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# The Journal of Gemmology



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# The Journal of Gemmology

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## Cover Picture

Tanzanian enstatite rough  
(see 'Gemmological investigation of a large faceted  
east African enstatite', p.92).  
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## An important Australian contribution to gemmology

R. Keith Mitchell, FGA

Almost forty years ago the late Lester B. Benson Jr, a brilliant innovator with the Gemological Institute of America, hit on the 'distant vision' or 'spot' method of obtaining approximate refractive index readings from cabochon or other curved polished surfaces. Ever since then successive students have struggled to put this method to use.

With the instrument scale viewed from a distance of about 30cm (1 foot) the exercise involves a good deal of head-movement, both vertically and from side to side, for the tiny image of the spot of contact fluid slides out of sight with remarkable ease and it is often necessary to re-position the stone on the instrument, and to jiggle the head endlessly before the required half shadow, half light, position is obtained. Then, with the elusive disc image hovering precariously in sight and nicely bisected, one realises to one's total disgust, that the instrument scale is completely out of focus!

For the present writer, who has severe astigmatism and wears bifocal glasses, this last problem was easily solved. The bisected spot image was located using the distance vision section of the spectacle lens, and the head then held rigidly steady in that position while the right hand raised the specs to the point where the scale could be seen, *in focus*, through the 'reading' section of the lens. But most people do not have this simple solution to hand.

However, the August 1987 issue of the *Australian Gemmologist* prints an excellent paper by Gordon S. Walker, ASTC, FIO, FGAA, in which he describes a remarkably simple device which very largely overcomes the difficulties which have brought misery and frustration to so many.

Mr Walker is an optician as well as a gemmologist, and is obviously familiar with the pinhole diaphragm as a primitive device to overcome focusing problems including either long or near sight. Some readers may have experimented with a pinhole camera which, *without a lens*, can give a picture in which a scene is always in focus, regardless of the distance of the subject from the pinhole. In this the only limiting factors are the size of the pinhole, which regulates the sharpness of the

picture, since the latter consists of an infinite number of images of the tiny hole, and the long exposure needed if a small enough hole is used. The same principle is used in more elaborate lensed cameras, when stopping down to a very small aperture increases the depth of focus very substantially. But in these the increased focal depth is still limited by the presence of a lens. The pinhole camera suffers no such limitation.

Mr Walker has cleverly used the universal focus principle to improve the Lester Benson distant vision RI method.

Using a pinhole rather less than a millimetre in diameter, held as close as possible to the eye and at a distance of no more than 6cm (2½ inches) from the refractometer eyepiece, he sees both the scale and the contact spot nicely in focus at one and the same time. This closer viewpoint also means that far more of the scale is now visible and the spot no longer plays its devilish hide and seek game with the viewer. An approximate RI can be obtained with no difficulty at all. Mr Walker even suggests that this so simplifies the procedure as to make accurate estimates to a third place of decimals possible.

I have now tried this little device exhaustively and can heartily recommend it. My pinhole was made in a developed, unexposed (black) photographic transparency by the simple expedient of pushing the point of a very fine stringing needle a short way through it. This gave me a reasonably clean hole of about 0.5mm in diameter. (The black surface is advisable to avoid distracting reflections from one of a lighter colour.) I placed a cabochon stone on a suitably small spot of contact fluid on the prism of the refractometer. Removing my spectacles, without which I can focus nothing, I brought the pinhole close to my right eye at a distance of about 7.5cm (three inches) from the instrument eyepiece. Both scale and spot were nicely in focus and a slight movement of my head brought the spot image to the position where it was bisected equally into light and dark areas. A reading of 1.54 for chalcedony was obtained immediately and with the utmost ease.

The previous need to stand up and move around

rather like an animated blancmange, while ogling the instrument from a distance, is obviated. The whole test can be carried out while sitting at the bench or table.

This very simple procedure adds so much to cabochon stone testing by making a difficult and rather elusive method absurdly easy, that one is left wondering why no one has hit upon it before in the many years since Lester Benson published his method in 1948. I do, however, take leave to doubt whether the reading facility is improved to the point where a reliable third place of decimals could be estimated. This has still to depend on the ability of the individual observer to judge when the spot is exactly bisected. That judgement may be easier, but the spot image is still very mobile with the slightest movement of the head and such accuracy would still be difficult.

But the fact remains that Mr Gordon Walker has found a way to make a rather tricky testing procedure almost as simple as the test for a faceted stone. All gemmologists should try it!

It is only fair to mention that distant vision testing is usually less difficult with the Rayner

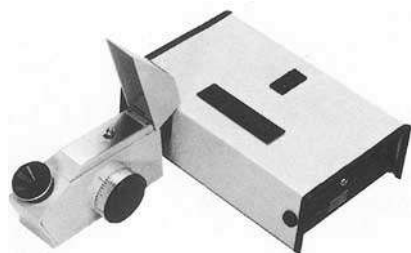
Dialdex refractometer because the black screen which moves down to mark the shadow-edge reading is always easily visible. But there is a tendency among students to assume that they can still estimate readings to three places of decimals when using the calibrated knob of this instrument to read the RI. In point of fact the method is no more accurate with the Dialdex than it is with the standard scale refractometer, and readings should still be regarded as rather approximate. The pinhole device still helps here since it allows the shadow edge to be seen from a closer viewpoint when the head can be held much steadier without undue strain, and a wider field of view allows one to judge much more easily when the spot is accurately bisected.

#### Reference

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[Manuscript received 8 January 1988]

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# Orientated lath-like inclusions of a new type in spinel

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## Abstract

A bluish-violet spinel from Sri Lanka with orientated inclusions was investigated by microscopy, X-ray single crystal diffraction, and electron microprobe techniques. The sample reveals four sets of lath-like double refracting crystal inclusions which are orientated parallel to the three-fold axes of the host. The guest mineral is one of the  $\text{Al}_2\text{SiO}_5$  polymorphs, most probably sillimanite. A general survey of the literature dealing with orientated inclusions and asterism in spinel is given.

## Orientated inclusions in spinel

In the present paper, orientated inclusions of a new type in spinel are described. The sample investigated did not show asterism. This fact is due to the dimensions of the lath-like guest crystals. Nevertheless, a summary of the literature dealing with orientated inclusions and asterism in spinel is presented for comparison as well as in order to avoid confusion with other types of orientated needle- to rod-like guest minerals in spinel.

The presence of orientated inclusions in natural spinel was of certain interest to gemmologists because asterism in spinel results from diffraction of light from these minerals. Asteriated spinels from Sri Lanka and Burma were described by different authors, e.g. Anderson and Payne (1954), Switzer (1955), Gübelin (1957) and Eppler (1958). In general, alternating six- and four-rayed stars are observed along the curved surface of the spinels which are cut in the cabochon form. The axes passing through the centre of each six-rayed star are parallel to the four three-fold axes of the cubic spinel; the axes passing through the centre of each four-rayed star are parallel to the three four-fold axes of the crystal. This common type of asterism in spinel is caused by triangular sets of needle-like inclusions (Figures 1, 2), which are orientated parallel to the six edges of the octahedron faces  $\langle 110 \rangle$ . According to the symmetry of the cubic system in each plane parallel to the eight octahedron faces of the spinel with inclusions parallel to  $\langle 110 \rangle$ , three intersecting sets of needles at  $120^\circ$  intervals are observed (Figures 1, 2). Each triangular

set of inclusions will produce a six-rayed star if the crystal is cut cabochon and viewed in directions parallel to the four three-fold axes, i.e. at right angles to the octahedral faces. The light bands of two different six-rayed stars intersect at  $90^\circ$  at each of the poles of the three four-fold axes of the spinel forming four-rayed stars if the crystal is viewed at right angles to the cube faces (cf. Switzer, 1955).

Extremely rare are spinels which disclose only one single six-rayed star on the surface of the cabochon. In these spinels, only one triangular set of intersecting needle-like inclusions is present lying in one single plane parallel to one octahedral face of the spinel (Gübelin, 1968; Gübelin and Koivula, 1986).

The nature of the orientated needle-like inclusions is described by different authors with some controversy. This is due to the fact that both types of asterism in spinel mentioned above were not clearly separated in each publication. The needle-like inclusions which are present in the common type of asteriated spinels showing alternating six- and four-rayed stars, are most probably small rutile crystals. This opinion was already published by Eppler (1958) and Strunz (1968) and was also confirmed by Gübelin and Koivula (1986). However, the only known experimental proof for the presence of rutile in asteriated spinel was made by the present author by X-ray powder diffraction (cf. Bank, 1980, 1983).

The cause of a single six-rayed star in the second rare type of asteriated spinel (cf. Gübelin 1957, 1968; Eppler, 1958) is due to the presence of orientated needle-like inclusions of sphene (Gübelin and Koivula, 1986). In that case, only one single plane with three sets of parallel inclusions is observable.

## Experimental procedures and results

In the present paper, a faceted bluish-violet spinel from Ratnapura, Sri Lanka, was studied. This sample was submitted to the author by a gem collector in order to determine the nature of some



Fig. 1. Asteriated red spinel from Sri Lanka; view in a direction parallel to one of the three-fold axes  $\langle 111 \rangle$ ; the axes of three sets of needle-like inclusions, most probably rutile, are orientated parallel to one octahedron face  $\langle 111 \rangle$  at  $120^\circ$  intervals. 75x.



Fig. 2. Asteriated red spinel from Sri Lanka; various sets of parallel orientated needle-like inclusions, most probably rutile. 75x.

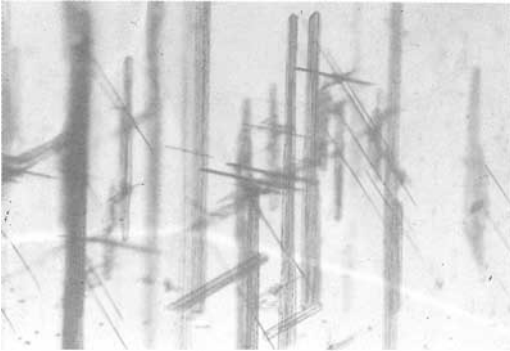


Fig. 3. Bluish-violet spinel from Sri Lanka containing four sets of parallel orientated lath-like inclusions, most probably sillimanite. 50x.



Fig. 4. Bluish-violet spinel from Sri Lanka containing four sets of parallel orientated lath-like inclusions, most probably sillimanite. 70x.



Fig. 5. Bluish-violet spinel from Sri Lanka; view in a direction parallel to one of the three-fold axes  $\langle 111 \rangle$ ; cross-sections of one set of lath-like crystals the axes of which are orientated parallel to the direction of view; three sets of parallel inclusions are observable parallel to the remaining three-fold axes  $\langle 111 \rangle$ . 75x.

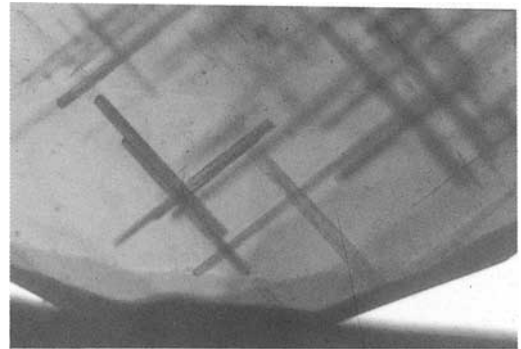


Fig. 6. Bluish-violet spinel from Sri Lanka; view in a direction parallel to one of the four-fold axes  $\langle 100 \rangle$ ; four different sets of parallel lath-like inclusions are orientated parallel to the four three-fold axes  $\langle 111 \rangle$ ; the crystals are orientated against each other according to the body diagonals of a cube. 35x.



needle-like inclusions. The stone was bought during a trip to Sri Lanka in 1980.

The microscopic investigation of the sample revealed four sets of parallel lath-like inclusions to be present (Figures 3, 4). The orientation of the axes of the double refracting crystals was determined to be parallel to the four body diagonals of a cube (Figures 5, 6). According to the symmetry of the host, the orientation of the axes of the lath-like guest minerals was assumed to be parallel to the four three-fold axes of the cubic spinel. This was confirmed by a combination of microscopy and X-ray single crystal diffraction.

Firstly, the host spinel was affixed with rubber to a goniometer head. Then, the direction of one set of lath-like guest crystals was orientated microscopically almost parallel to the primary X-ray beam of a precession camera. The deviation between the crystal axes and the X-ray beam was assumed to be less than  $5^\circ$ . After three orientation photographs

and some small corrections with the two arcs of the goniometer head, one plane of the reciprocal lattice of the host crystal was adjusted perpendicular to the primary X-ray beam. A direct X-ray photograph of this reciprocal lattice plane revealed the orientation of the plane to be parallel to one of the octahedron faces  $\{111\}$  of the host crystal. This investigation disclosed that one set of inclusions was parallel to one of the three-fold axes  $\langle 111 \rangle$  of the spinel. Thus, the axes of all four different sets of lath-like inclusions, which are related to each other as the body diagonals of a cube, are confirmed to be orientated parallel to the four three-fold axes  $\langle 111 \rangle$  of the cubic spinel (cf. Figures 5, 6).

