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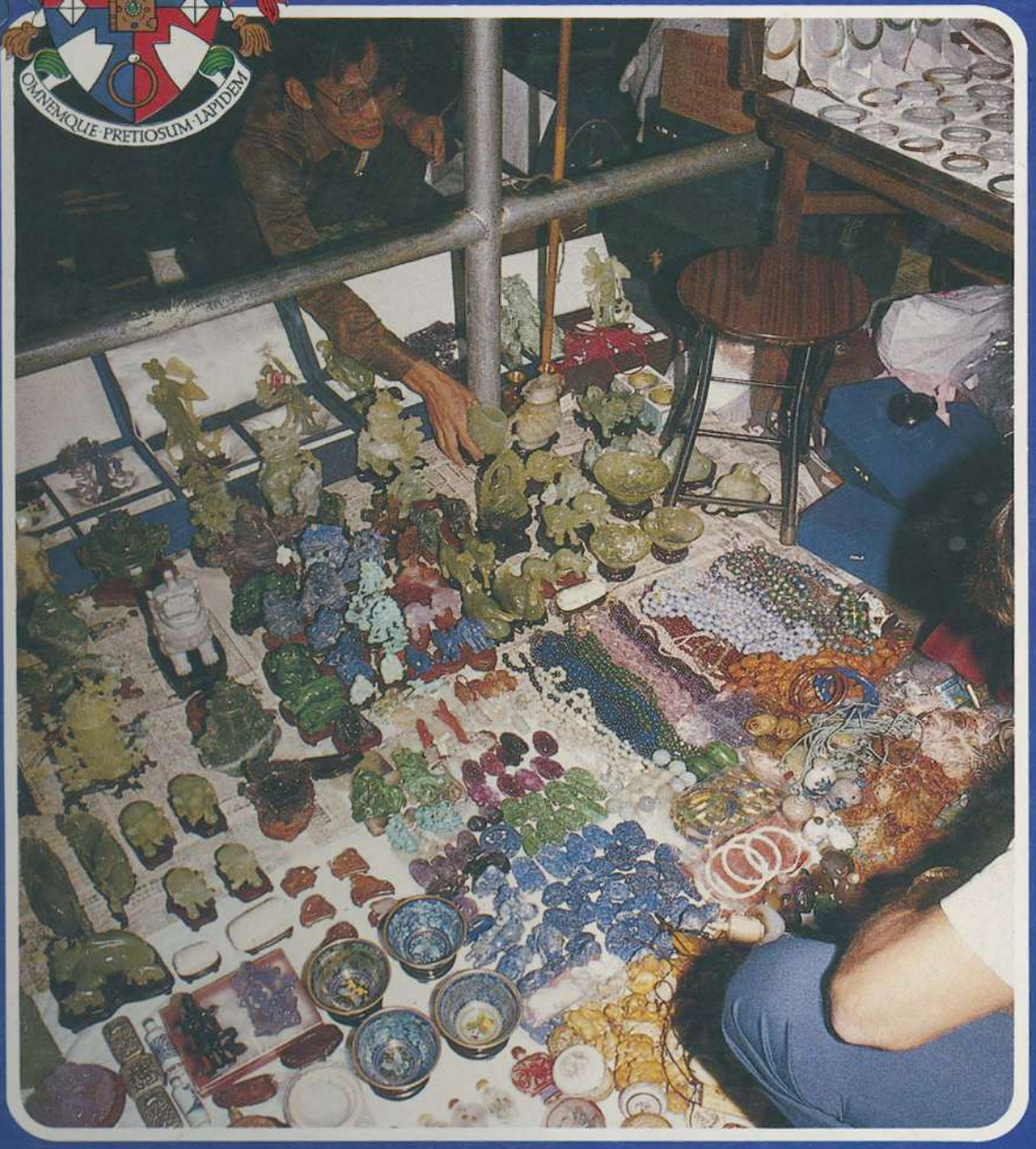

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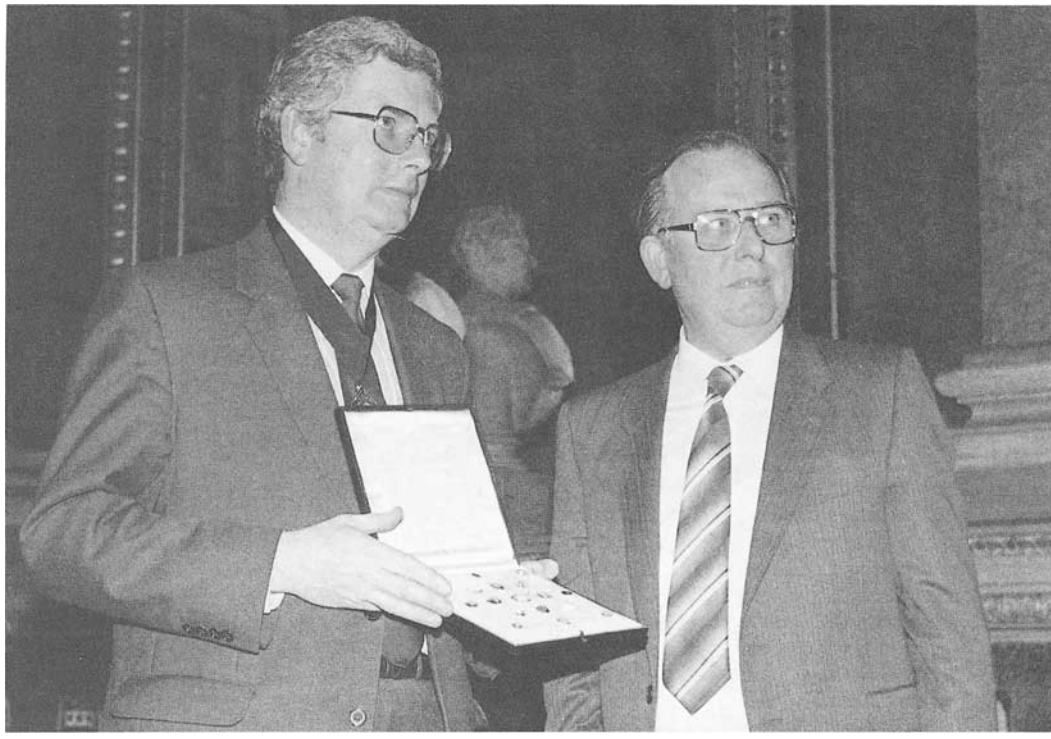
Cover Picture

A typical stall in the 'jade market' in Hong Kong.
Note the wide range of jade and other hardstone carvings available
(see 'A visit to Hong Kong', pp.270–1).
Photograph by E.A. Jobbins

ISSN: 0022–1252

A Major Presentation to the Gemmological Association of Great Britain.



The late Basil Anderson assembled a fine collection of cut stones during his near sixty years at the gemmological helm. This collection was auctioned recently at Christie's in London and was purchased anonymously.

The collection has now been presented to the Gemmological Association by this anonymous purchaser. We sincerely thank our generous benefactor on behalf of all Fellows and Members of the Association. The collection will be studied and catalogued by our Curator, Christopher Cavey, F.G.A., and full details will be given in a paper to be published in a future issue of the *Journal*.

The picture shows Mr A. Middlemiss, F.G.A., of Christie's, when he passed over part of the B.W. Anderson collection to the Chairman of the Association, Mr David Callaghan, F.G.A., at the Annual Presentation of Awards ceremony at Goldsmiths' Hall on 11 November 1986.

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Metallic inclusions in Chatham synthetic corundums

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Abstract

Metallic inclusions in coloured flux-grown Chatham synthetic corundums are described and illustrated. The inclusions are probably composed of platinum metal, derived from the walls of the crucible in which crystallization took place. Apart from the 'normal' triangular and hexagonal crystal shapes these inclusions may occur as plates, needles, spicules, daggers, blades, rods, bars, pyramids or in irregular forms. Several of the inclusions showed etched surfaces and some were closely associated with solid flux.

Description

A parcel of coloured synthetic corundums, kindly loaned by 'Chatham Created Gems' was recently subjected to detailed microscopic examination. The parcel included red, blue and orange-pink ('padparadscha' colour) rough material and crystal clusters (weighing a total of 1046 carats) together with 12 faceted stones (five orange-pink sapphires, four blue sapphires and three rubies).

Inclusions of solid flux, in various forms, were present in all of the specimens studied and many of the samples contained a wide range of beautifully developed metallic inclusions. Although the latter are almost certainly composed of platinum metal, the general term 'metallic' is used to describe them here since crucibles composed of rhodium or iridium may sometimes be used for flux growth.

The characteristics of flux inclusions in Chatham synthetic corundums have been discussed elsewhere (Gübelin 1983; Kane 1982, 1983; Scarratt 1977) and this short paper is primarily concerned with the visual appearance, particularly crystal shapes, of the metallic inclusions in these synthetic gemstones. As expected, all the metallic inclusions examined were strongly reflecting when suitably oriented and illuminated. Colours observed in reflected light were silvery, grey or yellowish. What was unexpected was the very considerable diversity of form which the inclusions displayed. The commonest shapes were triangles or hexagons although these were rarely perfectly symmetrical. Less common, but still fairly abundant, were forms resembling thin plates, needles, spicules, daggers, blades, rods, bars and pyramids. In addition some of the inclusions were quite irregular in outline. Another interesting feature shown by a number of the inclusions was the development of pitting or etching on one or more of their surfaces – an effect perhaps due to corrosion by the molten flux before the inclusion became incorporated in the growing corundum host. In a few cases the metallic inclusions were partly coated by a layer of white flux of variable thickness.

The features noted above are illustrated in the accompanying photographs.

Conclusion

Careful observation of the shapes of metallic inclusions could prove, in conjunction with flux inclusions, extremely helpful in determining the synthetic nature of a doubtful corundum. Although this paper has dealt exclusively with Chatham stones, it is reasonable to assume that equally diverse metallic crystal forms may occur in other gemstones produced by the flux melt process.

Acknowledgement

I am most grateful to Thomas Chatham of 'Chatham Created Gems', San Francisco, who kindly loaned me the synthetic corundums discussed in this paper. The parcel, which included synthetic emeralds as well as corundums, weighed in total 1333 carats and contained some of the finest examples of synthetic gem material I have ever seen.

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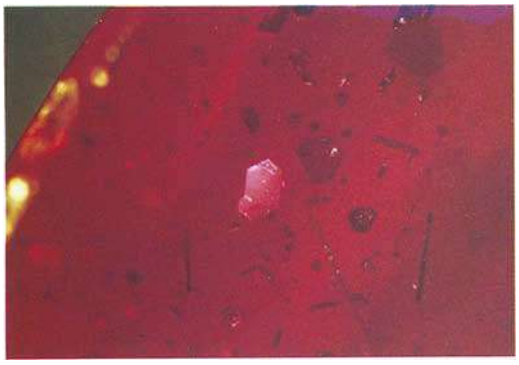

Fig. 1. Hexagonal plates (one strongly reflecting), triangles with truncated corners, bar and needle-like metallic inclusions. Chatham ruby cabochon (1.8 ct). Reflected light. 16x.

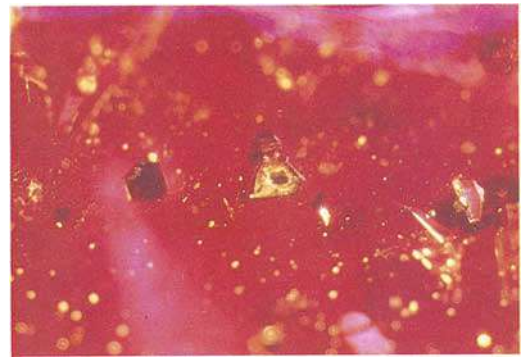

Fig. 2. Triangular inclusion (with attached white flux) pseudo-hexagonal and irregular metallic crystals. Chatham ruby crystal cluster (284 ct). Transmitted and reflected light. 16x.

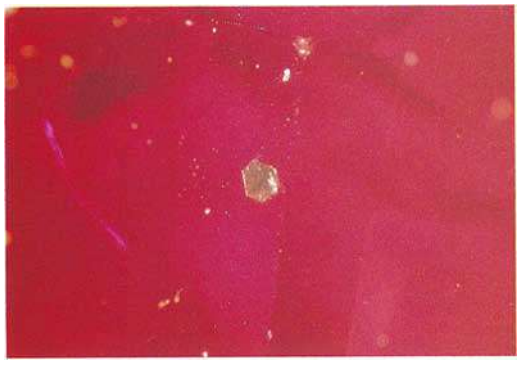

Fig. 3. Almost symmetrical, hexagonal metallic crystal with etched surface. Chatham ruby rough (189 ct). Transmitted and reflected light. 10x.

Fig. 4. Etched hexagonal metallic inclusions with some attached white flux. Chatham orange-pink ('padparadscha' colour) sapphire rough (425 ct). Reflected light. 10x.

Fig. 5. Dense concentration of metallic blades, spicules, plates and irregular forms. Chatham blue sapphire rough (45.8 ct). Transmitted and reflected light. 10x.

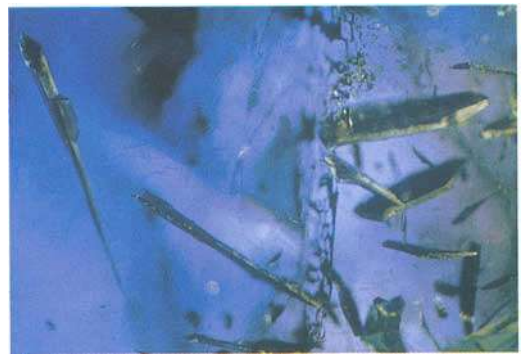

Fig. 6. Hexagonal plates, bars and dagger-like metallic inclusions. Chatham blue sapphire rough (45.8 ct). Transmitted and reflected light. 10x.

Fig. 7. Elongate, thin metallic blade (note 'feather' and white flux also). Chatham blue sapphire rough (45.8 ct). Transmitted and reflected light. 10x.

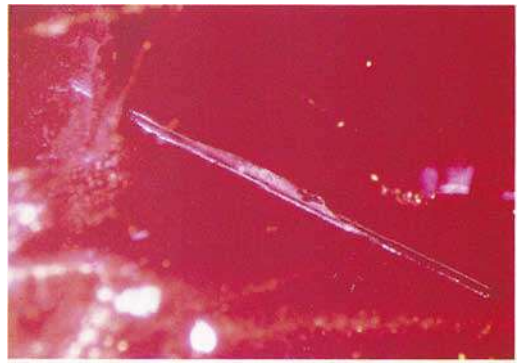

Fig. 8. Elongate metallic blade, partially coated with white flux. Chatham ruby rough (189 ct). Transmitted and reflected light. 10x.

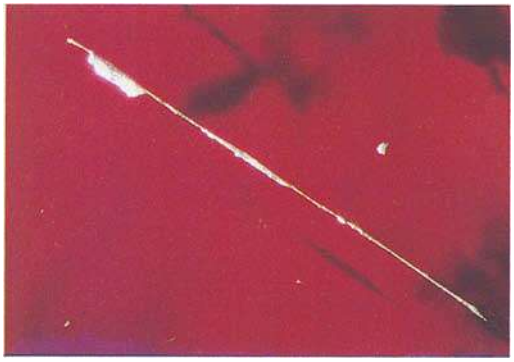

Fig. 9. Needle-like metallic inclusion coated with strongly reflecting white flux. Chatham ruby rough (189 ct). Transmitted and reflected light. 10x.

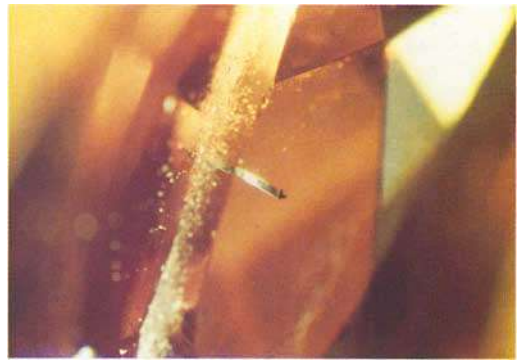

Fig. 10. Metallic bar with triangular cross-section immediately beneath girdle. Chatham orange-pink ('padparadscha' colour) faceted sapphire (0.89 ct). Transmitted and reflected light. 10x.

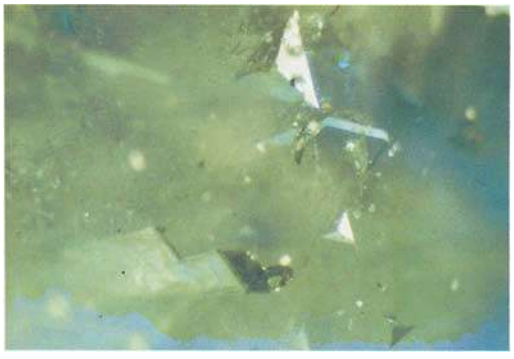

Fig. 11. Metallic pyramids, plates and irregular inclusions. Chatham blue sapphire crystal cluster (102 ct). Transmitted and reflected light. 16x.

Fig. 12. Irregular silvery, metallic inclusion. Chatham blue sapphire rough (45.8 ct). Transmitted and reflected light. 10x.

A visit to Hong Kong

L.E. Fitzgerald, F.G.A.

Education Administrator, Gemmological Association of Great Britain, London

One of the highlights of being Education Administrator for the Association, and there are many, is having visitors from literally all over the world – Alaska, Canada, the United States of America, Finland, Sweden, Holland, France, Belgium, Switzerland, Italy, Spain, the Canary Islands, Lebanon, Israel, Dubai, Kenya, Zimbabwe, South Africa, India, Sri Lanka, Thailand, Singapore, Hong Kong, Japan, The Philippines, Australia, New Zealand and Tasmania.

Each and every one of them is welcomed and ushered into the Education Department and I often wonder how they view the desk untidily littered with paper and the rather confined area reserved for visitors. Discussions often range from politics to religion or to personal matters, but the one bond that unites us all is the love of gemmology.

Many are the invitations to 'look me up when you are in . . .'. One of the most consistent and insistent of these was from Mrs Melinda Tilley, who lives in Kowloon, to visit Hong Kong and meet the gemmologists there. Many and varied had been the reasons which prevented me from accepting these invitations, but in 1985 I decided to go, much to Melinda's delight. With hindsight I can truthfully say that it was one of the best decisions I have made.

My pleasure was increased by the knowledge that Melinda's husband Frank was to be Flight Engineer on the Boeing 747 which conveyed me from this part of the globe to a land 7000 miles away and eight hours in advance on the clock, and by being invited into the cockpit for the take off from Gatwick.

I was met at Kai Tak airport by Mrs Tilley and quickly divested myself of the raincoat and jacket that had been necessary in London. I would not need these for two whole weeks, weeks that were packed with activity. My first impression was that of all first-time visitors to Hong Kong – the high buildings, the busy streets, the banners stretching across the roads – and the heat.

The next morning I was able to meet the class that gathers at the Tilleys' home for general studies in gemmology and to be amazed to see them looking through diffraction grating spectroscopes and talking about 'two lines in the blue'. General study group! They were ready to enrol in the serious business of the Course in Gemmology conducted by the GA of GB and in fact one of them has now taken the plunge.

Three of Mrs Tilley's past students are now established jewellers in Kowloon and proudly display the Diploma in Gemmology alongside other certificates from the USA and Hong Kong itself. Sometimes a whole wall is covered with framed certificates. Gemmology is a serious business in Hong Kong and I was pleased to note how greatly esteemed is the Diploma of the GA of GB.

One of these past students, Sunny Tsui, who has a small but well-filled shop and is proud of his stock of gems and jewellery, very kindly invited us to a Chui Chow Garden restaurant together with his wife, three children and his niece, who is a designer of fine jewellery. We sampled Chinese hospitality and some strange but delightful delicacies, beautifully presented. A truly memorable evening.

I felt very proud to represent the Gemmological Association of Great Britain and also to meet once again Mrs Kitty Wong, who is the co-ordinator of studies at the Hong Kong Baptist College. It was Kitty Wong who, in 1985, undertook the administration of the Examinations in Gemmology in Hong Kong on our behalf and with over 100 candidates – easily the largest centre outside the UK – made an admirable job of it.

The Hong Kong Baptist College is a large complex with many students. Gemmology is only part of the curriculum but the college possesses a fine range of equipment. Classrooms are airy and air-conditioned as are the laboratories with the gem-testing instruments. This is an important factor especially during the summer months. I also saw the large hall where the examinations are held and met senior academic staff, including Dr David Lovett and Dr Mary Wang. It is always a pleasure to meet the people who are responsible for providing accommodation and invigilation on our behalf for

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the Examinations in Gemmology and to establish lasting contacts with them. I feel it is of great benefit to all of us.

Alan Jobbins arrived in Hong Kong on Sunday and the next evening we had an enjoyable evening at Anne Paul's home, where we met representatives from the Gemmological Association of Hong Kong and the Hong Kong Baptist College. Alan soon found himself being cross-examined on topics ranging from colour in gemstones to the expectations of the Examiners in such subjects as the Diploma practical examination. We were able to assure these keen teachers of gemmology that the examiners are anxiously looking for marks to help students pass the examinations and not, as many think, trying to take away marks and fail them.

There were too many things to see and my time was fully occupied. Alan managed to visit the 'jade market' (see front cover illustration), but, regrettably, I was engaged on other business.

The next evening was an important occasion – the Annual Dinner of the Hong Kong Gemmological Association and Alan and myself were guests of honour. Alan gave an illustrated talk on the gemfields in Burma, Indo-China and Australia and answered many questions. After dinner the students who had been successful in' the Diploma Examination and had received their Diplomas, were presented with scrolls welcoming them to membership of the Gemmological Association of Hong Kong. Later we were able to talk to them and also to past students who had corresponded but never met us. Altogether another never-to-be-forgotten occasion.

The following day we both left the warm, welcoming people of Hong Kong for the long journey home to the cloudy, cold shores of the UK but our minds were filled with many happy memories and invitations to return.

[*Manuscript received 2 December 1985.*]

Chalcopyrite in peridot: a first observation

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Abstract

This paper describes, for the first time, inclusions of the copper-iron sulphide chalcopyrite in peridot. The peridot host was analysed for traces of copper to determine if copper might be playing a role in the coloration of this gem. No copper was detected.

Introduction

A small parcel of faceted Arizona peridot was recently donated to the Gemological Institute of America for use in the reference collection and for student study sets. While examining these peridots under magnification, it was noticed that one of them contained a few tiny rounded obviously protogenetic, metallic-looking, dark inclusions. One of these inclusions had been cut through during faceting and was now exposed at the host's surface. In the past, the authors had noticed similar metallic-looking grains as inclusions in Arizona peridot (Figure 1), but the inclusions were never before so conveniently laid out for analysis as they were in this gem. It was therefore decided that both X-ray diffraction and microchemical testing could be carried out to determine the identity of these inclusions.

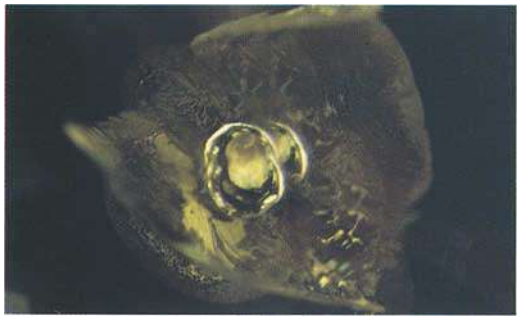

Fig. 1. Protogenetic chalcopyrite inclusion surrounded by a healed fracture system in an Arizona peridot. Dark-field illumination. 50x.

Description of the host

The peridot host (GIA collection number 14576) is a yellowish-green oval modified brilliant cut of medium intensity (Figure 2) weighing 1.29 ct and measuring approximately 7.98 × 6.11 × 3.83 mm.

The gemmological properties exhibited by this stone fell within the range of properties already established for Arizona material (Koivula, 1981). Using sodium vapour light, the refractive index was measured at 1.652 alpha, 1.670 beta, and 1.689 gamma with a birefringence of 0.037. The specific

Fig. 2. Oval faceted 1.29 ct peridot that was the subject of this study.

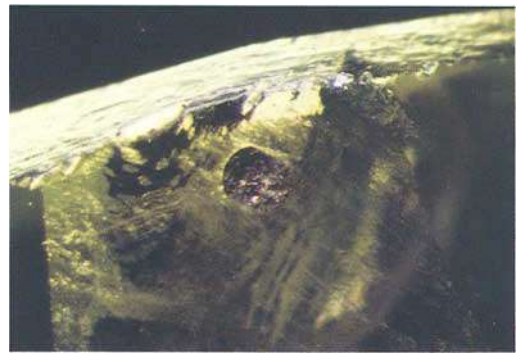

Fig. 3. Chalcopyrite inclusion analysed for this study, exposed at the surface of the gem shown in Figure 2. Oblique illumination. 50x.

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gravity was determined hydrostatically using a Voland double-pan balance. The average for three runs was 3.33. The gem's specific gravity was also checked using pure methylene iodide with a specific gravity of 3.32. The peridot sank very slowly in this liquid.

The visible light absorption spectrum was studied next using a Beck prism spectroscope and fibre optic, white light, illumination. The observed absorption pattern is typical for peridot from Arizona (Koivula, 1981). The gem shows a band in the blue-green with its strength at 496.0 nm and a weaker zone at 488.0 nm. A line is visible at 473.0 nm, while a weak band, centred at 452.0 nm is also present.

Preparation for analysis

The analysed inclusion breaks the peridot's surface on the pavilion, near the girdle, within the first row of facets (Figure 3).

To ensure a contaminant-free surface for analysis the facet containing the inclusion was freshly ground using a diamond-charged, 360 grit, grinding lap (not a copper lap). The gem was then placed in warm fresh distilled water, ultrasonically cleaned for five minutes, and then allowed to air dry.

Analysis of the inclusions

Once cleaned, it was apparent that the inclusion had a metallic appearance and a brassy colour when viewed in surface reflected light (Figure 3). Because of this, it was felt that the inclusion was probably a sulphide of iron, possibly pyrite. A decision was made that X-ray powder diffraction be used to identify the inclusion positively.

A spindle was prepared under magnification from a minute amount of powder obtained from the inclusion. The spindle was then mounted in a Debye-Scherrer powder camera and exposed to X-rays generated from a copper target tube at 46 kV and 26 mA for five hours. After developing the X-ray film, the pattern produced was measured for d-spacing with a Nies overlay scale corrected for film shrinkage. The strengths of the lines were estimated visually. This pattern was then compared with our standards for several different sulphides. A pattern match was obtained with the chalcopyrite standard.

Since chalcopyrite is easily decomposed by concentrated nitric acid, yielding free sulphur and a green-coloured copper-iron solution, it was decided that this simple microchemical test could be used to chemically test for the presence of copper in the inclusion. The test was carried out while viewing the inclusion microscopically in incident illumination. A tiny droplet of nitric acid was placed on the inclusion surface and within moments the expected reaction occurred and a green solution formed, although no distinct yellow sulphur crystals were visible at the low magnification that was used.

Analysis of the host for copper

With the discovery of protogenetic chalcopyrite in peridot, the question was raised that perhaps some of the copper present in the environment that precipitated the chalcopyrite might also have been incorporated structurally in the host peridot, at least in trace amounts. It was even thought that, if present, copper may be playing a partial role in the coloration of the peridot. It was therefore felt that, because of these questions, an analysis for trace-copper, within the peridot itself, was needed.

