown and pale brownish-yellow.

An X-ray powder photograph (No. mm 1138) made of one of these plates appeared to be characteristic for phlogopite.

Specimen 81721-3 Corundum with included apatite and phlogopite.

This 13·72 carat stone has a reddish-violet colour. Its indices of refraction are 1·760 and 1·768. The specific gravity appeared to be 3·904, the low value again is probably due to the great number of apatite crystals included. The stone has a distinct dichroism and straight colour bands are to be seen. Beside silk two different kinds of crystal inclusions may be observed (Fig. 3).

Numerous colourless crystals with a hexagonal prismatic habit are present. By optical inspection they showed a parallel extinction and rather high interference colours. An X-ray powder photograph (No. mm 1139) made of one of these crystals had a pattern similar to that of a number of apatites in the collection. Therefore it may be concluded that these inclusions are apatite crystals. The other inclusions have the same optical properties and habit as the phlogopite described in Specimen 81721-2. Although the identity was not checked by X-rays, it is almost certain, however, that the inclusions in question are phlogopite plates.

Finally it may be noted that X-ray powder photograph No. mm 1140, taken of material scraped down from the stone, turned out to be characteristic for rutile. Probably some of the silk is responsible for this.

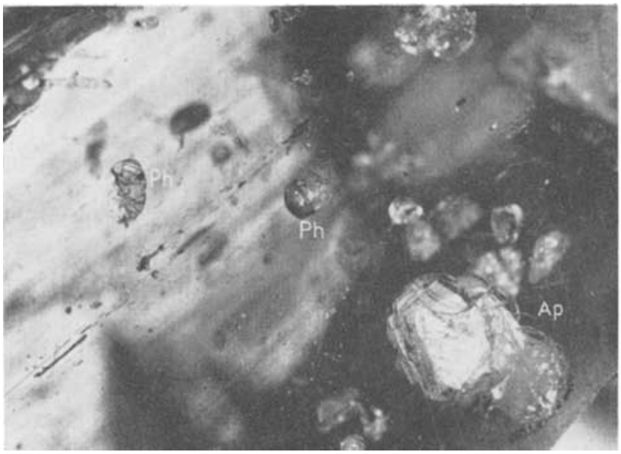

FIG. 3. *Apatite and phlogopite in corundum specimen 81721-3, in both reflected and transmitted light* (*20* ×).

FIG. 4. *Spinel octahedron in corundum specimen 81721-4 in reflected light* (*20* ×).

Specimen 81721-4 Corundum with included spinel and apatite.

An almost colourless corundum with a weight of 11·38 carats. The refractive indices are 1·762 and 1·770, the S.G. found is 3·957.

In the stone two crystals with a distinct octahedral shape may be seen (Fig. 4). These crystals have a metallic lustre in reflected light, due to a thin film of other material covering the surface.

Because of this they look as if they are opaque but in reality they are transparent and have a very dark bluish colour. It was impossible to examine them by optical methods.

An X-ray powder diagram (No. mm 1141) made from one of these crystals gave a characteristic pattern of Mg-spinel. The diagram is completely identical to that of the spinel included in corundum Specimen 81721-1 and very similar to other spinel X-ray photographs in the collection. In addition a number of colourless somewhat rounded crystals with a hexagonal habit occur in this stone. They have the optical properties as found with the apatites in the stones mentioned. With this experience it is almost certain that these inclusions are apatite crystals, although this has not been checked by X-rays.

Specimen 81721-5 Corundum with included spinel.

In its original state this pebble had the shape of a rounded hexagonal pyramid. Its colour is blue and its weight 5·10 carats. The refractive indices were found to be 1·760 and 1·768 respectively, and specific gravity was 3·921, a low value probably due to the large quantity of inclusions. As might be expected the stone has a distinct dichroism.

The inclusions occurring in the stone are a few octahedra of a very dark colour and much brownish-red powdery material. One of the octahedra has been checked by means of an X-ray powder photograph (No. mm 1143) and was found to be a Mg-spinel. The X-ray diagram was identical to those of the spinels included in the corundums Nos. 1 and 4.

An X-ray powder photograph (No. mm 1142) was also made of the powdery material included in this stone. The diagram was not very clear and it was impossible to obtain a definite result. The data have something in common with those of halloysite and the serpentine group of minerals.

FIG. 5. *Corundum in corundum specimen 81721-6, in reflected light (30 ×).*

Specimen 81721-6 Corundum with included corundum.

This very small colourless stone, weighing only 0·21 carats, with refractive indices 1·761 and 1·768 respectively and a specific gravity of 3·992.

Beside silk some platy colourless inclusions occur (Fig. 5). By optical examination no details may be seen, due to the fact that they are extremely small and that they have an unfavourable position in the stone.

An X-ray powder photograph (No. mm 1149) made of one of these inclusions was seen to be characteristic for corundum. This surprising result was questioned because the preparation could have possibly been made from material of the host mineral.

A second X-ray powder photograph (No. mm 1174) made, gave a pattern of diffraction lines characteristic for carborundum, this material being used as an abrasive to make the preparation.

A third attempt made was succesful, a complete crystal inclusion being isolated. The X-ray powcer photograph (No. mm 1189) made of this crystal turned out to be characteristic for corundum.

Specimen 81721-7 Almandine garnet with included apatite.

The stone has a wine-red colour and weighs 1·01 carats. Its refractive index is 1·768, the S.G. is 3·910. A distinct absorption spectrum may be observed with the well-known pattern for almandine.

A number of inclusions occur in the stone (Fig. 6). They have rather high interference colours but instead of being prismatic they are more or less rounded and they look as if they are isometric. An X-ray powder photograph (No. mm 1144) identified them as apatite crystals, a surprising result because the habit of the crystals differs strongly from that of apatite inclusions in other stones.

