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and

PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

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A STUDY OF RHODOLITE GARNET

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

IT is well known that a whole series of garnets exists from pyrope to almandine, due to the isomorphous replacement of Fe for Mg in the basic chemical composition, and for those lying near the middle of the series Anderson(1) has proposed the name "pyrandine". It is not so well known that a distinct subvariety of the series is recognized which, because of its rose-red to pale violet colour, has been named "rhodolite" (Gr. *rhodon*, a rose). It is a rare stone and many gemmologists may not have encountered a specimen. According to Phillips(2), this variety was found, in limited quantity, in Cowee Valley, Macon County, N. Carolina. However, a few other sources are known and Sinkankas(3) reports that fine quality material of unprecedented size has recently appeared from Tanzania.

Very occasionally, stones having the colour described for rhodolite are encountered, but carrying no qualification other than "garnet". It seems that there is some reluctance to apply the term "rhodolite" unless it is known that the stone originated from Macon County. If, however, a garnet possesses physical features, in addition to colour, which mark it as a distinctive entity within the pyrope-almandine series, it seems only reasonable that it be granted its status and accorded its value, irrespective of its source.

Rhodolite is a subvariety near to pyrope and Webster(4) notes that its composition lies between pyrope and almandine in the ratio of 2:1. The constants for pyrope show a considerable range and the figures given by different authors do not exactly correspond, particularly in the upper limits. This is not surprising, since one is reaching the intermediate ("pyrandine") type. Phillips(2) states the R.I. range to be from 1·730 to 1·751, but Anderson(1) gives 1·76 as the upper limit and Webster(4) records 1·77. It is perhaps rather curious that the R.I. of rhodolite, which belongs to this series, has only the single figure of 1·76 recorded against it(2),(4). The same applies to the S.G.; Phillips(2) gives a range of 3·65 to 3·82 for pyrope and other authors quote similarly, yet the single figure of 3·84 is given for rhodolite(2),(4). Apart from these two constants, the only definite information recorded in standard works is that rhodolite shows the absoption bands characteristic of the almandine spectrum.

With a view to obtaining data that might prove helpful in the identification of rhodolite, an examination was made of a rose-red stone (0·47 ct.), classified as rhodolite and stated to have originated from Mason's Mountain, Macon County, N. Carolina. This stone will be referred to as the "Carolina" stone. The findings were then compared with those obtained from 11 large specimens which appeared correct for colour but were of unknown source, and these will be referred to as the "test" stones. One of these stones (approximately 2 ct.) was mounted in a ring which had been bought in by an antique dealer. Although stated to be a garnet, the dealer felt somewhat unsure, because of the unusual colour. The other stones consisted of a parcel of 10 large cut specimens of fine quality, ranging from 1·95 to 3·25 ct., and were the property of a firm of manufacturing jewellers. They were stocked as "rhodolites" and destined for better grade jewellery.

General Results

The "Carolina" stone. Examination with a 10 × lens revealed a number of inclusions and this was fortunate since their microscopic investigation proved particularly interesting and will be dealt with separately. The R.I., taken with sodium light, was 1·758. Spectroscopy revealed the three main absorption bands characteristic of almandine, i.e., positioned at 5050, 5270 and 5760 A, and they were of moderate intensity. Through the Chelsea colour filter, the stone's colour appeared a little deeper but was not dulled.

The "test" stones. With the 10 × lens, no included matter was seen in any of the stones. The R.I.'s lay within a very narrow range and showed the following values: 1·745 (2 stones), 1·747 (5 stones, including the mounted stone), 1·748 (1 stone), 1·749 (2 stones) and 1·750 (1 stone). Thus, each showed a value considerably lower than that of the "Carolina" stone, and their average value of 1·747 is near the middle of the range for pyrope.

With the spectroscope, the three absorption bands characteristic of almandine were seen and of the same degree of intensity as in the "Carolina" stone. The result with the Chelsea colour filter was also the same.

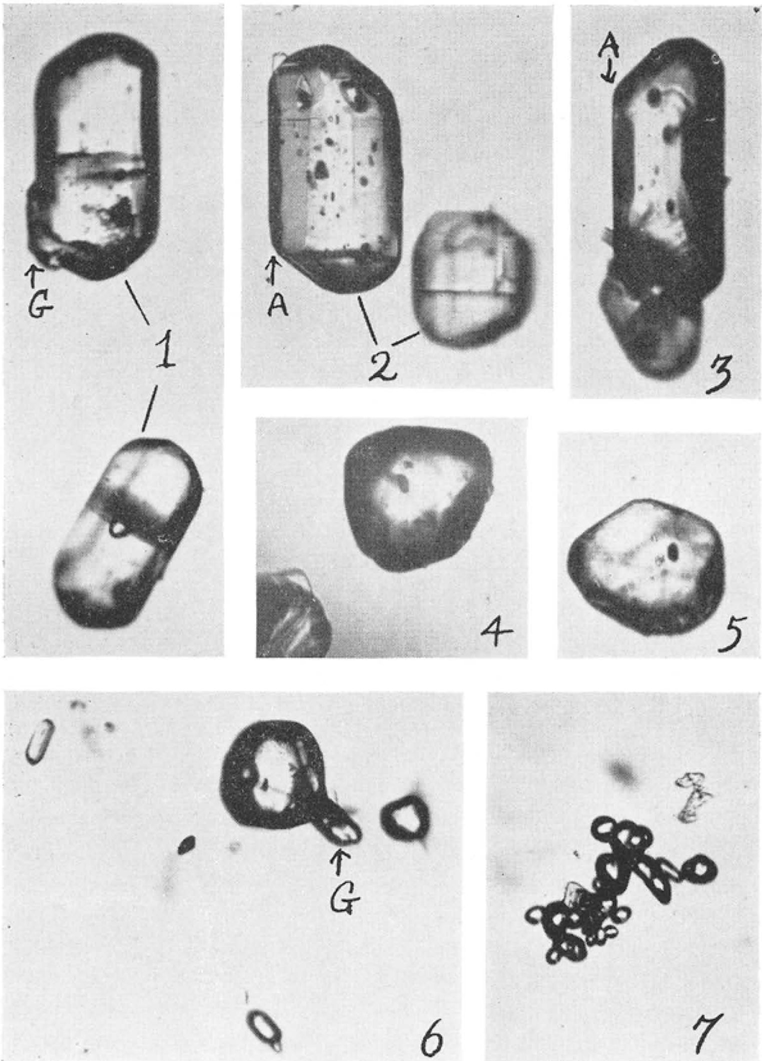
Although accurate estimations of the S.G. of these stones would have been of some academic interest, such an undertaking requires special laboratory facilities in the case of such heavy stones. It is simply recorded here that all the stones sank rapidly in pure methylene iodide, and at about the same rate.

Microscopic Examination

The "Carolina" stone. Examination of this stone, immersed in methylene iodide, revealed that the inclusions seen with the 10 × lens were doubly terminated prismatic crystals (Figs. 1–3). They lay at random and not in crystallographic orientation.

The crystals showed signs of wear, particularly at their terminations, but they appeared hexagonal in form and the ratio of length to breadth was 2:1. When the stone was suitably orientated to obtain an end-on view of the prisms, signs of wear were again evident, but in spite of unevenness of some of the faces and loss of sharpness of some of their edges, a roughly hexagonal outline was preserved (Figs. 4–6). A few crystals showed outgrowths (G in Fig. 1 and possibly in Fig. 6), and several showed a narrow transverse band (Figs. 1, 2). These bands almost certainly indicate basal cleavages. The band in the lower crystal of Fig. 1 appears broad due to light reflection; in other orientations it appeared narrow. Inclusions within the crystals themselves were common and were mostly round to oval, and presumably gas- or liquid-filled cavities (Figs. 1–5), but there were a few two-phase inclusions (Fig. 2).