Parallel to each of the four three-fold axes of a spinel, three symmetry equivalent orientations of the cross-sections of lath-like crystals are possible. However, parallel to each of the three-fold axes of the spinel investigated, only one single direction of the cross-sections of the guest crystals was observed

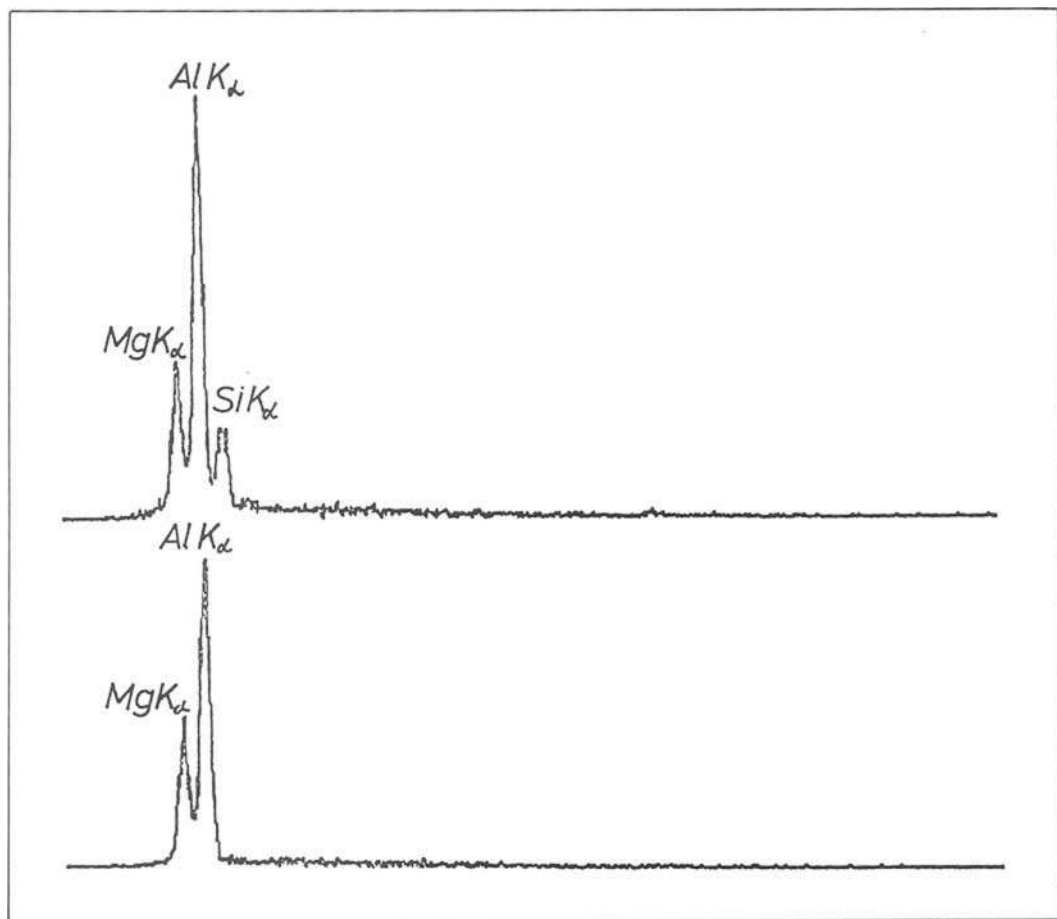


Fig. 7. Energy dispersive X-ray spectrum of bluish-violet spinel from Sri Lanka (below) and superimposed X-ray spectrum of the host spinel and the guest phase, most probably sillimanite (above).

(Figures 3-5). At present, the reasons for this restriction is not understood by the author.

A chemical investigation of the inclusions was undertaken by electron microprobe techniques. Due to the fact that the widths of the cross-sections of the lath-like inclusions (Figure 5) which were exposed to the surface on different facets were smaller than the diameter of the electron beam, quantitative analyses of the inclusions were not performable. However, semiquantitative investigations using the energy dispersive analysis system of the microprobe disclosed the composition of the lath-like mineral. In Figure 7 the energy dispersive X-ray spectrum of the host spinel is compared with the superimposed X-ray spectra of the host spinel and the guest mineral. In both diagrams, the intensities of the Mg signals were made comparable using appropriate counting times. The superimposed X-ray spectrum of both host and guest mineral, shows an additional line of Si as well as an increased intensity of the Al signal, compared with the intensity of Al in the pure host spectrum. Thus, the presence of Al and Si as main components in the guest mineral are disclosed. This interpretation is based on the assumption that Mg is not present in the guest compound, which was proved by the X-ray scanning technique (X-ray images for  $MgK_{\alpha}$ ,  $AlK_{\alpha}$  and  $SiK_{\alpha}$ ) for several cross-sections of the guest phase exposed to the surface of one facet.

From these chemical data, the orientated inclusions in spinel are determined as one of the  $Al_2SiO_5$  polymorphs andalusite, sillimanite, and kyanite. According to the morphology of the lath-like guest minerals in spinel, only sillimanite and andalusite form needle- to lath-like crystals, while kyanite in general is found in tabular plates. Two arguments favour the determination of the inclusions as sillimanite: orientated needle-like inclusions of sillimanite were recently determined in asteriated quartz from Sri Lanka as well as in chrysoberyl cat's-eyes from India (Woensdregt *et al.*, 1980; Soman and Nair, 1985). According to recent petrological studies of PT conditions of spinel-bearing mother rocks from Ratnapura area, Sri Lanka, sillimanite is the only common  $Al_2SiO_5$  polymorph in these Precambrian metamorphic rocks (Dahanayake *et al.*, 1980; Munasinghe and Dissanayake, 1981; Dahanayake and Ranasinghe, 1981).

## Conclusions

In summary, the bluish-violet host spinel from Ratnapura, Sri Lanka, contains four sets of lath-like inclusions. The axes of these doubly refracting minerals are orientated parallel to the four three-fold axes  $\langle 111 \rangle$  of the cubic spinel. The main components of the crystals are Al and Si. Morphological and petrological arguments support the determination of the inclusions as the  $Al_2SiO_5$  polymorph sillimanite. This new type of inclusion is different from orientated rutile and sphene crystals in asteriated spinels from Sri Lanka.

## Acknowledgements

The author is grateful to Mr H.J. Müllenmeister of Markt Schwaben, West Germany, who submitted the bluish-violet spinel for investigation. Asteriated spinels from Sri Lanka were kindly supplied by Prof. Dr H. Bank of Idar-Oberstein, West Germany. Financial support was given by grants of the Wirtschaftsministerium des Landes Rheinland-Pfalz, West Germany.

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[Manuscript received 25 September 1986 ]

## Synthetic opal

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Early in the 1980s there arrived in London a range of attractive opals with a very natural looking prismatic play of colour within the stones. The yellows, greens, oranges and reds were seen against a general pale bluish semi-transparency, and when illuminated from behind by a fibre optic light the stones showed a pale orangy colour. This whole appearance is compatible with certain natural opals and there was no 'chicken wire' as with the Gilson synthetic opal. The material gained some ground until identified later as synthetic.

The material is apparently synthesized in Japan, and it is helpful to note that when examined by immersion microscope between partly or totally crossed polars, a distinctive stratification is seen as in Figure 1. The effect is very similar to that noted as 'venetian blinds' in synthetic hydrothermal emeralds, and a similar occurrence in Colombian hydrothermal emeralds. The large dark area in the microphotograph is the drill hole of a part-drilled 4 mm bead - the materials ranging from 3 mm beads to 16 x 14 mm oval cabochons.

A support test for the opal material is that ultraviolet long-wave radiation produces little

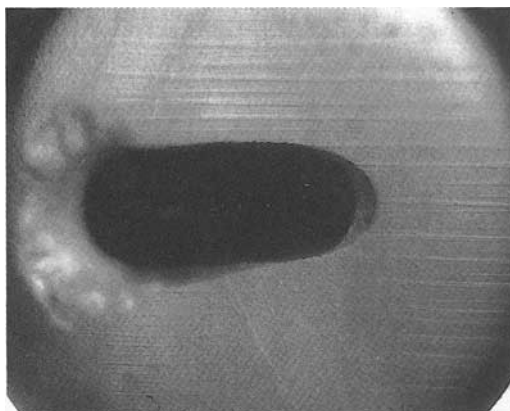


Fig. 1. Synthetic opal examined by immersion microscope. Crossed polarizers. 25x.

fluorescent and no phosphorescent response with the synthetic opal described, whereas similar natural opal invariably fluoresces and phosphoresces strongly.

[*Manuscript received 26 October 1987* ]

# Observations on turquoise, lapis-lazuli and coral, and some of their simulants

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## Abstract

Various aspects of the chemical, physical and gemmological properties of natural, Gilson simulants and imitations of turquoise, lapis-lazuli and coral have been described by Crowningshield (1974), Williams and Nassau (1976), Schiffmann (1976), Nassau (1977, 1979) and Schmetzer (1985). In this paper the results of X-ray diffraction (XRD) and X-ray fluorescence (XRF) analysis on Gilson simulants and other imitations (which were rectangular blocks imported from West Germany) are compared with those from natural materials. In addition the broken surfaces of these materials are viewed by scanning electron microscope (SEM) and the patterns obtained compared with those resulting from the natural materials. The effects of acid treatment on the surfaces are also photographed.

## Results

The X-ray powder diffraction patterns of the Gilson simulants of turquoise, lapis-lazuli and coral matched those of the natural materials. However, in the case of the Gilson lapis-lazuli significant amounts of zinc were detected by X-ray fluorescence analysis (compare Schmetzer, 1985). The imitation turquoise, lapis lazuli and coral consisted essentially of calcite and polystyrene. Their specific gravities (hydrostatic method) were in the 1.65–1.70 range. XRF analysis showed the presence of copper, cobalt and antimony in the turquoise, lapis-lazuli and coral imitations respectively. These elements may act as colouring agents in the respective imitation gems.

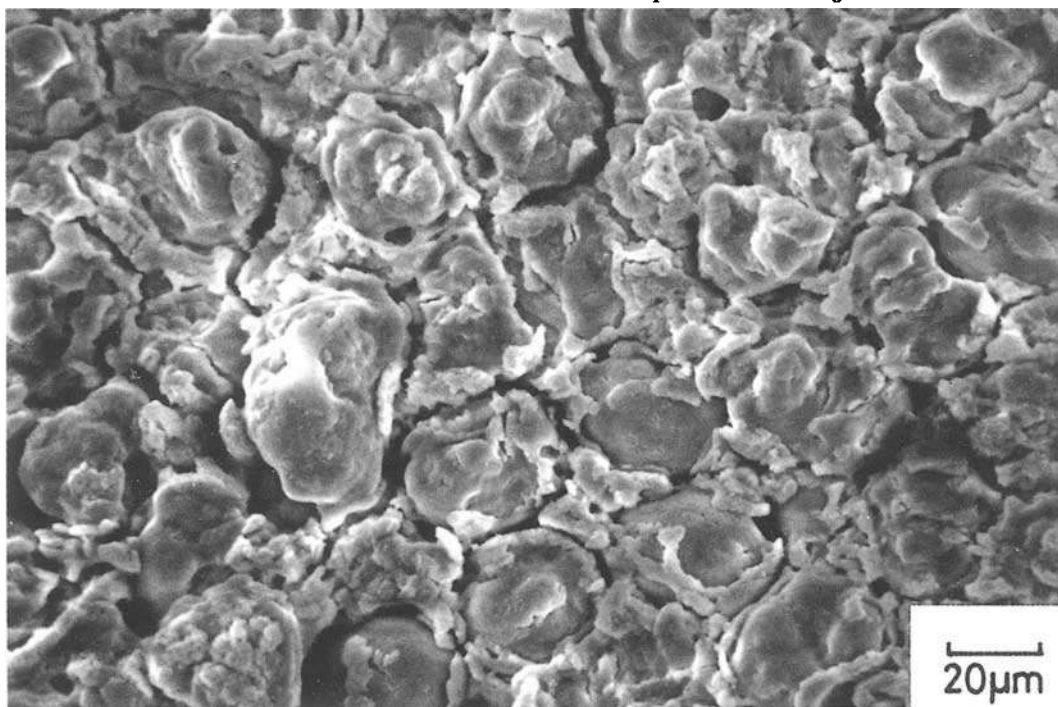


Fig. 1. Gilson turquoise after HF acid treatment; the obvious grains of about 20  $\mu\text{m}$  in size and the matrix, which may be different from the composition of the grains, appear.

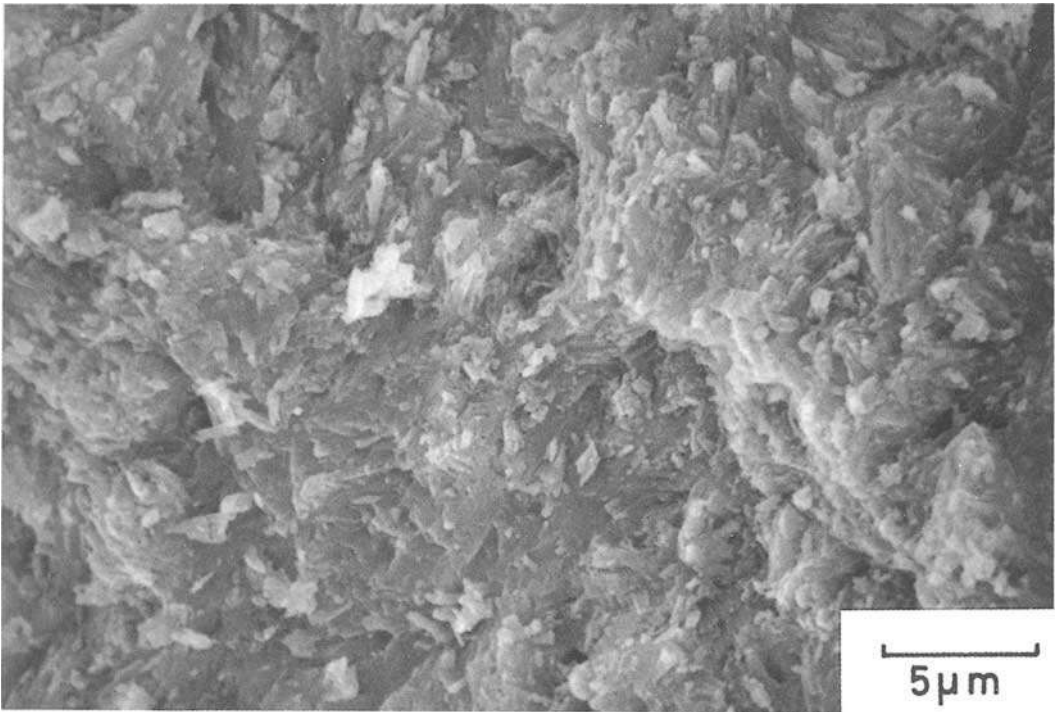


Fig. 2. Natural turquoise before acid treatment; the pillar-shaped crystal of about  $0.4 \times 2 \mu\text{m}$  in size.