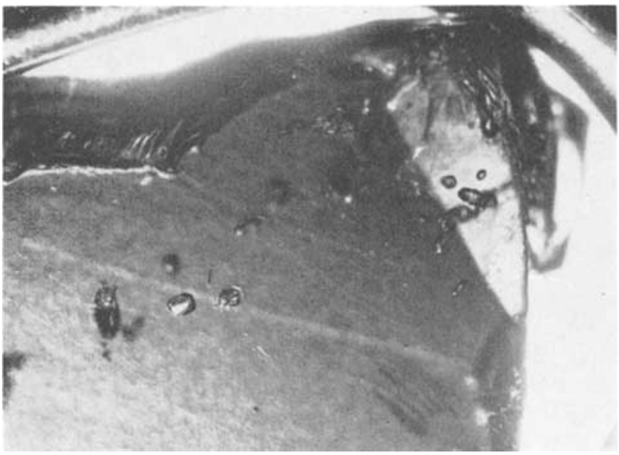

FIG. 6. *Apatite crystals in almandine garnet specimen 81721-7, in both reflected and transmitted light (20 ×).*

Specimen 81721-8 Almandine garnet with included rutile.

A stone with a brownish red colour. Its weight is 2·47 carats, its specific gravity was found to be 3·817. The refractive index is 1·759. A distinct almandine absorption spectrum may be observed. In polarized light the stone has anomalous double refraction.

Some crystals are enclosed, one of the biggest is shown (Fig. 7). In transmitted light they are almost opaque, due to the high refractive index in comparison with that of the garnet. In reflected light the crystals have a submetallic lustre, they are rounded and short prismatic. Their identity was checked by an X-ray powder photograph (No. mm 1145) and they were found to be rutile.

Specimen 81721-9 Almandine garnet with included apatite.

The weight of this garnet is 11·83 carats, its colour is deep brownish-red. The S.G. is 3·928 and the refractive index appeared to be 1·773. By spectroscopic examination a distinct almandine spectrum may be seen.

In addition an anomalous double refraction may be observed in polarized light.

The large number of included crystals can even be seen with the naked eye. They are all long, prismatic and have a hexagonal shape (Fig. 8). Basal cleavage traces are obvious in some crystals, and this is a characteristic of apatite. The optical properties examined by microscope are equal to those found with apatite inclusions in other gemstones; they are a parallel extinction and high interference colours. An X-ray powder photograph (No. mm 1148) made from one of these inclusions confirmed the opinion that again apatite was found in a gemstone.

Specimen 81721-10 Almandine garnet with included apatite and muscovite.

This brownish-red stone weighs 7·22 carats. The refractive index could not be measured with a Rayner standard refractometer, so it gave a negative reading. The specific gravity was found to be 4·176. Beside the almandine absorption bands an anomalous double refraction could be observed.

In the stone one large inclusion was noted (Fig. 9). At first sight it looks like a piece of calcite with rhombohedral cleavage planes. Optical examination of a powder preparate, however, indicated a material with a refractive index of about 1·635, small birefringence and an uniaxial negative interference figure, hence it has to be considered apatite. An X-ray powder photograph (No. mm 1147) gave a pattern of diffraction lines characteristic for apatite. In addition plates of another mineral are enclosed. An X-ray powder photograph (No. mm 1146) taken from one of these plates was very similar to the X-ray diagrams of muscovite in the collection.

FIG. 7. *Rutile crystal in almandine garnet specimen 81721-8, in reflected light (50 ×).*

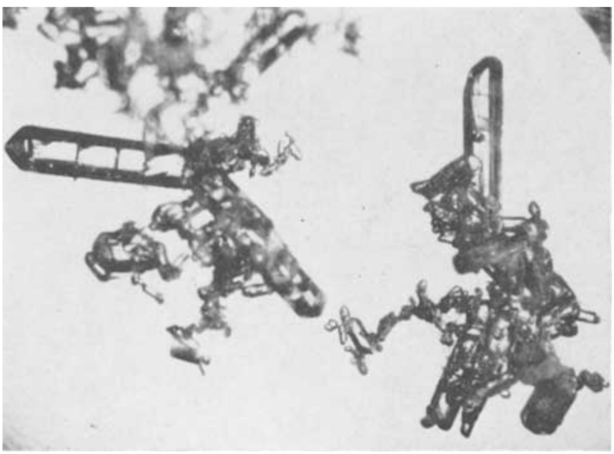

FIG. 8. *Apatite crystals in almandine garnet specimen 81721-9 (20 ×).*

Discussion of the Results

Apatite seems to be a very common inclusion in corundum and almandine garnet. Altogether we have found, up to now, apatite in three corundums, nine garnets and one spinel (including gemstones not described in this paper). It is striking that all these

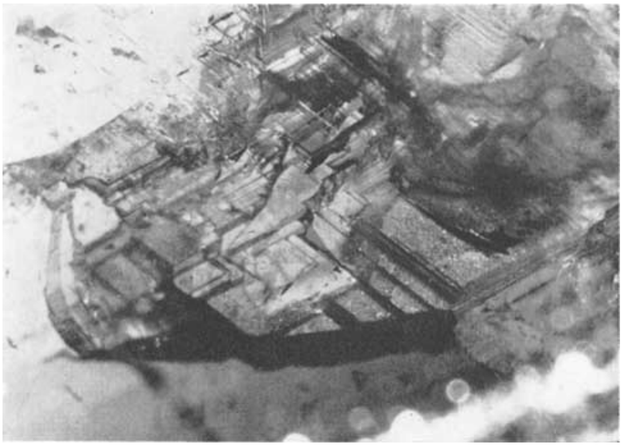

FIG. 9. *Apatite in almandine garnet specimen 81721-10, in reflected light (20 ×).*

apatites have identical X-ray powder diagrams and all belong to the group of the chlor-bearing hydroxyl-apatites.

Spinel, too, is not an uncommon inclusion, especially in corundum.

Apart from this it is clear that corundum may contain a large number of different minerals. Examples described in this paper include, beside apatite and spinel, pyrrhotite, phlogopite, rutile and even corundum. In addition we found calcite in two rubies not described here.