The optical features of the crystals were as follows. Some of them appeared to have a pale violet tinge, best seen with diminished illumination. They showed birefringence between crossed polaroid, with bright colour changes. As can be seen from the photographs, the R.I. of the crystals differed considerably from that of their



(*Plate* 1. *Figs.* 1-7)

FIGS. 1-3. *Idiomorphic prisms of apatite in rhodolite garnet from N. Carolina. Note their own inclusions, some basal cleavages and an occasional outgrowth* (*G*). *Two well defined interfacial angles* (*A*) *are seen.* 150 ×.

FIGS. 4-6. *Some of the prisms viewed end-on, showing a roughly hexagonal outline. In Fig.* 6, *G is probably an outgrowth.* 150 ×.

FIG. 7. *Cluster of very small xenomorphic crystals of apatite in a rhodolite of unknown source. Compare the morphology with that of the small crystals in Fig.* 6. 150 ×.

medium. Their facet edges darkened as the focus was raised, indicating that their R.I. was lower than their host (garnet) material, and this was confirmed by a modified Becke line test.

Another investigation possible was approximate measurement of an interfacial angle. In two crystals, one of the angles $(10\bar{1}0 \wedge 10\bar{1}1)$ was sufficiently well defined to admit of measurement (A in Figs. 2, 3). The outlines of these crystals were enlarged from the photographic plate to 600 × and the angle between the normals of the two faces measured. This was found to be 49° in the Fig. 2 crystal and 47° in the Fig. 3 crystal.

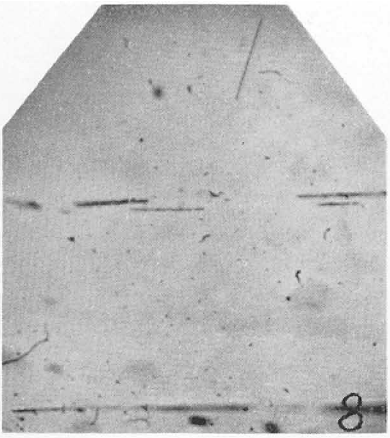
Following Gübelin's[5] classification, these crystals are primary xenogenetic inclusions. In general morphology and optical properties they correspond very closely with the crystals reported by Zwaan[6] to be common inclusions in specimens of almandine garnet and corundum from Ceylon, and proved by him to be apatite, following X-ray powder photography. Recently, Gübelin[7] has also described crystal inclusions of the same morphology in almandine garnet, spinel and ruby from Ceylon and in kornerupine, and by use of the electron microprobe he likewise proved them to be apatite.

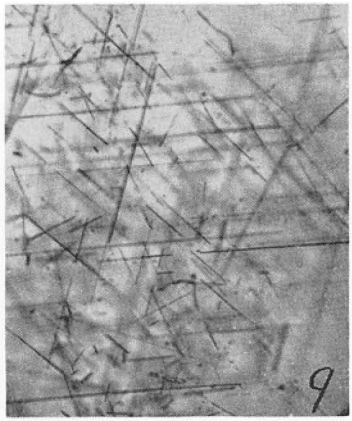
From the available evidence it therefore seems highly probable that the inclusions found in the "Carolina" stone are idiomorphic crystals of apatite, and this is supported by the interfacial angle measurement. The average of the two measurements was 48° and Dana[8] gives this angle for apatite as between 49° and 50°; it varies slightly with differences in chemical composition of the apatite.

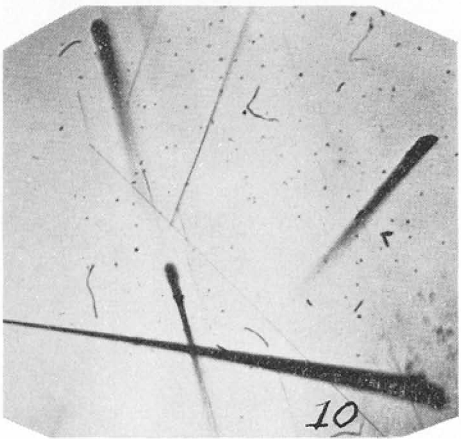
In addition to the crystals, a very small number of rather short, needle-like inclusions were present, and these were crystallographically orientated (Fig. 8).

The "test" stones. Of these stones, seven (including the mounted stone) showed no distinct inclusions. Of the remaining four, one contained small crystalline inclusions but no "needles", and three contained orientated, intersecting "needles". Only one of those containing "needles" showed a few small crystal inclusions, and these were similar in size and form to those found in the other stone.

The crystalline inclusions occurred both singly and in clusters. They consisted of very small round to subround grains and some of the latter showed a roughly hexagonal outline, very similar to that seen in the end-on views of the crystals in the "Carolina" stone







(*Plate* 2. *Figs.* 8-10)

FIG. 8. *Sparse, orientated "needles" in rhodolite garnet from N. Carolina.* 75 ×.

FIG. 9. *Numerous fine orientated "needles" in rhodolite of unknown source.* 75 ×.

FIG. 10. *Orientated "needles" in rhodolite of unknown source, some long and slender and others "comet"-like in form.* 75 ×.

(Fig. 7; compare with Fig. 6). It was also clear that there was the same disparity in R.I. between the crystals and the host material as was observed in the "Carolina" stone (see Figs. 6 and 7). It was concluded that these small inclusions are xenomorphic crystals of apatite.

The needle-like inclusions were very long, thin and few in number in one stone, in the second they were also thin, but shorter and closely set (Fig. 9), whilst in the third stone they were long but not all were thin; some had a curious club- or comet-like form, and these were probably cavities (Fig. 10).

Discussion of Results

From this study, it is suggested that the essential characteristics of rhodolite garnet are as follows. The R.I. lies within the range for pyrope, yet the stone is of an entirely different colour (rose-red to pale violet) whilst spectroscopy reveals the three main absorption bands of almandine, and these are of moderate intensity.

All 11 "test" stones satisfied the above criteria and, in a sense, more than satisfied, since each showed an R.I. well below that of the "Carolina" stone; their average R.I. was 1·747 whilst that of the "Carolina" stone was 1·758. This result, taken in conjunction with the microscopic findings, brings into focus the question of source and also the need for revision of the constants quoted for rhodolite. The single figures given for the R.I. (1·76) and S.G. (3·84) may have been obtained originally from a small supply of stones from Cowee Valley, and these could well have shown nearly identical values.

The study of inclusions is sometimes of assistance in stone identification and even in assigning stones to a particular locality. In the present study, two types of inclusions were found, namely, orientated needle-like inclusions and crystals, and the latter were almost certainly apatite crystals. The former are fairly common in pyrope and almandine garnet so their presence in a subvariety of the series comes as no surprise. It was perhaps no more than chance in a small sample that "needles" were few when crystals were present, and vice versa.

As noted earlier, both Zwaan[6] and Gübelin[7] have shown that apatite crystals are found in almandine garnet and other gem-stones from Ceylon and in these the usual habit was the idiomorphic prism; the xenomorphic crystal was uncommon. Furthermore, the chemical composition of the apatite was the same in all these stones [6].