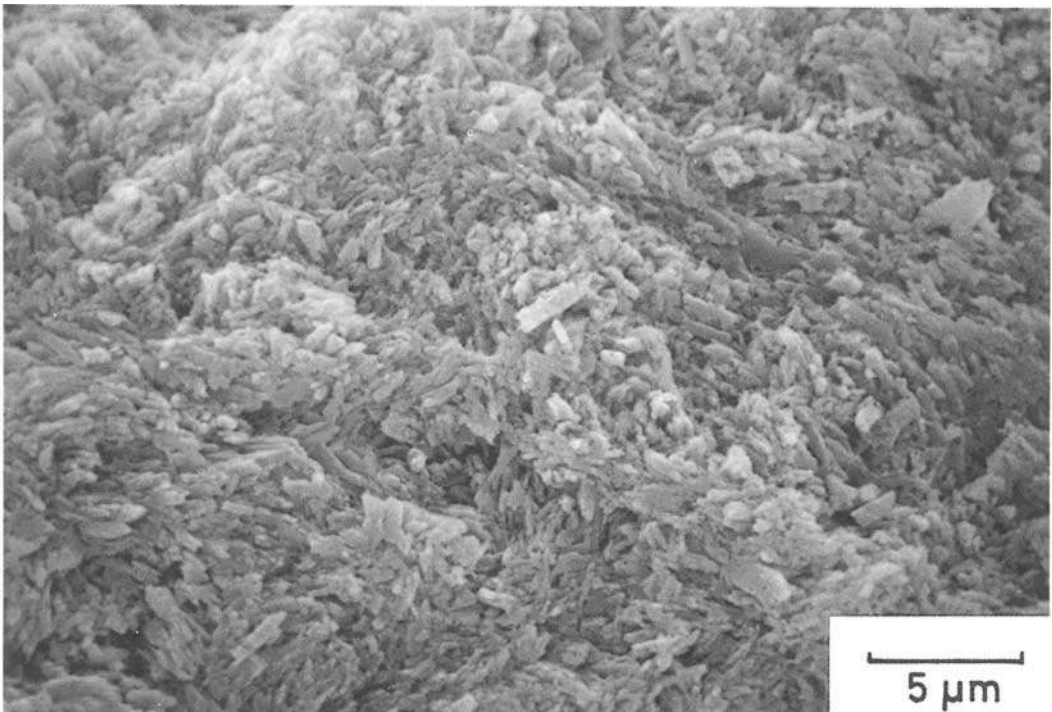


Fig. 3. Natural turquoise after HF treatment; the visible pillar-shaped crystals which are randomly distributed.

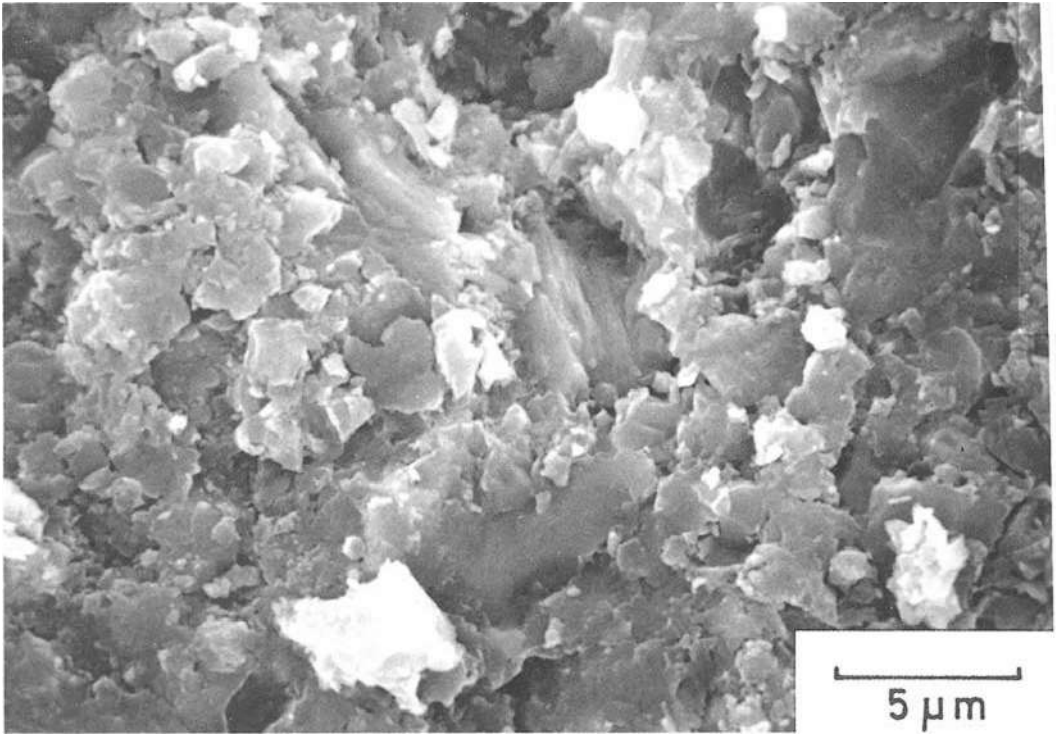


Fig. 4. Gilson lapis lazuli before acid treatment; the particles of various sizes.

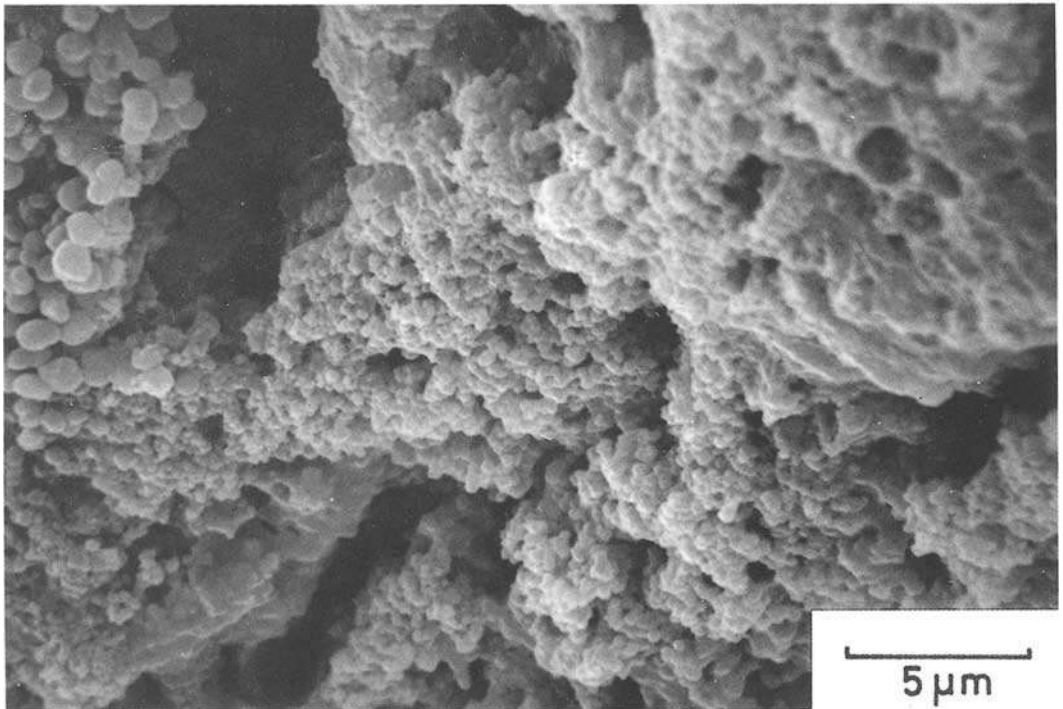


Fig. 5. Gilson lapis lazuli after HF acid treatment; the porous texture formed by partial dissolution.



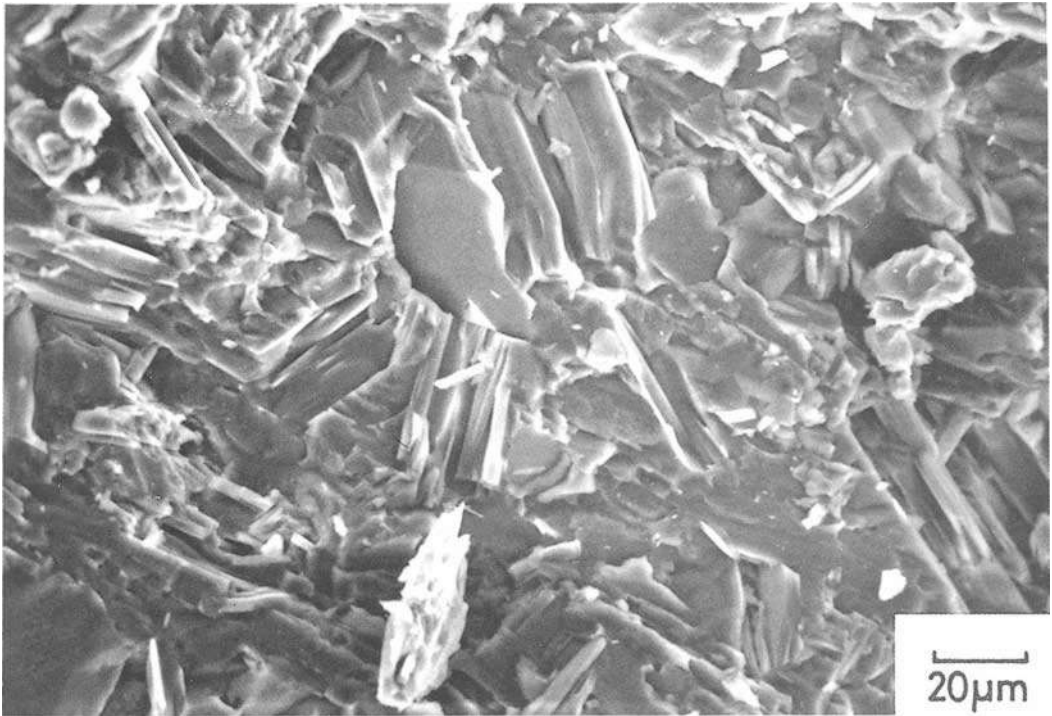


Fig. 6. Natural lapis lazuli before acid treatment; the plate-like crystals of about 10–30  $\mu\text{m}$  in length.

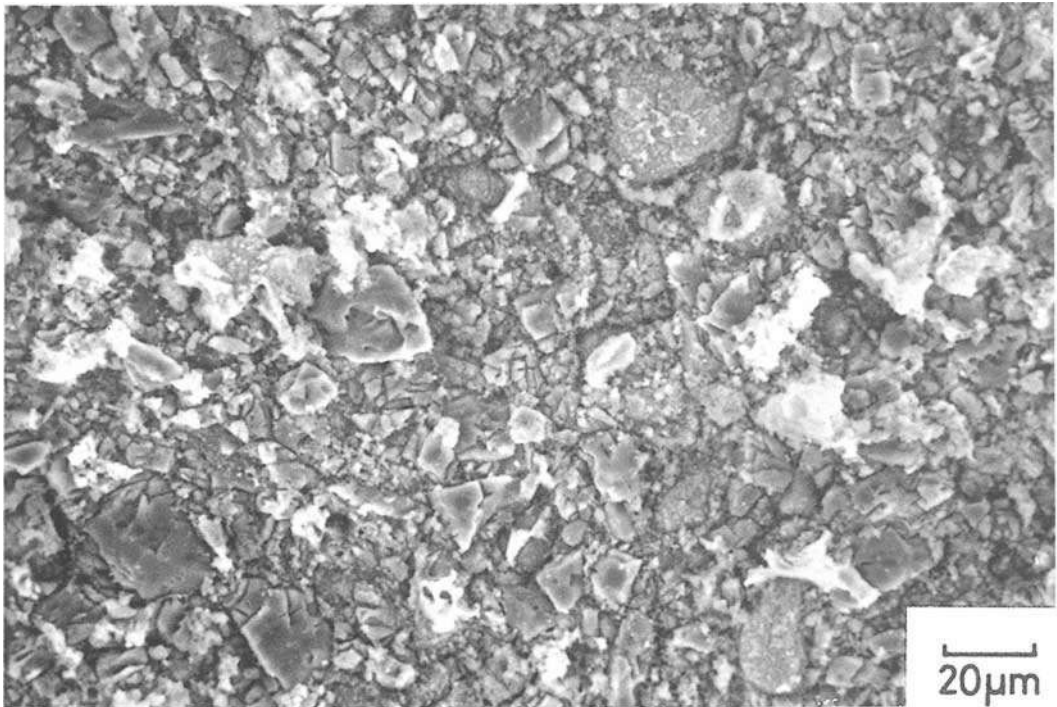


Fig. 7. Gilson coral before acid treatment; the angular particles of about 2–20  $\mu\text{m}$  in size and the rounded particles rather larger than the angular particles.