Many of the same minerals are observed in almandine garnet, moreover sphalerite appeared to be enclosed in two garnets not mentioned in this paper. Now it is an important question whether all these inclusions are characteristic for gem minerals from Ceylon. Hitherto one would be inclined to think so, but I am not certain. Much work must still be done before giving any further information.

ACKNOWLEDGMENTS

I wish to thank the technical staff of our Museum for several services. Mr. B. F. M. Collet carefully made the microphotographs, Mr. J. J. F. Hofstra and Mr. J. van der Linden prepared the X-ray powder photographs.

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THE CHARACTERISTICS AND INCLUSIONS OF BLACK STAR-DIOPSIDE*

By B. F. MARTIN, M.D., B.Sc., F.G.A.

FOUR-RAYED star stones are far from common; six-rayed stones belonging to the trigonal system of crystal symmetry are better known, e.g. corundum. An interesting example of the former is black star-diopside which has recently appeared from India. These attractive stones have recently received comment from Webster(1), in an article on black gemstones. He states that they are actually dark green in colour and have a small range of density between 3·30 and 3·40. He observed that the rays are not strictly at right angles and this is significant, since diopside belongs to the monoclinic system of crystal symmetry.

It should be noted that diopside is a pyroxene and is mainly a calcium-magnesium silicate, but some ferrous iron invariably replaces some of the magnesium and imparts some shade of green to gem material. The colour is finer and brighter if some chromium is present as well (chrome diopside). Not unexpectedly the physical constants vary; the refractive index average values are given as 1·67–1·70 (birefringence: 0·020–0·030) and the specific gravity varies from 3·27 to 3·31 (Webster(2); McLintock(3)). With increasing percentage of iron the colour darkens to an almost opaque black and such material, termed hedenbergite, shows higher constants; the refractive index rises to 1·732–1·751 and the specific gravity to 3·60 (Coles Phillips(4)).

Diopside is not often cut as a gemstone and it has the drawbacks of comparative softness (Hardness: 5 to 6) and easy cleavage. Some samples have a fibrous nature and when cabochon-cut show a chatoyant effect. Particularly good chrome diopside cat's-eyes have come from Burma(4).

The author has studied four black star-diopsides, weighing respectively 1·75, 2·12, 2·19 and 2·85 carats. All showed a high polish and a sharp star and in each case it was confirmed that the two rays do not cross at exactly a right angle. In addition, it was noticed that the arms of the two rays do not lie in a straight line and

*This work was submitted almost concurrently with that of W. F. Eppler, whose paper appeared in the preceding issue of this Journal (April 1967), and the results are essentially in agreement.

also the one ray is sinuous since the extremities of its arms curve in opposite directions. It was noted further that the angles between the arms of the rays change a little as the stone is rotated with respect to the light source. An investigation was therefore undertaken to determine the general characters of the stone and its star and a microscopic study was made for inclusions, since chatoyancy or asterism can only occur when long, thin inclusions are present, orientated parallel to one another in one direction to produce chatoyancy and in more than one direction to produce asterism. The inclusions function as thin cylinders which reflect cones of light, and when the stone is cut en cabochon the conical reflection produces a single line which runs perpendicular to the length of the inclusions (Eppler(5)).

General Characters of the Stone

By distant vision, the refractive index of the stones was estimated at approximately 1·67, and the specific gravity at approximately 3·34, since the stones sank very slowly in pure methylene iodide. These constants are near to those given by cabochons of black jadeite, but the lustre of the latter is quite different.

To determine the refractive index more accurately, a flat facet was polished on the base of one of the stones. Although the shadow edges were not very sharp, the readings obtained were 1·674–1·700 (birefringence: 0·026). An accurate specific gravity estimation, kindly undertaken on one of the stones by Robert Webster, gave a value of 3·35. Thus, the refractive index is within the normal range for diopside, and although the specific gravity is slightly higher than that usually quoted, both constants fall below those of black hedenbergite (quoted above), suggesting that their colour is more likely to be due to their inclusions (see later) than to a high content of iron.

A detailed investigation of the effect produced on the star by rotating the stone with respect to a fixed light source was made as follows. The stone was placed over the centre of a metal washer to stabilize it whilst it was rotated on a stage and photographed at 5 × magnification in different positions with respect to a spot source of light from a microscopic lamp, with its diaphragm partly closed. The appearance of the star in two positions is shown for one stone in Fig. 1 (A1 and A2) and in three positions for another stone (B1, B2 and B3). It can be seen that the two rays of the star

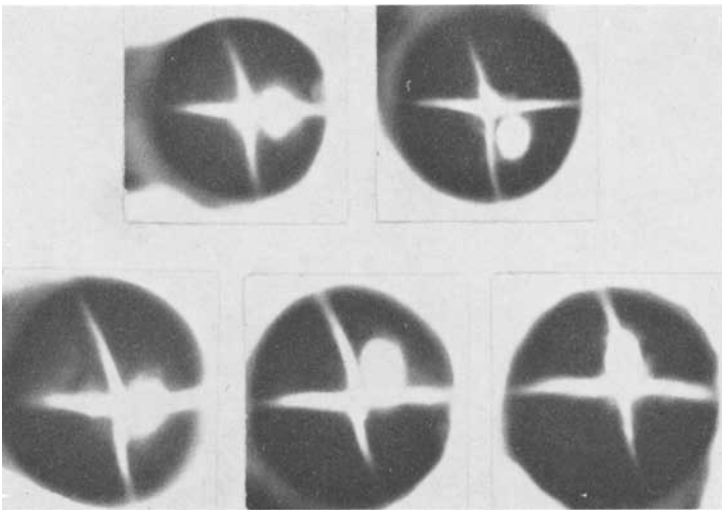


FIG. 1. *The form of the star and the changes in inclination of the arms of the two rays in two lighting positions for one stone (A1, A2) and in three positions for another (B1-3). 5 ×*

do not cross at a right angle, that the arms of each ray are inclined at an angle and that the arms of one of the rays are curved in opposite directions at their extremities to produce a sinuous effect. The sinuous ray is orientated vertically in the photographs. A further point is that the angle between the arms of each ray varies a little in the different positions and a position is reached where the arms of a ray reverse their direction of inclination; compare the arms of the horizontally orientated ray in B1 and B3.