In the study of crystal inclusions, it is important to establish not only their identity but also their predominant habit, since this may differ in stones from different localities. In this context, it might be pointed out that considerable interest was aroused amongst geologists when it was noted that although zircon crystals show considerable variation in habit, those obtained from rock formations of a particular locality show a preponderance of a particular habit and, in turn, the habit provides some clue to the early history of the environment (e.g. Callender & Folk[9]; Harris;[10] Larsen & Poldervaart[11]). Apatite, like zircon, is widely distributed, and furthermore its chemical composition is variable, so that a study of its predominant habit and chemical composition in stones of known source, by the refined techniques now available, may prove of considerable value to gemmology.

The results of the present study on rhodolite garnet suggest that the "test" stones were of a different source from the "Carolina" stone, since their R.I. was considerably lower and the habit of the crystal inclusions was different. Their large size and fine quality points tentatively to a Tanzanian origin. However, more data are clearly required from a larger number of stones of known source. Samples of this stone are in short supply and only one from N. Carolina was available for study, whilst of the 11 "test" stones only two contained crystal inclusions, in spite of their large size.

It is hoped that the observations made in this study will serve as a basis for further investigations on this unusual member of the garnet family.

ACKNOWLEDGMENT

I should like to express my thanks to Messrs. Steele & Dolphin, Ltd., Birmingham, for their kindness in allowing me to examine 10 rhodolite garnets from their stock of gemstones.

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STRANGE INCLUSIONS

By W. F. EPPLER

WHEN immersing aquamarine in benzylbenzoate(*), a liquid of a similar refractive index to that of beryl, any inclusions can readily be seen and easily studied. With a value of 1·569, the benzylbenzoate is just below the mean R.I. 1·575 of aquamarine.

On the other hand, this liquid has a higher viscosity than monobromobenzene, for instance, which has a R.I. of 1·56. Occasionally, the higher viscidity can be the cause of very strange "inclusions", of which Fig. 1 and 2 are amazing examples. Fig. 1 represents a cleavage crack parallel to the base plane of an aquamarine. The fissure is filled with benzylbenzoate as the immersion liquid, with the exception of four patches, which now are visible enclosures of films of air. They demonstrate that the cleavage of the aquamarine is not perfect but produces, as is shown in this case, uneven walls, which are the cause for the remaining or entrapping of air in the fissure, when the stone is immersed.

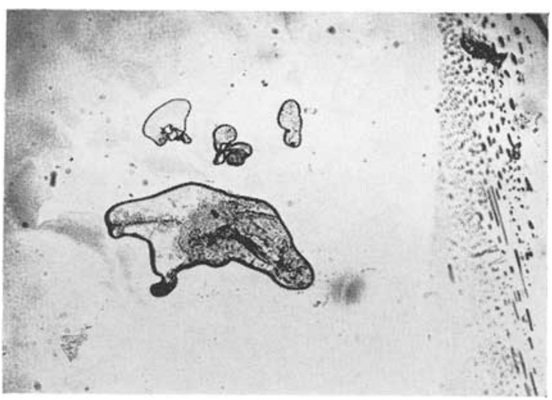

FIG. 1. *An open cleavage fissure in an aquamarine, partly filled with benzylbenzoate. Right: A natural healed fissure.* 22 ×.

* $C_6H_5 \;.\; CO_2 \;.\; CH_2 \;.\; C_6H_5$.

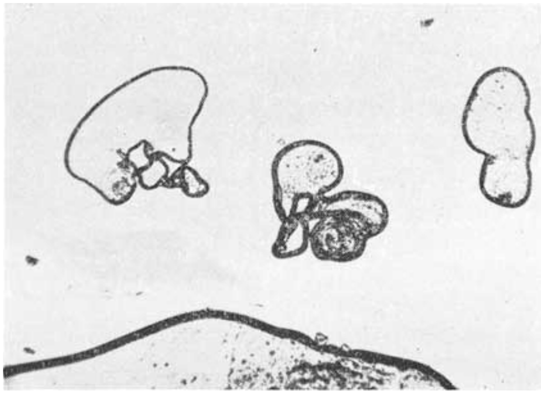

FIG. 2. *As Fig. 1 at a higher magnification of* 65 ×.

Fig. 2 exhibits the three upper patches of Fig. 1 at a higher magnification. They look like a particular kind of two-phase inclusion, even if they are only films of air which, due to the roughness of the walls, could not escape when the liquid entered.

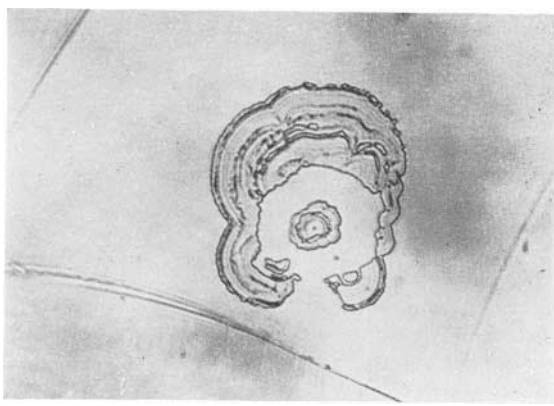

FIG. 3. *Emerald with a partly resorbed air film in a fissure filled with monobromobenzene.* 240 ×.

Fig. 3 reveals parts of a crack of random orientation in an emerald, which is embedded in monobromobenzene. Compared with the benzylbenzoate, this liquid has a lesser viscosity, and this property is the reason for another surprise. The air in the crack, which could not escape while immersing the emerald, forms a charming pattern, as shown in Fig. 3. But, after a certain time and favoured by the increasing temperature due to the lighting of the microscope, the picture steadily diminishes. After about an hour the air film disappeared with the exception of a small part of the upper rim. The reason for this is a slow diffusion of the air in the immersion liquid. When observing this "inclusion" first, it was totally "closed". The "opening" below and the broad white region around the "island" in its centre was air, emphasising the relief of the walls.

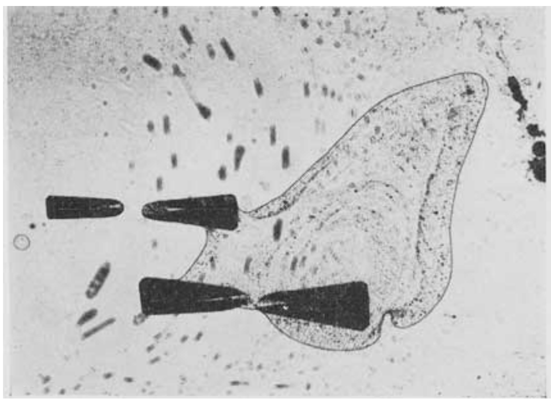

FIG. 4. *A cleavage crack parallel to the basal plane of an aquamarine with negative crystals. The stone is immersed in benzylbenzoate.* 22 ×.