The gem was thoroughly cleaned and then was taken to the California Institute of Technology in Pasadena, California, for analysis using a Kevex energy dispersive X-ray fluorescence unit. Concerning copper analysis, the detection limit of this instrument is in the parts per million range. The table facet was analysed but no trace of copper was detected within the peridot.

Conclusion

The identification of chalcopyrite as an inclusion in peridot is the first observation of this nature known to the authors. As such, it adds to the cumulative gemmological knowledge we have concerning this gem material. A lack of trace copper in the peridot ruled out the possibility that copper may be playing a partial role in the coloration of the peridot.

Acknowledgements

The authors would like to thank Carol M. Stockton, senior research gemmologist at the Gemological Institute of America in Santa Monica, for the trace elemental analysis for copper, and the California Institute of Technology for use of their energy dispersive X-ray fluorescence unit. Ruth Patchick deserves thanks for typing this manuscript.

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[*Manuscript received 14 April 1986.*]

New investigations of synthetic amethysts produced in Japan

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Abstract

Synthetic amethysts of Japanese production, which are now available in the gem trade, are characterized with respect to their diagnostic properties such as inclusions, growth structures, twinning, and infrared spectra. The gemstones frequently have feathers consisting of liquid-filled and two-phase inclusions, sharp growth zoning parallel to one rhombohedral face as well as twin structures. This twinning, however, can be distinguished from polysynthetic lamellar twinning in natural amethysts.

Introduction

Some comprehensive papers on the distinction of natural and synthetic amethyst using infrared spectroscopy and microscopy were recently published (Lind and Schmetzer 1982, 1983; Lind *et al.* 1983). Since that time, the authors have continuously investigated parcels of natural and synthetic amethysts with the methods thought to be useful for determinative purposes. The proposal for a determinative procedure for the distinction of natural and synthetic amethysts, as published by Lind *et al.* (1983), includes (I) investigations by the conoscope and (II) microscopic investigations as well as (III) infrared spectroscopy. This method was introduced in 1982 by the authors as a routine investigation for the measurement of faceted amethysts. The application of infrared spectroscopy was suggested for those samples which are still of doubtful origin after steps (I) and (II) of the determinative procedure. A practical method for an easy recognition of polysynthetic lamellar twinning in amethyst which is important for a distinction of natural and synthetic samples was developed by Schmetzer (1985 a,b), using an improved sample holder with a horizontal and vertical rotation axis for the immersion microscope. This additional investigation is practicable for everyone after a short time of training with typical samples of natural and synthetic origin.

It is self evident that the criteria for a practical distinction of natural and synthetic amethysts, which were worked out until the publications mentioned above were written and published, referred to the types of natural and synthetic amethyst which were available at that time in the trade. Synthetic amethysts then mainly originated from commercial production in the USSR. From the morphology of the rough crystals as well as the infrared spectra of those samples, the synthetic amethysts from USSR were identified by the authors of the present paper as being grown from highly K-alkaline solutions as described in 1975 by Chadshi *et al.* (cf also Balitsky, 1981). In the above investigations, however, some synthetic amethysts of other producers were also included. In addition to the synthetic amethysts produced in the USSR by the method of Chadshi *et al.* (1975), synthetic amethysts produced in Japan became more and more important for the trade. The first samples of this commercial production were already taken into consideration for the study of Lind *et al.* (1983). Meanwhile, the percentage of synthetic amethysts produced in Japan has increased compared with the percentage of synthetic amethysts produced in the USSR, which formerly were dominant in the trade.

In the last few months, an increasing number of synthetic amethysts of Japanese production showing extraordinary gemmological properties were found during routine investigations. Only some of the diagnostic characteristics of those synthetic amethysts are included in the papers published at present. Therefore, in order to avoid misinterpretations during the distinctions of natural and synthetic amethysts in the gemstone trade, the publication of the determinative properties of this new type of synthetic amethyst appears to be highly necessary in the opinion of the authors. Supposedly, the different structural properties as well as feathers consisting of fluid and two-phase inclusions which are now frequently observed in this new type of synthetic amethyst are caused by alternating growth conditions. Thus, the increase of commercial production techniques causes a permanent necessity of revising and enlarging the diagnostic criteria useful for a distinction of natural gemstones and their synthetic counterparts. These revising and enlarging investigations, in general, have to be carried out with normal samples available in the trade.

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Unlike the synthetic amethysts investigated in the past, samples of the new type of synthetic amethyst produced in Japan frequently reveal feathers consisting of fluid inclusions and two-phase inclusions (Figure 1).

For each gemmologist it is evident that fluid and two-phase inclusions may be found in all crystals grown under hydrothermal conditions, i.e. in natural as well as in synthetic amethysts. Feathers in synthetic amethysts, however, were found to be extremely rare in the samples investigated previously (cf. Lind *et al.*, 1983, 1985).

In synthetic amethysts from commercial Japanese production, which are described in the present publication, sharp lamellar structures connected with a distinct colour zoning were commonly observed by use of the immersion microscope (Figure 2). These lamellar structures are parallel to one rhombohedral face of the synthetic amethyst, which is parallel to the seed used for the growth of the synthetic amethyst crystal (i.e. perpendicular to the growth direction). In synthetic amethysts investigated in the past broad colour bands parallel to one rhombohedral face were rarely observed, whereas in natural amethysts generally sharp lamellar structures are observable parallel to several rhombohedral faces.

The different types of commercially grown synthetic amethysts of the trade, which were previously investigated by the authors, in general did not reveal polysynthetic twinning on the Brazil law. These results were consistent with the data published by Balitsky (1981) and Schneider and Dröschel (1983), who recognized the great importance of polysynthetic lamellar twinning in natural amethyst for a distinction of natural stones from their man-made counterparts (cf. also the determinative procedure of Lind *et al.*, 1983, 1985). In contrast, twinning on the Brazil law in synthetic amethysts was described by different authors (Melankholin and Tsinober, 1963; Chentsova *et al.*, 1966; Balakirev *et al.*, 1975; Balitsky, 1981). This type of twinning, however, is only confined to distinct areas of the synthetic crystal. By use of the gem microscope, these twinned areas are recognizable between crossed polarizers as triangular shaped zones which are incorporated into a main crystal. Balakirev *et al.* (1975) demonstrated that this type of twinning reveals a certain twin structure on the microscopic scale and, thus, is different from the twin structure on the macroscopic scale which is common in natural colourless quartz.

The investigation of samples of the new type of synthetic amethyst from commercial Japanese production by the authors showed twinning in triangular shaped zones which are incorporated into the main crystal in about half of the faceted synthetic amethysts studied. By use of the immersion microscope with the newly developed sample holder as a supplement, these acute-angled areas are easily recognizable between crossed polarizers as incorporations into the main crystal of synthetic amethyst which is not twinned on the Brazil law (Figures 3–6). A similar structure was found only in one sample of the recently investigated types of synthetic amethyst; this sample was from the commercial production in the USSR. Due to the microscopic appearance of this type of twinning in synthetic amethyst, a distinction from the different forms of polysynthetic lamellar twinning in natural amethyst, in general, is avoidable by careful investigations. For this purpose, a detailed knowledge of the various properties of polysynthetically twinned natural amethysts on the Brazil law as described comprehensively by Schmetzer (1985 a,b) is necessary.

Some samples of the new type of synthetic amethyst of Japanese production were investigated by infrared spectroscopy using an immersion cell which was especially developed for the study of faceted gemstones (Lind and Schmetzer, 1982, 1983). The infrared spectra of samples of the new type of synthetic amethyst reveal the additional absorption band which was recently found to be of diagnostic value for the distinction of natural and synthetic amethyst. This additional absorption band in the infrared area was first detected in synthetic amethysts produced in the USSR. Later, identical spectroscopic features were found also in the first synthetic amethysts from Japan. However, it is worth while mentioning that the additional absorption band in some synthetic amethysts from commercial Japanese production was only of low intensity. Additional investigations of synthetic amethysts of all types of commercial production available in the trade are continuously carried out.

The distinction of natural and synthetic amethysts now as ever before is based on a detailed microscopic investigation of the samples of unknown origin. This investigation includes the microscopic determination of a possible presence of growth structures, twinning and inclusions. For samples which are still doubtful supplementary investigations by infrared spectroscopy have to be performed (cf. the determinative procedure in Lind *et al.*, 1983, 1985). At present, by a combination of those methods which are recognized to be of diagnostic value in most cases it will be possible to find diagnostic properties which are suitable to characterise the sample of unknown origin. Each gem variety including amethyst, however, occasionally reveals samples without diagnostic properties of unambiguous value. Problems for a distinction between natural and synthetic amethysts, especially for small

Fig. 1. Synthetic amethyst from new Japanese production; feather consisting of fluid and two-phase inclusions. 30x.

Fig. 2. Synthetic amethyst from new Japanese production; sharp lamellar growth structures, connected with a distinct colour zoning (pictured above) parallel to the seed of the synthetic crystal (pictured below); feather consisting of fluid and two-phase inclusions. 20x.

Fig. 3. Synthetic amethyst from new Japanese production; acute-angled twinned area incorporated into the main crystal which is not twinned on the Brazil law. Crossed polarizers. 24x.

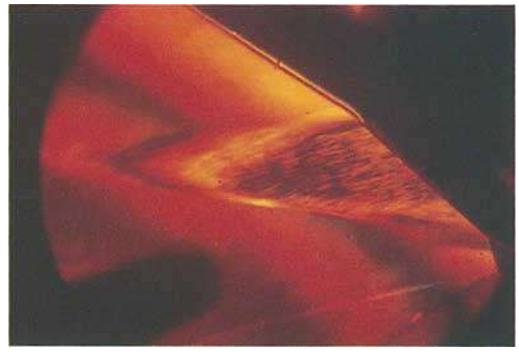

Fig. 4. Synthetic amethyst from new Japanese production; acute-angled twinned area incorporated into the main crystal which is not twinned on the Brazil law. Crossed polarizers. 40x.

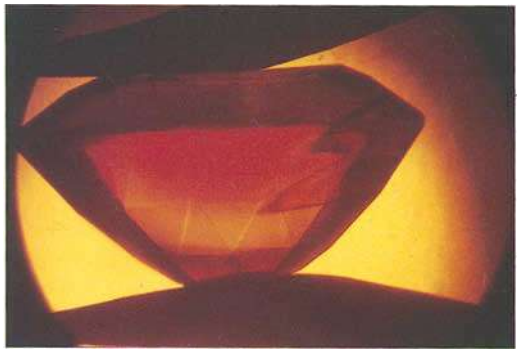

Fig. 5. Synthetic amethyst from new Japanese production; acute-angled twinned areas incorporated into the main crystal which is not twinned on the Brazil law. 16x.

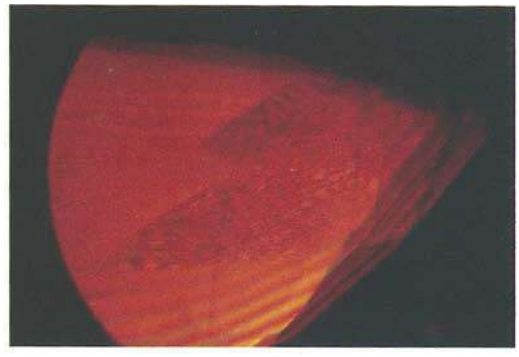

Fig. 6. Synthetic amethyst from new Japanese production; acute-angled twinned areas incorporated into the main crystal which is not twinned on the Brazil law. Crossed polarizers. 34x.

samples, may arise due to the fact that natural amethysts reveal polysynthetic lamellar twinning only in areas confined to the major rhombohedron of the crystals.

Acknowledgements

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On corundums from Umba Valley, Tanzania

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Abstract

The many colours exhibited by corundums from Umba Valley in Tanzania are related to their varying contents of Fe, Ti, Cr and V. Ni and Co could not be detected by the EDS-XRF technique used. The presence of abundant inclusions distinquishes these gemstones, and the following were found: zircon, rutile(?), apatite, hematite, mica, monazite, plagioclase, calcite, pyrrhotine and graphite. Healed fractures, negative crystals, colour zoning, twinning with traces of intersecting lamellae and boehmite(?) laths were noted. Techniques for the identification of inclusions are discussed. The densities (3.98-4.01 g/cm^3) and refractive indices (n_ε: 1.761-1.768, n_ω: 1.769-1.778) were also determined. Spectral features are given.

Introduction

Corundum is economically the most significant of the many unusal gemstones of East Africa. Numerous occurrences of ruby in Kenya and Tanzania (Longido, Lossogonoi, Mangari and Morogoro) have supplied the gem-cutting industry with raw material for a long time, but corundum from the Umba Valley is unique for the large range of colours exhibited by the mineral.

The aim of this study is to describe the properties and characteristics of the corundum from Umba Valley, and to supplement and confirm data and information from earlier publications.

Rubies from alluvial deposits were discovered in the vicinity of the River Umba in north-eastern Tanzania in 1960 (Solesbury, 1967). The host rock of the corundum was found not far from this location in a pegmatite which intrudes a greyish-green serpentinite. The pegmatite varies mineralogically, but where it hosts corundum it contains vermiculite and a calcic plagioclase. Gneisses (in part graphitic), amphibolites and marbles are geologically associated with these rocks. The geology of the area was described by Solesbury (1967). The erosive action of the River Umba resulted in the exposure of these rocks and the formation of alluvial deposits. Many corundum crystals were thus extracted from the host rock and accumulated in pockets and depressions.

Habit and colour of the crystals

The crystals or crystal fragments usually occur in tabular, hexagonal forms without pyramid faces. Generally, the basal faces seem to be corroded and, as with the prism faces, perforated with 'packets' of vermiculite. Intersecting furrows occur on the basal faces, often forming regular triangles. These originate where the traces of the rhombohedral cut the basal faces. The furrows are also exit positions of the fine twin lamellae which also lie parallel to the rhombohedral faces. In many ways, the corundum from Umba resembles that from the Missouri River in Montana (USA), especially as far as colour, habit and inclusion patterns are concerned. However the Umba corundum exhibits colours which are much more varied; all conceivable colour combinations of blue, red, yellow and colourless occur (Pough, 1972; Naftule, 1982). However, pure (spectral) colours are virtually never encountered and variations of bluish-green, bluish-grey, violet, pink, yellowish-green, brownish-yellow, orange or brown predominate. The best colour is exhibited in the direction of the *c*-axis, often paler in the centre of the crystal and more strongly coloured towards the crystal rims. Colour zoning in two different colours within the same crystal sometimes occurs.

Two colour varieties of Umba corundum have attracted particular attention. Firstly, the bright orange to yellowish-brown stones and secondly, the colour-changing alexandrite-like types (Naftule, 1982). At this stage, it should be pointed out that with respect to colour, the superb orange corundum from Umba Valley differs chemically from the padparadschas of Sri Lanka as far as the causes of the colour are concerned. The trace elements chromium (Cr) and iron (Fe) are mainly responsible for the colour of the orange Umba corundum, whereby Cr^{3+} is the cause of the red component, and Fe^{3+} of the yellow. The padparadschas of Sri Lanka owe their colour to a combination of chromium and lattice defects (the latter acting as colour centres), as well as to trace quantities of iron. In the latter case the chromium is the cause of the

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red colour component, but the yellow component of the orange stems mainly from the colour centres (Schmetzer *et al.*, 1982). As the two varieties of corundum are dissimilar both in appearance and as to the origin of their colour, there is no cause to designate the orange corundum from Umba as padparadscha (Gunawardene, 1984).

Many authors have studied the causes of colour in corundum (Harder, 1969, Lehmann *et al.*, 1970, Schmetzer *et al.*, 1981). The following data from corundums from Umba originates from the work of Harder (1969), who investigated a large number of differently coloured corundums from all over the world, using wavelength-dispersive X-ray fluorescence techniques (Table 1).

Table 1. Colouring effect of trace elements in corundum from Umba Valley. (after Harder, 1969)

	Cr	V	Fe	Ti
Red	0.03	–	0.05	0.006
Violet	0.04	0.002	0.1	0.009
Bluish	0.014	–	0.6	0.006
Yellowish-green	0.007	–	0.5	0.006
Greenish	0.002	–	0.4	0.009

(Values in weight %)

As can be seen in Table 1, the four main trace elements in Umba corundum occur in concentrations covering a wide range. Lattice position and oxidation state of Fe as well as its association with other trace elements play an important role in colour considerations. Basically, the following rules apply (after Schmetzer and Bank, 1981): *Yellow* corundum is either coloured by the presence of trivalent iron (Fe^{3+}) or by defects in the crystal lattice (colour centres). The iron in *blue* sapphire is mainly divalent and together with quadrivalent titanium it forms the blue colour of the mineral as (Fe^{2+}/Ti^{4+}) pairs. *Green* corundum probably possesses its colour through mixing of yellow and blue, the latter two colours resulting from the reasons given above. *Red* corundum (ruby) contains trivalent chromium (Cr^{3+}) and often also vanadium (V^{3+}) and iron. *Violet* stones can be expected to contain a mixture of Cr with Fe and Ti, as violet may be considered to be a mixture of red and blue. Vanadium plays a major role in the colour-changing alexandrite-type corundum (Hänni, 1983). On the other hand, the colour effect of such natural stones is often masked by further trace elements resulting in the predominance of other colours. Particularly in the case of Umba Valley corundum, the combined effect of different colour-giving trace elements can be observed. Depending on which combination of elements are present and their relative proportions, a rich palette of colour results.

Twelve corundum samples from Umba exhibiting a wide range of colours, were analysed for the four chromophore elements Cr, V, Ti, Fe by W. B. Stern (Basel). Using an energy-dispersive X-ray fluorescence unit (Stern and Hänni, 1982), the results of Harder (1969) were confirmed qualitatively. Measurable quantities of nickel or cobalt were not detected. Signals from Zr, Pb, Cu, Zn were registered in specimens containing numerous inclusions. There, Zr and Pb is explained by zircon crystals which in many cases reach the surface of the faceted stones. The Cu and Zn signals are most probably due to metal remainders stemming from the cutting wheels. The metal particles are fixed in fractures and open pores in the sample.

Physical Properties

The specific gravity of corundum varies only within a small range; any values outside this range are probably due to the presence of lighter or heavier inclusions. Table 2 shows a compilation of values of specific gravity and refractive indices also exhibit only small variations. The maximum values attained are extremes for corundum, and were measured on an orange-coloured specimen (see also Bank, 1972).

The absorption spectra reflect the many colour varieties and are combinations of the three basic spectra of ruby, sapphire and yellow corundum. Even very small amounts of Cr result in the fluorescence doublet at 693nm. On the other hand, the presence of vanadium or titanium when combined with other chromophores is hard to detect from the spectrum (Bossart, 1981). The Fe^{3+} in blue and bluish-green stones results in a strong band at 450nm. This can be so broad and strong in orange stones, that it merges with the absorption shoulder in the violet. This means that under the spectroscope, darkness occurs with such specimens after violet, below 470nm.

Four typical colour varieties of corundum from Umba exhibit the following absorption spectra (recorded using a Pye-Unicam SP8-100 spectrophotometer):

Orange: 700, 693, 688, 674, 657, 554 (wide, **470** general absorption.

Bluish-green: (693), 560 (wide;, 466, **450**, 388, 376, 360 general absorption.

Olive: (693), 650, 468, 456, **450**, 388, 376, 360 general absorption.

Light violet: **693**, 657, (560 wide), (466), 450, 388, 373, 320 general absorption.

Weak lines are in brackets, strong lines are in bold-faced type, and the last values represent the beginning of general absorption. Values are in nanometres (nm).

Table 2. Physical data of the Umba Valley corundums.

	This study	Zwaan (1974)	Gunawardene (1984)
Density (g/cm^3)	3.98_0-4.01_0	3.97_5-3.99_3	3.99-4.06
Refractive indices			
n_e	1.761-1.769	1.760-1.765	1.763-1.765
n_o	1.768-1.778	1.768-1.774	1.771-1.773

Mineral inclusions and their determination

Of the gemstones which occur in the Umba Valley, garnets have undergone the most in-depth study of their inclusions. Investigations by Schubnel (1972), Zwaan (1974) and Gübelin (1981) have shown that the following inclusions exist in the pyrope-almandine-spessartine-grossular mixed crystals of the garnet group:– apatite, monazite, zircon, rutile, pyrite, pyrrhotine, quartz.

With the exception of quartz, all the above minerals as well as some others can be found in corundum. The following is a list of minerals determined by Zwaan (1974), identified mainly by using X-ray powder techniques: apatite, graphite, pyrrhotine, rutile, spinel, vermiculite, zircon.

Observations of the occurence of a number of these minerals were made previously by Eppler (1973).

Unfortunately, results in publications seldom mention how mineral inclusions were identified. Nowadays, numerous techniques are available, and the commonest are briefly described below.

X-ray powder technique

A small amount of powdered sample material is usually used for this relatively simple investigation. After removal of included grains exposed on a surface or scraping off of powder using a diamond file, the characteristic diffraction pattern of the sample is compared with those of known phases.

Electron beam techniques

The study of tiny areas such as inclusions lying on the surface of a gemstone can be undertaken by means of two similar instruments: the scanning electron microscope (SEM) and the electron microprobe (EMP). Utilizing a fine beam of electrons, the atoms of the area studied are excited and generate characteristic X-rays. They are typical in terms of energy or wavelength for each element present in the sample. The emitted (fluorescence) radiation may be sorted using an energy-dispersive system (EDS) attached to the SEM or EMP. The resulting energy spectra enable one to read the chemical composition at least qualitatively (Figure 10). The SEM has the advantage that it can magnify strongly the analysed area and produce pictures of the surface. The EMP on the other hand is used primarily for fully quantitative chemical analysis rather than for imaging. Both techniques work non-destructively but possess the inherent disadvantage that the lightest elements cannot be analysed.

Raman-laser probe

Using this equipment, solid, liquid or gaseous inclusions within gemstones can be analysed. A monochromatic (wavelength, e.g., 488nm) laser beam is focused on an inclusion. The laser beam undergoes a frequency change characteristic of the material excited, through interaction with oscillating molecules. The spectra recorded in the infrared region are compared with reference spectra for known solid, liquid and gaseous phases.

Of the three methods discussed above, Raman spectroscopy is still a novel technique in the field of gemmology (Delé *et al.*, 1985).

Optical techniques

Inclusions are often solely identified by their appearance under the microscope (form, colour, relief, etc.) and compared with known phases, especially when other techniques cannot be applied through lack of equipment. On the other hand, identifications purely on the basis of optical comparison are relatively unreliable. Information on inclusions would be more valuable if the technique used for the determination was described.

There are, however, certain types of inclusions, although widely distributed and well-known, whose determination poses great problems: for example, the identification of fine rutile needles in corundum. It can be difficult to decide in certain cases whether, we are dealing with rutile needles, or with hollow cavities (the titanium detected can either occur in the corundum lattice, or as segregated rutile).

In corundum from Umba Valley, ruby from Thailand and Kenya, sapphire from Missouri River deposit (Montana, USA) and corundums from other sources, characteristic inclusions resembling scaffolding are found. These have not been definitely identified due to differing results obtained by various investigators. These linear elements which cross through the corundum in sets parallel to the rhombohedral edges have been described as:

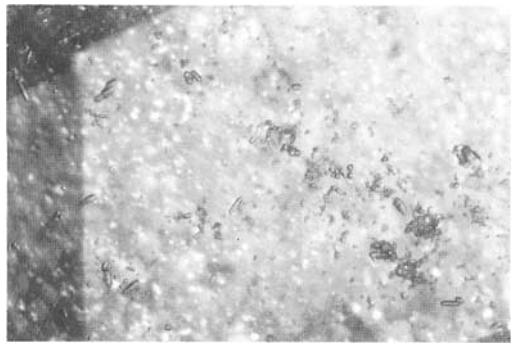

Fig. 1. The most common inclusions in corundum from Umba Valley are zircons. 25x.

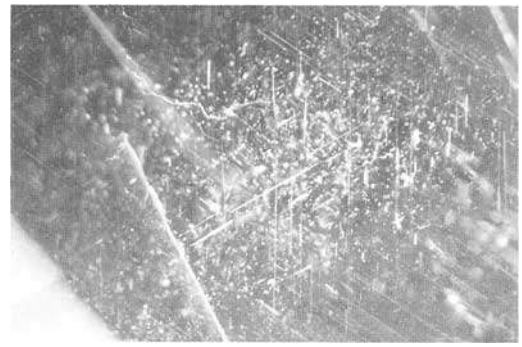

Fig. 2. Short and long needles of rutile, partly lanciform as twinned forms. Reflected light showing interference colours. 25x.

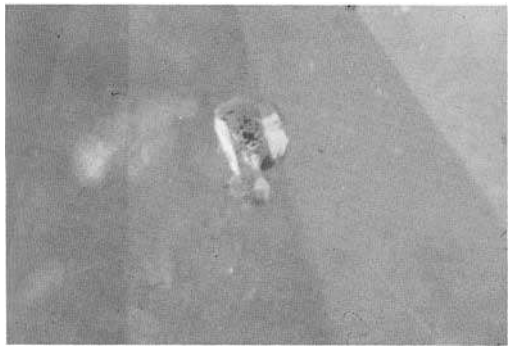

Fig. 3. Idiomorphic crystals of apatite with unidentified dark inclusions. 50x.

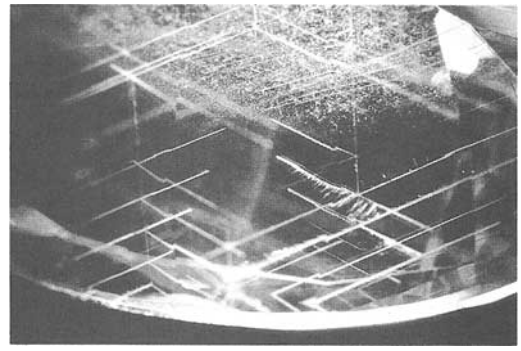

Fig. 4. Twin lamellae intersections and boehmite laths respectively, with fine fissures. Below: fine rutile segregations. 10x.

(a) needles of corundum (Eppler, 1973).
(b) traces of intersecting twin- or dislocation lamellae (Gübelin, 1974; Schubnel, 1972).
(c) boehmite (Keller *et al.*, 1985).

Regardless of the importance of these inclusions (sometimes wrongly taken for rutile) general discussions on their nature have as yet not taken place. The extensive treatment in Schmetzer (1985) will lead hopefully to a generally accepted and used term for this type of inclusion.

The different inclusions found in Umba corundums, as well as structural phenomena exhibited, are described in order of abundance below. The abbreviations following the mineral names denote the method of identification used for this study:
EMP Electron microprobe technique.
OM Optical microscopy.
SEM Scanning electron microscopy.
XRD X-ray diffraction (powder techniques).

Identified inclusions

Zircon (SEM) Figure 1. Small to very small crystals of slightly rounded tetragonal prisms, partly intergrown in groups. They exhibit no preferred orientation in corundum, but are often surrounded by stress fissures. A zoned structure is often observed. The ratio of length: width varies from 2:1 to 30:1. The colourless zircon crystals have a positive relief relative to the surrounding corundum.