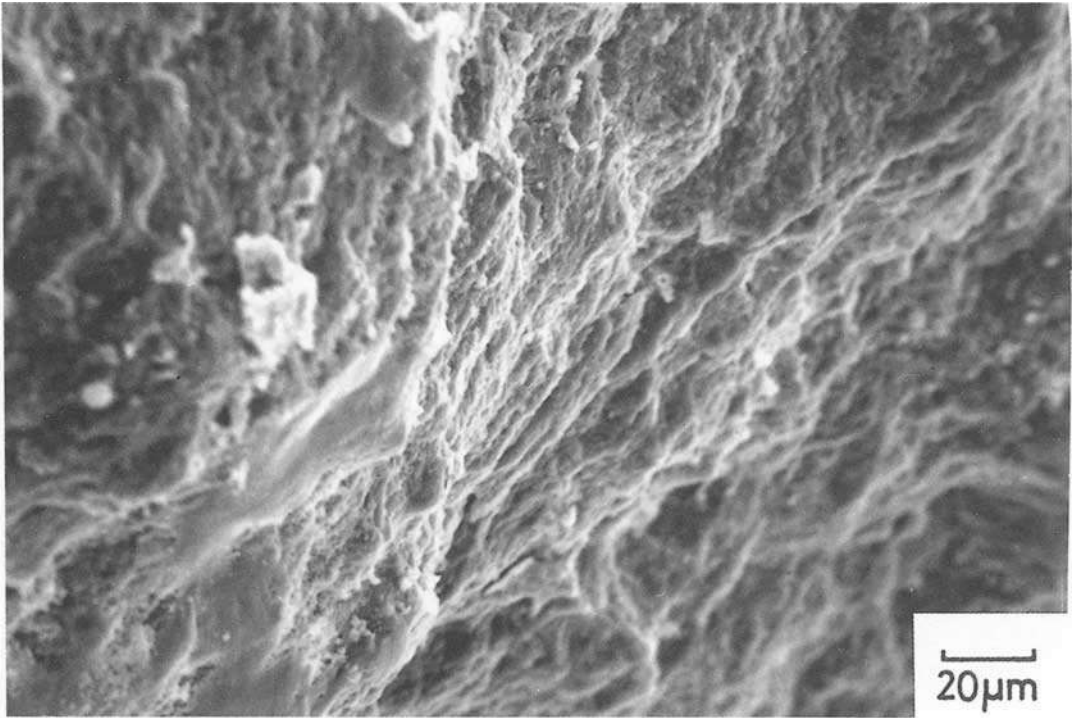


Fig. 8. Natural coral before acid treatment; the wave-like pattern showing the marks of growth.

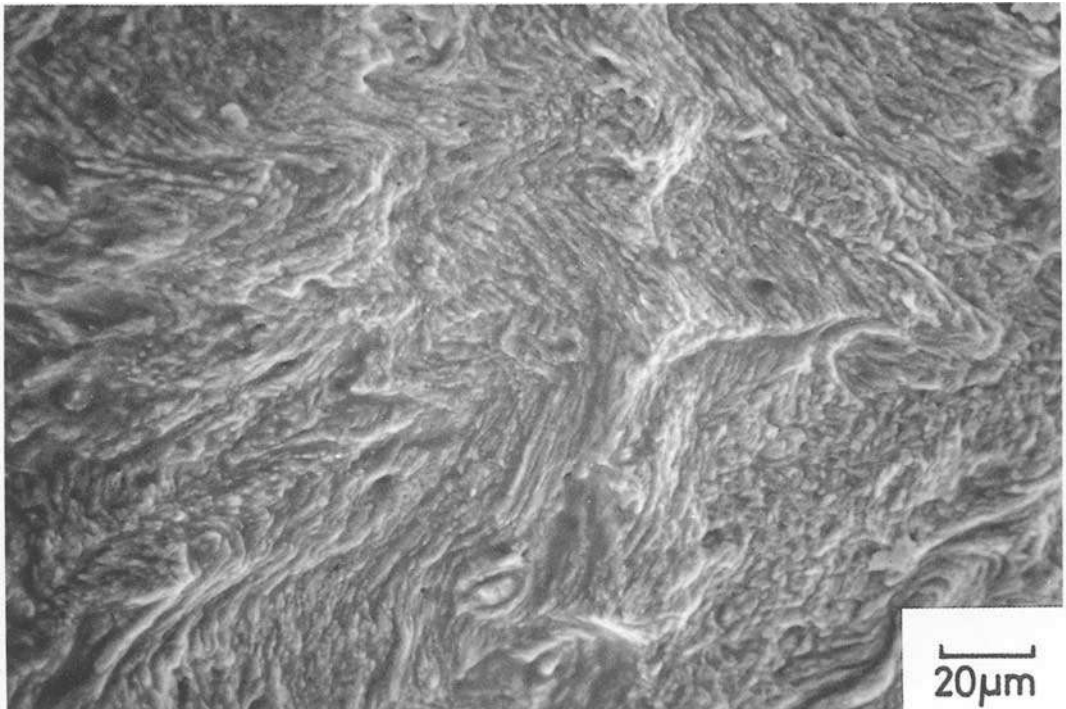


Fig. 9. Natural coral after HCl treatment; the further visible wave-like pattern.

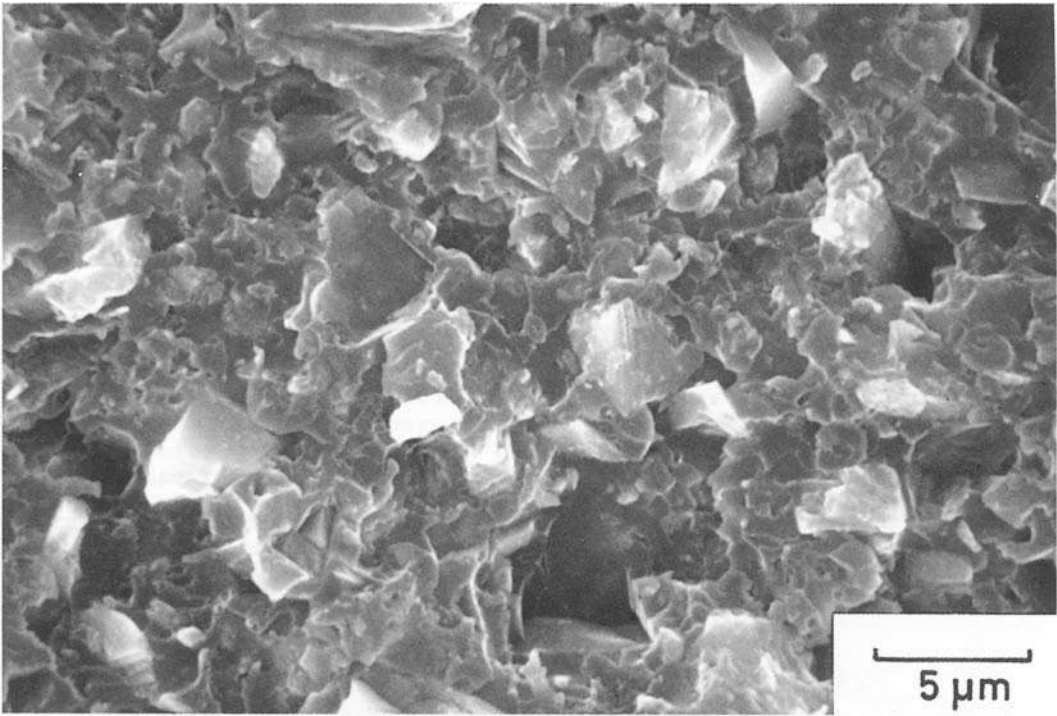


Fig. 10. Imitation turquoise, lapis lazuli, and coral before acid treatment; the complex broken-surface with plastic and calcite particles.

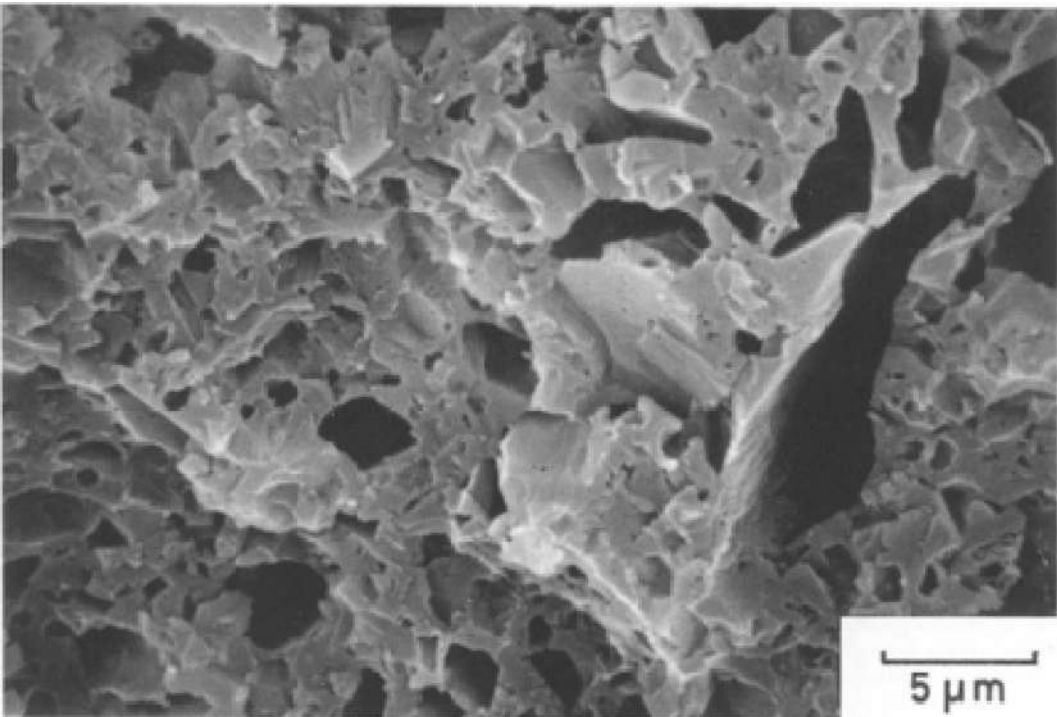


Fig. 11. Imitation turquoise, lapis lazuli, and coral after HCl acid treatment; many holes are formed by the dissolution of  $\text{CaCO}_3$  as one component.

Under the SEM Gilson turquoise shows a similar pattern (slightly deformed spheres) to that described by Eppler (1974). However, the greater magnification (X500) gives a better three dimensional picture than the thin-section (X246) of Eppler taken with a conventional microscope.

[Manuscript received 22 January 1987, revised 25 June 1987]

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## A fishy 'gem'?

R. Keith Mitchell, FGA

In 1985 I wrote a short paper about a small man-made oval plaque, or plate, with thin pearl-like sections of what were eventually identified as ooliths, pisoliths or 'cave pearls'. This was published in *Journal of Gemmology*<sup>1</sup>.



Fig. 1. A section through a large 'cave pearl'.

A letter in a subsequent issue<sup>2</sup> mentioned that Dr Jaques Deferne, of the Museum at Grotte de Bramabian, Garde, France, had cut a fine section from a much larger cave pearl, which Mr Andre Hettena, of Geneva, sent on to me. This 'pearl' section, which I now illustrate in Figure 1, was 39mm in diameter, and fluoresced very white in its lighter areas and a sandy yellow in the outer darker rings under long UV light.

A year later I received a letter from Dr H. Schreuders, of Cape Town, enclosing another strange ornamental 'stone' which he thought looked like my original illustration.

I have to agree that there is a strong resemblance, but this new specimen, Figure 2, is a homogeneous organic solid and is natural, whereas my plaque is a composite object assembled by man from a number

of separate thin inorganic sections cemented with a resin to a slate backing.

Dr Schreuders has given me details of the new specimen and tells me that it is actually a polished fragment of the bony palate of a large fish known



Fig. 2. A polished fragment of 'musselcracker' palate.

colloquially as a 'musselcracker'. This is the common name for two species, *Sparadon durbanensis* and *Cymatoceps nasutus*, both members of the family Sparidae. They feed mostly on hard black mussels or on crustacea, sea urchins and other hard-shelled sea animals. They need powerful jaws and a strong bone structure to crush such prey and the palate apparently develops protuberant knobs which, when polished flat, give rise to the well-marked, tessellated pattern of my illustration, a pattern which carries through to the underside of the specimen. There is a suggestion of a silky radial growth pattern on some of the surfaces sectioned by polishing, but there is no sign of the concentric 'onion ring' structure seen in pearls and in 'cave pearls'.

I think that this is one of those materials which are simple enough to recognize by sight once one is aware of their existence. Tests for bone or tooth substances, including slight reaction to acid may help, but the material really does not resemble mammalian bone. The polish and slight translucency is more like that of fine porcelain, quite different from the dull surface and opacity of the plaque in my original paper.

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[Manuscript received 22 January 1988]

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# More on Nelson's 'FMIR Body Colour'

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With the Editor's permission, let me add to the exchange between Dr James B. Nelson<sup>1,2</sup> and me<sup>3</sup>. I promise to be brief and, so as to sharpen the focus, will cover only essentials (which, in my opinion, were not answered by Nelson<sup>2</sup>).

Yes - colour measurements have triumphed in the many fields Nelson listed<sup>1</sup>, but all have this in common: their measurements correspond very closely to the colour that is visually perceived.