Another strange inclusion is shown in Fig. 4. It is a cleavage crack which runs parallel to the basal plane of an aquamarine from Brazil. It is partly filled with benzylbenzoate and it contains a greater patch of enclosed air. Again, the film of air exhibits a certain roughness of the walls of the cleavage fissure. The strangeness is represented by four negative crystals, the form of which reminds one of a sugar-loaf. These crystals have a threefold cross-section at their thicker end and they are flattened at their point. In Fig. 5, the crude pattern of the cleavage crack can be observed through the brighter part of the negative crystal, a fact which indicates its emptiness. The black areas result from the total reflection of the light and not from a liquid or a solid content. In reflected light, they show a silvery reflection, as is usual with empty bodies or

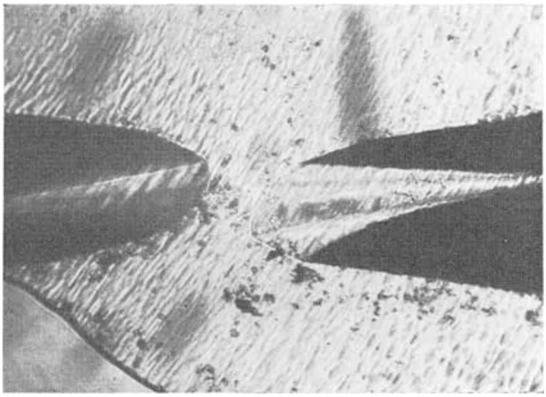

FIG. 5. *Part of Fig.* 4. 120 ×.

gas-filled bubbles within a material of higher refractive index. Also the even planes are characteristic for negative crystals. Fig. 5 also demonstrates that the pattern of the cleavage crack consists of very small cavities, most probably etch-pits. In the picture they follow with their elongation a direction from the upper right to the lower left. This direction and the geometric axis of the negative crystals include an angle of 60°. From this can be concluded that the negative crystals are parallel to the direction of a secondary axis of the aquamarine crystal. Until now, negative crystals of such extraordinary forms and orientation have not been observed, and it is not easy to find an explanation for their origin.

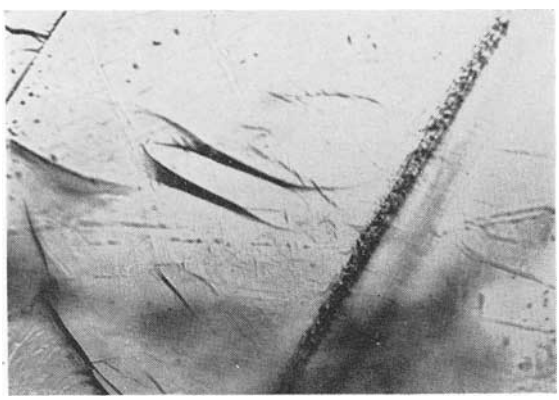

FIG. 6. *Blue sapphire, probably from Burma, with two cracks (centre), which have been mistaken as growth tubes when using a low magnification.* 120 ×.

Fig. 6 is offered as a warning. When first studying the stone, a sapphire of a fine blue colour, which the author owes to the generosity of Dr. Edward Gübelin, the two elongated inclusions in the centre were considered to be tubes of growth, as they often can be observed in synthetic emerald of hydrothermal origin. But when using a higher magnification, the inclusions proved to be cracks. It is therefore recommended to use the possibilities which are given by the greater enlargement of an inclusion, if any kind of doubt exists. The nature of the rod-like inclusion (right in Fig. 6) is not yet known; certainly it is not rutile.

DIAMOND NEWS FROM INDIA

By N. VISWANATH

PRODUCTION of diamonds in India increased fourfold in the past five years. Emerald mining, however, considerably declined in the last two years.

The following table gives production figures of various types of precious stones for the past five years.

Year	Diamonds (*carats*)	Emerald (*carat*)	Sapphire (*grams*)	Gem variety Garnet (*kgs*)	Agate (*tonnes*)
1964	2,260	53,000	203,280	2,554	262
1965	4,466	65,000	224,830	3,651	423
1966	2,113	54,000	185,000	5,170	493
1967	7,626	38,000	188,672	6,828	457
1968	8,764	23,000	194,522	4,986	630

Production of emerald in Rajasthan State went down from 10 kg in 1964 to 4·6 kg in 1968.

Up to the end of 1968, diamonds worth Rs.18·43 crores were exported from India as against Rs.15·72 crores and Rs.11·24 crores in 1967 and 1966, respectively. The main markets were Belgium, Kuwait, Hongkong, Lebanon, Malaysia, Switzerland, the United Kingdom and the United States. Only cut and polished diamonds are exported. Export of rough diamonds is not encouraged because of short supply.

Peerkhan, a tailor of the Panna diamond region in Rajasthan State of India, recently dug up a 28 carat diamond from his small quarry. It fetched about Rs.2·5 lakhs at an auction out of which he had to pay a royalty of 20 per cent to the National Mineral Development Corporation, a government of India concern.

Experts say the diamond is valuable but not rare. Since the discovery of Vijaya diamond about eight years ago, a 40 carat stone was found, but the gem was not publicised.

Peerkhan has not left his tailoring profession and said: "One must live by the sweat of one's brow and not on any windfalls". Half the amount of Rs.2 lakhs which was left over after payment of royalty, he gave his brother who has a share in the small quarry. That gave him just about one lakh of rupees, 25 per cent of which he donated to the local mosque for repairs, keeping the balance amount in a bank fixed deposit.

Diamond mining in Panna goes back at least 250 years. Chattrassi, a local warrior king, is said to have strayed into the vicinity of the Panna mines in his quest for funds to purchase arms to fight the then Moghul Emperors. A Brahmin admirer of Chattrassi blessed him in the following words: "Go forth, O King, and wherever your horse places its hooves the earth will turn into lustrous diamonds". And then he discovered the Panna mines.

A few weeks ago, Kundan, a sweeper of a village in the Saharanpur district, about 300 miles away from Delhi, purchased a fish at the weekly village fair, and, while embowelling it, he found a diamond inside.

Not knowing its worth, he showed it to a few city jewellers who offered him about Rs.10,000 provided he made a legal sale. The offer made him suspicious and without striking a bargain he returned home. Close on his heels, the police came after being tipped off by one of the jewellers, and confiscated the diamond.

The biggest ever diamond to be picked up from the Panna Mines weighed 16·8 carats, and the earlier one was about 14 carats. This is apart from Peerkhan's discovery because the mines are mostly prospected by the National Mineral Development Corporation.

At present India is exporting diamonds worth Rs.38 crores annually.

Recently, a team of British mining consultants have spoken of the "great potential" of the Panna diamond project in India. Mr. Arthur H. E. Taylor, partner of John Taylor & Sons of London, the firm appointed by the British Government to assist the project under technical assistance arrangements, has said: "The potential for diamonds, both at the pipe at Majhkawan and the gravel deposits at Ramkheria, is of major importance, and prospects for development of payable conglomerate deposits are also good". The team expects the project to reach its target figure of 23,000 carats annually.

Referring to the importance of diamond production in India, Mr. Taylor said: "There are also important prospects for discovery of diamonds in Andhra Pradesh which are now being examined by the Indian Corporation. Stones of gem quality will have a ready market both for local consumption and for export, while industrial diamonds will reduce the volume currently being imported into India".

The National Mineral Development Corporation has started bulk purchase of raw diamonds from world markets. This is because India wants to export increased quantities of cut and polished diamonds. At one time India had a monopoly in the world diamond market, but the situation changed completely after the discovery of diamonds in Brazil in 1728 and later in Africa. The current world demand for diamonds is about Rs.400 crores annually, and India's share in this was worth about Rs.30 crores last year.

The diamond cutting industry is concentrated in the Bombay region where about 20,000 skilled workmen are employed by the industry. Cutting and polishing of synthetic stones is done largely in Madras and Jaipur where about 10,000 workers are employed.