Rutile (OM) Figure 2. Very fine, oriented needles, often occurring in three intersecting systems. Mainly very loose and short. Due to the small amounts present and the minute exit positions to the corundum surface, rutile could not be confirmed either chemically or by X-ray techniques.

Apatite (SEM) Figure 3. Individual large to small crystals which occur frequently in reddish corundum and themselves often contain minute dark brown unidentified inclusions. Their hexagonal and prismatic forms with multi-faced to rounded terminations are usually readily recognizable. The mineral grains are colourless and possess a negative relief relative to corundum. Apatite is much rarer than zircon in the blue and green corundum varieties.

Boehmite-laths (OM) Figure 4. Fine to substantial lathlike to track-like structures run through the

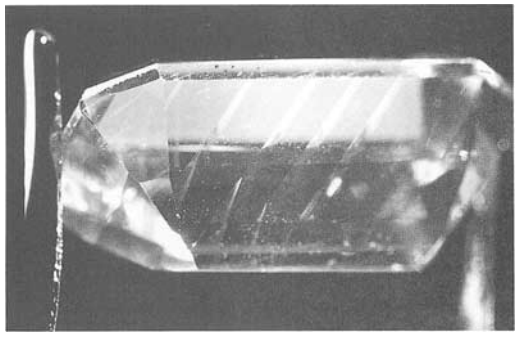

Fig. 5. Polysynthetic twinning, wide and narrow bands alternating. 10x.

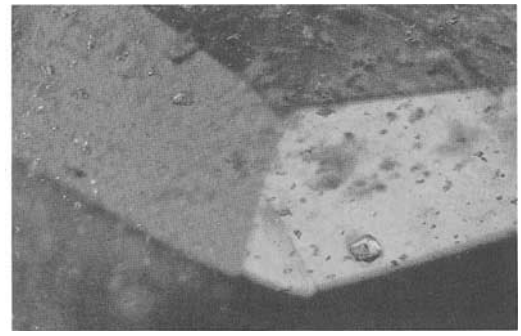

Fig. 6. Tabular greenish-yellow crystal of monazite, together with numerous small grains of zircon. 20x.

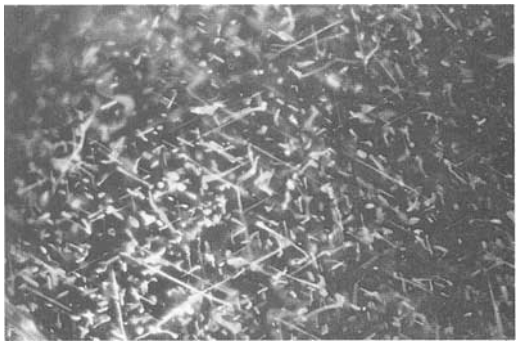

Fig. 7. Needles and thin platelets of hematite coloured brown in transmitted light. The regular pattern corresponds to the arrangement of the rutile-silk. 35x.

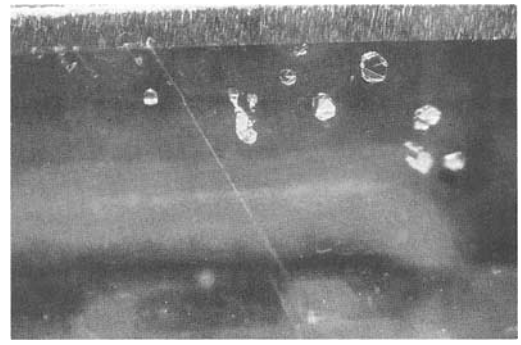

Fig. 8. Flat negative crystals, parallel to the basal face of corundum, in part exhibiting trigonal symmetry. 30x.

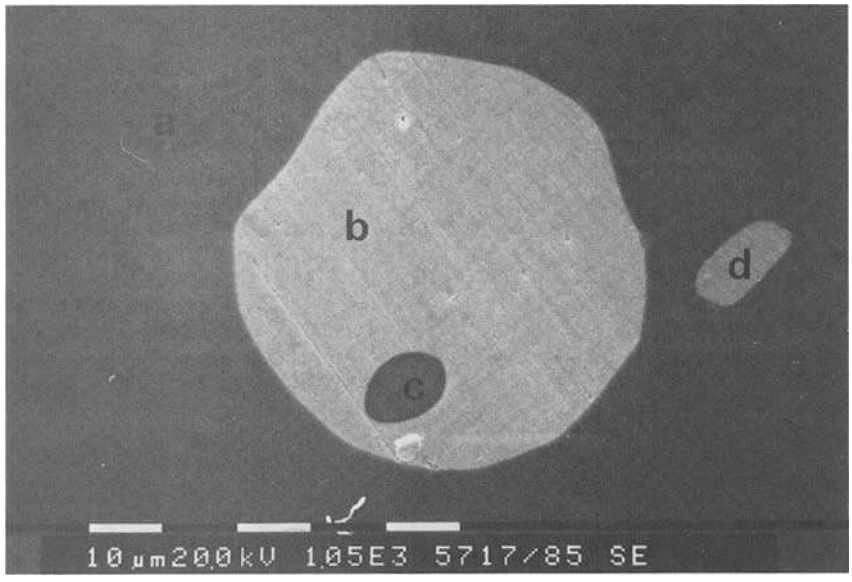

Fig. 9. SEM micrograph of a surface of corundum, showing intersected inclusions. The latter were identified on the basis of their EDS spectra: *a:* corundum, *b:* monazite, *c:* plagioclase, *d:* zircon.

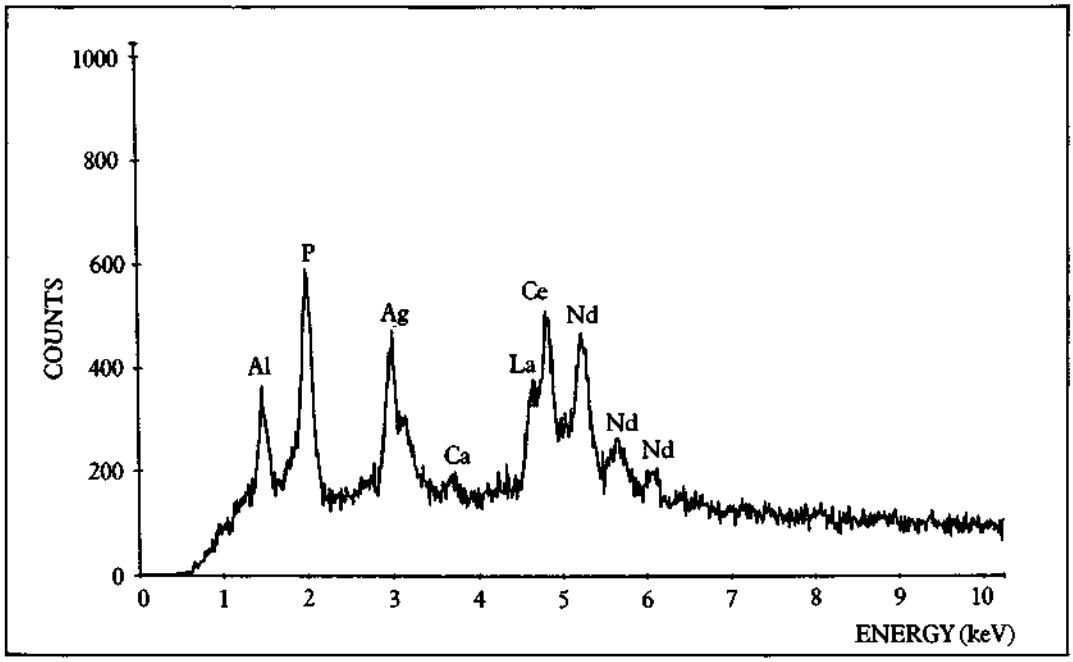

Fig. 10. EDS spectrum of the monazite grain in Figure 9. The Ag line is due to the necessary coating of the sample with a conductive material. The fact that monazite often contains rare earth elements is supported by this EDS spectrum.

corundums parallel to the rhombohedral edges. They occur mostly in three spatial directions and intersect each other at nearly right angles. Often very fine fissures emanate from these lines. The boehmite laths run within the traces of systems of intersecting twin lamellae. The impression arises that the laths are either hollow or filled with polycrystalline material (Delé, pers. com., 1984). As mentioned above, different names have been applied to this type of inclusion.

Twinning (OM) Figure 5. Polysynthetic twinning occurs very commonly in all the colour varieties, mainly in the form of alternating, very fine and broader lamellae. Two other common growth features often encountered are colour zoning, and zoning whereby differing amounts of mineral inclusions occur in definite zones.

Monazite (SEM) Figures 6 and 9. Yellowish-green tabular crystals, containing plagioclase inclusions (SEM). Monazite ($CePO_4$) usually contains different elements of the rare earth group, in this case lanthanum and neodymium (Figure 10).

Hematite (EMP) Figure 7. Very thin, parallel oriented transparent brown platelets to lanciform habits. These are very similar to the hematite inclusions in the brown star corundum of Ban Kha Cha, Thailand (Weibel and Wessicken, 1981). These hematite platelets are the main cause of colour in most of the brown corundums from Umba.

Negative crystals (OM) Figure 8. Flat, crystallographically shaped cavities (?), arranged parallel to each other, have been found, which exhibit interference colours when viewed with oblique illumination. They could also be regarded as liquid films.

Mica (XRD) Colourless and also greenish-brown scales or flakes, presumably vermiculite from the host rock, occur mainly in the reddish varieties.

Calcite (XRD) Whitish rounded crystals, identified in blue corundum.

Pyrrhotine (XRD) Dark brown to golden lustrous round or stepped crystals, identified in reddish corundum.

Graphite (XRD) Very shiny, opaque, black platelets or flakes, flexible, identified in reddish-violet corundum.

Mineral dust (OM) Minute unidentified dots in zones or as 'comets', often clouding the whole stone.

Healed fractures (OM) More or less well-healed fissures containing liquid droplets.

Acknowledgements

The author is grateful to K.E. Wild, Kirschweiler, who supplied study material, Professor W.B. Stern (Geochemical Laboratory, University of Basel) for the numerous EDS-XRF analyses, and M. Düggelin (Laboratory for Scanning Electron Microscopy, University of Basel) for his collaboration in the determination of inclusions.

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Notes from the Laboratory – 9

Kenneth Scarratt, F.G.A.

The Gem Testing Laboratory of Great Britain, 27 Greville Street, London, EC1N 8SU

We were recently sent a number of pieces of a blue material from Hong Kong for examination with the comment that they were the result of a 'joint venture' which was attempting to produce lapis lazuli. The pieces were in the form of a round, drilled bead weighing 9.53 ct, an oval cabochon weighing 5.03 ct and a number of pieces of rough material (Figure 1).

The material appeared to take a good polish and whilst the colour varied from piece to piece the combination of polish and colour in the drilled bead was pleasing. Some pieces displayed a schiller which was easily visible to the unaided eye and this was the first indication of the fibrous and radiating inclusions that could be seen in all the specimens with the aid of a 10x lens (Figure 2).

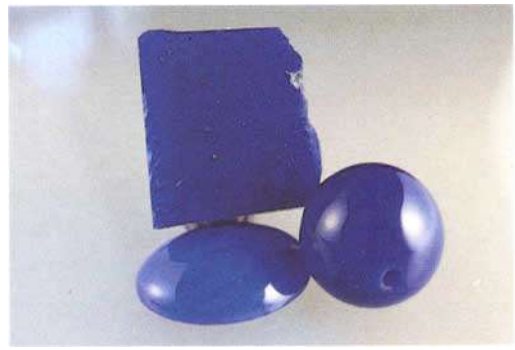

Fig. 1. Blue devitrified glass imitating lapis lazuli. One round drilled bead weighing 9.53 ct, an oval cabochon weighing 5.03 ct and one piece of the rough material.

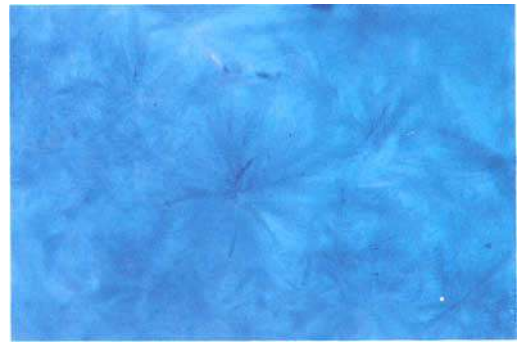

Fig. 2. Fibrous and radiating inclusions in blue devitrified glass imitating lapis lazuli.

Table 1: Electron microprobe analyses of blue devitrified glass from Hong Kong: mean of five points.

SiO_2	68.08
Al_2O_3	5.03
FeO	trace
MgO	0.18
CaO	15.21
Na_2O	7.65
K_2O	1.99
Cu_2O	1.45
S	trace
Cl	trace
	99.59%

Analyses were carried out on a Cambridge Instruments Geoscan with Link Systems energy dispersive detector and computer. The electron beam was defocused to 50–100μm diameter, and an accelerating voltage of 15kV and a specimen current of approximately 5.10^{-9} amp were used. Five spots were analysed and the mean is given in the table.

One surface on each of three specimens was polished flat in order to facilitate refractive index measurements. RIs were then obtained using a Dialdex refractometer in sodium light. Even with flat, polished surfaces the RI readings were still not sharp, though it is possible to state that the refractive indices for the three specimens varied between 1.506 and 1.508.

The specific gravity was determined for each of four specimens by hydrostatic weighing in distilled

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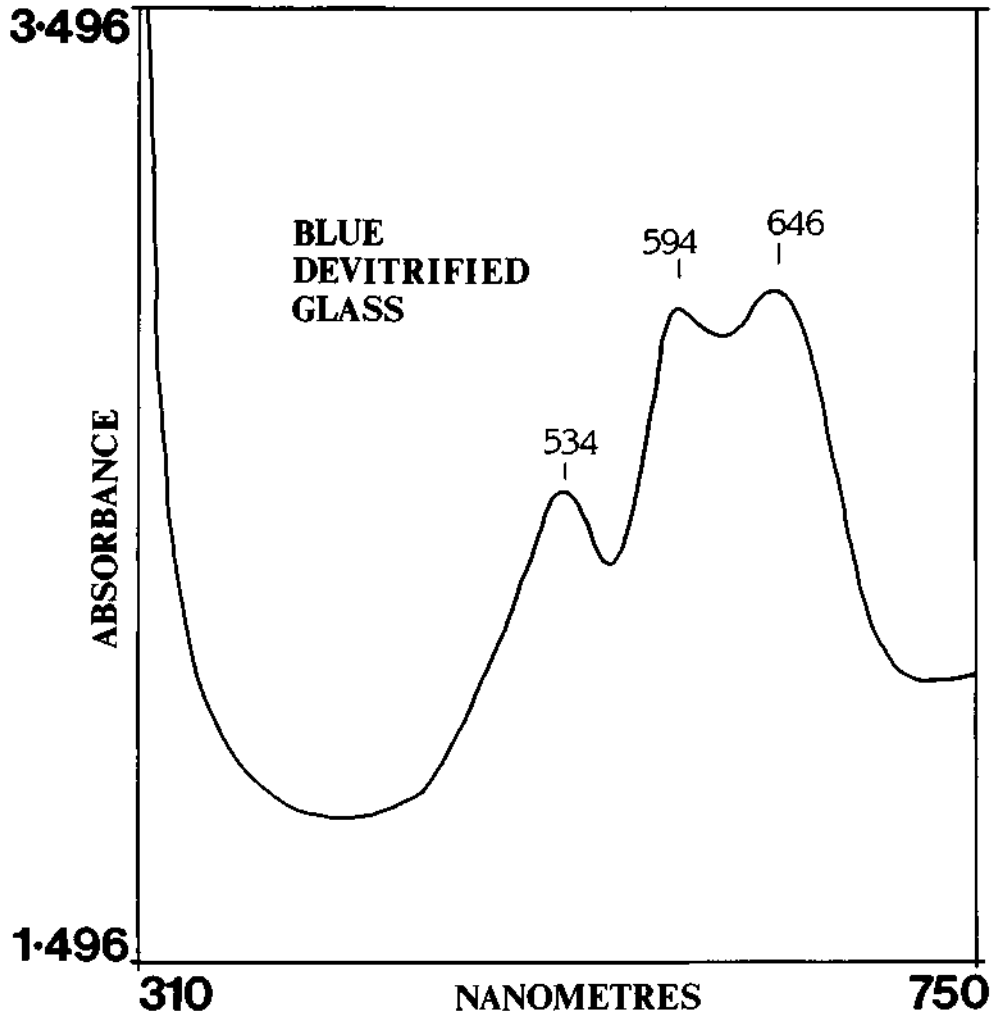

Fig. 3. The absorption curve of the blue devitrified glass in Figure 1. The curve was obtained using a Pye Unicam PU8800/03 UV/visible spectrophotometer (Basil Anderson model) with a speed of 1 nm/s and a bandwidth of 0.5 nm at room temperature. The path length was 0.5 mm.

water at room temperature and the results were 2.51, 2.54, 2.55 and 2.56. The Mohs hardness for each of three specimens was found to be 5–5½.

A thin slice was cut and polished from a rough sample in order to facilitate absorption measurements on the spectrophotometer and a curve between 750 and 310 nm was obtained (Figure 3). The curve appears to be typical of cobalt although no trace of this element was detected during electron microprobe analyses. Five spots were examined by electron microprobe analyses and a mean of the results is given in Table 1.

All pieces contain fibrous and radiating inclusions. In some pieces, e.g. the bead, these inclusions are fine and in others they are coarse. A small scraping was taken from one of the rough samples and this produced an X-ray diffraction pattern typical of wollastonite ($CaSiO_3$). In our opinion the material is a devitrified calcium alkali silicate glass containing fibrous wollastonite (Gübelin and Koivula, 1986, p.439).

A different devitrified blue glass imitating lapis lazuli was reported by Bosshart in 1983 (Bosshart, 1983).

* * *

Generally, pearls examined in the Laboratory conform in their internal and external structures to the arrangement of stacked aragonite platelets described by Webster and others (Webster, 1983, p.506; Hanni, 1983). When seen with the aid of a 10x lens or a microscope, the surface of most pearls, be they natural or cultured, will be resolved as a

series of overlapping platelets. The observation of the serrated edges to these platelets is a welcome sign to anyone wishing to distinguish natural and cultured pearls from the various imitations.

However, not every pearl conforms with the *standard*, and differing internal and external structures are possible. The pink conch pearl is, with its flame structure (Farn, 1986), a good example of this. Another good, if not striking example of the abnormal, was sent to us recently. It was sent from Scotland for our observations, and it was thought to be a natural black freshwater pearl which had fallen apart, revealing an interesting internal as well as a peculiar external structure. The surface structure is seen in Figure 4 and the internal structure in Figures 5 and 6.

The pearl is composed of long, slender crystals of aragonite all radiating from a central point; and the structure seen on the surface consists of the cross sections of these crystals. This structure was compared with various examples of pearl thin sections in the Laboratory's collection and it was found to resemble most closely that of a natural freshwater pearl (Figure 7).

* * *

Probably one of the most difficult tasks the Laboratory undertakes is the issuing of Damage Reports on gemstones that were not submitted for examination before the damage occurred. An example of a typical question might be 'Has the flaw in this diamond occurred recently?' Sometimes it is possible to answer the question but often it is not.

A few years ago I reported in '*Notes from the Laboratory*' (Scarratt, 1983) a most unfortunate case where a fine piece of lapis lazuli had been ruined by being placed in an acid bath for cleaning. We have examined the results of similar accidents both before and since that report, but none have displayed quite the devastation that resulted from the immersion of an amethyst necklace in hydrofluoric acid!

An enamelled necklace from which five hexagonal, faceted, amethysts were suspended, was sent to a workshop for the enamel to be recreated. During the course of the work the whole item was immersed in hydrofluoric acid. The outcome of this immersion was the severe etching of every facet on each amethyst, examples of which are shown in Figures 8 and 9.

* * *

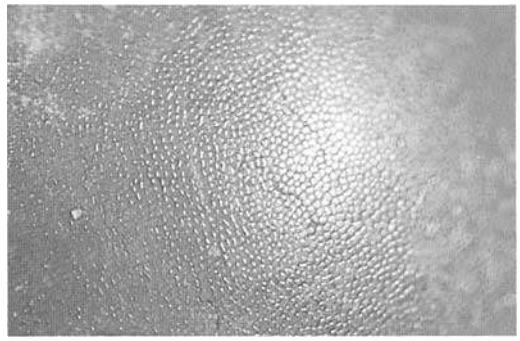

Fig. 4. The surface structure of a freshwater pearl from Scotland.

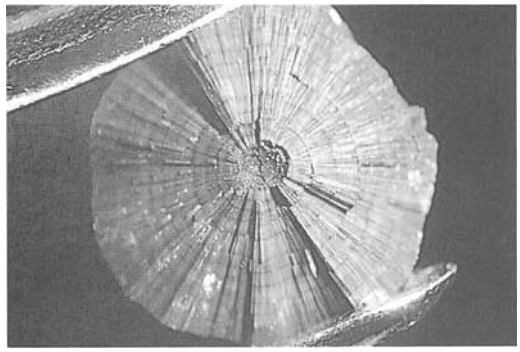

Fig. 5. The internal structure of a freshwater pearl from Scotland which was revealed when the pearl fell apart.

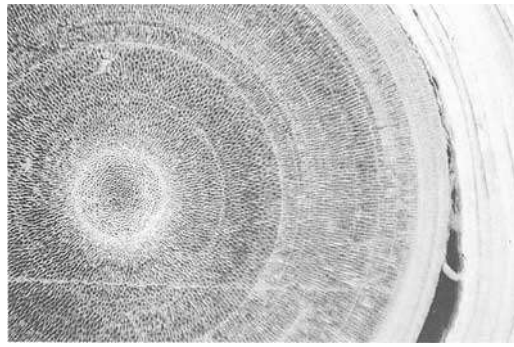

Fig. 6. A closer view of the internal structure of a freshwater pearl seen in Figure 5.

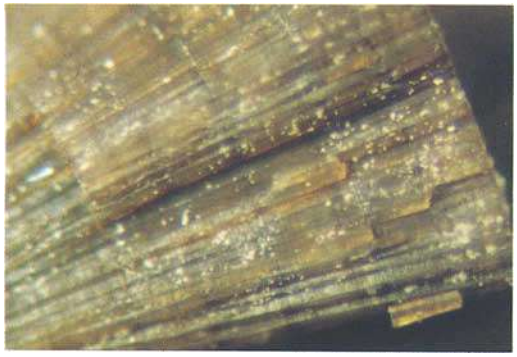

Fig. 7. The thin section of a natural freshwater pearl (Laboratory collection).

The difficulties concerning the identification of the cause of the colour in many green diamonds make even the most experienced gemmologists think more than twice before putting pen to paper. Bearing this in mind and the fact that nowadays laboratories are usually only requested to identify the problematic items, it was a most satisfying feeling to be able, almost immediately upon picking up a green diamond recently, to identify in a most positive fashion the cause of colour as being due to artificial irradiation. Around the culet area was the 'opened umbrella' pattern resembling a water mark and typical of cyclotroned diamonds. (Figure 10), and in the girdle area there was a clear ring of dark green coloration (Figure 11) (Webster, 1983, p.693).

* * *

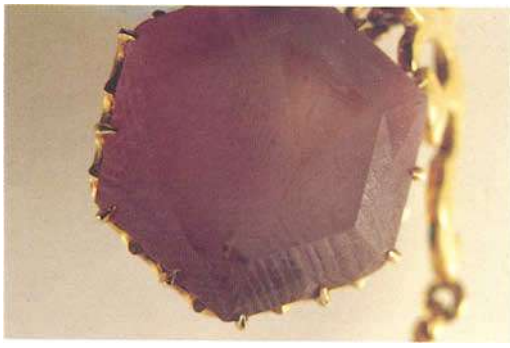

Fig. 8. One of five amethysts after being etched by hydrofluoric acid.

Fig 9. Close-up view of the etched surface on the amethyst.

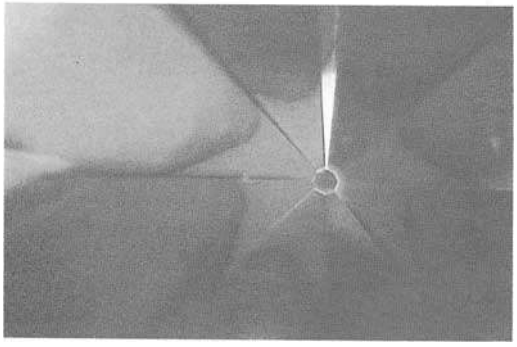

Fig. 10. The water-mark like opened umbrella pattern seen in the culet area of a cyclotroned green diamond.

Fig. 11. Colour concentration at the girdle of a green cyclotroned diamond.

During August 1981 we were asked to examine three loose rectangular, faceted, green stones which, it was said, were being offered in Switzerland as natural emeralds. It was further stated that these stones had been mined in Australia.

The stones, which weighed 1.07, 2.21 and 3.12 ct, had refractive indices of 1.571–1.576 and SGs ranging from 2.693 to 2.709. As the stones were green and had the typical RIs and SGs of beryl the obvious next step was to examine their absorption spectra for the presence of chromium lines. The spectrum observed consisted of the absorption of the violet, with an edge at approximately 466 nm, and a general absorption of the area between 582 and 620 nm. There was no indication of the normal emerald chromium lines in the red although a very weak single absorption line was seen in the deep red, i.e. at a much longer wavelength than is normal

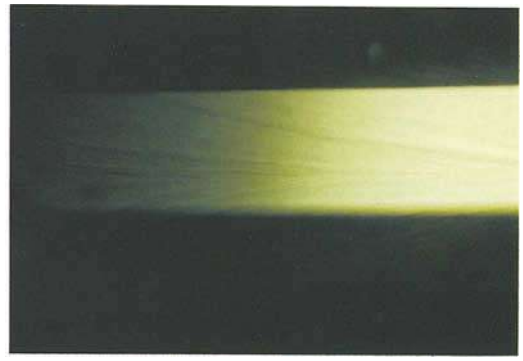

Fig. 15. A 'mountain peak' feature seen when looking down the optic axis of a 1.81 ct synthetic emerald.

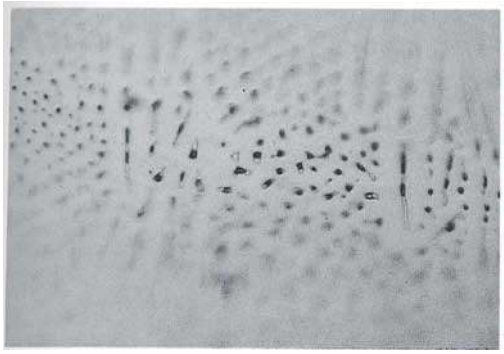

Fig. 12. Feather of two phase inclusions in a Biron synthetic emerald examined in 1981.