Nelson clearly states<sup>2</sup> that the FMIR body colour\* of a gemstone is not the same as the colour perceived by the eye, although I do feel that his

original article<sup>1</sup> continuously gives the impression that the two are at least very closely related.

Consider one simple example. A diamond coloured by green 'naturals', or a colourless diamond turned green by cyclotron irradiation at the girdle, both appear green to the eye because internal reflections spread the colour throughout the stone. The FMIR body colour would, however, not show any traces of green according to Nelson's own descriptions<sup>1,2</sup>.

I conclude, as previously<sup>3</sup>, that Nelson's model<sup>†</sup> just is not appropriate to the real world of gemstones.

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**Footnote:** \*For the sake of clarity, one should always distinguish between 'FMIR body colour' and 'body colour', since gemmologists often use 'body colour' to designate the visually-perceived colour near the centre of a stone - as for one example, in the GIA courses. It is, I think, imperative to adhere fully to the terminology of the gemstone discipline.

†I realize that Nelson states<sup>2</sup> "I have no need for any kind of 'model'". I am, of course, using this word as science epistemologists do (see any of Karl Popper's writings, for example), who recognized that every measurement, no matter how simple, is not an absolute, but merely 'models' some aspect of reality.

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[Manuscript received 8 January 1988]



## Notes on the inclusions in a greyish kyanite

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### Abstract

A greyish kyanite and its numerous inclusions were studied. Optical observations were made and X-ray diffraction and electron microprobe analyses were performed. The recognized inclusions are: andalusite, apatite, calcite and zircon. The tubular inclusions or channels are sometimes made evident by fillings consisting of andalusite and kyanite as well as iron oxides and hydroxides.

Approximate P-T conditions for the formation of this kyanite sample are estimated.

### Key words

Kyanite, mineral inclusions, andalusite, apatite, calcite, hematite, lepidocrocite, maghemite, zircon, channels, electron microprobe data, X-ray diffraction.

### Introduction

A greyish-blue, gem quality kyanite sample ( $12 \times 9 \times 3$  mm) was examined (Figure 1). The colour of the sample is not homogeneous, as a greyish hue is distributed unevenly in the crystal (White and White, 1967; Faye and Nickel, 1969), resulting in numerous intensively coloured areas which are large and undefined.

Furthermore, numerous mineral inclusions were noted inside the crystal. These are euhedral, often aggregated, forming bunches of prismatic, sometimes elongated, transparent crystals (Figure 2).

Besides sporadic transparent fibrous inclusions, rare minute opaque minerals were observed also.

The former are colourless, birefringent slim rods, developed parallel both to the groups of needle-like grooves or channels, and to the *c* axis of the host crystal (Figure 3). Such features produce a moderate cat's-eye effect. The unusual characteristics of this sample warranted various investigations and a thorough description of these features.

### Analytical results

#### Kyanite:

Chemical composition and physical data are reported in Table 1.



Fig. 1. Numerous transparent crystal inclusions and bunches of narrow channels, cause an evanescent cat's-eye effect. 10x.

Optical properties were determined by means of a universal stage. Pleochroism is barely noticeable, with  $\alpha$ : colourless,  $\beta$ : violet-grey and  $\gamma$ : cobalt blue-grey. The refractive indices were determined by means of the immersion method, yielding:  $n_{\alpha} = 1.712 \pm 0.004$ ;  $n_{\beta} = 1.720 \pm 0.003$ ;  $n_{\gamma} = 1.728 \pm 0.003$ ;  $n_{\Delta} = 0.015$ ;  $2V_{\alpha} = 83^{\circ}$ .

The density was measured by a Mettler  $H_2O$  scale with distilled water as displacement liquid, and it was found to be equal to  $3.670 \pm 0.004$  g/cm<sup>3</sup>.

It was possible to calculate the unit cell parameters by means of X-ray powder diffractometry, using Ni filtered,  $Cu_{K\alpha}$  radiation with five oscillatory scans at  $1/4^{\circ} 2\theta$  per minute from  $10^{\circ}$  to  $80^{\circ} 2\theta$ . Pure semiconductor grade crystalline silicon metal (Jarrel Ash JM, spectroscopy impurity less than 300 ppm) was used as an internal standard.

The lattice constants were estimated using a least-squares refinement (De Angelis *et al.*, 1977) of the X-ray data, indexed by comparison with the data listed by the JCPDS, card No. 11-46.

It was also possible, based on the lattice constants, to calculate the density of this kyanite as if it were totally free of inclusions. The value obtained was considerably higher than the measured one.



Fig. 2. Various large andradite and anhedral transparent calcite crystals. 20x.

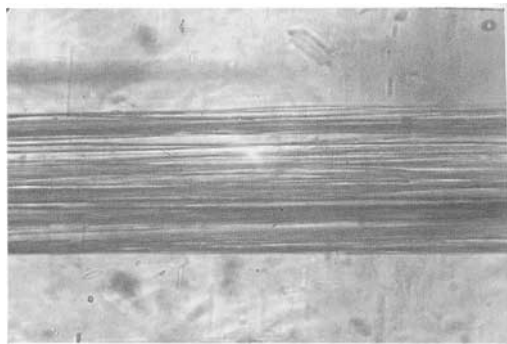


Fig. 3. Groups of channels, rigorously orientated parallel to the *c* axis of the host kyanite, are mainly responsible for the chatoyancy effect. 200x.

In order to investigate the chemical composition of this sample, some inclusion-free areas were analysed by means of a Jeol-50A electron microprobe, using natural and synthetic standards. Matrix corrections were performed using the EMPADR VII program (Rucklidge and Gasperrini, 1969).

A noticeable amount of inclusions made it possible to determine the ignition loss. The iron and titanium contents corresponded with the expected values, while the MnO content is a little higher and the alkali content is quite low (Pearson and Shaw, 1960; Albee and Chodos, 1969).

Table 1. Microprobe analysis, optical properties and X-ray data of greyish kyanite.

		Number of ions on the basis of 20 (0)			
SiO <sub>2</sub>	37.58 wt. %	Si	4.049	} 4.05	
Al <sub>2</sub> O <sub>3</sub>	62.19	Al	7.898		
TiO <sub>2</sub>	0.07	Ti	0.006		
FeO*	0.21	Fe	0.019		
MnO	0.20	Mn	0.018		
MgO	—	Mg	—		
Cr <sub>2</sub> O <sub>3</sub>	—	Cr	—		
BaO	tr.	Ba	—		} 7.95
SrO	—	Sr	—		
CaO	—	Ca	—		
K <sub>2</sub> O	0.05	K	0.007		
Na <sub>2</sub> O	—	Na	—		
H <sub>2</sub> O <sup>+</sup> } **	—	H	—		
H <sub>2</sub> O <sup>-</sup> }	—				
TOTAL	100.30				
<i>n</i> <sub>α</sub>	= 1.712 ± 0.004	<i>a</i>	= 7.059 ± 0.002 Å		
<i>n</i> <sub>β</sub>	= 1.720 ± 0.003	<i>b</i>	= 7.907 ± 0.007 Å		
<i>n</i> <sub>γ</sub>	= 1.728 ± 0.003	<i>c</i>	= 5.571 ± 0.003 Å		
birefringence:	± ± 0.016	α	= 89.1° ± 0.3°		
2 <i>V</i> <sub>α</sub>	= 83°	β	= 101.6° ± 0.3°		
ρ (g/cm <sup>3</sup> )	= 3.670 ± 0.004	γ	= 105.6° ± 0.6°		
ρ <sub>cal</sub> <sup>obs</sup>	= 3.783 ± 0.004				

\* All iron as FeO.

\*\* Not determined.

Table 2. Microprobe analyses of the inclusions of greyish kyanite.

Andalusite		Apatite		Calcite		Zircon	
SiO <sub>2</sub>	37.64	SiO <sub>2</sub>	—	CaO	55.34	SiO <sub>2</sub>	33.34
Al <sub>2</sub> O <sub>3</sub>	61.52	Al <sub>2</sub> O <sub>3</sub>	0.05	MgO	0.17	ZrO <sub>2</sub>	63.18
TiO <sub>2</sub>	0.05	FeO*	0.16	FeO*	0.03	TiO <sub>2</sub>	0.08
FeO*	0.28	MnO	0.01	MnO	0.08	Al <sub>2</sub> O <sub>3</sub>	1.07
MnO	0.04	MgO	0.26	CO <sub>2</sub> †	43.91	FeO*	0.60
MgO	—	CaO	53.25			R.E.	tr.
Cr <sub>2</sub> O <sub>3</sub>	—	BaO	—			MnO	tr.
CaO	—	SrO	—			MgO	0.22
BaO	tr.	Na <sub>2</sub> O	0.24			CaO	0.65
SrO	—	P <sub>2</sub> O <sub>5</sub>	41.36			P <sub>2</sub> O <sub>5</sub>	—
Na <sub>2</sub> O	—	CO <sub>2</sub>	—			H <sub>2</sub> O <sup>+</sup> } **	—
K <sub>2</sub> O	—	F	—			H <sub>2</sub> O <sup>-</sup> }	—
H <sub>2</sub> O <sup>+</sup> } **	—	Cl	0.19				
H <sub>2</sub> O <sup>-</sup> }	—	H <sub>2</sub> O <sup>+</sup> } **	—				
		H <sub>2</sub> O <sup>-</sup> }	—				
TOTAL	99.53 wt. %		95.52		99.53		99.14

\* All iron as FeO

\*\* Not determined

† Calculated

### Inclusions

The numerous inclusions were analysed by the electron microprobe (Table 2).

Conspicuous euhedral, prismatic crystals (up to 0.70 × 0.40 mm), characterized by high relief and low birefringence, were observed (Figure 2).

These inclusions are roughly aligned with the *c* axis of the host kyanite. The microanalyses show the presence of Si and Al in the same ratio as is found in kyanite, and of other minor elements. Therefore these crystals were identified as polymorphs of Al<sub>2</sub>SiO<sub>5</sub>, probably andalusite, based on their morphology (Figure 4). Moreover, a Rigaku X-ray microdiffractometer MDG2193V was used. The microdiffractograms revealed the reflections of andalusite and concurred well with the crystallographic data reported by JCPDS, card No. 13-122. Thus the guest mineral was confirmed as *andalusite*, the low-temperature, low pressure polymorph of Al<sub>2</sub>SiO<sub>5</sub> (Brown and Fyfe, 1971).

Other transparent and colourless inclusions were then examined. Some anhedral greyish crystals (up to 0.20 × 0.15 mm) show a composition very close to pure CaCO<sub>3</sub>, with small amounts of MgO, FeO and MnO. The CO<sub>2</sub> content was calculated by difference, bearing in mind the crystallochemical formula.

Long, prismatic crystals (up to 0.03 × 0.05 mm) are also present, with refractive indices lower than those of kyanite. The microprobe analyses indicated that they are *apatite*. The absence of fluorine and the presence of small amounts of chlorine suggest that they may be carbonate or hydroxy-apatite (Figure 5).

Sporadic thin non-pleochroic long prismatic crystals (up to 0.017 × 0.003 mm) were also noted, with very high relief, and refractive indices higher than the host kyanite. Electron microprobe scans revealed that the crystals are euhedral and prismatic. Their composition was found to be essentially ZrO<sub>2</sub> and SiO<sub>2</sub> with small amounts of Al<sub>2</sub>O<sub>3</sub>, CaO and FeO. This indicates therefore that they are *zircon*, characterized by the lack of Rare Earths and phosphorus (Figure 6).

Iso-orientated to the elongated crystals just described, are thin needle-like euhedral channels (up to 3 × 0.005 mm). These *channels* are parallel to the *c* axis of the host kyanite and their presence is made evident by fillings consisting of minute andalusite crystals (Figure 7), and yellow or brownish-red minute crystalline material (Figure 8). Moreover various little transparent crystals are visible (up to 0.002 × 0.001 mm). These channels are sometimes caused by the traction of some inclusions, mainly

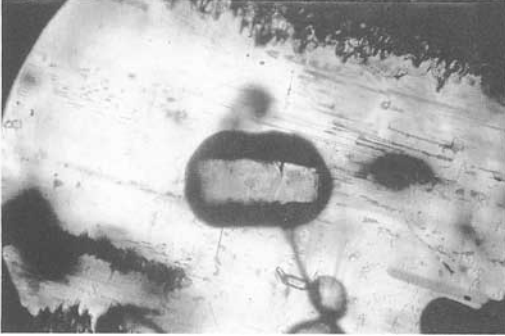


Fig. 4. Euhedral andalusite crystal with an outstandingly well-developed association of the {110} and the {011} prisms. 30x.

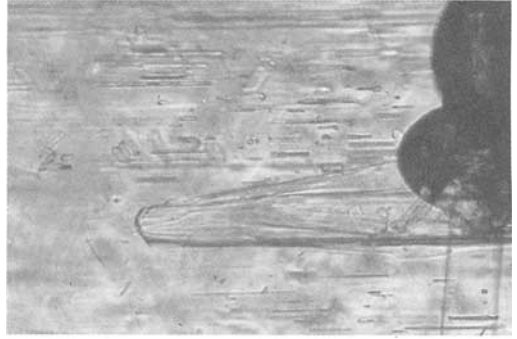


Fig. 5. Elongated prismatic apatite crystals are distributed among the thin channels. 200x.



Fig. 6. Long euhedral prismatic crystal of zircon. SEM photograph. 3000x.