Indian jewels are exported to some European countries, West Asia, Japan and America. In an effort to capture markets in Australia and Latin America, the Indian Jewellers' Association is improvising traditional items for modern use. Gem-testing laboratories have been set up at Delhi, Bombav and Jaipur.

THE BURGUNDIAN COURT GOBLET

By H. TILLANDER

THIS magnificent masterpiece of lapidaries' and jewellers' work has not previously been described in any detail. In the catalogues of the jewels in the Treasure Chamber of Vienna the description covers only a few brief lines. In one old inventory only, dated 1476, when the goblet still was in the possession of the Dukes of Burgundy, the diamonds are listed and their design explained.

According to available information the goblet was made in the Burgundian territory around 1425-1450, for Duke Philip the Good. When the Duchess Maria, Charles the Bold's daughter, married Emperor Maximilian I, it went with her as part of her heritage to Vienna, where it still can be admired.

The overall height is 18¼ inches (46 cm). The rock-crystal parts are of superb workmanship and so is the entire gold work, richly jewelled with pearls, rubies and above all with diamonds. To some extent the gold is decorated with enamels in the typical style of the Burgundian era.

A brief visit to the Austrian Treasury in April 1967 revealed to me the exceptional beauty of the very old and rare shapes of the diamonds and I applied for permission to analyse them in detail. This became possible in August 1968 and I decided to study them and in addition all the other antique diamonds in the museums of Vienna. Inspired by the team from the Royal Ontario Museum who studied the Iranian Crown Jewels, I invited my collaborator U-J Pettersson, F.G.A., to join me on the expedition. Equipped with every possible kind of tool we were able to register the essential details of the stones. Unfortunately, however, time did not permit taking exact measurements and even an approximate indication of sizes can therefore not be given this time.

Of the 20 diamonds in the Court Goblet five only are in individual settings, the others are arranged in groups. There are two fleur-de-lis ornaments, with five diamonds in each composition, and one lozenge-shaped figure, also with five diamonds.

For the sake of simplicity the diamonds are described under several headings, each dealing with one type of cut only. The names given to the various shapes are partly traditional and partly entirely new.

I. Point-Cut (Pyramidal Cut)

This shape is usually described as "the earliest form of diamond fashioning, consisting of simply polishing the natural faces of an octahedron". It is a surprising statement, since diamonds cannot be polished in the direction of their octahedral faces. Really perfect octahedra are extremely rare in nature, but they could have been made perfect through cleaving operations. I have examined many hundred point-cuts, but never yet seen one with smooth faces, sharp edges and octahedral angles. I have seen quantities of point-cuts with easily distinguishable natural faces and slight distortion or rounding, but mostly distinctly fashioned point-cuts. These point-cuts have proportions differing from those of the natural crystal. In practically every case the correction of the rough octahedron has been done by cutting towards the apices, with lower double pyramids as a result. The upper and bottom pyramids often received a different height, since the cutter obviously was satisfied when he arrived at a regular shape. It was then up to the jeweller to decide which pyramid should be displayed and which hidden in the setting. In exceptioanl cases only the proportions of the "pavilion" side resulted in satisfactory reflections from the back of the stone through the "crown". Foils, black inks or simply pitch were used in order to improve the light effects.

The diamond in the centre of Fig. 1 is the only point-cut in this collection. It is distinctly elongated and must have been cut from a very fine piece of rough since the angles of inclination towards the "girdle-plane" are only slightly below the crystallographic angles. The faces are faintly rounded, a clear indication of rubbing and polishing by hand and not on a wheel. The proportions can be ascertained by examining the dark square reflection. When its size is such that the corners touch the narrower outline of the diamond they are equal to a natural octahedron. In this case the reflection is just a fraction smaller and the stone thus slightly lowered by the cutter.

II. Table-Cut

In the very interesting article in the April 1968 issue of the "Lapidary Journal", Meen, Tushingham and Waite described the *table-cut* as a truncated octahedron. I share their opinion that the term table-cut should be restricted to this meaning, but I would like to add that a mere truncating hardly ever produced an acceptable

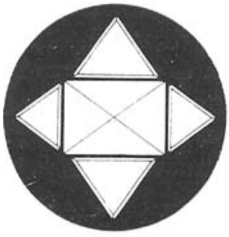

FIG. 1
1 point-cut centre.
4 triangular tablet-cuts.

FIG. 2
1 kite-cut.
2 drop-shaped rose-cuts.
1 elongated tablet-cut.
1 dodecahedral-cut.

FIG. 3
1 drop-shaped rose.
2 tablet-cuts.
1 rooflet-cut.
1 tablet-cut.

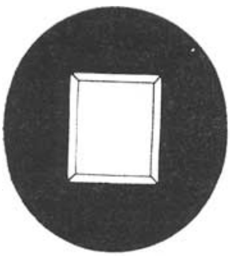

FIG. 4
Tablet-cut.

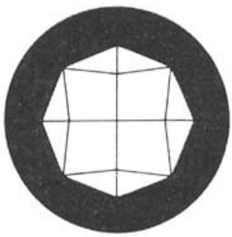

FIG. 5
Dodecahedral-cut.

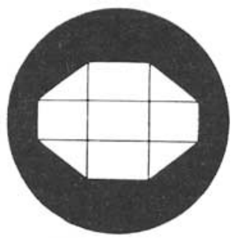

FIG. 6
Cubic-cut.

FIG. 7
6-facet rose-cut.

FIG. 8
Drop-shaped rose-cut.

table-cut. The four main facets both in the crown and in the pavilion were practically always worked down from the original $54\frac{3}{4}$ degree angle to between 50 and 45 degrees. This anybody can easily verify by examining such diamonds in the public collections.

Until quite recently I also found their definition of the *tablet-cut* precise and correct. Some very large "tables"—particularly those in the Austrian Crown Regalia from around 1600—with fine, deep pavilions, small culets, but with extremely flat crowns puzzled me. My theory was then that they might have been produced by sawing off a large part of the top pyramid, like overspread or swindled brilliant-cuts produced today. I then came across a number of models of rough diamond in plastic material. Experiments with two cleavages of identical size, which put on top of each other formed a full octahedron gave most surprising results. One of them was transformed into what I now call a tablet-cut with a square outline, a total depth of 57% and a culet size of 14%. The other had a rectangular outline, a total depth of 63·5% and a culet of 16%. In the first instance the weight loss was found to be around 60% and in the second just over 50% from the perfectly shaped rough.

A very similar diamond is the "Bohemian Crowned Lion," from the Treasury in the Royal Residence in Munich, which has a distinct cleavage plane orientated in such a manner that it must have been cut from rough shaped similarly to my plastic models.

Fine tablet-cuts have two advantages over the normal table-cut. First they can be produced from less expensive and more abundantly available rough and second, if correctly proportioned, they display a fascinating mirroring effect, so often described in inventories from the 15th century. One famous example is the Mirror of Portugal.

They can be described as having been shaped through extensive cutting from flats, maccles, glassies or similar rough, following the design of the table-cut with respect to the pavilion side, but with very flat crowns and very large tables. Since transformation of shape through extensive cutting was necessary for point- and table-cuts it is obvious that the only problems for the earliest diamond cutters were energy and time. The art of cutting a diamond—once learned—permitted any shape to be produced at their will and imagination.

But from the very beginning diamond cutters seem in many instances to have aimed more for size than for good proportions. This resulted in tablet-cuts which were given shallow pavilions and very large culets. With decreasing thickness of the available rough the tablet-cuts became less attractive and graded finally into the portrait-cut with culets of practically the same size as the tables.