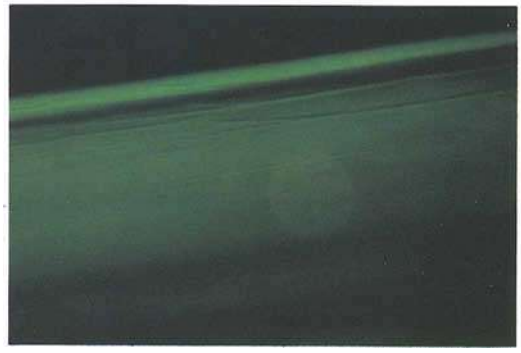

Fig. 16. The peaks and valleys of the 'mountain peak' feature seen in Figure 15 are revealed as long streaks passing along the length of the stone when viewed at right angles and through the girdle.

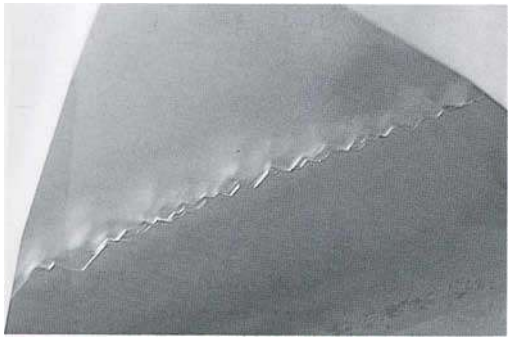

Fig. 13. Spear of arrow-point growth features seen in a Biron synthetic emerald examined in 1981.

Fig. 17. One of the possible appearances of the 'mountain peak' feature in the 1.81 ct synthetic emerald, as seen through the table facet.

for emerald. The line was too weak to measure with the hand spectroscope. All that could be established at that stage was that the material was green beryl.

A microscopic examination revealed that the stones were remarkably free from inclusions. However, in one stone a small feather of two phase inclusions could be seen (Figure 12) and a very small nail-head inclusion was seen after a prolonged search. The most notable feature of all three stones was a peculiar form of growth structure which may be likened to a spear or arrow-point (Figure 13).

Electron microprobe analyses were carried out on one of the stones. This confirmed a very low (<0.10%) chromium content, and a comparatively high vanadium content (0.61–0.51%).

After examining a number of Australian-grown synthetic vanadium beryls (Taylor, 1967) from the Laboratory collection, we were of the opinion that these stones were of synthetic origin.

Only a few weeks after our examination, fellow gemmologist G.A. Tombs, F.G.A.A., of Sydney, Australia, informed us that there was indeed a new synthetic 'emerald' being produced in Australia. He had examined some of these new synthetics and later reported upon them in *The Australian Gemmologist* (Tombs, 1983). His description of the material matched ours in most respects except that he had been able to observe chromium, if weakly, in the spectrum of his samples.

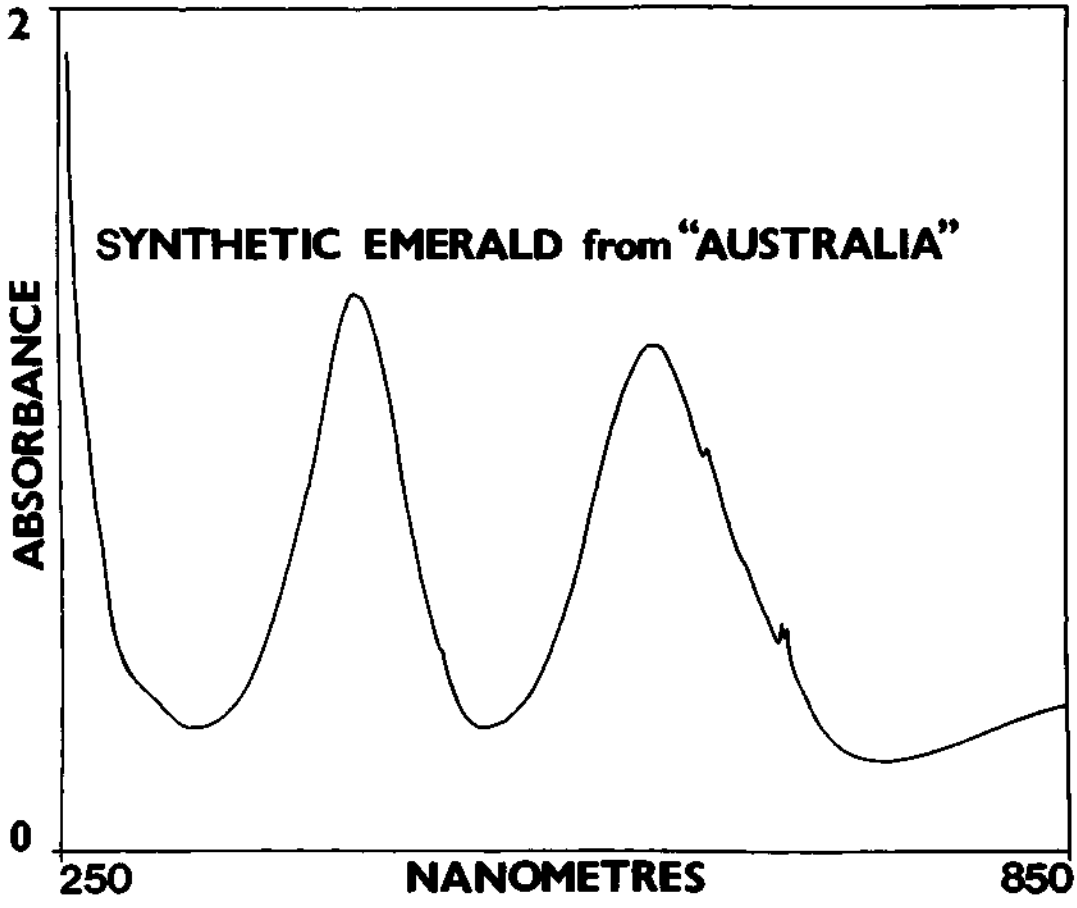

Fig. 14. The absorption curve of a 1.81 ct synthetic emerald said to come from Australia, taken at right angles to the optic axis. The curve was obtained by using a Pye Unicam PU8800/03 UV/visible spectrophotometer (Basil Anderson model) with a speed of 1 nm/s and a bandwidth of 0.5 nm at room temperature. The path length was approximately 6 mm.

Since that time the Biron synthetic emerald, as we now know it, has been well documented, and whilst the internal appearance seems now to differ from the original material its RIs and SG, as reported by Kane and Liddicoat, remain within the same range as that of the original material and, of course in the same range as that of some natural emeralds (Kane and Liddicoat, 1985).

Recently we were asked to examine one stone as a sample from a parcel of green stones that had been purchased as synthetic emeralds grown in Australia. The stone weighed 1.81 ct, was emerald cut, and was of a particularly pleasant emerald green colour. The refractive indices of this stone at 1.571–1.576, differ slightly from those reported by Kane and Liddicoat as being characteristic of the Biron synthetic emerald (1.569–1.573, [+ 0.001]) but they are the same as those reported by Darragh and Willing (Darragh and Willing, 1982), and the same as those of the stones examined by us in 1981. The ultraviolet fluorescence of this stone also differed from that described by Kane and Liddicoat, in that their stones were inert, whilst this one fluoresced a weak red under long-wave, and a much weaker red under short-wave ultraviolet light.

The SG of this stone was found by hydrostatic weighing in distilled water to be 2.702; it was deep red under the Chelsea colour filter, fluoresced red when exposed to a strong pin-point of visible light, and the dichroism was strong – yellowish-green/bluish-green. These four characteristics conform with those described by Kane and Liddicoat as being typical of the Biron synthetic emerald.

The recorded absorption curve of this stone, taken at right angles to the optic axis, is reproduced in Figure 14. The chromium peaks at 679.9 and 682.4 nm, are clearly present in this unpolarized curve and it can be seen that the stone transmits ultraviolet down to 250 nm.

From the foregoing, it is fair to state that the gemmological constants of this 1.81 ct stone are similar to those of the Biron synthetic emerald, but they are also within the same range as other hydrothermally grown synthetic emeralds, as well as being in the same range as some natural emeralds. Taking into account the information published so far on the internal features of the Biron synthetic emerald, and apart from a small feather formation and a minute nail-head inclusion which are similar to those observed in the first Biron synthetics, the other internal features of this stone appear to be more typical of the Linde synthetic emerald rather than the Biron (Gübelin and Koivula, 1986, pp.461–74).

The optic axis was parallel to the table facet and along the length of the stone. With the stone immersed in benzyl benzoate, upon looking down the optic axis a distinctive feature like mountain peaks could be seen (Figure 15). Similar features have been recorded in both natural and synthetic emeralds. Viewed at right angles and through the girdle, the peaks and valleys of the feature reveal themselves as long streaks passing down the length of the stone (Figure 16). Viewed through the table, the appearance of the 'mountain peak' features depends upon the lighting used and the angle of view. Figure 17 shows one of the possible appearances.

* * *

Acknowledgement

Thanks are due to Dr R.R. Harding for his advice and assistance and particularly for producing the electron microprobe analyses of both the blue glass and the Biron synthetic emerald.

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Some unusual cat's-eyes – 2

Yasuhiro Ito, G.G., F.G.A.

Osaka, Japan

After the publication of my previous paper (Ito, 1986), I was able to obtain some more rare cat's-eyes, including zircon, diopside, scapolite and kunzite. They are described in this short paper.

Zircon cat's-eye

When I paid a visit to Sri Lanka in 1984, I found a zircon cat's-eye in the stock of a dealer in Colombo, which had a dark green colour (maybe untreated) and weighed more than 5 ct. Of course I asked the dealer to sell it to me, but it was impossible for me to get it because he demanded a totally unreasonable price. This stone resembled that described in *Gems & Gemology*, Winter 1983 (Fryer (ed.), 1983).

Fig. 1. Two zircon cat's-eyes, 3.73 and 2.78 ct.

At the beginning of 1986, I got two zircon cat's-eyes (Figure 1), weighing 3.73 ct and 2.78 ct, brownish-grey and yellowish-brown in colour, which were said to be heat-treated. They showed sharp eyes and more than ten zircon lines under the spectroscope. I believe that zircons of other colours, such as blue, orange and colourless, can show chatoyancy. My stones came from Sri Lanka, but I think that stones from other localities, such as Canada, Burma, and USSR, can also show chatoyancy.

Diopside cat's-eye

From the point of view of jewellery, the chromium variety (dark green in colour) is the most popular of all kinds of diopside. Star diopside of almost black body-colour is also famous and much cheaper. In Sri Lanka there occurs light yellowish or greyish-green diopside which may be less attractive but is much less expensive than Cr-diopside. Some show chatoyancy very clearly because of compact tubular inclusions (Figure 2); generally they have a rather sharp eye.

Fig. 2. Sri Lankan diopsides. Cat's-eye and faceted stone.

I am not sure if diopside of other types and from other localities, such as Burma and USA, happen to show chatoyancy similar to that in my specimen from Sri Lanka, but I do think it would be splendid if Cr-diopside showed chatoyancy.

My collection has a stone of 3.45 ct but, of course, larger stones could be available. Refractive index is 1.68 (distant vision), and inert under ultraviolet rays.

Fibrolite (sillimanite) cat's-eye

In my previous paper, I reported on a nice greenish-yellow fibrolite cat's-eye which closely resembled chrysoberyl cat's-eye. Recently I obtained

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Fig. 3. Fibrolite cat's-eyes, 1.54 and 0.82 ct.

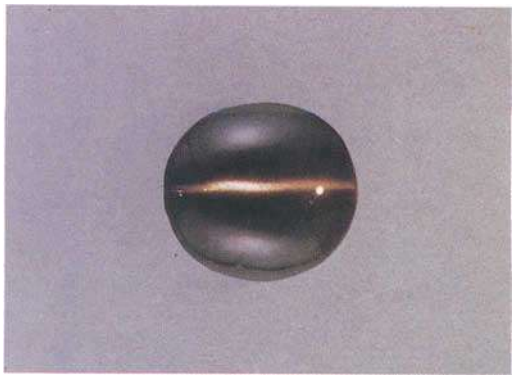

Fig. 4. Scapolite cat's-eye of black body-colour (from Sri Lanka).

another one from Sri Lanka which seems to be a more typical type for fibrolite. This weighs 1.54 ct and has a very attractive green colour. Many fibrous inclusions can be seen – which is appropriate for the name 'fibrolite'. Faceted fibrolite also occurs in Sri Lanka, some of which looks like aquamarine. Figure 3 shows two types of gem-quality fibrolite cat's-eye. The smaller is the stone reported in the previous paper, and the larger is described in this paragraph.

Scapolite cat's-eye

Colourless, violet and orange-brown scapolite cat's-eyes are popular, and often attractive. I obtained a black body-colour scapolite cat's-eye in March 1986 from Sri Lanka (Figure 4). This stone weighs 3.52 ct and is translucent. The refractive index is 1.55, and it is inert under ultraviolet rays.

Kunzite cat's-eye

In 1984 I had a chance to get rough material weighing one ounce which was described as 'kunzite cat's-eye', but from its appearance I doubted if it showed chatoyancy. As a result of cutting, three cabochons were made and one of them weighing 35.9 ct has a very sharp eye (Figure 5). The locality of this rough is unknown, but it has a rather attractive pinkish colour. Generally speaking the colour of kunzite tends to fade in sunlight. It will be interesting to see if the body colour of this stone will fade in the future. The stone has a massive structure, and shows purplish-pink colour under both long and short wave ultraviolet rays.

Fig. 5. Kunzite cat's-eye 35.9 ct.

Acknowledgements

I would like to thank Messrs S. Kihara and T. Fujiwara for useful advice.

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Ito, Y. 1986. Some unusual cat's-eyes. *J. Gemm.*, **20**, 3, 161–2.
Fryer, C.W. (ed.). 1983. Gem Trade Lab notes. *Gems Gemol.*, **19**, 4, 237.

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On twinning in natural and synthetic flux-grown ruby

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Abstract

Twinning in natural and synthetic flux-grown ruby is described with respect to its use in the distinction of natural and synthetic rubies.

Natural rubies rarely reveal contact twins on the basal pinacoid c (0001) or on the positive rhombohedron r ($10\bar{1}1$) with macroscopically developed individuals in twin position. Repetitive twinning on r ($10\bar{1}1$), consisting of thin lamellae of corundum in twin position intercalated parallel to one, two or three rhombohedral faces of a dominant individual, however, is common for natural ruby. Intersecting lamellae parallel to two rhombohedral faces form nearly rectangular chequered patterns.

In Chatham synthetic rubies contact twins on the prism faces ($10\bar{1}0$) or ($11\bar{2}0$) were frequently found. Ramaura synthetic rubies reveal penetration twinning about the c axis [0001]. In Kashan synthetic rubies as well as in Chatham synthetic rubies repetitive twinning of intercalated lamellae on r ($10\bar{1}1$) was found, even intersecting lamellae forming angles of 93.9° were observed.

Introduction

In mineralogical and gemmological textbooks various forms of twinning are mentioned as being common for natural corundum including the gem varieties ruby and sapphire. In scientific papers dealing with flux-growth of corundum and ruby a different type of twinning is described. In some original descriptions of new types of flux-grown rubies twinning, in general, is not quoted. In other papers as well as in some gemmological textbooks (e.g. Webster and Anderson, 1983), twinning of synthetic flux-grown rubies is mentioned without a detailed description and without any conclusions about the diagnostic applicability of twinning to problems of the distinction of natural and synthetic rubies.

The aim of the present paper is to report some properties of natural and synthetic ruby which are related to the different types of twinning observable in natural and synthetic corundum. In addition to the application of families of straight parallel growth planes to problems of the distinction of natural and synthetic rubies (Schmetzer, 1985a, 1986), twinning is the second important structural property which needs attention. In some cases twinning can be applied to problems of the distinction of natural and synthetic rubies. In other cases, the knowledge of all types of twinning which can occur in natural and synthetic ruby, e.g. the possible presence of repetitive rhombohedral twinning in Kashan synthetic rubies, is essential to avoid misinterpretations of microscopic observations.

Definitions

The following definitions of twinning and related conceptions are given by Bloss (1971):

'Two crystals of a given crystalline material are said to be twins if they occur intergrown so that all crystallographic directions of the first (for example, axes a_1, b_1 and c_1) are related to the corresponding directions of the second (for example, axes a_2, b_2 and c_2) by the operation of either (1) a mirror plane of symmetry, (2) a two-fold axis of symmetry or less frequently a three-, four-, or six-fold axis, or (3) a centre of symmetry $\bar{1}$. A twin plane or axis can never coincide in direction with any symmetry operation (in the untwinned crystal structure) for which this twinning operation is either identical or a subgroup. According to which of the above three types of symmetry relate the two individuals, the twins are called (1) *reflection twins*, (2) *rotation twins*, or (3) *centrosymmetric twins*, respectively. The plane of symmetry relating reflection twins is called the *twin plane*; the axis of symmetry relating rotation twins is called the *twin axis*; and the centre of symmetry relating centrosymmetric twins is called the *twin centre*. In *reflection twins* the twin plane is always parallel to a possible lattice plane (hkl). The twin plane's crystallographic direction is thus defined by stating the indices for this plane (in relation to either of the twinned individuals). For *rotation twins* the twin axis may generally be specified by designating the indices [uvw] of the one to which it is parallel.

'Twins are also classified and named according to the way they are intergrown. If the two twinned individuals are in contact along a well-defined plane so that a cut along this plane would entirely separate the two, they are called *contact twins* and the plane of contact is called the composition *plane*. On the

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other hand, two twinned individuals may either be in contact along an irregular surface or be so intergrown that no compositional plane exists along which a cut could be made to separate cleanly the two twinned individuals, each to its own side of the plane. Such twins, in which a composition plane is lacking, are called *penetration twins* or *interpenetrant twins*. In some materials the twin-producing symmetry operation may occur repeatedly so that numerous individuals and composition planes occur even within one relatively small grain. If the several composition planes are mutually parallel, the twinning is called *polysynthetic twinning.'*

Basic types of twinning in corundum

Corundum crystallizes in the hexagonal (rhombohedral) system and possesses the crystal class $\bar{3}$ 2/m (D_{3d}). In crystal class $\bar{3}$ 2/m the second-order hexagonal prism ($11\bar{2}0$) is parallel to a mirror plane, and hence ($11\bar{2}0$) cannot be a twin plane but a composition plane of twinned corundum crystals. In crystal class $\bar{3}$ 2/m a 180° rotation about the *c* axis [0001] is symmetrically equivalent to a reflection across the first-order hexagonal prism ($10\bar{1}0$) or the basal pinacoid (0001).

In natural corundum, two types of twinning are described:

(a) Contact twinning on the basal pinacoid *c* (0001), with *c* (0001) as both the twin plane and composition plane.
(b) Contact twinning on the positive rhombohedron *r* ($10\bar{1}1$) with *r* ($10\bar{1}1$) as both the twin plane and composition plane.

Though twinning in natural corundum generally is mentioned as being common, contact twins on *c* (0001) or *r* ($10\bar{1}1$) consisting of two or more well developed crystals are extremely rare (for a summary of the literature compare Spencer, 1927). Occasionally, symmetrical groups of three individuals around a central crystal due to twinning on three rhombohedral faces are observed (Drugman, 1943).

Lamellar twinning on *r* ($10\bar{1}1$), however, is found in a great number of natural corundum crystals. In this type of twinning, often also designated as polysynthetic twinning, thin lamellae or lamellar layers of corundum in twin position are intercalated with *r* ($10\bar{1}1$) as both the twin plane and composition plane into the dominant corundum individual. Due to an interfacial angle of 93.9° between two rhombohedral faces, intersecting lamellar seams of corundum are macroscopically observed as nearly rectangular striations on well developed prism faces of natural corundum (see Lasaulx, 1885; Judd, 1895; Melczer, 1902; Palache *et al.*, 1944).

Lamellar twinning on *c* (0001) is rarely mentioned in the literature. An unequivocal distinction of intercalated thin lamellae in corundum crystals with *c* (0001) regarded as both the twin plane and composition plane from basal parting, which is also known to occur parallel to *c* (0001) in corundum, however, is rarely found. Thus, the basal pinacoid *c* (0001), in general, is regarded as a structural plane, which can be either twin plane or parting plane (Judd, 1895; Bauer, 1896; Kronberg, 1957; Scheuplein and Gibbs, 1960).

In synthetic corundum, two types of twinning are described in papers dealing with growth conditions and properties of flux-grown crystals:

(a) Contact twinning on the first-order hexagonal prism ($10\bar{1}0$) or the second-order hexagonal prism ($11\bar{2}0$) as composition planes with ($10\bar{1}0$) as twin plane.
(b) Penetration twinning along irregular surfaces with 180° rotation about the *c*-axis [0001] as twin axis.

Due to the fact that both types of twinning (reflection and rotation twinning) are symmetrically equivalent, they can be observed within one single flux-grown corundum individual. In such samples more complex twin-boundaries than one single line were found on etched (0001) planes of flux-grown corundum crystals. Even twin boundaries changing direction frequently and irregularly as well as splitting boundaries were observed. In such cases the boundaries of three or more crystals twinned by 180° rotations about [0001] and/or by reflections across ($10\bar{1}0$) were found to meet at one single point. In other samples, several parallel twin bands were observed. In general, however, the twin boundaries tend to favour the ($11\bar{2}0$) and/or ($10\bar{1}0$) planes (Melczer, 1902*; Stephens and Alford, 1964; White and Brightwell, 1965; Janowski *et al.*, 1965; Champion and Clemence, 1967; Voronkova *et al.*, 1968; Lillicrap and White, 1976). No evidence of rhombohedral twinning is known by the present author from the literature for flux-grown corundum and ruby.

In gemmological literature, twinning is sometimes assigned only to natural rubies, e.g. in the description of Kashan synthetic rubies (Kane, 1979), and in the description of Kashan, Chatham and Knischka synthetic rubies (Gübelin, 1982a, b), or is not mentioned in the description of important new types of synthetic ruby, e.g. Ramaura synthetic rubies (Bosshart, 1983; Kane, 1983, Gübelin, 1984). Only for Chatham synthetic rubies, twinning or 'pseudo-twinning' is briefly mentioned without a detailed description (Fryer *et al.*, 1981; Brown, 1984).

* Melczer investigated an early type of Fremy's synthetic flux-grown rubies (cf. Elwell and Scheel, 1975).

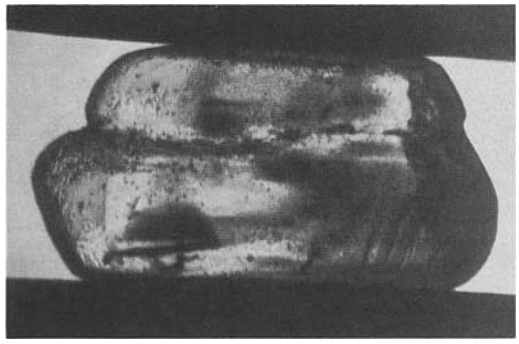


Fig. 1. Natural ruby from Sri Lanka, contact twin on (0001). 30x.

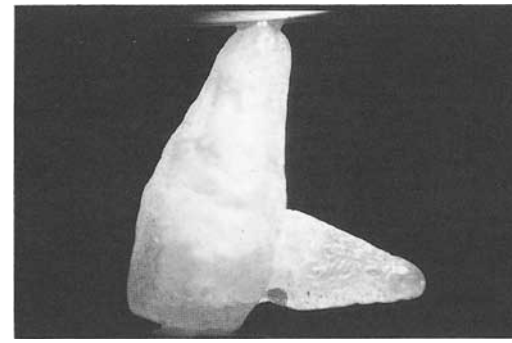


Fig. 2. Natural corundum from Sri Lanka, contact twin on $(10\bar{1}1)$. 12x.

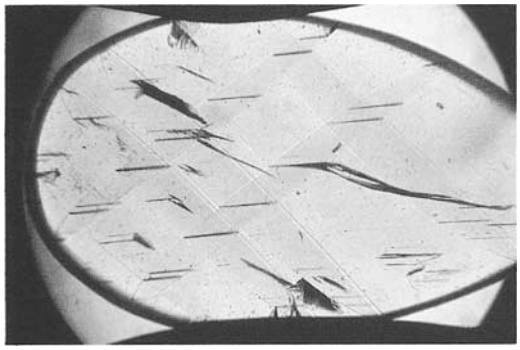


Fig. 7. Natural ruby from Umba, Tanzania, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces. 24x.

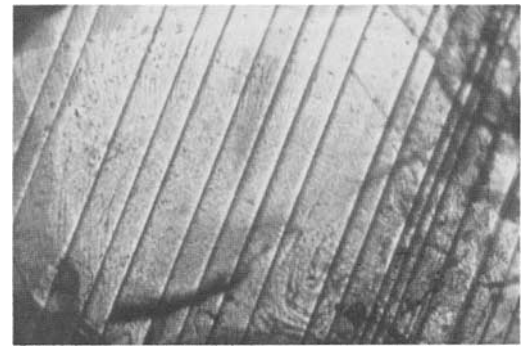


Fig. 8. Natural ruby from Burma, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$. 30x.

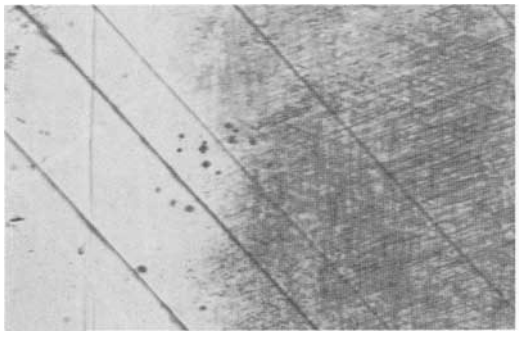


Fig. 9. Natural ruby from Sri Lanka, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$. 45x.

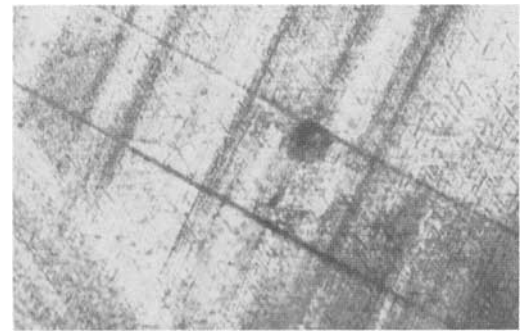


Fig. 10. Natural ruby from Sri Lanka, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$. 35x.

Fig.3. Natural ruby from Sri Lanka, contact twin on $(10\bar{1}1)$ with three crystals in twin position around a central crystal. x pol., 40x.

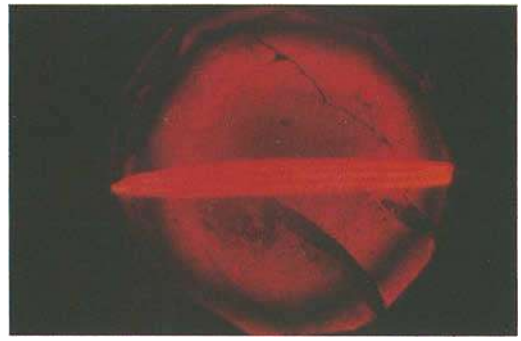


Fig. 4. Natural ruby from Sri Lanka, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$. x pol., 20x.