This phenomenon was studied further by photographing a third stone in eight positions during a complete rotation, i.e. when the light spot was directed on each of the four star arms as well as when it was equidistant between adjacent arms. From 30 × print enlargements, tracings of the star-outlines were made and from the star-centre lines were drawn as far as possible along the central axis of each star-arm, so that the angles between the arms could be measured. The results for this stone are illustrated diagrammatically in Fig. 2. It is seen that not only do the angles between the arms of each ray vary, and more so in the case of the sinuous ray, but also that there is a critical position, different for each ray, at which the arms start to incline in the opposite direction. Because of these variations, only an average value can be given for the angle

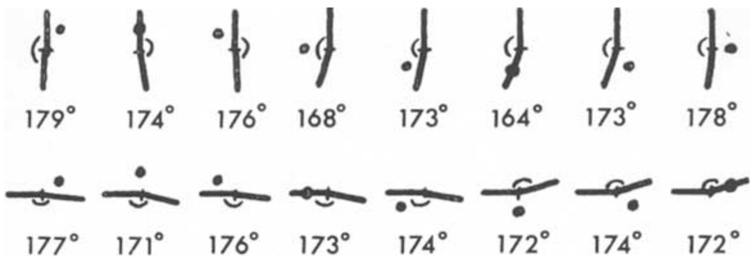


FIG. 2. *Illustrates the changes in inclination of the arms of the two star-rays, following illumination from eight different positions. The position of the incident light spot is shown by a circle and the arms of the sinuous ray are orientated vertically.*

at which the two rays cross. The average obtained from measurement of the obtuse angle between the rays in the eight positions of the stone was 105°, and this is important to note in relation to the inclusions, which remain to be considered.

THE INCLUSIONS

With a bright source of light, small rod-like inclusions could be seen with a 10 × loupe, brilliantly reflecting the light. By using a microscope lamp for illumination and a low-power objective ($1\frac{1}{2}$ inch) it was possible to obtain photomicrographs of the inclusions by incident light. The position of the lighting was quite critical. In many positions the interior of the stone appeared quite dark but in some positions the inclusions were seen, brilliantly reflecting the light against a dark background (Fig. 4a) and in other positions they appeared black in colour against a light background (Fig. 4b). As mentioned earlier, it is likely that the colour of the inclusions is responsible for the body colour of the stone.

Under the low magnification obtainable with incident light, the inclusions appear as rods of varying length, orientated in two definite directions. They are mostly very thin but a few are broader and may then be irregular. From print enlargements it is clear that the thin "rods" are each composed of a row of tiny, rounded particles (Figs. 3a, 3b). The small numbers of broad inclusions are composed of a series of short rows of particles. Each short row follows one inclusion direction but the rows are aggregated in parallel to form a long inclusion, and this follows the other inclusion direction. Such inclusions, being formed of particles in a compromise arrangement are sometimes of irregular outline and may even be bent (Figs. 3a, 3b); rarely are the particles arranged in an irregular cluster (Fig. 3b).

From prints enlarged to 180 ×, tracings were made of the inclusions so that their angle of inclination could be measured. Although there was some variation, the average result from twenty-five measurements was 105° which, not unexpectedly, was the average angle at which the two rays of the star had been found to cross.

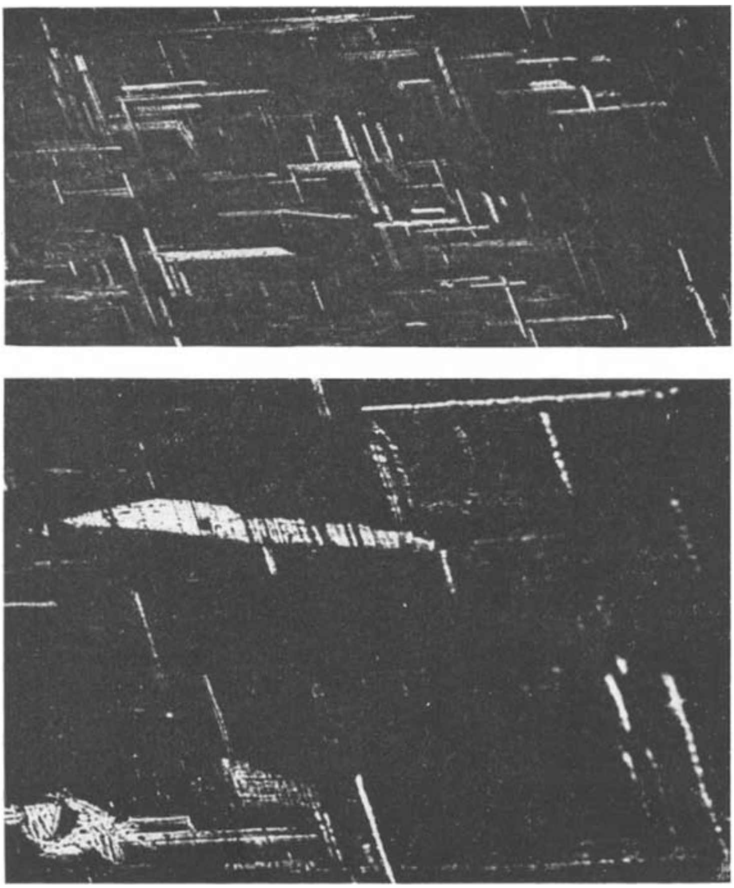
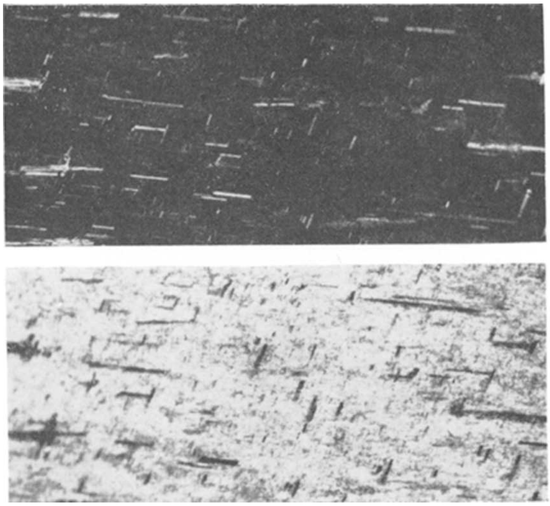