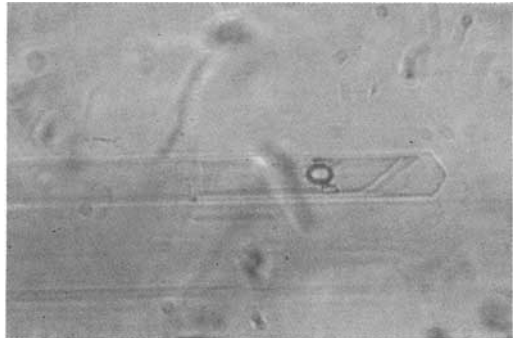


Fig. 7. Rare presence of minute euhedral andalusite crystals inside the channels. 250x.



Fig. 8. A channel filled with yellow lepidocrocite plates, unusually mixed with iron oxide slabs displaying a bright red colour. 250x.

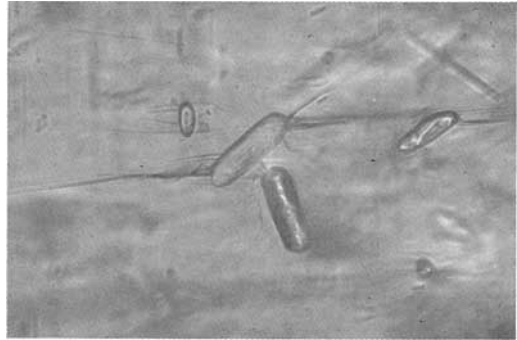


Fig. 9. The channels are sometimes caused by the traction of minute andalusite crystals. 250x.

the minute andalusite crystals (Figure 9).

Among the above mentioned mineral inclusions are yellow slabs formed by thin lamellae. Sometimes these are intergrown with brownish-red minute lenticular platelets (up to  $0.003 \times 0.001$  mm). The electron microprobe analyses disclosed the exclusive presence of iron in both these kinds of inclusions, indicating that they are *iron oxides* and *hydroxides* respectively.

The yellowish lamellae appear to be similar to *lepidocrocite* laminae containing *hematite*, *maghemite* and *Fe hydroxides* described by Graziani and Gübelin (1981).

The optical characteristics of the small transparent colourless crystals are very similar to those of the host kyanite. This suggests that kyanite also is present as a filling material of the channels.

The electron microprobe analyses show the presence of Si and Al and other elements in identical proportions to those of the kyanite crystals. The concurrence of the optical observations and the chemical analyses reveals that the described crystalline material is always *kyanite*.

Very minute, elongated, slightly reddish needles (up to  $0.014 \times 0.002$  mm) were observed; these are intergrown with the apatite prismatic crystals. These needles are randomly aligned and often angular. They may be one of the three polymorphs of titanium oxide.

## Discussion

The characteristic features of this greyish kyanite and the presence of numerous inclusions of different kinds lead to the following considerations:

The sample is remarkable for its unusual greyish-blue colour and by noticeable amounts of one of the minor elements (i.e. manganese).

Particular mention is made concerning the difference between the measured and calculated density values. Such a difference should be attributed to the large amount of inclusions of lower density such as andalusite, calcite and apatite in the kyanite. Consequently, values as high as  $3.78 \text{ g/cm}^3$  could be expected in an inclusion-free greyish kyanite of the kind analysed in this study.

The numerous parallel channels and fine fibrous inclusions are responsible for the weak chatoyant effect. The presence of syngenetic andalusite in the kyanite allows the individual plotting of the kyanite-andalusite equilibrium curve in the  $\text{Al}_2\text{SiO}_5$  system as a first clue to define the P-T conditions under which this sample formed (Holdaway, 1971). On the other hand, the impossibility of defining the exact reaction boundary curve on the diagram allows only the emphasis of 4 Kbar and temperature of  $500^\circ\text{C}$  as a maximum. In fact, the field in which these two polymorphs coexist can be

extended over a large P-T range (Richardson *et al.*, 1969).

In any case, the absence of pyrophyllite in the sample would suggest lower temperature and pressure values in this kyanite-andalusite assemblage, i.e.  $350\text{--}400^\circ\text{C}$  and 2.5–3.0 Kbar respectively.

The presence in some channels of kyanite together with iron oxides and hydroxides, indicates that the latter iron minerals crystallized after a subsequent filling up of the channels with an iron-rich fluid. Lepidocrocite dehydration is proved by the presence of reddish iron oxides, probably hematite or maghemite, which could have formed at temperatures around or above  $300^\circ\text{C}$ , depending on pressure conditions (Kulp and Treites, 1951).

## Acknowledgements

The authors wish to thank Dr S. Lucchesi, Dipartimento di Scienze della Terra, University of Rome, for useful suggestions. We are grateful to Mr G. Di Egidio, Department of Chemistry, University of Rome, for his assistance in carrying out scanning electron microprobe analyses.

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# Investigation of cat's-eye zircons from Sri Lanka

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## Introduction

Zircon, the most common radio-active gemstone, is found abundantly in the sedimentary gem beds of Sri Lanka. The chemical and structural aspects of zircon were detailed by Gottfried *et al.* (1956); Vitanege (1957); Vance and Anderson (1972); Sahama (1981) and recently by Rupasinghe (1984). There have been many reports in gemmological literature on zircon with chatoyancy effect in the past as well as in recent years (see Eppler, 1958; Fryer *et al.*, 1983, 1984 and 1985). During the last few months the authors were informed of an occurrence of zircon cat's-eye in Bibilé, Sri Lanka. Investigating this information during a recent visit of one of the authors to the 'Gem Island', it became apparent that a large number of zircon cat's-eyes were available in the local gem market. The sudden occurrence of phenomenal zircons from Sri Lanka aroused the authors' interest to research in detail whether there is an actual natural occurrence or whether some type of enhancement is carried out to produce a chatoyancy effect.

The author's visit to Sri Lanka yielded the answer to the problem of zircon cat's-eye effect in

that country. The chatoyancy can occur either naturally or after heat treatment to the gem. However, the former is rare (Figure 1). The majority of stones now available are subjected to a process of heating (Figure 2). This article aims therefore at describing the gemmological and chemical properties of 'natural' and 'treated' cat's-eye zircon. Particular details on the cause of the chatoyancy in both types are discussed.

## Gemmological properties

Several gemmological tests were conducted to determine the properties of two types of cat's-eye zircons, especially to distinguish between treated and untreated.

## Colour

The zircon cat's-eyes shown in Figures 1 and 2 exhibit overall light brown and whitish-grey colours respectively. The cat's-eye effect in 'natural' zircon was rather weak in appearance compared with the remarkable chatoyancy in heat-treated samples. The treated stones exhibited a slight bluish-sheen under reflected light.



Fig. 1. Zircon exhibiting a 'natural' cat's-eye effect found in Bibilé, Sri Lanka. Weight 3.43 ct.



Fig. 2. Heat-treated zircon exhibiting a chatoyancy effect. Most of the stones investigated in this study are of this type. Weight 5.52 ct.





Fig. 3. Growth tubes which are arranged parallel to one direction in the 'natural' zircon cat's-eye from Sri Lanka. Photographed by using colour filter to enhance the tube-like inclusions. Transmitted and reflected light illumination. 50 x.



Fig. 4. The growth tubes seen in 'natural' zircon cat's-eye from Sri Lanka are often filled with minute mineral matter. Dark-field illumination. 55 x.

**Refractive index and specific gravity**

Because of the high refractive index of zircon it was necessary to use the Riplus type refractometer and this provided, with great difficulty, the usual shadow-edges for high and intermediate type zircons. The 'natural' cat's-eye zircon provided the intermediate type values, whereas the treated ones gave the values for high type (Table 1). The specific gravities of the samples were determined hydrostatically on a Sartorius balance at room temperature. The cat's-eye zircons revealed specific gravities ranging from 4.00 to 4.69.

**Spectroscopic and ultraviolet radiation analysis**

The absorption spectra of these zircons were determined by the use of hand-held prism-type spectroscope. The most diagnostic 653.5 nm absorption line accompanied the other lines at 660.5, 662.5, 621.0, 615, 589.6, 562.0, and 516.2 nm.

None of the samples exhibited any noteworthy luminescence when illuminated under either ultraviolet radiations.

**Gem microscope observations**

Under high magnifications a clear-cut answer to the origin of the zircon cat's-eye can be obtained. The 'natural' chatoyant zircon contained numerous growth tubes arranged parallel to one direction in the gem (Figure 3). These tubes seem to be quite large in diameter (Figure 4) and are often filled with mineral matter. Although the mineral plates have not contributed to the effect of chatoyancy they were identified as biotite mica (Figure 5).

The inclusions in heat-treated cat's-eye zircons were in no way similar to those described above. In appearance they were comparatively free from inclusions. However, with magnification fine disc-shaped fissures were visible (Figure 6). These ultrathin tension fissures were arranged in a parallel

**Table 1. The gemmological properties of 'natural' and heat-treated zircon cat's-eyes from Sri Lanka.**

	Refractive index	Specific gravity	Absorption spectrum in nm	Inclusions
'Natural' zircon cat's-eye (1 sample)	1.83	4.04	660.5, 653.5, 621, 589.5	Hollow tubes parallel in one direction and often filled with biotite mica inclusions.
Heat-treated zircon cat's-eyes (10 samples)	1.92-1.97	4.60-4.69	660.5, 691.0, 662.5, 653.5, 621, 615, 589.6, 562, 537.6, 516.2.	Fine disc-shape tension fissures arrange in one orientation. Cracks on the unpolished surfaces.



Fig. 5. The enclosed minerals within the tubes were identified as biotite mica in zircon cat's-eye of untreated origin. Dark-field illumination. 80 x.



Fig. 6. Fine disc-like tension fissures arranged in parallel orientation in heat-treated zircon cat's-eyes are now available in the trade. Dark-field illumination. 60 x.



Fig. 7. Visible fire cracks often seen on unpolished surfaces of heat-treated zircons from Sri Lanka. Transmitted light illumination. 53 x.

orientation in the stone and when such zircons are cut en-cabochon they provide a chatoyancy with a bluish-sheen under reflected light. Many heat-treated zircon cat's-eyes observed exhibited fire cracks (Figure 7) on unpolished surface areas.

#### Chemical analysis

Microprobe analysis were conducted on two cat's-eye zircons of natural and heat-treated origins. The treated zircons contained no iron and showed less percentages of the common radio-active elements

such as Hf, Th, and U. The results obtained in this analysis are given in Table 2.

#### The cause of chatoyancy

The chatoyancy in zircons from Sri Lanka described in this paper is caused by the parallel arrangement of hollow or growth tubes or ultra-thin disc-like fissures. In natural zircon cat's-eyes the arrangement of growth tubes takes place in one direction. If the needle-like inclusions orient compactly within the gem the effect is pronounced. However, in many instances, as one shown in Figure 1, the included tubes are rather far apart from each other and this causes somewhat indistinct chatoyancy.

The fine disc-shape fissures can also produce a cat's-eye effect if the arrangement takes place in a regular manner. Heat-treatment influences such arrangements within zircons and this leads to chatoyancy.

#### Heat treatment of zircon cat's-eye

Heat-treating zircon is well-known and is reported in detail by Webster (1975). The majority of zircons found in Sri Lanka are often subjected to heat. However, it was only quite recently that treaters began to produce a cat's-eye in zircon. The process is similar in practice to that of heat-treating

Table 2. Chemical data (in wt%) for 'natural' and heat-treated zircon cat's-eyes from Sri Lanka.

	SiO <sub>2</sub>	FeO <sup>a</sup>	ZrO <sub>2</sub>	HfO <sub>2</sub>	ThO <sub>2</sub>	UO <sub>2</sub>
'Natural' zircon cat's-eye	34.28	0.04	63.70	1.40	0.25	0.67
Heat-treated zircon cat's-eye	33.96	nd <sup>b</sup>	65.10	1.19	0.22	0.34

<sup>a</sup> Total iron calculated as FeO    <sup>b</sup>nd = not detected

amethyst to set in a schillerization. At the request of the operators the authors have kept the exact details of the process secret. It was apparent however, that the temperature used in this instance was lower than in the amethyst treatment. The lowering of temperature causes the result of fine fissures and often cracking of the stone. A similar sheen to that of moonstone-like quartzes often results in treated zircons. However, as has been observed by one of the authors it is not at all an easy task to treat zircons to show chatoyancy.

### Conclusion

Zircon with a cat's-eye effect is not a new occurrence to either gemmology or to the trade. However, heat-induced zircon cat's-eyes have not been mentioned previously in literature. Such stones are now encountered often in the trade. Therefore the properties mentioned in this article are of value in future determinations of the origin of cat's-eye zircons.

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# Gemmological investigation of a large faceted east African enstatite

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## Abstract

This article describes the identification and scientific documentation of a large, gem-quality, faceted Tanzanian enstatite that was presented to the Gemological Institute of America. The results of chemical analysis, X-ray powder diffraction, and various gemmological tests, carried out on this gemstone, are reported.

## Introduction

GIA was recently given a large, gem-quality, orangish-brown, rough crystalline mass, mined in Tanzania, that weighed approximately 75 carats. Shown in Figure 1, the rough, presented to the GIA



Fig. 1. Tanzanian enstatite rough before faceting. Photo by Tino Hammid.

as hypersthene, was superficially covered with numerous extremely fine parallel striations (Figure 2) that resulted from the surface exposure of abundant, minute, acicular growth tubes. The growth tubes were so fine and evenly disseminated that they gave the rough crystal a directionally-dependent translucency that complemented its rather strong pleochroism. The pleochroism and the general appearance were what one might expect of a pyroxene.