The outline of a tablet-cut is not necessarily square or rectangular, as in the examples from the Court Goblet seen in Figs. 3 and 4. It may just as well be octagonal like the elongated diamond in Fig. 2. It can be triangular, like the four diamonds surrounding the oblong point-cut in Fig. 1 or pentagonal like the two wings in the fleur-de-lis of Fig. 3. In fact any conceivable outline may have been produced, depending upon the character and shape of the rough.

III. Rooflet-Cut

The elongated diamond in the centre of the fleur-de-lis shown in Fig. 3 has two faces only in the crown, sloping down from a central, lengthwise facet edge. It is probably a slightly improved distorted octahedron or a "cleaved baguette". I have the impression these shapes were called "Dos d'anes" (donkeys' backs) by the French during the 15th century.

The pavilion however has been worked following the design of the table- and tablet-cut with four large facets and a culet. In this case the culet is boat-shaped and distinctly rounded. The outline of the diamond is quite irregular, the only rather primitive stone in the goblet.

IV. Kite-Cut

The largest diamond in the fleur-de-lis, reproduced in Fig. 2 has the shape of a kite with four triangular facets in the crown and four very narrow girdle facets. It was not possible to ascertain the design of the pavilion. Comparisons with other similar diamonds of the period give full reasons to believe that this stone was cut from a rough piece of diamond very similar in shape to a cleavage resulting from two subsequent divisions of a perfect octahedron into two equal parts. If this supposition is correct, the pavilion facets in the kite-shaped diamond are haphazardly placed and not worth further study and description.

In many instances kite-cuts have only four main facets and no girdle facets. Depending on the quality of the rough from which they were cut, the outline may be of different proportions, merging eventually into the rhomboid- or lozenge-cut with the main facets of equal size and symmetrically placed.

V. Dodecahedral Cut

There are two diamonds of this shape in the Court Goblet. The largest of them is a splendid example of a very early diamond displaying brilliancy in the modern sense of this word (Fig. 5). It was apparently shaped from an almost perfect dodecahedron and cut with a minimal loss of weight, thus an exceptionally economic shape. This may have been one reason for its popularity during the 15th century. Such stones are frequently described in contemporary inventories as diamonds with four facets polished to lozenge-shape and four to semi-lozenges. In many cases they were just called round faceted diamonds and when of exceptionally fine quality, displaying considerable brilliancy, the attribution "mirroring" was added.

The second dodecahedral cut can be found in the fleur-de-lis ornament in Fig. 2, below the elongated tablet-cut diamond. This stone does not display much brilliancy, apparently due to a mishapen pavilion. The ancient cutters were not always successful with their achievements.

VI. Cubic Cut

This term was chosen for the diamond in Fig. 6, for the reason that it clearly displays all the six cubic planes of a diamond crystal. The girdle outline is an elongated octagon with four rectangular main facets in the crown, inclined towards the girdle from an equally rectangular table. Between these large facets, which appear to form a cross, is in each corner one triangular facet. The girdle is composed of eight large vertical facets, whereas the pavilion design is similar to that of a normal table- or tablet-cut. The culet is small and elongated. The table, the culet and the four girdle facets are all parallel to the cubic planes.

Apart from having achieved an interesting and unique shape with little loss of weight from the rough, the cutter—probably unintentionally—produced an exceptionally brilliant diamond. In fact this is so brilliant that during my first visit to the Treasury in Vienna and after an inspection through the glass of the showcase only, I made a note that this diamond could be a modern replacement. A close and thorough inspection of this stone as well as of all the other diamonds in the goblet showed that, without any doubt, no transformations had taken place. U–J Pettersson, who made all the rough sketches during our visit and who is also responsible for the final exact designs for this article, is an expert diamond-setter and teacher and thus well qualified to make an assessment.

This cubic cut and the previously described tablet- and dodecahedral-cuts are fine examples of diamonds, dating from as early as around the year 1400, which display beautiful light effects, well comparable to the brilliancy of a modern brilliant-cut diamond. This effect in diamond was thus known practically from the very beginning, but apparently it was not sufficiently appreciated. Other factors were more important, such as the mythological relation between squares, and diamond remained for centuries mainly a symbol of wealth and a talisman, displaying only part of its inherent beauty.

VII. Six-Facet Rose-Cut

There is one six-facet dome-shaped diamond with a hexagonal outline, shown in Fig. 7. The girdle appears to be very thick and the base flat. For these reasons it is classed as a rose-cut. So far no similar stones from early periods have been studied and further remarks would therefore be mere guess-work. It is, however, very tempting to classify this type as a predecessor of the modern six-facet rose-cut.

VIII. Drop-Shaped Rose-Cut

A pair of drops can be recognized in the fleur-de-lis of Fig. 2. They have three main facets meeting in an apex. Beside these four-sided facets two small ones, triangular in shape, have been applied, one on each side. These could perhaps be termed girdle facets. The quality of the cut is rather primitive, with an irregular, partly chipped and partly very rough girdle.

In a separate setting (Fig. 8) is a diamond with a beautiful and exceptionally regular design, a multifaceted drop-shaped stone. It has three rows of facets and in principle an eight-fold symmetry. This elaborately decorated stone is a good example of the cutters' ability to arrange a number of facets at their own will and with free imagination.

Together with other profusely faceted diamonds from the first half of the 15th century this stone seems to prove that diamond cutting was learnt by approximately 1450, with technical improvements only to follow.

Gemmological Abstracts

LIDDICOAT (R. T.). *Highlights at Gem Trade Lab in Los Angeles.* Gems and Gemology, 69, XIII, 2, 63.

High indices in Lechleitner synthetic emerald overgrowths on beryl are reported at 1·59 plus to almost 1·60. The latest Linde hydrothermal emerald examined has had indices of approximately 1·571-1·578 and a specific gravity of 2·678. There was much less fluorescence in both long- and short-wave ultraviolet than in the earlier Linde product. Phenakite crystals at the end of daggerlike spaces were present as well as wispy two-phase inclusions. A flux-fusion synthetic emerald contained a large phenakite crystal.

S.P.

CROWNINGSHIELD (R.). *Highlights at Gem Trade Lab in New York.* Gems and Gemology, 69, XIII, 57.

Examination of zoisite before and after heat-treatment may provide a partial answer to why some stones have fractured following the use of ultrasonic. Most heat-treatment of zoisite, as well as other commonly heated stones, is done after the stones are cut, since insignificant flaws can spread in the rough. It is possible that in some cases ultrasonic has aggravated heat-induced fractures within stones.

S.P.

BANK (H.). *Die Bedeutung der Doppelbrechung für die edelsteinkundliche Diagnostik.* The importance of double refraction in gemmology. Zeitschr. d. deutsch. gemmol. Gesellschaft, 1969, 18, 2, pp. 73-78.

The author discusses the value of double refraction in determining a gemstone. Refractometer and polariscope are the two instruments used. Recognition of the double refraction is subdivided into (*a*) its presence, (*b*) numerical value, (*c*) optical character, (*d*) anomaly and (*e*) aberration, as used in differentiating between natural and synthetic spinels. Absence of double refraction often indicates that one is dealing with an imitation. Bibliography.

E.S.

MORRISSEY (FRANK R.). *Note on Turquoise Deposits of Nevada.* Nevada Bureau of Mines, Report 17, 1968, pp. 30 + map.