FIG. 3. *Inclusions are reflecting the light against a dark background at 80 × magnification (a) and at 160 × (b). They follow crystallographic directions an dare composed of single rows and occasionally multiple rows of particles.*



(a) (b)

FIG. 4. *Photographs at 17 × through a back facet, showing inclusions bright against a dark background (a) and black against a light background, as the lighting is altered (b). Note their sinuous course*

From these figures, it is clear that the inclusions are arranged according to crystallographic directions. Rogers and Kerr(6) give the β angle for diopside as 74° 10′, whereas Phillips(7) states that the β angle between the x and z axes should be quoted, by convention, as the obtuse angle and this would therefore be a little over 105°.

Although the inclusions follow crystallographic directions, they show an added complexity. It was noted above that bending of an inclusion may be seen, but when low power photographs were taken through a polished back facet it became apparent that the course followed by the inclusions is not straight, and in the one direction their course is sinuous, which would account for the sinuous nature of one of the star rays (Figs. 4a, 4b). The changes in inclination of the arms of the star-rays with change of position of the light source may also be determined by this imperfect orientation of the inclusions. It is known that individual rod-like inclusions may become bent during growth of the host crystal, as Gübelin(8) found in the case of included tremolite needles in Habach emeralds, but it must be an unusual circumstance for inclusions to follow such direction changes as found in the present study.

The nature of the particles composing the inclusions was not determined, but their identification would be of interest. Since they are distributed throughout the host material according to crystallographic directions, they probably fall within the class of solid secondary inclusions, formed by exsolution, which Gübelin[9] has discussed in his classification of inclusions. Eppler[10] suggests that they may consist of clinoenstatite.

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Gemmological Abstracts

LENZEN (G.). *Begrifflicher und Historisches zur Bearbeitung des Diamanten.* Facts and History of the polishing of diamonds. Zeitschr. d deutsch. Gesell. f. Edelsteinkunde, 1966/67, 58, pp. 4-19.

Interesting summary of the polishing of diamond and its history, with a bibliography of 65 items. Cleaving, sawing, bruting and polishing are described, as are the optimum values of Tolkowsky's brilliant-cut and various fancy cuts. It is not known when diamonds were first polished in India; most certainly it was not before the 6th century. The first mention of diamond polishing in Europe was in the 14th century. Diamond cutting seems to have occurred in India as well as in Europe in the 16th century. According to Tavernier the working of the diamond in the 17th century differed between India and Europe.

E.S.

EPPLER (W. P.). *Eilat-Steine.* Stones from Eilat. Zeitschr. d. deutsch. Gesell. f. Edelsteinkunde, 1966/67, 58, p. 23.

This was published in the Deutsche Goldschmiedezeitung 19/1966, and discussed the stones found near Eilat on the Red Sea, in the former copper mines of King Solomon in the 10th century B.C. These mines in Southern Israel are now worked again. The stones are of cuttable quality and of pure turquoise or turquoise with malachite veins. This material is a very lively blue, with green, and its S.G. is between turquoise and malachite, depending on its composition. E.S.

Smaryll. Zeitschr. d. deutsch. Gesellschaft f. Edelsteinkunde, 1966, 57, pp. 47-48.

A new emerald imitation on the market, sold as "Smaryll". The colour is good, both upper and lower part consist of colourless beryl, very pale aquamarine or pale emerald. The two parts are cemented together by an acid-resistant duroplastic of emerald-green colour with a thickness of 0·15 mm. It is interesting that these Smarylls appear green when viewed from the side. Physical constants are given. The correct name would be "emerald-coloured beryl doublet".

E.S.

SCHLOSSMACHER (K.). *Gedanken zur Ausbildung von Diamantsachverstaendigen.* Thoughts on the education of diamond experts. Zeitschr. d. deutsch. Gesell. f. Edelsteinkunde, 1966/67, 58, pp. 2-4.

At the moment there are three courses in Germany specializing on diamonds. One is a three-day course in Idar-Oberstein organized by the Deutsche Gesellschaft f. Edelsteinkunde, the second is also a three-day course run by the Gesellschaft der Edelsteinfreunde in Hanover and the third is a two-week course of the Köenigsteiner Schule. The author suggests that students should attend all three courses and the results of each course and/or exam. be judged by a Commission.

E.S.

LENZEN (G.). *Geschichte der Qualitätsmerkmale des Diamanten.* History of the signs of quality in a diamond. Zeitschr. d. deutsch. Gesellschaft f. Edelsteinkunde, 1966, 57, pp. 18-39.

The first part of a historical summary about the various aspects of diamonds. The first part deals with colour and the importance of its nomenclature. The author shows that colour was of no importance as far as value was concerned in India (between the 4th and 6th century B.C.). Two monks named Buddhabhatta and Varahamihira summarized colours found in various occurrences; these are listed and compared. The diamonds found in Paundra were said to be grey, those of Kalinga yellow, of Vena colourless and those found in Himalaya copper-red. The different colours were said by the monks to belong to the different gods, and this was carried into the caste system, so that the Brahmans had the colourless stones, while the Sudras had the black stones. With the discovery of the Brazilian deposits it was known that colourless stones were much rarer and thus they became also more valuable. The top (colourless) quality was called Golconda, and this fell by stages to the Bahias, which were light yellow. The author explains the "old terms" such as Jager, River, Top Wesselton, etc., and the names in the yellow and brown series. The difficulties of determining colour are mentioned. Bibliography.