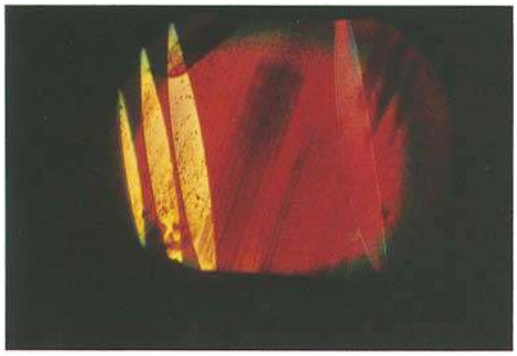


Fig. 5. Natural ruby from Burma, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$. x pol., 24x.

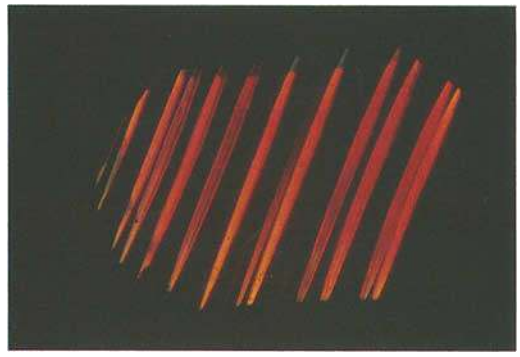


Fig. 6. Natural ruby from Burma, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$. x pol., 26x.

Fig. 13. Natural ruby from Sri Lanka, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$; the lamellae showing interference striations. x pol., 25x.

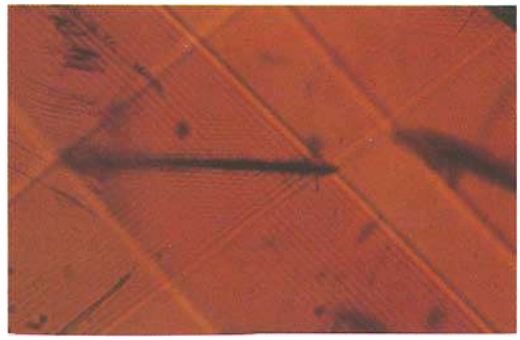


Fig. 14. Natural ruby from Umba, Tanzania, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces; the lamellae showing interference striations. 80x.

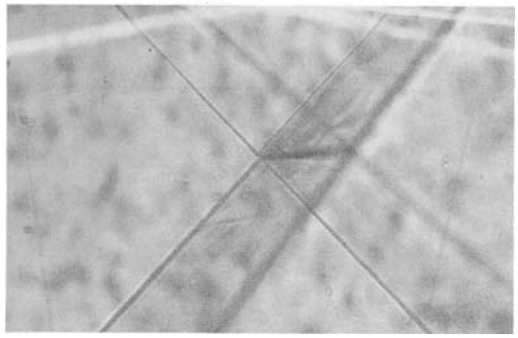


Fig. 11. Natural ruby from Burma, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces. 40x.

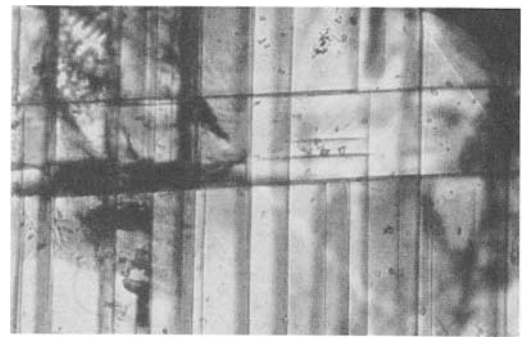


Fig. 12. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces. 35x.

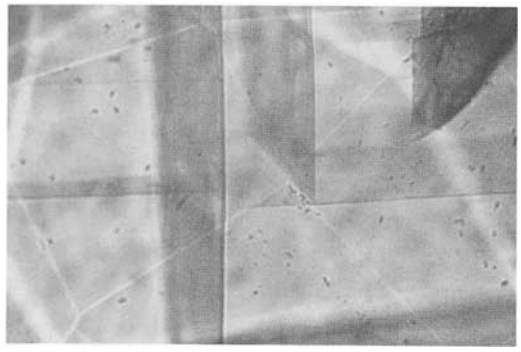


Fig. 20. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces; one lamella ends at another lamella running through the crystal in nearly rectangular direction. 50x.

Fig. 21. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces; single lamellae end at other lamellae running through the crystal in nearly rectangular direction. 100x.

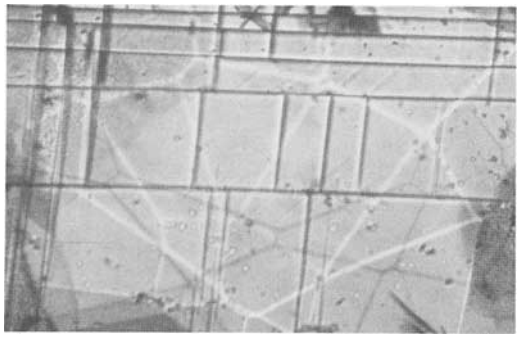


Fig. 22. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on $(10\bar{1}1)$ parallel to two rhombohedral faces; single lamellae end at other lamellae running through the crystal in nearly rectangular direction. 50x.

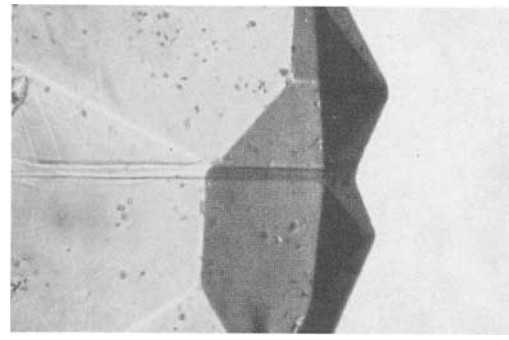


Fig. 26. Chatham synthetic ruby, contact twin on $(10\bar{1}0)$ with composition plane, view parallel to the optic axis. 40x.

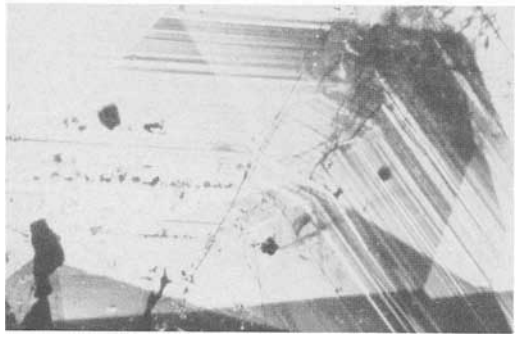


Fig. 27. Chatham synthetic ruby, contact twin on $(10\bar{1}0)$; the composition plane and families of straight parallel growth planes parallel to $n(22\bar{4}3)$ and $r(10\bar{1}1)$ are visible. 20x.

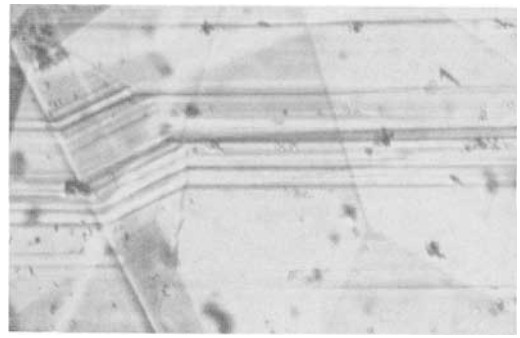


Fig. 28. Chatham synthetic ruby, contact twin on $(10\bar{1}0)$; the composition plane and families of straight parallel growth planes parallel to $n(22\bar{4}3)$ and $r(10\bar{1}1)$ are visible. 50x.

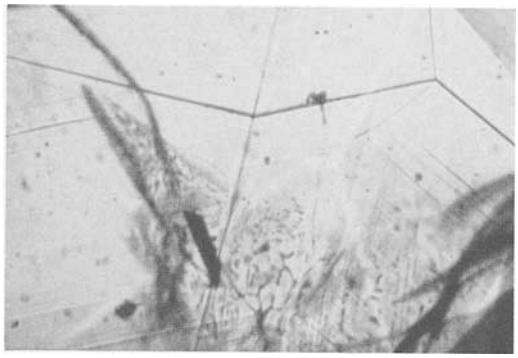


Fig. 29. Chatham synthetic ruby, contact twin on $(10\bar{1}0)$; the composition plane and families of straight parallel growth planes parallel to $n(22\bar{4}3)$ and $r(10\bar{1}1)$ are visible. 30x.

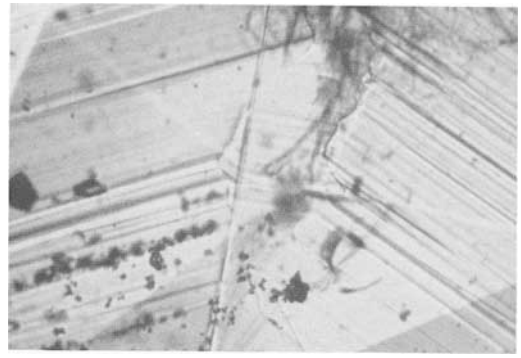


Fig. 30. Chatham synthetic ruby, contact twin on $(10\bar{1}0)$; the composition plane and families of straight parallel growth planes parallel to $n(22\bar{4}3)$ and $r(10\bar{1}1)$ are visible. 30x.

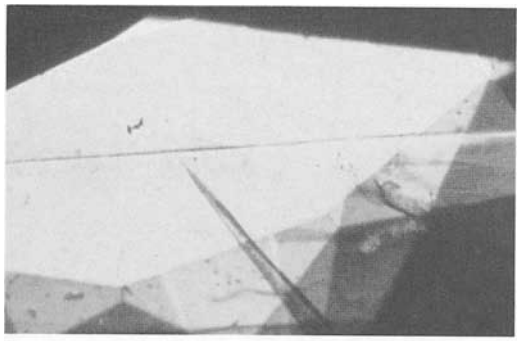
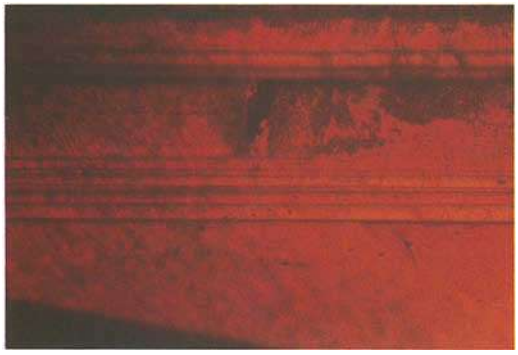


Fig. 31. Ramaura synthetic ruby, contact twin on $(10\bar{1}0)$ or penetration twin along [0001]; the composition plane runs parallel to the prism zone. 30x.

Fig. 32. Ramaura synthetic ruby, penetration twin along [0001], view nearly parallel to the optic axis. 40x.

Fig. 15. Natural ruby from Burma, intercalated lamellae of corundum in twin position on (10$\bar{1}$1) parallel to two rhombohedral faces; the lamellae showing interference striations. x pol., 35x.

Fig. 16. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on (10$\bar{1}$1); the lamellae showing interference striations. x pol., 30x.



Figs. 17, 18. Natural ruby from Sri Lanka, polysynthetic twinning on (10$\bar{1}$1). Using plane polarized light, in different orientations of the polarizer the pleochroism of polysynthetically twinned ruby becomes visible. 80x.

Fig. 19. Natural ruby from Sri Lanka, polysynthetic twinning on (10$\bar{1}$1). Plane polarized light. 80x

Fig. 23. Natural ruby from Burma, one intercalated lamella of corundum in twin position on (10$\bar{1}$1) ends irregularly within the dominant crystal. x pol., 32x.

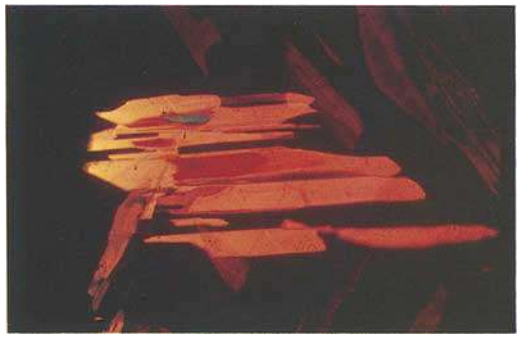


Fig. 24. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on (10$\bar{1}$1) parallel to three rhombohedral faces end irregularly within the dominant crystal. x pol., 35x.

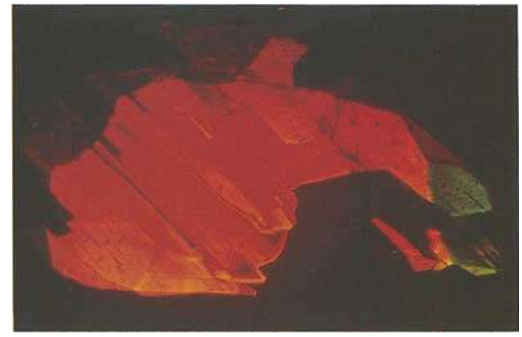


Fig. 25. Natural ruby from Thailand, intercalated lamellae of corundum in twin position on (10$\bar{1}$1) end irregularly within the dominant crystal. x pol., 35x.

Fig. 35. Chatham synthetic ruby, intercalated lamellae of corundum in twin position on (10$\bar{1}$1). x pol., 35x.

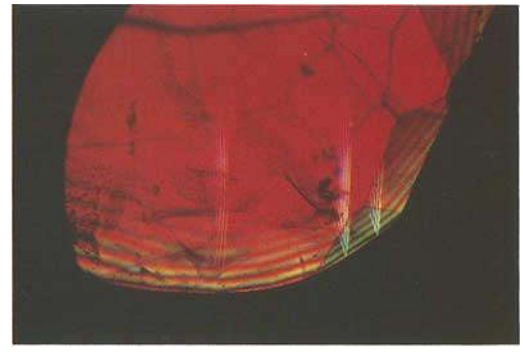


Fig. 38. Kashan synthetic ruby, intercalated lamellae of corundum in twin position on (10$\bar{1}$1). x pol., 40x.

Fig. 39. Kashan synthetic ruby, intercalated lamellae of corundum in twin position on (10$\bar{1}$1). x pol., 45x.

Fig. 41. Kashan synthetic ruby, one intercalated lamella of corundum in twin position on (10$\bar{1}$1) ends irregularly within the dominant crystal. x pol., 24x.

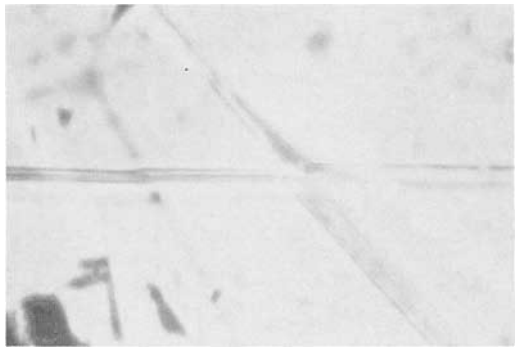


Fig. 33. Chatham synthetic ruby, intersecting structural planes (twin boundaries?). 95x.

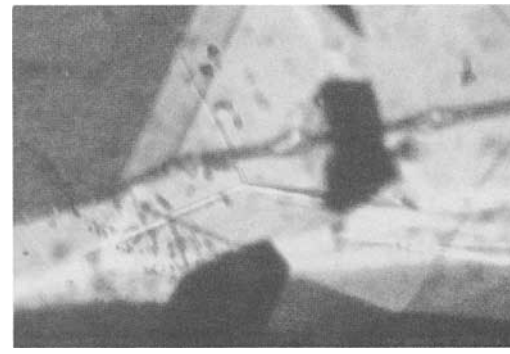


Fig. 34. Chatham synthetic ruby, three structural planes (twin boundaries?) meeting at one point. 80x.

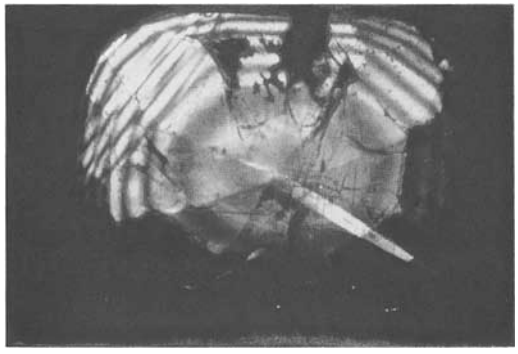


Fig. 36. Chatham synthetic ruby, intercalated lamellae of corundum in twin position on (10$\bar{1}$1) parallel to two rhombohedral faces. x pol., 20x.

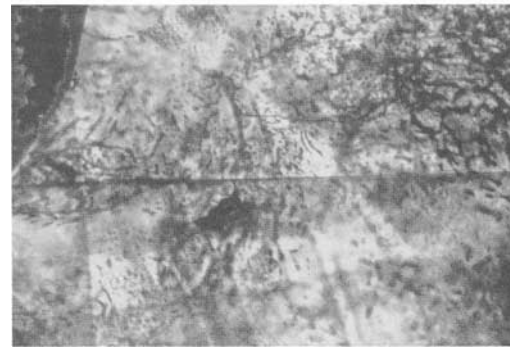


Fig. 37. Chatham synthetic ruby, intercalated lamellae of corundum in twin position on (10$\bar{1}$1). 70x.

Fig. 40. Kashan synthetic ruby, intercalated lamellae of corundum in twin position on (10$\bar{1}$1) parallel to two rhombohedral faces. 50x.

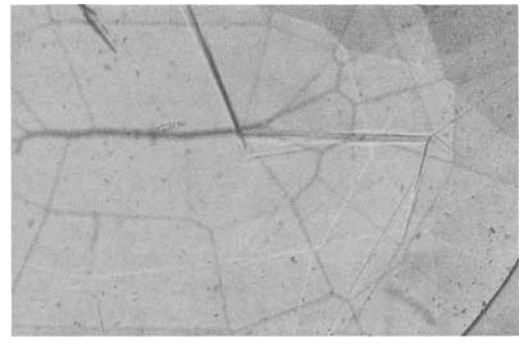


Fig. 42. Ramaura synthetic ruby, irregular structural surface. 30x.

Results

Twinning in natural ruby

(a) Contact twinning on *c* (0001)
In rough samples, contact twinning on (0001) is very rarely recognizable by the morphology of the sample (fig. 1). Due to an identical optical orientation of corundum crystals which are related by reflection twinning on the basal pinacoid (0001), no optical interference figure is observable in the microscope. Thus, the unambiguous recognition of contact twinning on (0001) to cut natural rubies, i.e., a distinction of a twin boundary parallel to (0001) from growth planes or from glide planes parallel to (0001), is extremely difficult or even impossible without etching.

(b) Single contact twinning on *r* ($10\bar{1}1$)
Contact twins on the positive rhombohedron *r* ($10\bar{1}1$) which are macroscopically developed are known to the author from parcels of rough corundum crystals from Sri Lanka (fig. 2). During the investigation of cut rubies from Sri Lanka by the microscope, contact twins consisting of two or more macroscopically developed individuals were rarely recognized due to the different optical orientation of the twinned corundum crystals. Occasionally, a central crystal which is twinned on three rhombohedral faces was found (fig. 3).

(c) Repetitive twinning on *r* ($10\bar{1}1$)
Repetitive twinning on the positive rhombohedron *r* ($10\bar{1}1$) is common in natural rubies from different localities. In general, thin lamellae of corundum in twin position are intercalated parallel to one, two or even three rhombohedral faces of the dominant crystal (figs. 4–12). Intersecting lamellae parallel to two or even three rhombohedral faces form two- or three-dimensional patterns of lamellae intersecting at angles of 93.9°. Under crossed polarizers, intercalated lamellae of corundum are recognizable by interference striations caused by the different orientation of the dominant crystal from the intercalated lamellae (figs. 13–16).

In some gemmological textbooks dealing with microscopic features of natural corundum (e.g. Gübelin, 1953, 1974) intercalated lamellae of corundum are mostly regarded as twin boundaries between polysynthetically twinned crystals. However, in more than 95% of corundum crystals, investigated by the present author, these 'twin boundaries' are recognized as intercalated thin lamellae parallel to the rhombohedral faces of a dominant crystal. Only some rubies from Sri Lanka and Burma were found to consist of unusually thick lamellae of corundum in different crystallographic orientations, which are easily recognized in plane polarized light due to the pleochroism of various parts of the corundum crystal in different optical orientations (figs. 17–19). Only in such cases, the term polysynthetic twinning *sensu stricto* should be applied to corundum, which implies repeatedly twinned parts of similar thickness.

Intercalated lamellae in twin position in natural rubies often run through the whole cut sample. Lamellae parallel to one rhombohedral face are common for some important localities of gem rubies, e.g. Sri Lanka or Burma. Intersecting lamellae parallel to two faces forming an angle of 93.9° are less common in samples from these localities. Rubies from other countries, e.g. Thailand, Tanzania or Kenya, on the other hand, tend to have intercalated lamellae mostly parallel to two or even three rhombohedral faces.

In some rubies of different localities, single lamellae were found to end at another corundum lamella which runs through the ruby in nearly rectangular direction (figs. 20–22). In other samples, lamellae were found to end irregularly within the dominant crystals (figs. 23–25).

Twinning in synthetic ruby

(a) Contact twinning on ($10\bar{1}0$) and ($11\bar{2}0$) and penetration twinning about [0001]
Macroscopic contact twinning on the first-order hexagonal prism ($10\bar{1}0$) or the second-order hexagonal prism ($11\bar{2}0$) was occasionally observed in rough Chatham synthetic rubies (fig. 26). Under the microscope, single twin boundaries parallel to ($10\bar{1}0$) or ($11\bar{2}0$) are frequently observed in this type of synthetic ruby (figs. 27–30). Due to an identical orientation of the optic axes of the twinned individuals, no interference figures are observed under crossed polarizers. In synthetic rubies available at present in the gem trade, no growth planes parallel to the prism faces are observed (Schmetzer, 1985a, 1986). Thus, by a recognition of one single straight plane parallel to the prism faces reflection twinning in synthetic ruby is obvious. On the other hand, a family of straight parallel planes indicating prism faces is conclusive for growth planes parallel to ($11\bar{2}0$) in natural corundum.

In Ramaura synthetic rubies occasionally more or less irregular boundaries nearly parallel to prism faces were observed (figs. 31–32). Obviously, these irregular boundaries are due to penetration twinning with a 180° rotation about [0001]. Similar structural properties were never found in natural rubies.

In synthetic rubies, frequently in Chatham synthetic rubies and Ramaura synthetic rubies,

distinct types of structural properties were observed which possibly are also due to penetration twinning. In the immersion microscope, three or more lines are observed which meet at one point with different angles (figs. 33–34). These structures are similar to twin boundaries as described in the literature, which were observed after etching of (0001) faces of synthetic flux-grown rubies. Thus, these structures are possibly also caused by penetration twins. Another possible interpretation is a combination of growth planes and contact or penetration twinning. However, further examination without non-destructive methods, e.g. etching of cut faces in various orientations, is necessary.

(b) Repetitive twinning on r $(10\bar{1}1)$
Repetitive twinning consisting of thin intercalated lamellae which are running through a dominant crystal was frequently observed in Kashan synthetic rubies and occasionally in Chatham synthetic rubies (figs. 35–40). In Kashan synthetic rubies intercalated lamellae of corundum in twin position were found to run parallel to one or two rhombohedral faces of the dominant crystal, and even patterns of intersecting lamellae were observed. In Chatham synthetic rubies, intercalated lamellae mostly were found to run parallel to one rhombohedral face, in different parts of some crystals occasionally lamellae parallel to a second $(10\bar{1}1)$ face were found. However, no intersecting lamellae forming nearly rectangular structures were found so far in Chatham synthetic rubies. In addition, no combination of reflection twinning on $(10\bar{1}0)$ or $(11\bar{2}0)$ and intercalated lamellae was observed. In synthetic rubies, an irregular ending of intercalated lamellae within the dominant crystal was found to be more common than in natural ruby (fig. 41).

Discussion

Different types of twinning were found to be common in both natural and synthetic rubies. The recognition of intercalated lamellae parallel to r $(10\bar{1}1)$ in natural and synthetic rubies is possible without difficulty by use of the immersion microscope (between crossed polarizers interference striations become visible). The recognition of twinning on c (0001), i.e. the distinction of twin boundaries from growth planes or glide planes parallel to (0001) is almost impossible with the microscope. The recognition of contact twinning on faces parallel to the prism zone with twin boundaries parallel to the first-order and/or second-order hexagonal prism in synthetic ruby, in general, is easily done with the microscope (in natural rubies families of straight parallel growth planes parallel to $(11\bar{2}0)$ are observed; a single line parallel to the faces of the prism zone, however, indicates reflection twinning in synthetic ruby). The recognition of penetration twinning about [0001] is dependent on the direction and form of the more or less irregular twin boundary. In some cases, e.g. in some Ramaura synthetic rubies (fig. 42), designation of irregular surfaces as irregular twin boundaries or irregular growth structures is impossible by investigations with the immersion microscope alone.

For a distinction of natural and synthetic rubies complete knowledge of properties of each type of natural or synthetic ruby is necessary. By a combination of several experimental methods of investigation, e.g. microscopy and UV absorption spectroscopy, a complete set of data should be available to identify positively a certain type of natural or synthetic ruby and, in addition, to exclude positively all other possibilities. In the opinion of the author a complete set of data for ruby identification consists of, at least, the knowledge of structural properties (twinning and growth planes), inclusions, and of the full information available for the UV absorption spectrum (cf. Schmetzer, 1985a, b, 1986).

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[*Manuscript received 1 June 1985.*]

Gemmological Abstracts

ARPS, C.E.S. 1986. In search of the source rocks of Sri Lanka's gemstones, a progress report. *Australian Gemmologist*, **16**, 3, 117.
Abstract delineates localities. R.K.M.

BANK, H. 1986. Gemmologische Kurinformationen. (Short gemmological notes.) *Z.Dt.Gemmol.Ges.*, 35, 1/2, 69–71.
The author reports on incidents where glass has been offered as aquamarine and as amethyst. Also fluorite of an intense green colour, mainly 'rolled' (water-worn?) flat and longish stones, has been offered as emerald. In the autumn of 1984, the author was offered a six-rayed greenish-black, cut star diopside, from Nammkal, South India. Star diopsides are usually only known to have a four-rayed star. A so-called star corundum has been offered on the market, not with the usual angles between rays of 60°, but irregular angles between 51–64°. This was found to be a star bronzite. The notes also contain some further data on the colourless yugawaralite from India, a tecto silicate. E.S.

BECKER, G. 1986. Gem carving. *Australian Gemmologist*, **16**, 3, 120.
Abstract outlines history and methods of carving. R.K.M.

BIRCH, W.D. 1986. Gemstones of the Beechworth area. *Australian Gemmologist*, **16**, 3, 101–6, 5 figs (4 in colour).
Museum collections show that this largely depleted area has produced diamond, corundum, schorl tourmaline, garnet, zircon, quartz and some rarer gem minerals. R.K.M.

BORELLI, A. 1986. Osservazioni sulle inclusioni solide degli smeraldi di Santa Terezinha di Goias (Brasile). (Observations on solid inclusions in emeralds from Santa Terezinha de Goias, Brazil.) *La Gemmologia*, **11**, 3, 6–10, 9 figs in colour.
Energy dispersive X-rays coupled with a scanning electron microscope were used to investigate inclusions in emerald from Santa Terezinha, Goias State, Brazil. The chief mineral inclusion was found to be a ferroan magnesite; talc and a chrome hercynite were also found. M.O'D.