The rough crystalline mass was subsequently cut by Mr Michael Gray of Los Angeles, California, into a large, antique cushion modified step cut, shown in Figure 3, weighing 46.56 carats. We believed this to be perhaps the largest known faceted pyroxene. Once faceted, the gem and a remaining fragment of the rough crystal were subjected to a variety of testing techniques to determine its properties and correct identity, which proved to be enstatite.

## Gemmological properties

### Microscopy

Examination of the faceted stone with a gemmological microscope revealed a multitude of extremely fine acicular inclusions as well as a few coarse ones (Figure 4). The inclusions, all lying parallel to one another in a single direction, were thickly disseminated throughout the stone. Had a decision been made to fashion the rough crystal in a properly oriented cabochon form, it would probably have resulted in a fine cat's-eye stone displaying excellent chatoyancy. Distinct colour and growth zones, of a light yellowish-brown hue, running in a direction perpendicular to that of the acicular inclusions, were also visible through the microscope. One of these is shown bisecting the acicular inclusions in Figure 5.

### Refractive index

Using a sodium vapour light source and a Duplex II refractometer the refractive index of the faceted stone was observed to be  $\alpha = 1.662$ ,  $\gamma = 1.673$ , and

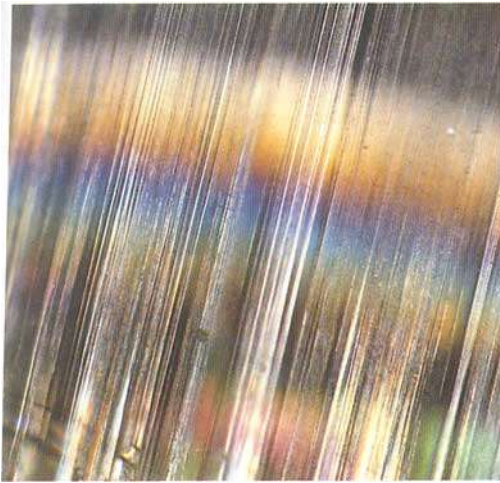


Fig. 2. Fine parallel striations on surface of rough enstatite crystal. Magnified 85x.

the intermediate reading  $\beta = 1.667$ . Because  $\beta$  was determined to be slightly closer to  $\alpha$ , the stone exhibited a biaxial positive optic character. The birefringence is 0.011. This was the first indication that the gemstone might be enstatite since hyperssthene is biaxial negative with a higher birefringence (0.012–0.021).

#### Specific Gravity

The specific gravity of the faceted stone and the rough crystal were determined in two ways. Using pure methylene iodide with a known specific gravity of 3.32 as a heavy liquid, it was found that both the faceted stone and rough crystal section sank slowly. On the basis of this observation the specific gravity was estimated to be approximately 3.35. Next, utilizing a Voland double pan diamond balance the specific gravity was determined by the hydrostatic method. The values so obtained on the two pieces ranged from 3.33 to 3.41.

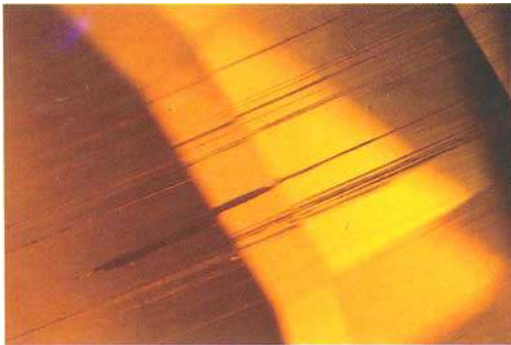


Fig. 4. Some of the coarse and fine acicular inclusions observed in the faceted enstatite. Magnified 50x.



Fig. 3. Faceted antique cushion step cut enstatite weighing 46.56 carats (possibly the world's largest), size 21.52 × 20.34 × 13.73 mm. Photo by Tino Hammid.

#### Spectroscopy

A GIA-GEM spectroscopy unit with a Beck prism spectroscopy was used to check the visible light absorption characteristics of this faceted gem. The spectroscopic examination, carried out at room temperature, showed a textbook spectrum for brown enstatite (Liddicoat, 1981). A strong sharp line at 506.0 nm, flanked closely by two weak lines at 503.0 and 507.5 nm are readily visible. The stone also shows a single band located between 547.5 and 550.0 nm as well as a series of weak bands in the blue.

#### Pleochroism

The presence of strong pleochroism in this stone was first noted during microscopic examination. Strong pleochroism is a characteristic feature of many coloured pyroxenes. Since the material was determined to be biaxial it was thought that perhaps three distinct pleochroic colours might be observed

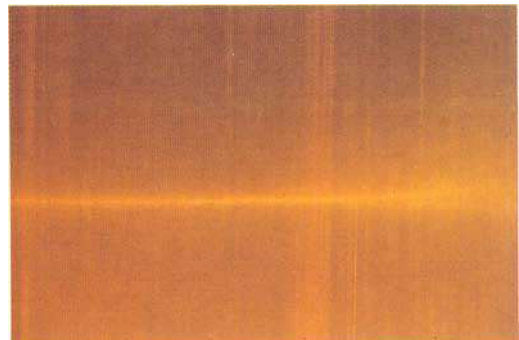


Fig. 5. Colour-growth zone, bisecting the acicular inclusions at a right angle, as seen in the faceted enstatite. Magnified 50x.

through a calcite dichroscope. A strong fibre-optic light source was used during testing. As suspected, through the dichroscope, three distinct pleochroic colours were observed: (1) greenish-brown, (2) yellowish-brown, and (3) reddish-brown.

#### Luminescence

The reaction of this gem material to both long-wave (366.9 nm) and short-wave (253.7 nm) ultra-violet radiation is negative.

#### Hardness

Using a set of hardness points, a microscope, and oblique incident illumination, the hardness of both the rough crystal section and the faceted stone was determined. The tests, carefully performed on inconspicuous areas, showed a hardness of approximately 5½ to 6 on the Mohs' scale.

#### X-ray diffraction

Using a sharp-edged diamond scribe, a tiny amount of powder was carefully scraped from the girdle edge of the faceted stone. The powder was used to prepare a spindle for X-ray powder diffraction. The sample was mounted in a Debye-Scherrer powder camera and exposed for eight hours to X-rays generated at 46 kV and 26 mA from a copper target tube. The diffraction pattern obtained matched that of orthopyroxene in the area of the enstatite-hypersthene portion of a complex six-member solid solution series between enstatite and orthoferrosilite based on the magnesium/iron ratio (Deer *et al.*, 1978).

#### Chemical analysis

In order to establish where the faceted stone and rough crystal section fit into this solid solution series, it is necessary to determine, through chemical analysis, the percentages of both iron and magnesium that are present.

Using the electron probe microanalyser at the California Institute of Technology, Carol Stockton, GIA's senior research gemmologist, found average weight per cent values as follows: SiO<sub>2</sub> 56.99, MgO 33.78, FeO 7.45, Al<sub>2</sub>O<sub>3</sub> 0.74, CaO 0.36, TiO<sub>2</sub> 0.04,

Cr<sub>2</sub>O<sub>3</sub> 0.08, MnO 0.18, sum: 99.62 wt%. Pyroxenes such as enstatite and hypersthene belong to a solid solution series in which magnesium and iron substitute for one another in varying amounts. The series extends from pure end member enstatite (Mg<sub>2</sub>(SiO<sub>3</sub>)<sub>2</sub>) to pure end member orthoferrosilite (Fe<sub>2</sub>(SiO<sub>3</sub>)<sub>2</sub>). The series is arbitrarily divided into six regions, each with a mineral name and range of composition. The names and ranges (numbers refer to percentage of Fe<sub>2</sub>(SiO<sub>3</sub>)<sub>2</sub> in formula) are as follows: enstatite (0–12), bronzite (12–30), hypersthene (30–50), ferrohypersthene (50–70), eulite (70–88), and orthoferrosilite (88–100). The chemical analysis and measured properties of this gemstone indicate that it is enstatite with approximately 11% Fe<sub>2</sub>(SiO<sub>3</sub>)<sub>2</sub> in its composition.

#### Conclusion

Properties obtained from the battery of standard gemmological tests, such as refractometry, spectroscopy, and specific gravity, together with the results obtained by X-ray powder diffraction and electron microprobe analysis, prove this gemstone to be the orthopyroxene enstatite. It is close to the borderline between enstatite and bronzite. At 45.56 carats it is much larger than any faceted enstatite previously reported (Arem, 1977) and may be the largest faceted enstatite yet reported.

#### Acknowledgements

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# Lechleitner synthetic rubies with natural seed and synthetic overgrowth

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## Abstract

A new type of Lechleitner synthetic ruby was investigated with respect to determinative properties useful for distinction from natural samples. The new synthesis consists of natural seeds of corundum from Sri Lanka, which are coated by a thin layer of flux-grown synthetic ruby. Spectroscopic, chemical and microscopic properties are given.

## Introduction

Lechleitner synthetic rubies and sapphires were first announced by Bank (1983) and later described by Kane (1985) and Gunawardene (1985). According to the publications mentioned, faceted samples of Lechleitner synthetic rubies and sapphires reveal curved growth striations and flux material in the form of wispy veils and fingerprints (Kane, 1985) as well as various forms of flux residues (Gunawardene, 1985). Due to the investigation of rough and faceted samples of Lechleitner synthetic corundum by one of the present authors (Schmetzer, 1986a, b), it is evident that faceted and pre-shaped forms as well as irregular fragments of Verneuil-grown synthetic corundums were used by the producer as seeds for his synthesis. The synthetic Verneuil seeds were overgrown with a thin layer of synthetic corundum in a flux process. This method of synthesis is generally described by Koivula (1983). Most probably, the flux used by Lechleitner for crystal growth is in the system  $\text{Li}_2\text{O}-\text{MoO}_3-\text{PbF}_2$  and/or  $\text{PbO}$ . Due to the small thickness of the synthetic flux-grown layer of Lechleitner synthetic rubies and sapphires, the complete overgrowth or at least part of it was removed during the faceting process. The remaining samples consisted of the Verneuil seed with induced fingerprint patterns of residual flux material and, in some cases, with a thin flux-grown coating. Similar samples of Verneuil grown synthetic ruby with induced fingerprint

pattern and thin flux-grown coating were formerly produced and marketed by Chatham and Knischka and recently by an unknown producer (cf. Schmetzer, 1986a,b).

With the basic knowledge of Lechleitner's process, some of the observations of Kane and Gunawardene become more easily understandable. Most probably, the two cut samples revealing curved growth striations, which were available to Kane (1985), consisted only of Verneuil-grown seeds, the overgrowths of which were completely removed during the cutting process. The visual appearance of various forms of flux residues pictured in the paper of Gunawardene (1985) are in part typical for flux inclusions in the overgrowth (e.g. Figures 14-17) as well as for induced fingerprint patterns in the Verneuil-grown seeds of Lechleitner synthetic corundums (e.g. Figures 18-24). However, without a detailed investigation of the Verneuil-grown corundum versus flux-grown corundum contact zone as well as without an investigation of the areas with and without curved growth striations in each sample, which is most conveniently performable with the immersion microscope using methyleneiodide as immersion liquid, the assignment of inclusions to the seed or the overgrowth is connected with some uncertainty. Unfortunately, curved growth striations were not mentioned in the paper of Gunawardene and therefore, a more detailed interpretation of his figures is extremely difficult.

Not long ago, the first samples of a new type of Lechleitner synthetic ruby were made available for investigation. In contrast to the stones mentioned above, this new synthesis consists of natural corundum crystals from Sri Lanka which were used as seeds, with thin layers of synthetic flux-grown corundum as overgrowth. Due to the presence of

natural inclusions in the seed crystals as well as due to the visual appearance of the irregular boundary between natural seed and synthetic overgrowth, samples of this synthesis are more difficult to recognize compared to the old type of stone with Verneuil-grown seeds. Thus, a description of this new type of synthetic ruby appears necessary and helpful in order to avoid misinterpretations in determinative procedures.

### Colour and spectroscopic properties

For the present investigation six faceted samples of the new type of Lechleitner synthetic ruby were available. The colour of the stones (Figure 1) is red with a light violet hue, which is equal to the coloration of the well known pink to violet series of natural rubies from Sri Lanka. In some samples, the coloration of the zone confined to the girdle of the



Fig. 1. Lechleitner synthetic rubies with natural seed and synthetic overgrowth. Size of the samples approx. 6 mm. (Photo by O. Medenbach, Bochum, West Germany.)

cut stones is more intense compared to the coloration of the zone confined to the table of the synthetic ruby (Figure 2). This visual appearance resembles the colour zoning known from sapphires which are diffusion treated in order to improve the intensity of the blue coloration (Hänni, 1982). In Lechleitner synthetic rubies the strengthened colour intensity of some samples in the girdle area is due to an increased thickness of the flux overgrowth in the rim area compared to the lighter zone confined to the table of the sample. This visual appearance of the faceted samples indicates the use of very light reddish or even colourless samples as seed crystals.

Absorption spectra of Lechleitner synthetic rubies with natural seeds reveal the typical absorption bands of  $\text{Cr}^{3+}$  in corundum which are superimposed by a weak  $\text{Fe}^{2+}/\text{Ti}^{4+}$  absorption in the red area of the visible region (Figure 3). This type of absorption spectrum with a strong ruby component and a weak blue sapphire absorption superimposed

is normally observed in pink to violet rubies from Sri Lanka and confirms the similarity in colour of Lechleitner synthetic rubies of the new type with the common type of rubies from Sri Lanka as already mentioned above.