Frank Morrissey was for many years an amateur mineralogist although he worked on the editorial staff of the Oakland Tribune. On retirement he specialized in the locating and cutting of turquoise and made many visits to Nevada, assembling quantities of manuscript notes which were checked and put in order by the Bureau of Mines on his death in 1962.

It is believed that Nevada has produced over 30 million dollars worth of rough turquoise, the bulk of it being shipped for mounting in Arizona and New Mexico native jewellery. The majority of the known deposits lie in a belt running NNE across the central part of the state, the host rocks being limestone, shale, chert, intrusive bodies or metamorphosed volcanic or sedimentary rocks. Sixty-nine separate mines or districts known to contain turquoise are listed in the report.

Each location is listed with its full map reference, name of discoverer, occurrence of turquoise and lists of other minerals found with it. A particularly fine stone was found at the No. 8 mine, Eureka County, from which a nodule of spider-web turquoise weighing nine pounds was sold for 1,600 dollars.

M.O'D.

WAITE (G. G.). *The unusual opals of Mexico.* Lapid. Journ. 1969, 23, 9, 1220, 2 col. plates.

Details are given of the more unusual types of opals found in Mexico, and includes the so-called "contra-luz" opal. Finely illustrated by a two-page colour plate.

R.W.

EPPLER (W. F.). *Einschluesse im blauen Zoisit.* Inclusions in blue zoisite. Zeitschr. d. deutsch. gemmol. Gesellschaft, 1969, 18, 2, pp. 56-60.

Generally blue zoisite is exceptionally clear, although there are sometimes negative crystals, hexagonal flakes, which are most probably haematite. The author shows five photomicrographs taken of two stones. These show various healing "tears" and parallel needles, which seem to be iron ore. The advantages of the name "zoisite", as compared with "tanzanite", are discussed. Bibliography.

E.S.

BANK (H.), BERDESINKINSKI (W.), NUBER (B.). *Durchsichtige gelbe und braune Granate (Grossulare) aus Tansania.* Transparent yellow and brown garnets (grossularite) from Tanzania. Zeitschr. d. deutsch. gemmol. Gesellschaft, 1969, 18, 2, pp. 66-68.

During the last few years some transparent green, yellow-green, yellow and brown grossularite from Tanzania have been examined. The lattice values, specific gravity and refractive indices are given. Bibliography.

E.S.

BANK (H.), NUBER (B.). *Rosarote Granate aus Tansania.* Reddish-pink garnets from Tanzania. Zeitschr. d. deutsch. Gesellschaft, 1969, 18, 2, pp. 69-72.

Since the turn of the century one has known about the find of garnets in Tanzania, but only during the last few years has rhodolite been exported. This is a pink to violet crystal of pyrope and almandine. The author publishes his finding of their lattice values, specific gravity and refractive indices. Bibliography.

E.S.

BANK (H.). *Hellbraune bis farblose durchsichtige Zoisite aus Tansania.* Light yellow to colourless transparent zoisites from Tanzania. Zeitschr. d. deutsch. gemmol. Gesellschaft, 1969, 18, 2, 61-65.

Apart from the sapphire blue zoisite Tanzania has exported some light brown to colourless zoisites. These are found in the Mirarani hills near Sambarai, which is in the south-east of Arusha. The mine and the general view of the district are illustrated together with a map with the location.

E.S.

SCHROECKE (H.). *Neuere Aspekte zur Diamantbildung.* Newer aspect of the formation of diamond. Zeitschr. d. deutsch. gemmol. Gesellschaft, 1969, 18, 2 pp. 51-55.

It has been shown that the habit of the diamond crystal is dependant on the conditions prevalent during its formation. A graph illustrates the relationship between the carbon, graphite and the melt. The inclusions in the primary crystallization, say, of the kimberlite magma, are discussed and it is shown that certain inclusions, for instance pyrite, almandine and mica, prove the inner pressure of the magma to be less than that of the diamond field. Bibliography.

E.S.

DUYK (F.). *L'identification du brillant.* Bulletin de l'Association Française de Gemmologie, 1969, 21, 7.

A method of identification of brilliant cut gems which relies upon the measurement of the base of the triangular star-facets joining the table. It is possible for suitable photographic enlargement to classify stones by this method which weigh 0·10 ct. or more. With larger stones identification is more easily carried out. In an example quoted the base of the triangular star-facets measured 16 mm, 18 mm, 16 mm, 16 mm, 16·5 mm, 18 mm, 16 mm and 17·5 mm on an enlarged photograph of a stone weighing 0·10 ct. The diameter of this stone was 3·2 mm with a height of 2 mm.

S.P.

RÖSCH (S.). *Farbmessungen am Diamanten.* Measuring the colour of diamonds, part I. Zeitschr. d. deutsch. gemmol. Gesellschaft, 1969, 18, 3, pp. 126-140.

This article includes a bibliography of 32 items and gives the measurements of 54 diamonds showing their origin, and also the measurement of some of the 150 coloured diamonds in the De Beers collection. The results are also correlated in 2 CIE colour tables. Not all of the 150 stones were examined. The CIE card and also the German norm DIN 6164 was used, giving the colour shade, the colour saturation and the "darkness" which was the reciprocal value of the "light". Various interesting gems were seen, such as a stone from Vienna (no. 44) the colour of which was comparable to that of an emerald. The author plans a second part of this article in which he will deal with the statistics of colour in diamonds.

E.S.

MALES, (P. A.). *Pseudophite and Precious Serpentine.* Australian Gemmologist, 1968, X, 3, pp. 13-15.

A general review of the serpentine group of minerals, with special reference to Australian sources.

R.W.

BOOK REVIEWS

SUNAGAWA, ICHIRO. *Diamonds—their genesis and properties.* Tokyo (Maruzen), 372 pp., 161 figs., 7 tables, (in Japanese), 1969. Price 600 yen.

This book consists of the following 14 chapters: (1) Introduction—a letter from the depth of the earth, (2) Historical review—various genetical theories on diamond, (3) Conjecture from the results of diamond synthesis—where diamonds are formed, (4) External morphology and surface micro-structures of diamond crystals—mechanism of crystal growth, (5) Curved crystals—evidence of dissolution, (6) Trigons—controversy between growth and dissolution theories, (7) Zonal structures—analysis of growth histories, (8) Internal structures and physical properties—growth histories define the properties, (9) Cleavage of diamonds—relation between cleavage and growth history, (10) Inclusions—clues to the environmental conditions, (11) Impurity elements—nitrogen and alumina, (12) F. C. Frank's new theory on the genesis of diamond, (13) Diamonds in meteorites—a controversy, (14) Evaluation of gem diamonds, and Appendix. The book covers the up-to-date knowledge of the physical and chemical properties and the genesis of diamonds, as well as the results of diamond synthesis.

M.S.J.

LEWIS, M. D. S. *Antique paste jewellery.* Faber, London, 1970. £3.50.

Mr. Lewis's book is the first of a collectors' library series, and is the first book to deal with all aspects of the fascinating subject of antique paste jewellery, including gemmological aspects. There are abundant illustrations, eight of them in colour. A scholarly and authoritative work with general and technical information, particularly concerning the important period of the eighteenth and first half of the nineteenth century.

S.P.

ASSOCIATION NOTICES

BRANCH MEETINGS

A well-attended meeting of the Scottish Branch of the Association was held in Edinburgh on the 11th February, 1970. It was a gemstone quiz evening involving common and less common stones. The specimens were discussed in detail, after identification, by Mr. Maurice Turner, the Branch Secretary. Mr. Dennis Hill, who presided, gave a short talk on the work of the Scottish Branch.