E.S.

PERIZONIUS (R.). *Skapolith. Scapolite.* Zeitschr. d. deutsch. Gesellschaft f. Edelsteinkunde, 1966, 57, pp. 41-44.

Description and physical constants of scapolite. The variety most commonly used as gem is mizzonite, found in Espirito Santo in Brazil and in Madagascar. There are various other occurrences, such as Norway, Finland, New Jersey, Quebec, but these do not yield gem material. Other varieties are dipyrite, which is found in white or pink crystals of 3-5 mm length, marialite, which seems to be the most chemically resistant variety, and mejonite, which is attacked by hydrochloric acid. This latter type is found in a clear colour in Sweden and also in Bolton, Mass., U.S.A., in a grey-green variety. Some pink scapolites and also some dark blue to violet ones have a fibrous structure; when cut as cabochons they show chatoyancy.

E.S.

SEAL (M.). *Inclusions, birefringence and structure in natural diamonds.* Nature, 1966, 212 (57), p. 1528.

Natural diamond crystals can be inhomogeneous in their internal structure, due in many instances to alteration of regions of type I and type II material. The author suggests that some of the inhomogeneity must be the result of subtle changes in the texture.

S.P.

BOOK REVIEWS

VOLLENWEIDER (MARIE-LOUISE). *Die Steinschneidekunst und ihre Kuenstler in Spaetrepublikanischer und Augusteische Zeit.* The Art of stone engraving and its artists in the late republic and at the time of the Augustine empire. Bruno Grimm, Baden-Baden, Western Germany, 1966.

This well-produced book is a collection of gems and intaglios produced in antiquity. There are 100 tables with 577 black and white photographs, with the exception of the first cameo, which is a sapphire and shows Venus with an eagle. This seems to be the largest antique cameo known, measuring 35 mm by 30 mm, with a depth of 8 mm. The text is concise, each item is described and there are indices of the engravers, goldsmiths and jewellers, and of the mythological and real people despicted on the gems.

King's "Antique Gems", which provides the basis of the subject of antique gems, is only briefly mentioned. The last four tables illustrate modern copies of antique cameos and intaglios. E.S.

LENZEN (G.). *Produktions- und Handelsgeschichte des Diamanten.* The History of the production and trade of the diamond. Duncker and Humblot, Berlin, 1966, pp. 280.

This book was originally a doctorate thesis and has now been published in book form. Because of this and of the many details mentioned it is difficult to read. It is well illustrated (38 photographs), has an extensive bibliography and the index is sub-divided into names and geography.

The author deals with the diamond as material, then as a mineral, as gem and as industrial tool. The main part of the book is divided into geographical sections, dealing with diamonds from India, Brazil and Africa. The importance of Russian deposits and of the synthesis for industrial purposes is only fleetingly mentioned.

The historic finds in India are described, as well as the type of production and the way diamonds were traded in the middle ages and up to the present time. A large part of the book deals with African finds, especially finds in the Union. The formation of the Diamond Syndicate is described and also the present structure of the various DeBeers Companies. The author suggests systematic surveying and drilling of Indian and Brazilian deposits, similar to those performed in South Africa.

E.S.

PALMER (J. P.). *Jade.* Spring Books, London, 1967. 15s.

This brief introduction to jade will be best appreciated for the 54 superb colour illustrations. The pieces illustrated are excellent examples of the jade carver's art, as well as showing the richness and variety of the many colours of jade. A bibliography would have been helpful. The author is an Assistant Keeper at the Fitzwilliam Museum, Cambridge. In relation to its excellence the book is very modestly priced.

S.P.

ASSOCIATION NOTICES

ARMORIAL BEARINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

In 1966 the Association made application to the Earl Marshal and Hereditary Marshal of England for a grant of Armorial bearings, based upon a design prepared by H. Ellis Tomlinson, M.A. Mr. Tomlinson was responsible for the design of the Arms of the National Association of Goldsmiths of Great Britain and Ireland, under whose aegis the Gemmological Association was formed in 1931, after being the Education Committee of the N.A.G. since 1908.

The accompanying description of the Arms has been prepared by Mr. Ellis Tomlinson.

Jewel-Blazon

In mediaeval times heraldry, like other manifestations of man's artistry, was subject to fanciful treatment in both language and ornament. One such conceit was the practice of naming the heraldic colours by reference to jewels, especially in blazoning the arms of the high nobility. Guillim in his "Display of Heraldry" (late 17th and early 18th Century) equates the tinctures thus:—
Or (gold) = topaz; Argent (silver) = pearl; Gules (red) = ruby; Azure (blue) = sapphire; Sable (black) = diamond; Vert (green) = emerald; Purpure (purple) = amethyst; Tenne (orange) = jacinth; Sanguine (dark red) = sardonyx.

"These", he says, "are nowhere us'd but in England", but Fox-Davies (Complete Guide to Heraldry) quotes an Austrian grant of arms of 1458 in which ruby, pearl and emerald are used for red, silver and green. He says he is "Not aware of any instance of the use of these terms in an English Patent of Arms", and certainly no such official use has been discovered in recent researches. It is therefore no small distinction that attaches to the official blazon of the Arms of the

Gemmological Association, which, by special dispensation of the Kings of Arms, is couched with obvious appropriateness, in the nomenclature of the mediaeval lapidary, viz:

Arms

Pearl on a cross formy quadrate throughout quarterly ruby and sapphire a closed book bound and clasped topaz the cover set with an emerald environed of pearls between two sapphires in pale and two rubies in fess between in chief within an annulet topaz a rose-cut diamond proper in fess two lozenges pearl each charged with a cross diamond and in base a ring topaz gemmed pearl.