BULVNINA, G.P. 1986. A skilful selection of gems, a perfect composition. *Gem world*, **14**, 1, 31–3, 2 figs.
The work of the Moscow jewellery factory is described. M.O'D.

CAMPBELL, I.C., 1986. Notes from the laboratory. *South African Gemmologist*, 2, 2, 14–15.
Dyed quartz crystals in a capsule and offered as Sandawana emerald are reported as well as bowenite beads offered as jadeite. M.O'D.

CAMPBELL, I.C., THOMAS, A.E. 1986. Lennix, an African synthetic emerald. *South African Gemmologist*, 2, 23–7, 3 figs (1 in colour).
Twenty-four specimens were tested giving an average SG of 2.62–2.63 and RI of 1.559 (at its lowest) and 1.564 (at the highest). Average DR was 0.004. Twisted smoke-like veils, coarse hollow voids, some containing apparent flux residues, flux traceries, granular whitish inclusions, some concentrated in planes and fine feather-like structures, perhaps of a relatively transparent solid, are found in the stones. M.O'D.

CASSEDANNE, J.-P., BARROS, J.-C. 1986. Quelques gîtes d'émeraudes de Goias. (Some emerald sites in Goias.) *Revue de Gemmologie*, 88, 9–12, 6 figs (2 in colour).
The main emerald-producing sites in the Brazilian state of Goias are described. M.O'D.

DE GRAVE, E., VOCHTEN, R., ZWAAN, P.C., CRAENEN, J. 1986. Characterization of some scapolite, corundum and spinel crystals from Kochipadana and Amarawewa, Kataragama area, Sri Lanka. *Z.Dt.Gemmol.Ges.* 35, 1/2, 47–57. 5 figs, 2 tables, bibl.
The composition and the nature of the inclusions of some scapolite, corundum and spinel gemstones from Kochipadana and/or Amarawewa, Sri Lanka, have been determined by microprobe analysis. Eight spinels with Fe substitutions have been studied in detail by X-ray powder diffraction, EDX and ^{57}Fe Mössbauer spectroscopy at 80 and 300K. All samples contain 4–8% Fe^{3+} relative to the total iron content. The major part of the Fe^{2+} ions are located on tetrahedral sites but the broad quadruple

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splitting distributions indicate a partially inverse spinel structure. E.S.

DELÉ-DUBOIS, M.-L., POIROT, J.-P, SCHUBNEL, H.-J., 1986. Identification de micro-inclusions dans des rubis et émeraudes de synthèse par spectroscopie Raman. (Identification of micro-inclusions in synthetic ruby and emerald by Raman spectroscopy.) *Revue de Gemmologie*, 88, 15–17, 12 figs in colour.

Raman spectroscopy is suggested as a means of identifying synthetic ruby and emerald by their inclusions. M.O'D.

DEREPPE, J.-M., MOREAUX, C. 1986. Appication de la résonance magnétique nucléaire à l'etude des gemmes. (Application of nuclear magnetic resonance to the study of gems.) *Revue de Gemmologie*, 88, 7–8, 2 figs.

NMR techniques already widely used in mineral studies are suggested for the testing of gemstones, particularly emerald. M.O'D.

FEDERMAN, D. 1986. Inside Europe's coloured gem capital, Idar-Oberstein. *Modern Jeweler*, March 1986, 44–8, 7 figs (2 in colour).

The author traces Idar-Oberstein's development through the ages and describes its place in the gem trade today. The rise and decline of the diamond cutting industry is historically explained. The two colour plates show (a) amethysts, faceting pavilions with intaglios on top, and (b) so-called gem sculptures, i.e. fantasy cuts of large citrine, green tourmaline, yellow beryl and amethyst. E.S.

FETTEL, M. 1986. Mineralfundstellen bei Kasern im inneren Ahrntal/Südtirol. (Mineral locations around Kasern in the inner Ahrntal, South Tirol.) *Lapis*, **11**, 9, 11–15, 9 figs (7 in colour).

Gem minerals found in this area of Austria include quartz, sphene and euclase. Crystals are illustrated. M.O'D.

FRANKLIN, B.J., GILES, A.D., 1986. Scanning electron microscope and polarizing microscope techniques used in identification of inclusions in sapphire. *Australian Gemmologist*, **16**, 3, 121.

Abstract describes methods used. R.K.M.

FRENZEL, G., STÄHLE, V., BANK, F.H. 1986. Ein oktaedrischer Gahnospinell-Rohstein von Ratnapura, Sri Lanka. (An octahedral gahnospinel from Ratnapura, Sri Lanka.) *Z.Dt. Gemmol.Ges.*, **35**, 1/2, 39–46, 7 figs (1 in colour), bibl.

The gahnospinel crystal weighed 4.53g and was found in Ratnapura. The diameter was approximately 15 mm. It is the first well-defined idiomorphous gahnospinel crystal described in detail. Definite steps could be observed on the crystal surface which changed slightly from blue towards red. The edges and corners were a little rounded, probably caused by transport by river. Some opaque zinc-iron-aluminate spinel inclusions, some negative crystals, elliptic healing cracks caused by tension. E.S.

GHERA, A., GRAZIANI, G., LUCCHESI, S., MARTINI, M. 1986. Colour zoning in natural and synthetic materials. *Australian Gemmologist*, **16**, 3, 125–7, 3 figs in colour.

Uneven colour is often seen in gems. Kyanite and Chatham synthetic sapphire were used in this study. R.K.M.

GORDON, J.L. 1986. Gem minerals of the Harts Range. *Australian Gemmologist*, **16**, 3, 121–8.

Abstract: garnet, ruby, iolite, beryl, etc., are found. R.K.M.

GÜBELIN, E. 1986. Les opales mexicaines. (Mexican opal.) *Revue de Gemmologie*, 88, 3–6, 11 figs in colour.

A historical and technical review of the various types and locations of opal in Mexico. M.O'D.

GÜBELIN, E.J. KOIVULA, J.I. 1986. Einschlüsse im Quarz. (Inclusions in quartz.) *Lapis*, **11**, 9, 19–26, 42 figs in colour.

The paper presents a series of colour pictures of inclusions in quartz from the authors' book *Photo-atlas of inclusions in gemstones**. M.O'D.

HÄNNI, H.A. 1986. Korunde aus dem Umba-Tal, Tansania. (Corundums from the Umba Valley, Tanzania.) *Z.Dt.Gemmol,Ges.*, **35**, 1/2, 1–13, 10 figs (2 in colour), bibl.

An English version of this article is published on p.278 above. E.S.

HARDING, R.R. SCARRATT, K. 1986. Description of a ruby from Nepal. *Australian Gemmologist*, **16**, 3, 116.

Short abstract on a new ruby source. R.K.M.

HENN, U. 1986. Saphire aus Nigeria und von Sta Terezinha de Goias, Brazilien. (Sapphires from Nigeria and from Santa Terezinha de Goias, Brazil.) *Z.Dt.Gemmol.Ges.*, **35**, 1/2, 15–19, 4 figs in colour, bibl.

Lately blue sapphires from Nigeria have reached the market, supposed to come from a new

*See review on page 312–3.

occurrence 50km north of Jos in northern Nigeria, but nothing exact is known. The rough crystals show flat prismatic to pinacoidal habit, are dark blue to inky. SG 3.96–4.00; RI 1.760–1.764, 1.770–1.772; DR 0.008–0.010. The sapphires from Brazil come from the well-known emerald mine at Santa Terezinha de Goias, are bluish-grey with frequent definite colour zoning from greyish-blue to dark blue. RI 1.758–1.760, 1.765–1.767; DR 0.007; SG 3.91–4.35, depending on inclusions which can be muscovite and margarite; these inclusions are found along the cleavage planes and detract from the transparency of the stone. There are also liquid inclusions present. E.S.

HENN, U. 1986. Sugilit aus Südafrika. (Sugilite from South Africa.) *Z.Dt.Gemmol.Ges.*, **35**, 1/2, 65–7, 2 figs in colour, bibl.

Since 1982 this gem has been traded in the USA under the name of 'royal lavulite' and 'royal azel'. It is a complicated silicate. Only three occurrences are known; Iwagi Islet in SW Japan, Madhya Pradesh in Central India, but all cuttable material comes from the Wessels Mine, 23 north-west of Hotazel in Cape Province, South Africa. Sugilite can easily be mistaken for sogdianite, with practically the same RI, SG, spectrum and UV reaction, but sugilite contains no zirconium, while sogdianite contains up to 9.8% in weight of ZrO_2. Both may be violet to purple. E.S.

HEYLMUN, E.B. 1986. Tantalizing turquoise. *Lapidary Journal*, **40**, 6, 49–50, 1 fig.

Describes turquoise deposits near Courtland, Arizona. M.O'D.

JOBBINS, E.A., COUPAR, A.G. 1986. A.C.D. Pain and the gemstones of Burma. *Australian Gemmologist*, **16**, 3, 116.

Short abstract of biographical paper. R.K.M.

KANIS, J. 1986. Zambian gemstones. *Australian Gemmologist*, **16**, 3, 128–9.

Abstract: Kafubu emeralds better than Miku stones. Aquamarine, tourmaline and amethyst found. R.K.M.

KELLY, S.M.B. 1986. Bowesite – a new lapidary material from Australia. *Wahroongai News*, **20**, 7, 8–10.

An opaque green rock containing diopside, epidote, grossularite, actinolite, plagioclase, quartz, sphene, iron oxide and calcite, which gives a patterned material similar to nephrite in appearance and suitable for carving. RI 1.57, SG 2.78 to 3.10. R.K.M.

KOSMOWSKA-CERANOWICZ, B. 1986. Bernsteinfunde und Bernstein-lagerstätten in Polen. (Amber finds and amber occurrences in Poland.) *Z.Dt. Gemmol.Ges.*, **35**, 1/2, 21–6, 4 figs (3 in colour), bibl.

The author describes a new deposit of Baltic amber near Chlapowo and other fossil resin finds in Poland. Age and genesis of resin-bearing sediments are discussed. Some of the pieces recovered seem to be quite large, one photograph depicting a piece of amber weighing 880g. E.S.

MACGREGOR, E. 1986. The beneficiation and treatment of Brazilian emeralds. *Australian Gemmologist*, **16**, 3, 120–1.

Abstract of paper. Beneficiation means concentration and sorting of rough. R.K.M.

MATHUR, S.M. 1986. Panna mine revisited. *Indiaqua*, 44, 2, 23–7, 21 figs in colour.

The Panna diamond mine in India is described. Work on diamond recovery is still in progress. M.O'D.

MOLINÉ SALA, A. 1986. Un equipo-accesorio acoplado a balanza, para determinación del peso especifico. (Accessory apparatus with a balance for the determination of specific gravity.) *Gemologia*, **24**, 69/70, 5–11, 2 figs.

Details are given of an apparatus for SG determination combined with a simple balance. M.O'D.

MÜLLENMEISTER, H.J. 1986. Untersuchung radioaktiver Edelsteine und Mineralien. (Investigating radioactive gemstones and minerals.) *Z.Dt. Gemmol.Ges.*, **35**, 1/2, 59–63, 2 tables, 2 graphs, bibl.

Various uranium minerals and radioactive gemstones, mainly zircons and ekanite from Sri Lanka, were investigated with regard to their γ and β radiation. A colourless chrysoberyl was used as the comparison stone for induced radioactivity. The dark green zircons were found to have most active radioactivity, while the originally brown zircons from Kambodscha which have had their colour changed to blue have neither γ nor β radiation. E.S.

MUMME, I.A. 1986. Modes of occurrence of emeralds in Australia. *Australian Gemmologist*, **16**, 3, 106–8.

Emerald has been mined in New South Wales and in Western Australia. R.K.M.

O'DONOGHUE, M. 1986. Rubi y zafiro sinteticos de Lechleitner y corindon recubierto de Lechleitner. (Lechleitner synthetic ruby and sapphire and reconstructed Lechleitner corundum.) *Gemologia*, **24**, 69/70, 12–16.

A summary, taken from the author's *Synthetic crystals newsletter* and *Gemmological newsletter* of the features of recent Lechleitner production of solid ruby and sapphire and of a so-called reconstructed corundum. (Author's abstract.) M.O'D.

O'DONOGHUE, M. 1986. Pakistan. *Gemologia*, **24**, 69/70, 17–22, 1 fig. (In Spanish.)

An account, translated from the author's paper in *Gemmological newsletter*, of gemstone deposits in Pakistan. (Author's abstract.) M.O'D.

O'DONOGHUE, M. 1986. Diamante-gema sintetico. (Synthetic gem diamond.) *Gemologia*, **24**, 69/70, 23–6.

An account of recent progress in the synthesis of gem quality diamond taken from the author's *Synthetic crystals newsletter*. (Author's abstract.) M.O'D.

O'NEILL, K. 1986. Roses of the sea. *Lapidary Journal*, **40**, 5, 49–52, 2 figs in colour.

A short account of rhodonite from the Sea Rose mines off the coast of British Columbia. M.O'D.

READ, P.G. 1983–1985. (1) Reflectivity versus Thermal Conductivity. *Gem Instrument Digest*, May 1983, **1**, 1, 2–3, 2 figs: (2) Gem Instrument Reports, *ibid.*, 3–12, 13 figs. 1 table: (3) The Kashan Identification Myth, *id.*, August 1983, **1**, 2, 15–17, 2 figs: (4) Gem Instrument Reports, *ibid.*, 17–25, 12 figs, 1 table: (5) Challenge of the new synthetic emeralds, *id.*, November 1983, **1**, 3, 30–1, 2 figs: (6) Gem Instrument Reports, *ibid.*, 31–42, 18 figs: (7) The Identification of Precious Metals, *id.*, February 1984, **1**, 4, 47–8, 1 fig: (8) Gem Instrument Reports, *ibid.*, 48–58, 17 figs: (9) Electronics in Gemmology, *id.*, May 1984, **1**, 5, 64, 1 fig: (10) Gem Instrument Reports, *ibid.*, 65–71, 10 figs.

(1) Reflectivity and thermal instruments give different and complementary test information: it is advisable to test a suspect diamond with both.

(2) Reports on Rayner 'Raylight' (LED refractometer light source); CUEL 20 W (fibre-optic light source); two thermal conductivity testers (GEM Mini-DiamondMaster/Presidium Fact; Eickhorst Thermolyzer Diamond-Tester); two gem microscopes (Correct SJM-2, Krüss Gemstone-Microscope KA13); Okuda DC-530A Diamond Color-Tester and Presidium Master Program for calibrating it; Krüss UV Gem Spectroscope 1303; Kalnew/GAAJ 'Gemcolor 2' diamond spectrophotometer.

(3) The Kashan Synthetic Ruby is not unique in needing a little more than average care for its identification.

(4) Reports on Kassoy 'Xtra-Vue' 10X loupe; S & T CubiCZ refractometer; two fibre-optic light sources (TBL 50 watt; GemLab high intensity System C illuminator); Rayner DiamondScan reflectivity probe; two electronic diamond scales (Kassoy portable; Haigis CE40); two colour comparison systems (GemLab Research 'Gem Color Manual'; 'GemDialogue' charts); HRD BL70-1 stereo-zoom microscope; Wedgewood gold touchstone; Mitsubishi ultrasonic gold bar tester Type FD-410G.

(5) For some years flux-grown synthetic emeralds such as Gilson, Chatham and Zerfass were detectable by their low RI, DR and SG due to absence of iron oxides (which would have eroded the platinum apparatus): later Gilson used ceramic apparatus for his 'N' synthetic emerald, with constants nearer to the natural. Flux-melt 'Lennix' by Lens, hydrothermal products such as Nacken and Lechleitner, 'Regency Created Emerald' (Vacuum Ventures) and 'Crescent Vert' (Kyocera Co. of Japan) are also mentioned. As with Kashan synthetic rubies, identification depends on colour (and zoning), luminescence, S.W.UV transparency, RI, DR, SG, and, in particular, inclusions.

(6) Reports on Presidium Gem Weight Computer; Ceres CZecker thermal diamond checker; instruments by Theo Muller (LED refractometer light source; spectroscope; polariscope; fibre-optic cold-light; microscope); Gemlab spectrometer; Japanese microscopes (GAAJ DX and SP; GSM890 and GSM1080 from Gemprint; EMT (turret) and EMZ (zoom); Microtec magnifiers; fine metals testing kit by Pure Metals Corporation of Australia; Kassoy's CU5 and MP4 polaroid systems for jewellery photography; computer systems for the jeweller-gemmologist (NAG Computer Package, NAG Plan and NAG Writer, by Duncan Bransom Office Systems Ltd; Retail Jewellery Stock Analysis and Control Program, by A.J. Hales Computers; Jewel Manager, by Gemlab Gemmological Services Research and Technology group; Polygon Automated Diamond Trading Network; American Gem Market System; CompuGem, by Gemological Research Corporation; GemData 1, by P.G. Read Consultancy Services Ltd.

(7) Refers to Wedgewood Gold Touchstone (streak), Mitsubishi gold bar tester (acoustic velocity), and testing kit by Fine Metals Corporation of Australia (dilute acids) and to author's use of Ceres Diamond Probe; Gemtek (UK) and Presidium Diamond Pte Ltd (Singapore) understood to be

working on a thermal conductivity instrument calibrated to give caratage of gold alloys; Gemlust Pty Ltd (Australia)'s Model GS500PGS is a reflectivity gem tester with extra control unit and probe for testing gold.

(8) Reports on Duogemmeter; Alpha-test Electronic Gemstone Indicator; Gemlab Multi-function Polariscope; Krüss UV Gem Spectroscope 1303; E.Ö.G.G. Grading Lamp Unit; two microscopes (Eickhorst Mini-Diascope; Kassoy Gem Microscope); Krohn Fluxed-flame Torch; Kalnew Gemcolor 2 Diamond Spectrophotometer; Rayner Opticaids; CUEL Cold-Light Illumination Equipment; Rubin CZ Masterstones.

(9) Starting about ten years before with the reflectivity meter (a simple device with infrared LED, photodetector, resistors and a meter – later with voltage regulator circuit and a circuit producing infrared pulses) and followed by the thermal conductivity tester, both instruments have become increasingly sophisticated, with the aid of microprocessors and computers.

(10) Reports on Presidium 'Duotester'; GfD 'Gemexpert'; CCTV Spectroscope Camera System by Gemlab; S & T Dichroscope; two electronic balances (Trans-American TA620 Multi-mode; Shimadzu ED-1400C/G Electronic); Gemlab Immersionscope; Gemlab Inclined-Scope; two jewellery cleaners ('Connoisseurs' vibratory unit; Medelco MD-5 ultrasonic unit). J.R.H.C.

REMAUT, G., VOCHTEN, R. 1986. Blue-green apatite from Gravelotte, South Africa. *Australian Gemmologist*, **16**, 3, 115–6, 2 figs.

Bluish-green apatite has been found among emerald deposits. The infrared spectrum printed lacks an abscissa scale. R.K.M.

ROBERT, D. 1986. A propos de turquoises plus ou moins fausses. (About turquoise more or less false). *Revue de Gemmologie*, 88, 18–20, 5 figs in colour.

The author provides a general survey of natural, synthetic and treated turquoise. M.O'D.

SCARRATT, K., HARDING, R.R. 1986. Ruby and sapphire with glass infillings. *Australian Gemmologist*, **16**, 3, 119.

Abstract says that alkali aluminosilicate glasses are used. R.K.M.

SCHIFFMANN, C.A. 1986. Limitations to the spectroscopic identification of a treated diamond. *Australian Gemmologist*, **16**, 3, 108–9, 3 figs.

Outlines difficulties in assessing origin of colour in fancy diamond using standard equipment. Laboratory testing may be necessary. R.K.M.

SCHIFFMANN, C.A. 1986. Note on a large rough taaffeite. *Australian Gemmologist*, **16**, 3, 118, 2 figs.

Abstract of report on a taaffeite of 11.07 ct. R.K.M.

SCHMETZER, K. 1986. Production techniques of commercially available gem rubies. *Australian Gemmologist*, **16**, 3, 95–100, 12 figs in colour.

The title is misleading. Author deals only with synthetics, covering known manufacturing processes. R.K.M.

SCHMETZER, K. 1986. Färbung und Bestrahlungsschäden in elektronenbestrahlten blauen Topasen. (Coloration and radiation damage in electron treated blue topaz.) *Z.Dt.Gemmol.Ges.*, 35, 1/2, 27–38, 8 figs (2 in colour), 2 tables, bibl.

The material investigated was two lots of fairly heavily damaged topaz from Nigeria, treated in the USA and compared with material treated with gamma rays and electrons, heat-treated blue topaz of various origins, and treated as well as natural blue topaz from Brazil, Nigeria and Zimbabwe. The electron irradiated samples revealed cracks and parting planes parallel to the basal pinacoid. Also, a shell-like structure was observed which consisted of a blue rim, a colourless intermediate zone with various irradiation-induced defects, and a colourless zone; this may be due to the temperature gradient from the surface to the topaz centre. The temperature gradient is formed during the irradiation process by all-round cooling with running water. E.S.

SEGNIT, E.R. 1986. Decorative serpentine from Marble Bar area, Western Australia. *Australian Gemmologist*, **16**, 3, 120.

Abstract describes a chlorite serpentine which can be chatoyant. R.K.M.

SEVERI, P. 1986. Zaffiri stellati. (Star sapphires.) *Gemmologia*, **11**, 3, 16–21, 17 figs in colour.

A description of the effects of asterism in the blue sapphire variety of corundum. M.O'D.

SHERMAN, E.G. 1986. The Australian opal fields. *Australian Gemmologist*, **16**, 3, 129.

Abstract: commercial fields are Cretaceous and lie in the Great Artesian Basin. R.K.M.

SOBOLEV, N.V., SOBOLEV, E.V., YEFIMOVA, E.S. 1986. Some physical and chemical characteristics of diamonds from Copetown, New South Wales. *Australian Gemmologist*, **16**, 3, 119.

Abstract gives nitrogen content and inclusions. R.K.M.

SUNAGAWA, I. 1986. Morphology of ruby and sapphire. *Australian Gemmologist*, **16**, 3, 119.
Abstract suggests that habits are controlled by the growth media. R.K.M.

SUPERCHI, M. 1986. Gypsum alabaster from Volterra, Tuscany; an Italian gem material. *Australian Gemmologist*, **16**, 3, 118–19.
Abstract describes this as high quality alabaster. R.K.M.

TERRENCE, S., COLDHAM, B.A. 1986. Inclusions in Australian sapphire before and after heat treatment. *Australian Gemmologist*, **16**, 3, 122–5. 7 figs in colour.
Contributes to the difficult problem of identification of heat-treated sapphires. R.K.M.

THEMELIS, T. 1986. Spectroscope comparison. *Lapidary Journal*, **40**, 5, 42–8, 9 figs in colour.
A simple, lucidly presented account of the main types of hand spectroscopes available to the gemmologist and hints on their use. M.O'D.

VOCHTEN, R., DE GRAVE, E., ZWAAN, P.C. 1986. A study of scapolite, corundum and spinel crystals from the Tissamaharama area, Sri Lanka. *Australian Gemmologist*, **16**, 3, 91–4, 5 figs.
Chemical composition and inclusions were examined. R.K.M.

WANG, F. 1986. (A gemmological study of some garnets in China.) *Acta Geologica Sinica*, **16**, 2, 151–63, 10 figs (7 in colour). (Chinese with English abstract.)
Chemical analyses and optical and physical properties (including the visible transparency, chromaticity coordinates, dominant wavelength and degree of colour saturation) are reported for seven garnets from China. These garnets occur in magmatic and pegmatitic rocks, skarns and placer or drift deposits and include pyrope (2), pyrope-almandine (2), spessartine (1), and grossular (2). The visible absorption spectra of these garnets are shown and colour photographs are presented, one of these showing two-phase inclusions. Some details are given of cutting styles, the round brilliant-cut and oval brilliant-cut being the most favoured. R.A.H.

WEINER, K.L. 1986. Ein besonderer Quarz-Kristall aus Brazilien. (An unusual quartz crystal from Brazil.) *Lapis*, **11**, 10, 30–3, 8 figs (1 in colour).
A rock crystal from Diamantina, Minas Gerais, Brazil, showed a number of unusual features, including trigon-like markings on some of the faces. M.O'D.

ZOYSA, E.G.G. 1986. Gem deposits in Sri Lanka with special emphasis on recent discoveries. *Australian Gemmologist*, **16**, 3, 110–14, 1 map, 3 tables.
An abstract listing about thirty species. R.K.M.

Argyle Diamond Mines Joint Venture, 1986. *The Rio Tinto Zinc Corporation PLC Annual Report and Accounts (1985)*, 19.
Slightly more ore was processed than in 1984 and 24% more diamonds produced. Alluvial operations ceased, but the kimberlite mine and plant started up in December and output should achieve target level of 25 000 000 ct by late 1986. J.R.H.C.

The paradise of gems. 1986. *Gem World*, **14**, 1, 38–43, 1 fig.
A short summary of the present position of the Brazilian gemstone industry with a list of the gem species currently produced. M.O'D.

NOTE: *The Australian Gemmologist*, 1986 (May), **16**, 2, and (August), **16**, 3, included the Proceedings of the 20th International Gemmological Conference and contained both some complete papers and abstracts of others.

Indian Gemmologist. The first number of this new Journal was published in November 1986. Subscription rates are US $10 for sea mail and US $25 for airmail. Further details from Forum of Indian Gemmologists, 29 Gurukul Chambers, 187–9 Mumbadevi Road, Bombay 400 002, India.

Book Reviews

FINOT, L. 1986. *Les lapidaires indiens.* (Indian lapidaries.) Adidom, Paris, pp.179. Price on application.

Reprint of a work first published in Paris in 1896, this simply-produced book describes some Indian lapidaries with a comprehensive introduction. M.O'D.

GÜBELIN, E.J., KOIVULA, J.I. 1986. *Photoatlas of inclusions in gemstones.* ABC Edition, Zurich, pp.532, 15 illus. in black-and-white, 1,449 in colour. £110 from Gemmological Instruments Ltd, London.

This book is the successor to Gübelin's *Internal World of Gemstones* published in 1974. In this volume the superb photography by Gübelin is reinforced by the innovative photographic genius of Koivula, who has won awards for his photographic research and is a senior research gemmologist with the Gemological Institute of America. The result is a photographic feast coupled with the results of their own research work and enhanced with chapters by other leading scientists. Despite the scientific input the average reader will find everything explained in lucid, not too technical, terms.

Essentially the book is divided into six uneven parts. Part I (30 pages) contains the introduction and a very informative section (with good diagrams) on photomicrography and the specialized illumination of the gemstone. The uses of phase-contrast microscopy and the shadowing technique are described here. Part II (68 pages) discusses the genesis of mineral inclusions in gemstones, and this is followed by three specialist contributions from Dr E. Roedder on 'The origin of fluid inclusions in gemstones', Prof. Henry O.A. Meyer on 'The inclusions in diamonds and the genesis of diamond' and 'The formation of quartz and its inclusions' by Prof. Dr H.A. Stalder. These sections are accompanied by a series of fine colour photographs.