A meeting of the Midlands Branch of the Association was held in Birmingham on the 13th February, 1970. Mr. Bernard Lowe of B. C. Lowe Limited, spoke about the coloured stones seen through his many years as a stone merchant. The second speaker was Mr. C. J. Fox, who emigrated to New Zealand fifteen years ago. He took up prospecting as a hobby and now has 100 acres of land to which he has claims.

At a meeting held at Goldsmiths' Hall, London, on the 27th January, 1970, the following films were shown:

Hallmarking (produced by the Worshipful Company of Goldsmiths).

Celtic Gold in Ireland.

The Refining of Precious Metals from the Sudbury Nickel Ores in Canada.

Members are reminded that there are branches of the Association in Birmingham and Scotland (Glasgow). Anyone who does not at present receive the branch circulars and would be interested in attending meetings in Birmingham or Glasgow should communicate with the office.

GIFTS TO THE ASSOCIATION

The Council of the Association is most grateful for a donation from N. J. Sorsby, Skipton-in-Craven, Yorks., and for a gift of sapphire crystals from M. Bielenberg, Hamilton, Montana, U.S.A.

The Council of the Association is indebted to John R. Fuhrbach, B.Sc., F.G.A., G.G., of Amarillo, Texas, for photographs made with the GIA photoscope and the Polaroid Land 250 camera.

OBITUARY

Robson, A. H. of Leeds, Yorkshire, December 1969. (Fellow 1915).

MEMBERSHIP

In Vol. 12 No. 1 the name Johannes, Biesbroek, should have read Biesebroek, Johannes, The Hague, Holland.

COUNCIL MEETING

At a meeting of the Council of the Association held on Tuesday, 27th January, 1970, the resignation of Dr. G. F. Claringbull as senior examiner was received with regret. Dr. Claringbull has acted as an examiner since 1938 and the Association is indebted to him for his valuable services over the years. Dr. E. H. Rutland was appointed to act as an examiner.

The Council made nominations for submission to the annual general meeting to be circulated with the notice convening the meeting.

Since 1957 the annual subscription to the Association has been £2.2.0. In view of increased administration and other costs it was decided that the subscription for Fellows and Members would be £3 a year commencing 1st January, 1971.

The following were elected:—

Fellowship

Ali, Nasim, Sutton. D. 1969
Allen, Rendall James, Darwen. D. 1969
Andrews, Robert Eric, Cheadle Hulme. D. 1969
Berger, Francis, Geneva, Switzerland. D. 1969
Bergmans, Paul Clemens Maria, Rotterdam, Netherlands. D. 1969
Bloomberg, Maurice, Redbridge, Essex. D. 1969
Bradshaw, Stephen Charles, London. D. 1969
Brady, Deanna Mary, Heswall. D. 1969
Brennan, John Douglas, Birmingham. D. 1969
Christophersen, Elsa, Sandnes, Norway. D. 1969
Cragg, George Edward, Leicester. D. 1969
Crawford, Brian Henry, Monte Vista, Cape Town, S. Africa. D. 1969
Egea, Anthony, London. D.1969
Farwell, Yvette, London. D. 1969
Fruhwald, Georg, Wiesbaden, Germany. D. 1969
Fry, Peter M., Dover. D. 1969
Gartrell, Mark Paul, London. D. 1969
George, Antony Philip, Copthorne, Surrey. D. 1969
Gull, Peter, Walsall. D. 1969
Hayes, Bernard Edwin, Ormskirk. D. 1969
Hill, Josephine Ann, Sheffield. D. 1969
Hindle, David Ronald, Exeter. D. 1969
Hird, Frank, Bournemouth. D. 1969
Hobbs, Robert George, London. D. 1969
Hodgson, Jean Frances, London. D. 1969
Horsfall, Richard Thomas Lister, Halifax. D. 1969
Hundy, Christopher Leslie, Sutton Coldfield. D. 1969
Karlberg, Willy, Oslo, Norway. D. 1969
Kitson, Geoffrey Knowles, Hathersage, Yorks. D. 1969
Lattimore, John Christopher, Harrow. D. 1969

Lay, Mg,
Mandalay, Burma. D. 1969
McCorquodale, Iain Douglas,
London. D. 1969
Marsall, Terence,
Sherwood, Nottingham. D. 1969
Matthews, Sidney Allen,
St. Helens. D. 1969
Osborne, David Leonard,
Leigh-on-Sea. D. 1969
Milton, Mark Seymour,
Liverpool. D. 1969
Reilly, Hugh Joseph Andrew,
London. D. 1969
Renton, Brent Sanderson,
Preston. D. 1969
Richardson, George,
Glasgow. D. 1969
Silcock, James Barry,
Southport. D. 1969
Statham, Patricia Margaret,
London. D. 1969
Stewart, Reginald William
(Group Captain),
Bickley, Kent. D. 1969
Suter, Peter,
Lucerne, Switzerland. D. 1969
Tan Hien Tjwan, Albert,
Surabaja, Indonesia. D. 1969
Thompson, Ian Trevor,
Ripon. D. 1969
Wallace, Lindsay James,
Gainsborough. D. 1969
Wallace, Robert James,
Kirkcaldy, Fife. D. 1969
Watson, Vivian Peter,
Northwoodhills. D. 1969
Webster, John Henry,
Leicester. D. 1969
Williams, Alan, Liverpool. D. 1969
Wright, William Anthony,
Potters Bar. D. 1969
Zelley, Howard Douglas,
Norwich. D. 1969

Ordinary Membership

Alabaster, Wendy Jane,
Birmingham.
Allardyce, Anthony Stanley,
Maidenhead
Anderson, Arthur A., Guildford
Arakaki, Earl S., U.S.A.F.
Ashbaugh, Maurice Donald Jr.,
Halstead
Beeney, Patrick Laurence Lavington,
Poole
Blount, John E.,
Macon, Ga., U.S.A.
Bowbrick, Richard Donald,
Guildford
Bradford, Kenneth James,
Westcliff-on-Sea
Buckie, Anthony Linton, Hayes
Buckie, Peter Roger, London
Burrows, Patricia Anne, Wrexham
Caruso, Victor E. (Dr.),
Wyckoff, N.J., U.S.A.
Chesters, Norman I., Glasgow
Clayton, Norman Arthur,
Killara, N.S.W., Australia
Collins, Joseph Wray,
Niagara Falls, Canada
Cotton, John Alan Day, London
Forbes, Brian Winston Travers,
Johannesburg, S. Africa
Fox, Cyril John, Warley
Grist, Nigel, Sheffield
Guard, Norman Wesley,
Blackrock, Co. Dublin
Hayward, Stephen Grant,
Brentwood
Hilbourne, Anthony Charles,
Maidenhead
Hind, Derrick Duncan,
Tripoli, Libya
Jobbins, Howell Stevens,
Toms River, N.J., U.S.A.
Kramer, L. M., London
Levy, Hanukah, London
Lofberg, William, London
Matsumoto, Shigeyoshi,
Gunba-ken, Japan
Millard, Alice,
Liverpool, N.S.W., Australia

Muggeridge, Alan Gordon, Reporoa, New Zealand
Murakami, Kimio, Hiroshima-City, Japan
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Mr. Hugh Leiper, F.G.A., has relinquished the editorship of the *Lapidary Journal* and will continue as Consulting Editor, Publications. Mrs. Pansy D. Kraus, G.G., F.G.A., has been appointed Editor.

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