Crest

On a wreath pearl ruby and sapphire a demi-lynx proper holding between the paws an escarbuncle of eight rays ruby each floretty and pommety of a jewel respectively from the base pearl, ruby, jacinth, topaz, emerald, turquoise, sapphire and amethyst.

Motto

Omnemque pretiosum lapidem. The motto is taken from the first Book of Chronicles, 29.2 ("I prepared) all manner of precious stones").

INTERPRETATION

Shield

The cross is a variation of that in the Arms of the National Association of Goldsmiths of Great Britain and Ireland. It is quartered red and blue like the associated Arms of the Worshipful Company of Goldsmiths and the N.A.G. In the middle is a gold jewelled book which represents the study of gemmology and the examination work of the Association. Above it is a top plan of a rose-cut diamond inside a ring, suggesting the scrutiny of gems by magnification under the lens. The lozenges represent uncut octahedra, and the gemmed ring, from the N.A.G. Arms, indicates the use of gems in ornamentation. The colours of the shield are mainly the national red, white and blue, which also cover the main range of gems.

Crest

The lynx is renowned for his keenness of sight and perception, and in ancient times was credited with the faculty of seeing through opaque substances. He represents the lapidary and the student scrutinizing every aspect of gemmology. In his paws is one of the oldest heraldic emblems, an escarbuncle. This is said to represent a very brilliant jewel, usually a ruby, the radiating arms suggesting the light it diffuses. The 17th century heraldic encyclopaedist, Guillim, writes:

"Stones precious are of that sort that we call in Latin 'Gemmae'; which are of estimation either for that they are rarely to be gotten, or for some vertue fancied to be in them, or for that they are such as man's eye is wonderfully delighted withal by reason of their pureness, and beautiful transparent substance. Of which kind are the Diamond, Topaz, Escarbuncle, Emerald, Ruby and such like . . . But of all these several kinds, the Escarbuncle is of most use in Arms . . . This is called in Latin 'Carbunculus', which signifieth a little Coal, because it sparkleth like Fire, and casteth forth, as it were, fiery Rays". (He continues in an amusing postscript: "There is another kind of, but fiery, carbuncle, which Chyrurgeons can best handle; one of those of the lapidaries is more to be desired than ten of the other").

The escarbuncle is, as it were, heraldry's special emblem of gemmology. It is often shown with the *fleurs-de-lis* at the tips and the pommels round the rays in a different colour from the rays and central jewel. Here, the tips and pommels are shown as jewels representing the respective colours of the spectrum, completed by pearl for the white light representing the fusion of the spectrum colours. This is a unique treatment of the escarbuncle, which, with the lynx holding it carefully, represents the aims and activities of the Association.

The right to a coat of arms conferred by a grant of arms, made by the Kings of Arms under the royal authority, is a limited right, defined by the limitations in the patent, and not a right which the grantee can pass on to a third party. Any reproduction of the Association's Arms or any colourable imitation thereof is not permitted without the prior consent of the Council of the Association.

MIDLANDS BRANCH

A meeting of the Midlands Branch of the Association was held on the 12th January, 1967, at the Auctioneers' Institute, Birmingham. Mr. D. King presided and introduced Mr. L. S. Lipkin, who gave a talk, supported with colour transparencies, on "Cultured Pearls".

Everybody who attended the annual meeting of the Midlands Branch of the Gemmological Association held in Birmingham on 19th April had a chance to test their knowledge in a gemmological quiz. Four teams of experts Messrs. Beresford, G. W. Davis, K. Hoskyns, J. F. Marshall, D. E. Price, J. Salloway, J. R. Shaw and P. Spacey brought along uncut gem material and gem-set antique and modern jewellery which they set up for the other members to identify and to estimate weights and values.

This lively and enjoyable session followed the more serious business of the meeting in which Mr. W. Peplow (senior) proposed, and Mr. K. Hoskyns seconded, the re-election of officers *en bloc* to serve for the forthcoming year. They are: chairman, Mr. D. N. King; deputy chairman, Mr. N. A. Harper; vice-chairman, Mr. Pete Spacey; secretary, Mrs. S. E. Hiscox. Committee members: Messrs. G. W. Davis, J. F. Marshall, D. E. Price and J. Salloway.

The Chairman's report for the year gave details of all the meetings and functions held including a visit to Mappin & Webb's (Bull Street, Birmingham) "Diamond exhibition", by courtesy of the directors of Mappin & Webb's. The branch had had the pleasure of interesting guest speakers at three meetings. At one, Mr. D. J. Ewing talked on his visits to Idar Oberstein in Germany. At another Mr. Leo Lipkin talked on cultured pearls and on pearl fisheries in Japan. This was well supported by slides, and Mr. Keith Gardener, sales manager of Lotus Pearls, talked on sales aspects. At the March meeting, Mr. N. A. Harper talked on De Beers "Diamond Symposium" and this had been followed by the film "Out of the blue", dealing with the recovery of diamonds in pipe mines in S. Africa.

Finally, a very successful dinner, dance and cabaret had been held in November at the "Barn Restaurant", Hockley Heath, Solihull.

OBITUARY

May 1967. Oscar Fahy, Birmingham. Mr. Fahy was one of those who qualified in the first gemmological diploma examination held in 1913. He was a well-known gem dealer in the Midlands.

WEST OF SCOTLAND BRANCH

At the annual meeting of members of the West of Scotland Branch of the Association it was decided to change the name of the Branch to "The Scottish Branch of the Gemmological Association of Great Britain".

Mr. J. M. B. McWilliam was elected as Chairman, Mr. J. H. A. McRae, Vice-Chairman, and Mr. D. A. Hill, as Secretary for the ensuing year. In commenting upon the work of the year the out-going Chairman, Mr. J. Gilloughley, recalled the interesting summer outing to the Pass of Kilicrankie, and the talks given by Mr. Robert Webster and Mr. J. M. B. McWilliam. Mr. Gilloughley exhibited the most comprehensive and valuable collection of gem specimens that had yet been shown to the Branch. Members of the organizing committee were thanked for their work in connection with one of the most successful years the Branch had had.