Parts III (102 pages) and IV (218 pages) form the real core of the Photoatlas. Part III (arranged alphabetically as is Part IV) deals with a series of individual mineral species inclusions found in a variety of host gemstones. The species described include (among many others) amphibole, apatite, chromite, feldspar, glass, goethite, graphite, ilmenite, magnetite, quartz, sphene, tourmaline and multiple inclusion scenes, aggregates and twins. The fantasy of inclusions and their odd shapes in gemstones leads the authors to create in the imagination an old fashioned stove, a shrew and a prehistoric bird amongst other extraordinary resemblances. Part IV (the largest) is the most important part of the book and deals with 25 host species and their varieties. Some idea of the comprehensive nature of the treatment provided may be gauged by the section on emerald. The inclusions in stones from Brazil (several localities), Habachthal, Ajmer, Colombia (several mines), Lake Manyara, Mozambique, Pakistan, Sandawana, Transvaal, Urals, Zambia are all described and usually with several different photographs for each locality. Each photograph is provided with a concise description of the various inclusions and details of the type of lighting and the magnification. Ruby, sapphire and other important commercial gemstones are given comparable treatment and there is a very fine section on treated corundums. This part and the following Part V will be of crucial importance to the practising gemmologist.

Part V (88 pages) deals with the inclusions of man-made stones. It opens with a short review of the development of the various methods of gemstone synthesis and discusses the use of the terms imitation, artificial and synthetic. Over 40 photographs are used to illustrate inclusions in a wide variety of glasses. Synthetic emeralds (50 photographs) receive full treatment and photographs of several types, such as Lennix, Biron and Regency-created are included. Synthetic ruby (90 photographs) is described and figured comprehensively and includes details of the latest Knischka, Kashan and Ramaura types. Synthetic sapphire of various colours are also illustrated very fully.

Part VI (15 pages) – the 'concluding thoughts' – includes a geological timetable, a glossary of scientific expressions used, an extensive bibliography and a list of works cited. A very welcome addition to this volume is the provision of an index.

This *magnum opus* is exactly that. The provision of some 1,400 photographs and descriptions could be confusing, but here they have been logically arranged and a good contents list and index provided. The book is not just beautiful, it is also a comprehensive laboratory manual for those (most gemmologists!) who do not have access to the enormous range of natural stones from numerous localities or the range of very clever fakes which are now produced. Criticisms can be few, the reviewer (and some of his friends) find the outer cover disappointing in its near monochrome appearance, and the page margins somewhat ungenerous for the superb contents. It it to be hoped that binding will stand up to the very hard usage that many copies will receive. At £110 (in London) the book is expensive, but this is understandable when one considers the very extensive use of colour and the superb reproduction. The reviewer recommends buying the book first and affording it afterwards. It is the ideal gift for the gemmologist, jeweller, mineralogist, geologist (or anyone else for that matter) who has everything else. E.A.J.

LÉMERY, N. 1986. *Dictionnaire universel des drogues simples*. 3rd edn. (Universal dictionary of simple drugs.) Adidom, Paris, pp.124. Price on application.

Reprint of a work first published in 1733 and dealing with the medicinal and curative powers of drugs obtained from minerals. Typescript index. M.O'D.

Proceedings of the Gemmological Association of Great Britain and Association Notices

OBITUARY

M.D.S. Lewis was born in London on 1 March, 1901 and died on 8 July, 1986. He was probably best known to gemmologists and jewellers as the author of the definitive work 'Antique Paste Jewellery' and from his articles in the *Journal*.

He took his B.Sc. in 1921 at London University. There were few openings for science graduates at that time and he was unable to obtain a suitable post which could make use of his particular talents, which were mathematics and physics. His uncle was the proprietor of the jewellery manufacturing firm of Lazarus and Co., in Fitzroy Square, London, and offered him an opening as a jewellery designer. He found it to be very much to his liking and remained there for most of his working life. He was married in 1930 and the couple lived in Hampstead. From all accounts, he was a superb performer in both amateur ballroom dancing and ice-dancing.

Shortly before the war he began to be intrigued by the gemstones which were so much a part of his work and decided to enrol in the Chelsea gemmology classes. During the war his firm became wholly involved in the manufacture of various optical-mechanical components for aircraft. Because of this he was not called up for active service, but his scientific background led him into becoming a Gas Identification Officer, based in London.

He was awarded the F.G.A. and Tully Medal in 1944. In 1945 the G.A. Council decided to initiate an international Research Diploma to encourage and recognise post-graduate work of merit. A thesis submitted by Lewis entitled 'Some Surface Properties of Gemstones' convinced the Council that he should be the first recipient of the G.A. Research Diploma.†

†The succeeding Diploma awards were made in 1946 to R. Webster (London), in 1953 to G.F. Leechman (Falmouth, Cornwall), in 1957 to E. Gübelin, Ph.D. (Meggen, Switzerland), in 1959 to L.C. Trumper, B.Sc. (Devizes, Wiltshire), and in 1976 to the last recipient Pete J. Dunn, (Washington, DC, USA).

In 1947 the Gemological Institute of America awarded him their Graduate Gemologist Diploma. The photograph was taken at about this time.

When the firm resumed their jewellery manufacturing after the war, his uncle died and he took over the management of the business. In 1960 his salesman, who was a close personal friend, was killed in a car accident. This shock, coupled with the fact that he had not particularly enjoyed his new role, which had taken him away from the designing and production side of the business, made him decide to abandon jewellery manufacturing altogether. He was then able to devote himself fully to those pursuits closest to his heart. His researches resulted in the scholarly and authoritative survey *Antique Paste Jewellery* which was published by Faber and Faber in 1970 and sold in the Victoria and Albert Museum bookshop.

It was an earlier series of articles to the *Journal*, however, which most impressed the writer. These dealt with the effects and mechanisms of the interaction of light with transparent, coloured, faceted gemstones. The extremely unusual fusion of artistic and scientific abilities allowed him to describe these complex optical phenomena in a startlingly lucid manner. In his assertion of the

importance to gemmologists of a clear understanding of colour production, perception and measurement, he was decades in advance of his time. His explanations of the almost unintelligible intricacies of the internationally-adopted method of colour measurement known as the CIE Tristimulus Colour System are by far the best the writer has seen. A list of his contributions to the *Journal* is given below.

During the later part of his life he wrote many articles for the *Connoisseur* magazine and was a consultant for both Sotheby's and Christie's on antique jewellery. His advice was frequently sought by producers of historical cinema films. A rather shy and retiring person, he never delivered lectures, but when approached was massively generous with his time and knowledge. He possessed an intense love of fine antique jewellery and displayed a warmth of feeling towards those who shared it. This is very evident in a tribute to Mosheh Oved, the proprietor of the 'Cameo Corner' in Holborn's Museum Street, which was published in the November 1958 issue of *Goldsmiths Journal*. It is the writer's lasting regret that he never had the opportunity of talking to or meeting with so remarkable a man.

Latterly, he suffered from a debilitating illness, together with a serious eye affliction which greatly impaired his enjoyment of life. He leaves a son, Mr Graham Lewis and a daughter, Mrs Jennifer Parkhouse, both of Brighton.

Articles by M.D.S. Lewis in the *Journal of Gemmology*:

Selective reflection, 1947 **I**, 4, 10–14.
Speculations on lustre, 1948, **I**, 8, 9–17.
Paste, 1949 **II**, 4, 141–50.
Hardness tests, 1950, **II**, 6, 221–6.
Colour perception in gemmology, 1952, **III**, 6, 249–67.
Measurement of colour, Part 1, 1952, **III**, 7, 289–304.
Measurement of colour, Part 2, 1952, **III**, 8, 341–50.
The first half of the 19th century, 1955, **V**, 1, 17–28.

J.B.N.

JOHN GEORGE RAE, M.B.E., F.G.A., Weisdale, Shetland, died in November 1985 at the age of 80. Mr Rae passed the Diploma examination in 1934, and was amongst the first in Scotland to do so. He worked in Edinburgh until 1945 when he went to Shetland as a lay agent of the Church of Scotland. In 1955 he resumed his trade and founded the manufacturing business of Shetland Silvercraft and then the retail business of J.G. Rae Ltd. He was a member of the County Council and numerous local committees. He received the M.B.E. from the Queen in 1980.

* * *

GORDON W. WHITEHEAD, F.G.A. (D.1949 with Distinction), Surbiton, died on 19 September 1986.

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to the following for their gifts:

Creative Gemcrafts Pty Ltd, Adelaide, Australia, for two hessonite garnets.

Mr H.G. Stonley, F.G.A., Aylesbury, for a selection of gemstones including peridot, aquamarine, topaz, garnet and tourmaline.

Mr I. Thomson, of E.A. Thomson (Gems) Ltd, London, for a beryl doublet imitating a ruby.

NEWS OF FELLOWS

Mr E. Alan Jobbins was invited to lecture in Milan on 15 October 1986 in the series 'Gemmologia Europa' organized by CISGEM (Centro Informazione e Servizi Gemmologici) on behalf of Azienda Speciale della Camera di Commercio Industria Artigianato e Agricoltura di Milano. His subject was 'Gemstones of south-east Asia' and four other lectures followed at fortnightly intervals given by Prof. E. Gübelin, Switzerland, Dr J. Kanis, Portugal, Dr H. Schubnel, France, and Prof. P. Zwaan, Netherlands. The whole series was conceived to celebrate the sexcentenary of Milan Cathedral.

On 23 October 1986 Mr M.J. O'Donoghue, M.A., F.G.S., F.G.A., presented a paper on crystal growth information at a seminar on new materials held by the Science Reference and Information Service of the British Library.

MEMBERS' MEETINGS

London

On 14 October 1986 at the Flett Theatre, Geological Museum, Exhibition Road, South Kensington, London S.W.7, Dr J. Ponahlo, F.G.A., of the Austrian Gemmological Association, gave an illustrated talk entitled 'Quantitative cathodoluminescence of gemstones'.

Midlands Branch

On 17 October 1986 at Dr Johnson House, Bull Street, Birmingham, a talk was given by Mr Frank Diesch, of Mikimoto Pearls. He gave an account of the history of Mikimoto and of present day culturing, and concluded with a guide to the valuation of pearls.

On 21 November 1986 at Dr Johnson House, Mr Ken Scarratt, F.G.A., Director of the Gem Testing Laboratory of Great Britain, gave an illustrated talk entitled 'Gems from the Laboratory'. A selection of the latest instruments and books was displayed by representatives from Gemmological Instruments Ltd.

South Yorkshire and District Branch

On 6 November 1986 at the Sheffield City Polytechnic, Pond Street, Sheffield, Mr Eric Emms, F.G.A., of the Gem Testing Laboratory of Great Britain, gave an illustrated talk on the workings of the Laboratory.

ANNUAL REUNION OF MEMBERS AND PRESENTATION OF AWARDS

The Annual Reunion of Members and Presentation of Awards was held on 10 November 1986 at Goldsmiths' Hall, London. The Chairman, Mr David J. Callaghan, F.G.A., presided at the Presentation, and welcomed those present. Mr Callaghan noted that nearly 1000 students had taken the Association's examinations in 1986 and among those before him were award winners from Cyprus, Dubai, Kenya, Netherlands, Norway, Portugal, Spain, Sweden, Sri Lanka and the USA.

The Chairman then called upon Mr Herbert Tillander, F.G.A., of Finland, to present the awards to the successful candidates. After making the presentations, Mr Tillander delivered the address which is printed in full below.

The Vice-Chairman, Mr Noel Deeks, F.G.A., gave the vote of thanks, paying tribute to Mr Tillander's work.

Mr Callaghan then announced that part of the gemstone collection of the late Basil Anderson was being donated anonymously to the Gemmological Association. The collection was presented to Mr Callaghan on behalf of the Association by Mr A. Middlemiss, F.G.A., of Christie's, a full report of which appears on p.266.

ADDRESS BY MR HERBERT TILLANDER, F.G.A.

Ladies and Gentlemen,

It is a great day for all of us invited to join the officers, members of the Council, examiners and instructors of the world's oldest gemmological organization.

For those who have just received their awards this ceremony marks the start of a hopefully long and successful career.

For the officials of the Association it certainly means a great deal of satisfaction if they win applause from the audience in recognition of their voluntary and very worthy contributions in promoting gemmology world-wide.

For me it is a delight to have over-generously been invited to meet all of you and share your enthusiasm. Twenty-five years have passed since I was first honoured with this same privilege and just over half-a-century since I received my Diploma.

I congratulate those who have gained awards and sympathize with those who have unfortunately for some reason not been successful, but have at least acquainted themselves well with the subject. Since the standard of the diploma is *very* high and since few students are able to devote more than their spare time for study, there is no question about it being a real achievement to qualify for a Diploma. It could be said without much exaggeration that a normal student has less chance to pass than to fail. In some cases, also, factors outside the control of the student may have disturbed the normal rhythm of studies and practice in gem-testing. It really needs enthusiasm and sacrifice of time during two long years and a very good head for study to pass the present stiff examination with distinction.

There is a tendency among some overseas members of the Gemmological Association to strive after recognition as gem experts by the public and even the courts of justice. A very dangerous ambition indeed, since theoretical knowledge must be coupled with long experience in the trade and constant handling of such gems that have to be competently tested and in addition correctly appraised.

You need constant practice with gems in order to know them better and this is now possible without the strain of an examination ahead of you. I am sure you will get very much pleasure from such a study.

You will have to keep well informed about new developments in the gemmological field in order to remain up to date. This, in my opinion, involves not just thoroughly studying every issue of our excellent *Journal of Gemmology* but also other publications. The 'Gemmological Abstracts' and the 'Book Reviews' of the British journal will guide you well in this respect. Personally I have found the American *Gems and Gemology* and the Conclave issues of *Guilds* well worth reading and memorizing.

The Diploma alone does not make you an expert. In every profession, in every science and even in a hobby you are more or less a beginner when you have received your Diploma, but you have all the qualifications to achieve the reputation of a real expert if you proceed.

Much, obviously, depends on the type of occupation you are engaged in or look for. It may be, for instance, testing, grading, appraising or research work or any other job which permits you in connection with your work to keep abreast of the times.

During the hectic studies for the examinations many of you will have paid attention to some narrow sector which caught your specific interest but which was not dealt with in detail. Why not start proper research on this or any other subject as an earnest hobby and gradually qualify yourself as an expert. This is what I decided about twenty years ago. I gave up overall gemmology and my preceding hobby, diamond grading, and began a serious research on the history of diamond cuts. My treatise with over 1000 line drawings and as many photographs is still in manuscript, and it remains to find a publisher. But on account of a vast correspondence, a number of articles published and lectures held in various countries I appear to be a universally recognized specialist in this field. This research with numerous exciting discoveries has filled all my spare time with joy and contentment.

Gemmology has indeed a very wide scope and many sectors of this science have yet been only cursorily handled. The range for new discoveries is still substantial and I do hope some of you at least will decide to fill such gaps.

COUNCIL MEETINGS

At the meeting of the Council held on 16 September 1986 at the Royal Automobile Club, Pall Mall, London S.W.1, the business transacted included the election to membership of the following:

Fellowship

Adams, Amanda C., Leicester. 1986
Aloupas, Phiros, Nicosia, Cyprus. 1986
Bellers, Veronica O., Crawley. 1986
Blackburn, James O., Winchester. 1986
Booker, Martin, Chester. 1986
Cooney, Tracy J., Birmingham. 1986
Davidson, Helen, Chester le Street. 1986
Dean, John A., Ossett. 1986
Emerson, Michael E., Auckland, New Zealand. 1983
Goodall, Andrew M., Abbots Langley. 1986
Helmore, Peter R., London. 1986
Hudson, Carole A., Ware. 1986
Iwahori Mitsuo, Tokyo, Japan. 1975
Jackson, Sarah E., Chorleywood. 1986
Jayasundera, Amarasekera B., Kandy, Sri Lanka. 1970
Kenny, Ian P.A., Tralee, Co. Kerry, Ireland. 1986
King, Barry J., Bury St Edmunds. 1986
Klimek, Bettina A.L., Tunbridge Wells. 1986
Linley, Mark A., Worcester. 1986
Magudia, Ratilal H., St Albans. 1986
Nalliah, Selliah, Victoria, Australia. 1970
Neumand, Marion J.S., Richmond. 1986
Parker, Claire E., Worthing. 1985
Potter, Christopher, Whitstable. 1986
Robinson, Timothy, Wirral. 1986
Salmon, Shereen B., Preston. 1986
Schlussel, Roland, Colombier, Switzerland. 1985
Simpson, Geoffrey P., Marple. 1986
Spencer, Jonathan P., Bristol. 1986
Thompson, Howard W., New Malden. 1986
Topitz, Ursula A., Los Angeles, Calif., USA. 1983
Tyler, Karen, Blackpool. 1986
Waldeck, Stephen J., Ringwood. 1986
Walsh, Claire E., London. 1986
Watson, Margery E., London. 1986
Welch, Mark G., Taunton. 1980
White, Robert, Northampton. 1986

Transfers from Ordinary Membership to Fellowship

Abramson, Pamela J., Orlando, Fla., USA. 1986
Akers, Patrick J., Wimborne. 1986
Amemiya, Tamami, Tokorozawa City, Japan. 1986
Anderson, Vanessa K.A., Hong Kong. 1986
Armand, Marcel, Auckland, New Zealand. 1986
Bartholomew, Jurgen C., Shoreham-by-Sea. 1986
Burton, Nicholas J., Lichfield. 1986
Butfoy, Carol A., Kenton. 1986
Campbell, Norma B., Hong Kong. 1986
Carroll, Elizabeth K., Auckland, New Zealand. 1986
Chung, Stephen W.K., Leeds. 1986
Coleman, Rachel R., Newbury. 1986
Deeley, Peter J., Birmingham. 1986
Elkins, Heather, Nairobi, Kenya. 1986
Fedell, Jean M., Crystal Lake, Ill., USA. 1986
Fessel, Robert P., Paulding, Ohio, USA. 1986
Gardiner, Margot, Glasgow. 1986
Geolat, Patti J., Dallas, Tex., USA. 1986
Glaveau, Beatrice, Paris, France. 1986
Hamawi, George, Nairobi, Kenya. 1986
Hawkhead, Carol, Bournemouth. 1986
Hirama, Katsunori, Tokyo, Japan. 1986
Hirose, Sairi, Nagasaki Pref., Japan. 1986
Jones, Michael H., Northampton. 1986
Kato, Kuniaki, Osaka, Japan. 1986
Kent, Jeni, Hyde Park, SA, Australia. 1986
Kuittinen, Raili, Helsinki, Finland. 1982
Martin, David J., Warrington. 1986
Meister, Adrian, Zurich, Switzerland. 1986
Mellor, Karen, Amersham on the Hill. 1986
Merk, Roger L., San Diego, Calif., USA. 1986
Mills, Edwin T., Ely. 1986
Powell, Warren, Prestwich. 1986
Reynolds, Gerald N., Arlington, Tex., USA. 1986
Seibert, Jack, Arlington, Tex., USA. 1986
Shaw, Patricia V., Leeds. 1986
Smith, Adrian S., Portsmouth. 1986
Stewart, Robert M., London. 1986
Taylor, Anne R.E., Poole. 1986

Taylor, Roger J., Kings Norton. 1986
Van Gelder, Lizbeth S., London. 1986
Williams, Bret J., Matamata, New Zealand. 1986
Xanthopoulos, Celia, London. 1986
Yandle, Lorna R., Bethesda, Md, USA. 1986

Ordinary Membership
Agrawala, Das S.K. Orissa, India.
Atkinson, Gordon, Caithness.
Best, Gwendoline, Bridport.
Booth, Christine, Oldham.
Brown, Douglas C., Singapore.
Brown, Lee N., Nimes, France.
Browne, Andrew J., Caterham.
Caithness, Sharon M., Harare, Zimbabwe.
Carry, Peter D., Aberdeen.
Chan, Chi Wa, Hong Kong.
Choo, Boo Seng S., Singapore.
Craddock, Joan, Loughborough.
David, Ian G.H., Dunmow.
Durham, Dennis, Hull.
El-Sirgany, Adel A., Freeport, Ill., USA.
Evans, Elma B.H., Spring Valley, Minn., USA.
Ferris, Alan, Banbridge, Co. Down, N. Ireland.
Ferry, John M., Norwich.
Gay, Bernice M., Romsey.
Godwin, James G., Brighton.
Gollance, Caryl I.P., London.
Hage-Chahine Sawaya, Nayla, Paris, France.
Hansen, Gary R., St Louis, Mo., USA.
Hawke, Thelma C., Newquay.
Hayashi, Masahiko, Tokyo, Japan.
Horiuchi, Satoru, Tokyo, Japan.
Houbail, Ahmed J., Manama, Bahrain.
Jack, Barbara M.H., Glasgow.
Kent, David W., London.
Kim, Won Sa, Chungnam, Korea.
Kneip, John R., London.
Korevaar, Marianne, Ter Dar, Netherlands.
Leung, Marilyn S., Hong Kong.
Lewis, Anthony J., Toronto, Ont., Canada.
Lombardi, Armando, Alessandria, Italy.
Mansell, Luke E., Cambridge.
McGill, Robert, London.
McGregor, Celia, Turramurra, NSW, Australia.
Meurice, Alison S., Hythe.
Miller, Marvin D., Fairfax, USA.
Moralee, Jean M., Saltburn.
Palfreyman, William D., ACT, Australia.
Petersen, Allen C., Granby, Conn., USA.
Pintz, Frank E., Northbrook, Ill., USA.
Pyzowski, Carl C., Frackville, Penna., USA.
Rennes, Michael D., London.
Serret, Michel, Paris, France.
Sherwood, Peter H., London.
Smith, Michelle, Paris, France.
Sosnowski, Javier, Barcelona, Spain.
Spiro-Haccou, Geertruida J., Jakarta, Indonesia.
Stocker, Betty, Chipping Campden.
Sulaiman, Zahari, Selangor, Malaysia.
Sultan, Rebecca, Borehamwood.
Taylor, Helen M., Whitby.
Turner, John F., Wakefield.
Vasquez, Tomas, Barranquilla, Colombia.
Wallace, Janice M., Johannesburg, S. Africa.
Woolley, Shirl L., San Diego, Calif., USA.
Youens, Philip A., Bristol.

At the meeting of the Council held on 18 November 1986 at the Royal Automobile Club, the business transacted included the election to membership of the following:

Fellowship
Abear, Marga, Ottawa, Canada. 1986
Andrews, Olive M., Gateshead. 1986
Arnold, Gillian M., London. 1986
Bennett, David W., Royston. 1980
Bruciak, Thomas M., Lanham, Md, USA. 1986
Burns, Brian, Huddersfield. 1986
Chalandon, Tohra, London. 1986
Chan, Pik Yuk Addy, Hong Kong. 1986
Choopojcharoen, Chatchai, Bangkok, Thailand. 1986
Clarke, William R., Toronto, Ont., Canada. 1986
Cowell, Gawin, Hobart, Tasmania. 1986
Dagli, Yogesh P., Bombay, India. 1984
Daniell, Mary L.S., Hong Kong. 1986
de Haer, Robert H., Stuttgart, Germany. 1986
de Maesschalck, Alexandra A., Amsterdam, Netherlands. 1986
Essex, Philip E., Toronto, Ont., Canada. 1986
Fitzgerald, Trevor M.P., Folkestone. 1986
Gillett, Graham, Bexhill On Sea. 1986
Gold, Francine I., Markham, Ont., Canada. 1986
Gumuchdjian, Michael A., Teufen, Switzerland. 1986
Hamilton, Ann, Paisley. 1986
Hepburn, John A., Orpington. 1986
Ho, Frankie K.K., Hong Kong. 1984
Hoefer, William D., San Jose, Calif., USA. 1986
Holton, Yvonne, Edinburgh. 1986
Hopkins, Corrinne B., Singapore. 1986
Klein, Linda S., Stockholm, Sweden. 1986
McGregor, Robert G., Nepean, Ont., Canada. 1986
McQueen, Colin F., Lincoln. 1986
Masin, Roy P.A., Soestdijk, Netherlands. 1986
May, Jasper B. St J., Banbury. 1986
Mazza, Deborah R.H., Idar Oberstein, W. Germany. 1986
Merry, Neil J., Broxbourne. 1986
Nishimori, Yoshie, Fukui-Ken, Japan. 1986

Norcott, Susan C., Bristol. 1986
Onishi, Hirokazu, Osaka, Japan. 1986
Palombi, Robert J., London, Ont., Canada. 1986
Payette, Francine, Sillery, Que., Canada. 1985
Pfneisl, Thomas, Vienna, Austria. 1986
Phillips, Glenys J., Brighouse. 1986
Pieris, Ishita K., Nawala, Sri Lanka. 1986
Powell, Gregory J., Prestatyn. 1986
Rice, Karen L., Solihull. 1986
Rickard, Patricia L., South Laguna, Calif., USA. 1986
Smith, Gillian M., Wetherby. 1986
Smith, Susan A., Hendon. 1986
Swinkin, Barry D., Toronto, Ont., Canada. 1986
Tatlock, John F., Washington DC, USA. 1986
Tidswell, Linda A., Bingley. 1986
Unhjem, Reinholdt Z., Oslo, Norway. 1986
Vara, Pradip, Stanmore. 1986
Witschard, Peter R., Stockholm, Sweden. 1986
Wong, Kai S., Hong Kong. 1986
Woodward, Elizabeth, London. 1986
Yu Fuk Kau, David, Hong Kong. 1986
Zainuddin, Nisreen A., Deira-Dubai, UAE. 1986

Ordinary Membership
Abrahams, Ashley H., Kenley.
Adam, Adam, London.
Anwar, Pasha, London.
Ash, Brian G.V., Kings Lynn.
Baumann, Yvonne, Dungarvan, Waterford, Ireland.
Best, Jean H., Wimborne.
Booley, Timothy J., Wakefield.
Burbridge, Colin D. Birmingham.
Ching, Estella S.T.T., Hong Kong.
Coward, Stephanie J., Colchester.
Dibbens, Ian J., Christchurch.
Dormer, Colin L., Sutton.
Drukker, M., Amsterdam, Netherlands.
Esser, Clara L.M., Singapore.
Findlay, Caroline E., London.
Fitzmaurice, Karl M., Dublin, Ireland.
Hamid, Jeffery A.B.A., Perak, W. Malaysia.
Hossen, Iqbal H., Port Louis, Mauritius.
Kabamba, Bujitu M., Leven.
Kasler, Jesse M., Chula Vista, Calif., USA.
Krysler, Clement, London.
Liechtenstein, Helene, Steiermak, Austria.
Lind, Thomas, Idar Oberstein, W. Germany.
Loube, Lynne P., Washington DC, USA.
McCleland, Susan M.F., Haslemere.
Maddens, Claudine Z., Belgium.
Mahaux, Jacques R., Overijse, Belgium.
Malin, Dianne M., Wembley.
Moldes, Rhyna, Miami, Fla., USA.
Ng, Avis L., London.
Nunes, Michel, George, S. Africa.
Reynolds, W.A.G., Sydney, NSW, Australia.
Richner, Sally J., Grosse Pointe, Michigan, USA.
Schneirla, Peter C., New York, NY, USA.
Scott Young, Rosemary S., Glasgow.
Straub, Bernard C., Reading.
Sumpster, Antony M., London.
Talberg, Judy, Burkina Faso, W. Africa.
Theriault, Peter J., Camden Maine, USA.
Tong, James P.T., Hong Kong.
Treloar, Karl R., Banwell.
Van Rooyen, Brent A., Glenstantia, S. Africa.
Vest, Geraldine M., London.
Vincent, Patricia J., Wokingham.
Wagner, Martin K., Gerrards Cross.
Woodward, Zena P., London.