COUNCIL MEETING

At a meeting of the Council of the Association held on Wednesday, 3rd May 1967 the following were elected:—

Fellowship

Cremer, Viktor (Dr.), Winterleitenweg, Germany. D.1961
McNeilly, Henry Hart, Belfast 1, N.I. D.1929
Stocker, Philip Leslie, Welling, Kent. D.1959

Ordinary Members

Ashton, Howard Neill, London, W.2
Barkle, Bessie Edith Mary (Mrs.), Wembley, West Australia
Bennett, Elsa Carol Freda (Mrs.), Keswick, Cumberland
Bosch, Jose M. (Dr.), Barcelona, Spain
Chang, Felix S. Y., Taiwan, Formosa
Coleman, Walter D., Arvada, U.S.A.
Cook, Eric David, Marlborough
Coomans, Hendrikus Eduard, Amsterdam, Holland
Cronstedt, Katharina (Mrs.), Mt. Yokine/W.A. Australia
Eveleigh, Michael Leonard, London, S.W.1
Hayes, Lillian Eveline (Mrs.), London, N.W.9
Hayton, Pauline (Miss), London, S.E.3
Hossen, Abdool Hamid, Port-Louis, Mauritius
Kawashima, Tomio, Tokyo, Japan
Leonard, Paul Lucas, Cobourg, Canada

Newman, Brian Anthony, Cape Town, South Africa
Pous, Joaquin Montoriol (Dr.), Barcelona, Spain
Radford, Herbert George, Jnr., Barrhead, Scotland
Robinson, Geoffrey, London, N.W.3.
Roysko, Aake Lionel, Tampere, Finland
Singer, Herman, Chevy Chase, U.S.A.
Tamiya, Haruaki, Tokyo, Japan
Thim, Tham Yen, Penang, Malaysia
Thurgar, Stanley H., Burlington, Canada
Trenholme, Russell Shannon, Tokyo, Japan
Wasilkowski, Wanda K. (Mrs.), Miami, U.S.A.
Yamamoto, Shigeo, Tokyo, Japan
Yeung, Stanley Kai Yung, Hong Kong
Bramley, Donald, Doncaster, Yorks.
Suddaby, David C., Sutton Coldfield, Warwicks
Horii, Ayako (Miss), Tokyo, Japan
Wadhwa, Pushpa (Mrs.), Eldoret, Kenya
Grimminger, Alfred, Frankfurt, Germany
Pacal, Zdenek, Prague, C.S.S.R.

Probationary Members

Birkinshaw, David William, Wakefield, Yorks
Bond, Ian Norman, Whangarei, New Zealand
Covent, Richard Jeffery, Toronto, Canada
Engstrom, Barbara (Miss), Woodford Green, Essex
Heriz-Smith, Nicholas Peter, London, S.W.12
Holton, David John, Wilstead, Bedfordshire
Ishizumi, Momoyo (Miss), Shiga-Ken, Japan
Masterman, Gillian Elizabeth (Mrs.), Gerrards Cross, Bucks.
Porter, Graham Stanley C., Birmingham, Warwicks.
Upchurch, David Ward, Colchester, Essex

The Council received notice that the West of Scotland Branch had changed its title to that of the Scottish Branch of the Gemmological Association of Great Britain.

It was reported that the National Association of Goldsmiths was acquiring additional space in Saint Dunstan's House and that organization was prepared to allocate extra space to the Gemmological Association for dealing with its increasing gemmological educational work and sales of instruments.

ANNUAL MEETING

The thirty-seventh annual meeting of the Association was held at Goldsmiths' Hall, Foster Lane, London, E.C.2. on 3rd May. In presenting the annual report the chairman, Mr. Norman Harper, referred to the problems that the increased demand for the Association's courses and examinations had produced. The Association had had a successful year and he recorded appreciation of the work of the council, local branches and others who had contributed to the steady growth of the Association. Dr. C. T. Cross seconded the motion for the adoption of the annual report and accounts, which were unanimously approved.

The following officers were elected: President, Sir Lawrence Bragg, C.H., F.R.S., Chairman, Mr. Norman Harper; Vice-chairman, Mr. Philip Riley; Treasurer, Mr. F. E. Lawson Clarke. The chairman recalled that Sir Lawrence had been made a Companion of Honour in the New Year's Honours List.

Miss I. Hopkins, and Dr. E. H. Rutland were re-elected and Mr. D. King elected to serve on the Council. A resolution proposing the re-election of Mr. C. T. Mason notwithstanding that he had reached seventy years of age was unanimously approved.

The vice-chairman, Mr. Riley, suggested that it should be ascertained whether a pastel portrait of Sir Lawrence Bragg, which was on show at the summer exhibition of the Royal Academy, could be purchased by the Association.

GIFTS TO THE ASSOCIATION

The Association is indebted to Mr. Jean-Claude Rufli, of Stockholm, for a collection of Swedish and Norwegian gem minerals.

Mr. S. Gunaratne of Ceylon has kindly sent a Ceylon Government publication "Gems of Ceylon".

Mr. Z. Pacal, of Prague, has presented a collection of minerals found in Czechoslovakia.

1967-1968 COURSES IN GEMMOLOGY

The final date for enrolment in the Association's Correspondence Courses in Gemmology is 31st August, 1967. Application for entry into local classes in gemmology should be made to the Principal of the School or College concerned.

MEETINGS OF MEMBERS

A reunion of members, followed by the presentation of awards, will be held at Goldsmiths' Hall, London, on Tuesday, 10th October, 1967, at 6 p.m.

The Herbert Smith Memorial Lecture for 1967 has been arranged for 16th November, in London.

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C O N T E N T S

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