GEM DIAMOND EXAMINATION 1986

In the Post-Diploma Gem Diamond Examination 39 candidates sat and 38 qualified. The following is a list of the successful candidates arranged alphabetically.
Ambrose, Janice M., Enfield.
Arno Fece, Nuria, Barcelona, Spain.
Ashraf, Ashfaq A., London.
Baquero Petricorena, Manuel, Barcelona, Spain.
Batalla Vivas, Jose I., Barcelona, Spain.
Bernad Soria, Pedro J., Barcelona, Spain.
Biosca Bas, Ma de los Angeles, Barcelona, Spain.
Cabre Bores, Nuria, Barcelona, Spain.
Campos Ruiz, Ma T., Barcelona, Spain.
Carmena Coelho, Jose A., Barcelona, Spain.
Evans, Gareth D., Potters Bar.
Francis, Shirley J., Frinton-on-Sea.
Gascon Cuello, Fernando, Barcelona, Spain.
Goad, Jane F.C., London.
Herold, Richard A.J., Salisbury.
Hutton, Andrew J., Sanderstead.
Iacovou, Elena N., Nicosia, Cyprus.
Insa Sales, Juan M., Barcelona, Spain.
Jones, Karen, Bangor.
Juan Sampablo, Teresa, Barcelona, Spain.
Lewis, Doreen E., Monmouth.
McKearney, Michael C., London.
Marti Martinez, Nicolas, Barcelona, Spain.
Medniuk, Melanie A., Witham.
Moore, Elaine, Northwood.
Morling, Anthony J.D., St Mary, Jersey, CI.
Morrison, Stephen P., London.
Pajaron Gamon, Ma L., Barcelona, Spain.
Parker, Claire E., Goring-by-Sea.
Pascual Torres, Jose L., Barcelona, Spain.
Platon Davila, Susana, Barcelona, Spain.
Ramsey-Rae, Philippa, London.
Spreckley, Vaughan G.M., London.
Stead, William A., London.
Sturman, Nicholas P.G., London.
Taank, Avinash, Ilford.

Wackan, Susan K., London.
Wilson, Andrew R., Goring-by-Sea.

EXAMINATIONS IN GEMMOLOGY 1986

In the 1986 Examinations in Gemmology 704 candidates sat the Preliminary examination and 456 (65%) passed, 466 sat the Diploma examination and 187 (40%) passed, 13 with distinction.

The Tully Medal, to be awarded to the candidate (trade or non-trade) who submits the best set of answers in the Diploma examination, has not been awarded this year.

The Anderson/Bank Prize for the best non-trade candidate of the year in the Diploma examination has been awarded to Lizbeth Sara Van Gelder of London.

The Rayner Diploma Prize for the best candidate of the year whose main income is derived from activities essentially connected with the jewellery trade has been awarded to Karen Lindsey Rice of Birmingham.

The Anderson Medal for the best candidate of the year in the Preliminary examination has been awarded to Eeva Katri Harjula of Finland.

The Rayner Preliminary Prize for the best candidate under the age of 21 years on 1 June whose main income is derived from activities essentially connected with the jewellery trade was awarded to Mei Po Mak of Hong Kong.

The names of the successful candidates are as follows:

DIPLOMA

Qualified with Distinction

Abell, Alison M., Nairobi, Kenya.
Amemiya, Tamami, Tokorozawa City, Japan.
Haque, Mohammed, London.
Helmore, Peter R., London.
Hirama, Katsunori, Tokyo, Japan.
Meister, Adrian, Zurich, Switzerland.
Rice, Karen L., Solihull.
Robinson, Timothy, Wirral.
Simpson, Geoffrey P., Marple.
Stewart, Robert M., London.
Tyler, Karen, Cleveleys.
Unhjem, Reinholdt Z., Oslo, Norway.
Van Gelder, Lizbeth S. London.

Qualified

Abear, Marga, Ottawa, Ont., Canada.
Abramson, Pamela J., Orlando, Fla., USA.
Adams, Amanda C., Burstall.
Aggarwal, Kamal K., Patiali, India.
Akers, Patrick J., Wimborne.
Aloupas, Phivos, Nicosia, Cyprus.
Amarasiri, Sujatha, Colombo, Sri Lanka.
Anderson, Vanessa K.A., Hong Kong.
Andrews, Olive M., Hong Kong.
Armand, Marcel, Auckland, New Zealand.
Arnold, Gillian M., London.
Batholomew, Jurgen C., Shoreham-by-Sea.
Beckett, Michael J., London.
Bellers, Veronica O., Horsham.
Blackburn, James O., Winchester.
Bolland, Wendy M., Hong Kong.
Booker, Martin, Chester.
Bruciak, Thomas M., Lanham, Md, USA.
Bruggeman, Renate F., Almelo, Netherlands.
Buis, Jan D.B., Lopik, Netherlands.
Burns, Brian, Huddersfield.
Burton, Nicholas J., Lichfield.
Butfoy, Carol A., Kenton.
Campbell, Norma B., Hong Kong.
Campillo Pastor, Marina, Barcelona, Spain.
Carroll, Elizabeth K., Auckland, New Zealand.
Casanova Guillen, Luis M., Barcelona, Spain.
Chalandon, Tohra, London.
Chan, Pik Y.A., Hong Kong.
Chandrasena, Vishwakanthie, Idar-Oberstein, W. Germany.
Chard, Duncan, London.
Cheung, Yiu W.D., Hong Kong.
Choopojcharoen, Chatchai, Bangkok, Thailand.
Chow, Winston W.S., Hong Kong.
Chung, Stephen W.K., Leeds.
Clarke, William R., Toronto, Ont., Canada.
Coleman, Rachel R., Newbury.
Cooney, Tracy J., Birmingham.
Cowell, Gawin, Hobart, Tasmania.
Daniell, Mary L.S., Hong Kong.
Davidson, Helen, Chester-le-Street.
Dean, John A., Ossett.
Deeley, Peter J., Birmingham.
de Haer, Robert H., Zwolle, Netherlands.
de Maesschalck, Alexandra A., Amsterdam, Netherlands.
Domenech Lahoz, Christiane, Barcelona, Spain.
Duque Camp, Susanna Ma, Barcelona, Spain.
Elkins, Heather, Nairobi, Kenya.
Essex, Philip E., Toronto, Ont., Canada.
Fedell, Jean M., Crystal Lake, Ill., USA.
Fernandez Nunez, Francisco J., Barcelona, Spain.
Fernandez Sanchez, Fernando, Barcelona, Spain.
Fessel, Robert P., Paulding, Ohio, USA.
Fitzgerald, Trevor M.P., Folkestone.
Gardiner, Margot, Glasgow.
Gentsidou, Fotina, Athens, Greece.
Geolat, Patti J., Dallas, Tex., USA.
Gillett, Graham, Bexhill-on-Sea.
Glaveau, Beatrice, Paris, France.
Gold, Francine, Markham, Ont., Canada.
Goodall, Andrew M., Abbots Langley.
Goodlin, Fran, Toronto, Ont., Canada.
Gumuchdjian, Michael A., Teufen, Switzerland.

Hamawi, George, Nairobi, Kenya.
Hamilton, Ann, Bridge of Weir.
Hawkhead, Carol, Bournemouth.
Hepburn, John A., Orpington.
Hirose, Sairi, Nagasaki Pref., Japan.
Hoefer, William D., San Jose, Calif., USA.
Holton, Yvonne, Edinburgh.
Hopkins, Corrinne B., Bangkok, Thailand.
Hudson, Carole A., Ware.
Indrebø, Solveig, Oslo, Norway.
Jackson, Sarah E., Watford.
Jain, Monica, Bombay, India.
Jones, Michael H., Northampton.
Kalannayake, Lenaduwa L.Y.R., Colombo, Sri Lanka.
Kato, Kuniaki, Osaka, Japan.
Kenny, Ian P.A., Tralee, Co. Kerry, Ireland.
Kent, Jeni, Hyde Park, SA, Australia.
Kievit, Wouter, Rotterdam, Netherlands.
King, Barry J., Bury St Edmunds.
Klein, Linda S., Stockholm, Sweden.
Klimek, Bettina A.L., Tunbridge Wells.
Kotewall, Pikyee, Hong Kong.
Krot, Carine A.P., Amsterdam, Netherlands.
Lam, Keturah M.H., Hong Kong.
Lee, Mei-Ying, Hong Kong.
Leung, Marilyn S., Hong Kong.
Linley, Mark A., Worcester.
Lloyd, Jeremy J., Birmingham.
McGregor, Robert G., Nepean, Ont., Canada.
McIntosh, Stewart F., Glasgow.
McQueen, Colin F., Lincoln.
Magudia, Ratilal H., St Albans.
Mak, Yim Ming, Hong Kong.
Malhotra, Kapil, Bombay, India.
Marazzi, Roberto, Lugano, Italy.
Marti Beltran, Fernando, Barcelona, Spain.
Martin, David J., Warrington.
Masin, Roy P.A., Soestdijk, Netherlands.
Maskonen, Seija S., Helsinki, Finland.
Mavridou, Angelika, Thessalonika, Greece.
May, Jasper B. St J., Birmingham.
Mazza, Deborah R.H., Idar Oberstein, W. Germany.
Mellor, Karen, Amersham-on-the-Hill.
Merk, Roger L., San Diego, Calif., USA.
Merry, Neil J., Broxbourne.
Mills, Edwin T., Ely.
Murano, Fumiko, Osaka, Japan.
Neumand, Marion J.S., Richmond.
Ng, Li Neng, Penang, Malaysia.
Nidharak, Gurdip S., Solon, Ohio, USA.
Nishimori, Yoshie, Tokyo, Japan.
Norcott, Susan C., Bristol.
Onishi, Hirokazu, Osaka, Japan.
Palmer, Valerie G., London.
Palombi, Robert J., London, Ont., Canada.
Pfneisl, Thomas, Vienna, Austria.
Phillips, Glenys J., Brighouse.
Piedvache, Roland, Paris, France.
Pieris, Ishita K., Colombo, Sri Lanka.
Poblador Cerezo, Luis M., Barcelona, Spain.
Potter, Christopher, Whitstable.
Powell, Gregory J., Prestatyn.
Powell, Warren, Prestwich.
Preston, Karen L., Burnley.
Rafols Garrit, Yolanda, Barcelona, Spain.
Rehbinder, Anne C.M., Stockholm, Sweden.
Reynolds, Gerald N., Arlington, Tex., USA.
Rickard, Patricia L., South Laguna, Calif., USA.
Salmon, Shereen B., Preston.
Seibert, Jack, Columbus, Ohio, USA.
Senaratne, Amal C., Colombo, Sri Lanka.
Serra Palau, Carles, Barcelona, Spain.
Shah, Manoj D., Bombay, India.
Shaw, Patricia V., Leeds.
Smidt, Margot, Voorburg, Netherlands.
Smith, Adrian S., Emsworth.
Smith, Alan, Blackpool.
Smith, Gillian M., Wetherby.
Smith, Susan A., Hendon.
So Nai Leung, Jimmy, Hong Kong.
Spencer, Jonathan P., Bristol.
Swinkin, Barry D., Toronto, Ont., Canada.
Tai, Anissa M., Singapore.
Tassabehji, Basima, Manchester.
Tatlock, John F., Washington DC, USA.
Taylor, Anne R.E., Poole.
Taylor, Roger J., Kings Norton.
Thethy, Avtar S., London.
Thompson, Howard W., New Malden.
Tidswell, Linda A., Bingley.
Torrance, Claire H., Auckland, New Zealand.
Tortosa Domingo, Ramon, Barcelona, Spain.
van Dijk-Pietrzak, Jolanta A., Rijswijk, Netherlands.
Vara, Pradip, Stanmore.
Vilanova Cardona, Elvira, Barcelona, Spain.
Vittachi, Nedra, Colombo, Sri Lanka.
Waldeck, Stephen J., Ringwood.
Walsh, Claire E., Hendon.
Watson, Margery E., London.
Wezel, Annemarie, Alkmaar, Netherlands.
White, Robert, Northampton.
Williams, Bret J., Waikato, New Zealand.
Winter, Kim M., Toronto, Ont., Canada.
Witschard, Peter R., Stockholm, Sweden.
Wong, Kai S., Hong Kong.
Woodward, Elizabeth, London.
Xanthopoulos, Celia, Athens, Greece.
Yandle, Lorna R., Bethesda, Md, USA.
Yu Fuk Kau, David, Hong Kong.
Zainuddin, Nisreen A., Deira, Dubai, UAE.
Zaveri, Narendra I.Z., Bombay, India.

PRELIMINARY

Qualified

Aketa, Haruo, Tokyo, Japan.
Alegria Oses, Ma Roas, Barcelona, Spain.
Allen, Elizabeth A., London.
Amemiya, Tamami, Tokorozawa City, Japan.
Amiel Fresneda, Josefa, Barcelona, Spain.
Aresti, Anthony, Barnet.
Armangue Martinez, Ma Angeles, Barcelona, Spain.
Arnold, Patricia, F., Amersham.
Arratia San Hueza, Antonio, London.
Asensi Marti, Ma Victoria, Barcelona, Spain.
Asensi Rolland, Asuncion G., Barcelona, Spain.
Ashby, Paul J., Dover.
Asiain De Los Angeles, Jorge J., Barcelona, Spain.
Atkinson, Mavis W., Bradford.
Atkinson, Morris, Bradford.
Atkinson, Timothy C., Ripon.
Au Yeung, Kwai H., Hong Kong.
Axell, Anita C., Stockholm, Sweden.
Baker, Sylvia V.J., Bangkok, Thailand.
Bargilis, George C., Limassol, Cyprus.
Barlow, R.M., Hong Kong.
Barnes, Joyce J., Marazion.
Baron, Raymond, Liverpool.
Baumann, Yvonne, Dungarvan, Waterford, Ireland.
Beale, Evelyn M., Beamsville, Ont., Canada.
Beattie, Paul J., Liverpool.
Becker, Kim A., Francistown, Botswana.
Bernat Serra, Marcos, Barcelona, Spain.
Bertran Codina, Xavier, Barcelona, Spain.
Bettridge, Howard E., Keston.
Biffer, Howard N., New York, NY, USA.
Billingham, Carole J., Richmond.
Birch, Claire A., Sacramento, Calif., USA.
Birchall, Steven, Hyde.
Bishop, Lyndall, A., Hong Kong.
Blackford, Peggy, Harare, Zimbabwe.
Boardman, Chat Ngoc, McLean, Va, USA.
Bode, William E.G., Harrogate.
Boe, Olav A., Alhus, Norway.
Boot, Maria, Cotgrave.
Borreda Hernandez, Frederico, Barcelona, Spain.
Bosch Lucia, Pilar, Barcelona, Spain.
Bourke, Mary, Enniscorthy, Wexford, Ireland.
Bowis, Mark L., London.
Braithwaite, Doris, Farsley.
Bramham, Kathleen, London.
Bramsden, Manny, Maidenhead.
Brandligt-van der Hoed, Maria A.G., Bussum, Netherlands.
Brasok, Nadia, Toronto, Ont., Canada.
Bristow, Peter H., Whitley Bay.
Bruciak, Thomas M., Lanham, Md., USA.
Brummer, Pieter, Almelo, Netherlands.
Burbridge, Colin D., Birmingham.
Burdett, Martin A., London.
Burman-Roy, Chaya R., Glasgow.
Burques Montserrat, Ma J., Barcelona, Spain.
Burt, Peter O.K., Great Mongeham.
Canty, Jesse, London.
Carpmael, Malcolm P., Shoreham-by-Sea.
Cartmill, Edith L.L., Bangor, N. Ireland.
Cass, Elliott, London.
Castoro, Loretta C., New York, NY, USA.
Caulfield, Gwendolyn R., King City, Ont., Canada.
Chan, Leung F.P., Hong Kong.
Chan, William T.W., Hong Kong.
Chan, Yiu Chung, Hong Kong.
Cheeseman, Alan S., Birmingham.
Cheng, Shik-Ching Lilian, Hong Kong.
Cheng-Lau, Kwai L.K., Kowloon, Hong Kong.
Cheung, Paul K.K., Hong Kong.
Ching, Estella S.T.T., Hong Kong.
Chiu, Sin Y., Hong Kong.
Choopojcharoen, Chatchai, Bangkok, Thailand.
Choy, Boo S.R., Hong Kong.
Christensen, Cherie A., San Jose, Calif., USA.
Christensen, Hanne L., Oslo, Norway.
Chu, Chi H., Hong Kong.
Chung, Ying K., Hong Kong.
Churcher, Mark, Kettering.
Clarke, Deborah L., Tenterden.
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Curran, Paul H., Brighton.
Currant, Paula, Bath.
Dabell, Louise C., Nottingham.
Dallas, James A., London.
Dalmau Bafalluy, Ma N., Barcelona, Spain.
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de Jong, Peter, Zwijndrecht, Netherlands.
de Jong-Flick, Diana, Zwijndrecht, Netherlands.
de Maesschalck, Alexandra A., Amsterdam, Netherlands.
de Visser, Irene M., Rotterdam, Netherlands.
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Gay, Michael, Romsey.
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Gumuchdjian, Michael A., Teufen, Switzerland.
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Gunaratne, Dhammika D., Moratuwa, Sri Lanka.
Hackenberg, Astrid M., Schoonhoven, Netherlands.
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Hare, Michael, South Woodham Ferrers.
Harjula, Eeva K., Helsinki, Finland.
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Hazel, Dougal, Clondalkin, Dublin, Ireland.
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Heibrandt, Lars P., Stockholm, Sweden.
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Hirose, Sairi, Nagasaki Pref., Japan.
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Wang, Winnie, Hong Kong.
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Wiborg-Jenssen, Nellie, Tunbridge Wells.
Winnubst, Albertus, Overberg, Netherlands.

Winter, Kim M., Toronto, Ont., Canada.
Withey, Moira E.J., Leigh-on-Sea.
Wolfsbergen, Margaretha T., Wassenaar, Netherlands.
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Wong, Chun-Wing, Hong Kong.
Wong, Kai S., Hong Kong.
Wong, Wai M., Hong Kong.
Wong, Yui K.H., Hong Kong.
Woods, Janina B., Warwick.
Wren, Rebecca J., Ware.
Yapp, Dorothy M.W., Hong Kong.
Yau, Kong K., Hong Kong.
Yim, Ting K.D., Hong Kong.
Yim, Yuk N.S., Hong Kong.
Yip, Fung K., Hong Kong.
You, Yun B., Bangkok, Thailand.
Yuen, Nuen S., Hong Kong.
Zabihi, Mairianne, London.

THE INTERNATIONAL SILVER AND JEWELLERY FAIR AND SEMINAR

This event is to be held at The Dorchester, Park Lane, London W.1, on 30, 31 January and 1 and 2 February 1987. This International Fair dealing in silver, jewellery, miniatures and objects of vertu will, as usual, have a series of lectures given by many of the world's most eminent academics. It is a unique opportunity to hear learned discussions of all periods and origins, and of course an opportunity to purchase similar pieces from the varied collections displayed by international antique dealers.

This year an exhibition will be on loan at the Fair entitled 'Treasure trove – jewellery presented to the Nation through the National Art-Collections Fund'.

Further information from the organizers, Brian and Anna Haughton, 3B Burlington Gardens, Old Bond Street, London W1X 1LE.

THE INSTITUTE OF PROFESSIONAL GOLDSMITHS

This Institute was formed some three years ago to promote the highest standards of craftsmanship in the working of gold and other precious materials. Further information is available from the Administrative Secretary, Institute of Professional Goldsmiths, 32 Savile Row, London W1X 1AG, telephone 01-734 0171.

INTERNATIONAL COLORED GEMSTONE ASSOCIATION

The second congress of the Association will be held in Bangkok, Thailand, from 18 to 20 May 1987. Further details from ICA, 22643 Strathern Street, Canoga Park, CA 91304, USA.

GEM IDENTIFICATION COURSE

This year Mr Alan Hodgkinson, F.G.A., will be running two-day gem identification basic courses, and three-day refresher courses for those with some knowledge and experience. They will be held under the sponsorship of the *Retail Jeweller* at the British Horological Institute, Upton Hall, Newark, Notts. The dates are 23/24 February and 28/29 September for the two-day, and 25–27 February and 30 September to 2 October for the three-day courses.

Full details from the *Retail Jeweller*, 100 Avenue Road, London NW3 3TP.

DATES FOR 1987

Tuesday, 31 March
Talk by Mr K. Wild, The Flett Theatre, Geological Museum, Exhibition Road, South Kensington, London S.W.7.

Thursday, 10 September
Talk by Professor I. Sunagawa, The Flett Theatre.

Tuesday, 13 October
Talk by Mr C.R. Burch, The Flett Theatre.

Monday, 9 November
Annual Reunion of Members and Presentation of Awards, Goldsmiths' Hall, Foster Lane, London E.C.2.

GEMMOLOGY AND JEWELLERY STUDY TOUR OF LONDON NOVEMBER 1986

A group of fifteen American gemmologists, most of whom are engaged in the jewellery trade, began their highly successful study programme with an illustrated talk on antique jewellery by Jack Ogden, followed by a tour of the British Museum jewellery collections, including the Hull Grundy Gift. They attended a seminar on 'Synthetics and gemstone enhancement' with Ken Scarratt and his colleagues at the Gem Testing Laboratory of Great Britain, and took a special 'behind the scenes' tour of the London Assay Office. Other visits and guided tours included De Beers Diamond Information Department, Monnickendam's diamond cutting workshops at Hove, near Brighton, the Museum of London with a detailed view of the jewellery of the Cheapside Hoard, the Jewellery Gallery at the Victoria and Albert Museum, and the Gemstone Gallery at the Geological Museum. There were also illustrated talks on 'Jade' by Alan Jobbins and 'Glyptic gems' by Christopher Cavey. The final day included a visit to view the Crown Jewels, and the highlight of the evening was the attendance at the Presentation of Awards.

Other social events included a celebration dinner at the Royal Automobile Club, Pall Mall, London S.W.1, and visits of the tour included Windsor and Hampton Court, the Lord Mayor's Show, and attendance at the Service of Remembrance at the Cenotaph, Whitehall.

Members of the Study Tour group at Goldsmiths' Hall.

The party included the following Fellows and wives: Ellamae Anderson, James Coote, Murray Feine, Bob and Nancy Fessel, Dorothy Gibson, Eunice Miles, Jeanne Miller, Chuck Pollack, A. Rider, Jack and Margaret Seibert, Charles and Lillian Sharp, and Dan Simpson.

Letter to the Editor

From Kurt Nassau

Dear Sir,

My attention was drawn to the article 'A treatment procedure for improving colour and quality of zircons' by M.S. Rupasinghe and A. Senaratne (*J. Gemm.*, **20**, 3, July 1986) by an editor who wondered if his readers should be alerted to this work in his magazine. My comment had to be that it is certainly useful to have accessible the heat-treatment behaviour of Sri Lankan zircons of different colours; however–

1. This is hardly a 'new method' since zircons have been successfully heat-treated to colourless and various colours for a century or more; Bauer mentions heated zircon 'Matura diamonds' in his 1904 (1896) treatise and Webster details the heating of Sri Lankan zircons in his. No reference is given in the article to relevant older reports, e.g. those by W.F. Eppler (*Goldschmiede Zeitung*, **51**, 531, 1936), G.O. Wild (*Gemmologist*, 7, 98, 1938), and W.C. Buckingham (*J. Gemm.*, 2, 177, 1950) or to recent reviews such as that by K. Nassau in *Gemstone Enhancement*, Butterworths, 1984, pp. 172–3.

2. Colourless zircon long ago ceased to be an important commercial diamond substitute because synthetics supply a much more convincing simulation.

3. As discussed in the above-cited review and elsewhere, some heat-treated zircons may revert partially or completely to their original colour in the sun or even in the dark, a behaviour apparently not checked or at least not mentioned in this article.

4. Irradiation usually restores the original colour and it is rather doubtful whether this simple oxidation-state explanation referred to can cover the many colours and colour changes in zircon.

5. The authors' comment on the 'unmistakable' relationship between an elevated uranium content and a green colour implies cause and effect; note, however, that the iron content is equally elevated in the green samples, a result on which no comment is made. And so on.

Yours etc.,
Kurt Nassau

4 October 1986
170 Round Top Road, Bernardsville, NJ 07924, USA.

CORRIGENDUM

On page 202 above, in the footnote, for '**Odes**, ode ci, 1.10.' read 'CI, 10.'

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

The Arms and Crest of the Association, conferred by a grant of Arms made by the Kings of Arms under royal authority. The cross is a variation of that in the Arms of the National Association of Goldsmiths of Great Britain and Ireland. In the middle is a gold jewelled book representing 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 a lens. The lozenges represent uncut octahedra and the gem-set ring indicates the use of gems in ornamentation. The lynx of the crest at the top was credited, in ancient times, with being able to see through opaque substances. He represents the lapidary and the student scrutinizing every aspect of gemmology. In the paws is one of the oldest heraldic emblems, an escarbuncle, to represent a very brilliant jewel, usually a ruby. The radiating arms suggest light diffused by the escarbuncle and their tips are shown as jewels representing the colours of the spectrum.

Historical Note

The Gemmological Association of Great Britain was originally founded in 1908 as the Education Committee of the National Association of Goldsmiths and reconstituted in 1931 as the Gemmological Association. Its name was extended to Gemmological Association of Great Britain in 1938, and finally in 1944 it was incorporated in that name under the Companies Acts as a company limited by guarantee (registered in England, no. 433063).

Affiliated Associations are the Gemmological Association of Australia, the Canadian Gemmological Association, the Gem and Mineral Society of Zimbabwe, the Gemmological Association of Hong Kong, the Gemmological Association of South Africa and the Singapore Gemologist Society.

The *Journal of Gemmology* was first published by the Association in 1947. It is a quarterly, published in January, April, July, and October each year, and is issued free to Fellows and Members of the Association. Opinions expressed by authors are not necessarily endorsed by the Association.

Notes for Contributors

The Editors are glad to consider original articles shedding new light on subjects of gemmological interest for publication in the *Journal*. Articles are not normally accepted which have already been published elsewhere in English, and an article is accepted only on the understanding that (1) full information as to any previous publication (whether in English or another language) has been given, (2) it is not under consideration for publication elsewhere and (3) it will not be published elsewhere without the consent of the Editors.

Papers should be submitted in duplicate on A4 paper. They should be typed with double line spacing with ample margins of at least 25mm all round. The title should be as brief as is consistent with clear indication of the content of the paper. It should be followed by the names (with initials) of the authors and by their addresses. A short abstract of 50–100 words should be provided. Papers may be of any length, but long papers of more than 10 000 words (unless capable of division into parts or of exceptional importance) are unlikely to be acceptable, whereas a short paper of 400–500 words may achieve early publication.

Twenty five copies of individual papers are provided on request free of charge; additional copies may be supplied, but they must be ordered at first proof stage or earlier.

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