The absorption spectra of Lechleitner synthetic rubies in the ultraviolet area are less uniform than the spectra in the visible region (Figure 3). This result is understandable by various percentages of seed versus overgrowth in different samples; the influences of both are added to the ultraviolet spectra of the samples. Furthermore, different types of corundum from Sri Lanka may have been used as seed crystals. Samples from this country reveal extremely variable transparencies in their ultraviolet spectra (cf. Schmetzer, 1985). For both reasons mentioned, the contribution of the natural seed of corundum from Sri Lanka to the spectroscop-



Fig. 2. Colour zoning in Lechleitner synthetic rubies with natural seed and synthetic overgrowth; in one sample the 'silk' of the natural seed is visible. - Size of the samples 8 x 9 and 7 x 7 mm. (Photo by O. Medenbach, Bochum, West Germany.)

pic properties of the entire overgrown sample is variable and cannot be separated from the contribution of the synthetic overgrowth.

### Chemical properties

Investigations of residues of the flux material in Lechleitner synthetic rubies with natural seeds using X-ray fluorescence and electron microprobe techniques yielded the presence of traces of Mo. This result is consistent with chemical investigations of Lechleitner synthetic rubies with Verneuil seeds (Schmetzer, 1986a,b) and indicates crystal growth by the flux method with fluxes in the system  $\text{Li}_2\text{O}-\text{MoO}_3-\text{PbF}_2$  and/or  $\text{PbO}$ .

### Microscopic properties

All six samples available at present to the authors consist of natural seeds with an all-around thin

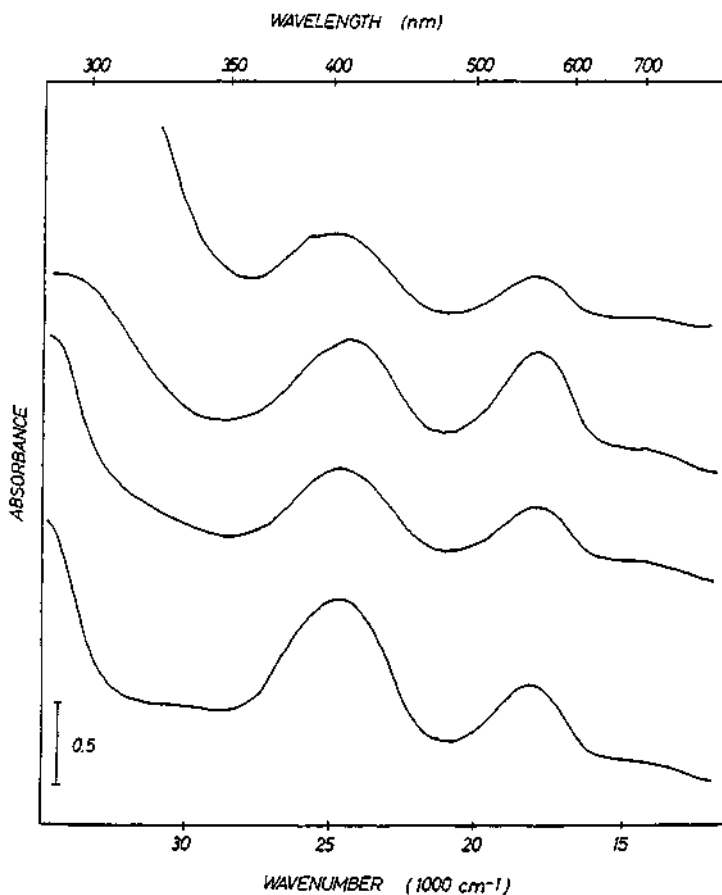


Fig. 3. Absorption spectra of Lechleitner synthetic rubies with natural seeds and synthetic overgrowth; the  $\text{Cr}^{3+}$  absorption bands have weak  $\text{Fe}^{2+}/\text{Tl}^{4+}$  intervalence absorption bands in the red area superimposed.

overgrowth of synthetic ruby (Figure 4). Obviously, pre-shaped or cut samples as well as roundish or irregularly shaped seeds were used by Lechleitner (Figures 4-9). In some cases it is evident that very light or even colourless corundum seeds were selected by the producer (Figures 6-8). If irregularly formed seeds are used for the process, the contact zone between natural seed and synthetic overgrowth (Figure 8) resembles swirl-like irregular growth structures in natural rubies from Burma or Sri Lanka, which are known to gemmologists as 'treacle'. Similar growth structures with irregularly shaped seeds are also known to the authors from the first generation of Knischka synthetic rubies.

The natural seeds used by Lechleitner display various forms of structural properties and inclusions, which are common for rubies and sapphires from Sri Lanka: intercalated lamellae of corundum

in twin position (Figure 10), families of straight parallel growth planes that form an angle (Figure 11), irregularly shaped and rounded cavities as well as negative crystals (Figure 12), rounded mineral inclusions (Figure 13), rutile needles or 'silk' (Figure 2), tabular mineral inclusions surrounded by liquid feathers (Figure 14), as well as partly healed fissures with liquid and two-phase inclusions (Figure 15). In unhealed cracks within the seed, residues of the flux material are incidentally observed (Figure 16), which are induced during the period of crystal growth by the flux method.

In the synthetic overgrowth of Lechleitner synthetic rubies, various forms of flux residues are included (Figures 6-9, 17, 18). Doubly refracting crystals are occasionally observed at the boundary between natural seed and synthetic overgrowth (Figures 13, 19). According to investigations of

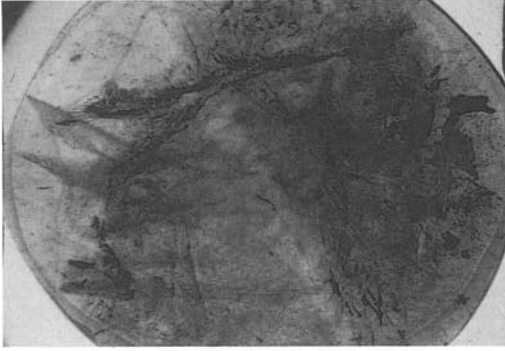


Fig. 4. Lechleitner synthetic ruby; rounded natural seed and all-around synthetic overgrowth. 26x.

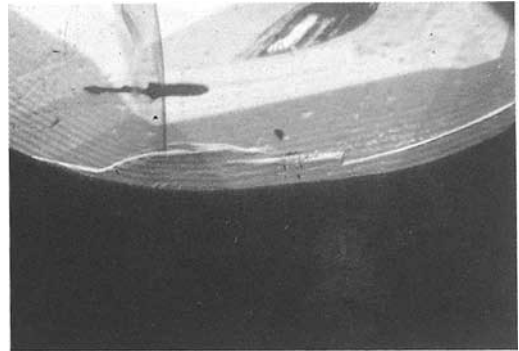


Fig. 5. Lechleitner synthetic ruby; contact zone between natural irregularly shaped seed and synthetic overgrowth. Crossed polars, 35x.

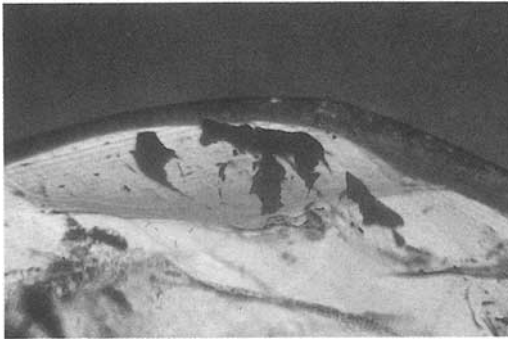


Fig. 6. Lechleitner synthetic ruby; contact zone between irregularly shaped natural seed and synthetic overgrowth resembling swirl-like irregular growth structures ('treacle') in natural ruby; flux residues are trapped in the overgrowth. Crossed polars, 45x.

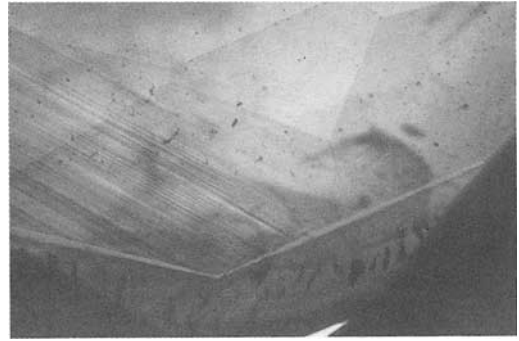


Fig. 7. Lechleitner synthetic ruby; contact zone between pre-shaped or faceted natural seed and synthetic overgrowth. 25x.



Fig. 8. Lechleitner synthetic ruby; contact zone between pre-shaped or faceted natural seed and synthetic overgrowth; flux residues are trapped in the synthetic overgrowth. Crossed polars, 45x.

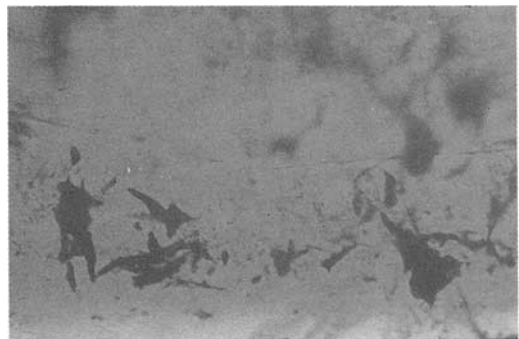


Fig. 9. Lechleitner synthetic ruby; contact zone between pre-shaped or faceted natural seed and synthetic overgrowth; flux residues are trapped in the synthetic overgrowth. 65x.

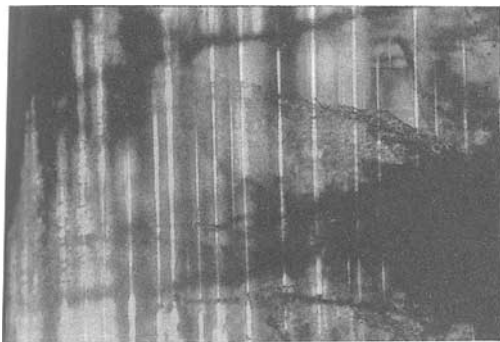


Fig. 10. Lechleitner synthetic ruby; natural seed with intercalated lamellae of corundum in twin position on  $r$  (1011). Crossed polars, 50x.

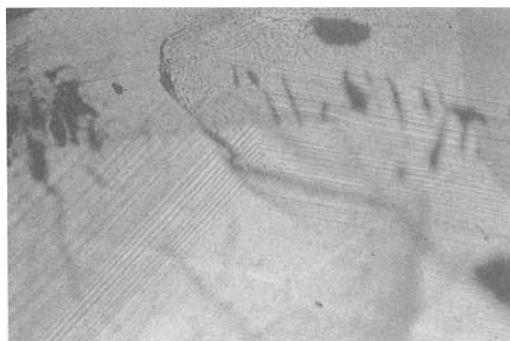


Fig. 11. Lechleitner synthetic ruby; natural seed with families of straight parallel growth planes parallel to  $w$  {1121} that form an angle of  $124^\circ$ ; flux residues in the synthetic overgrowth. 40x.

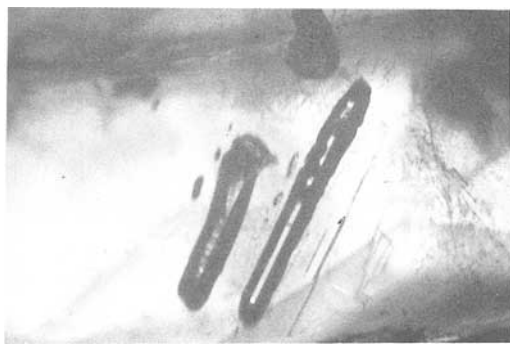


Fig. 12. Lechleitner synthetic ruby; natural seed with negative crystals. 60x.



Fig. 13. Lechleitner synthetic ruby; natural seed with rounded doubly refracting mineral inclusion (centre); doubly refracting crystals (most probably corundum) confined to the contact zone between natural seed and synthetic overgrowth (left). Crossed polars, 35x.



Fig. 14. Lechleitner synthetic ruby; natural seed with platy mineral inclusions (most probably mica) surrounded by liquid feathers. 85x.

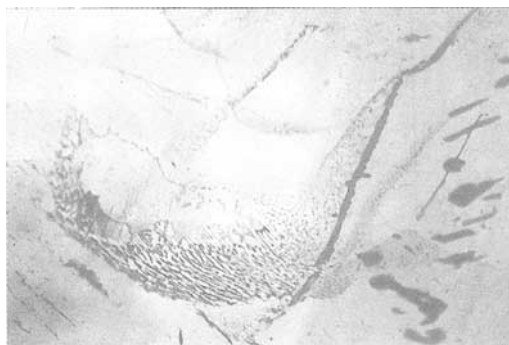


Fig. 15. Lechleitner synthetic ruby; natural seed containing healed fissures with liquid and two-phase inclusions (centre); synthetic overgrowth with residues of the flux (right). 40x.



Fig. 16. Lechleitner synthetic ruby; natural seed with induced flux material. 55x.

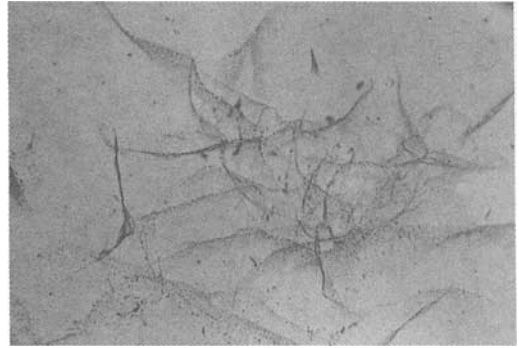


Fig. 17. Lechleitner synthetic ruby; synthetic overgrowth with residues of the flux. 45x.



Fig. 18. Lechleitner synthetic ruby; synthetic overgrowth with residues of the flux. 60x.

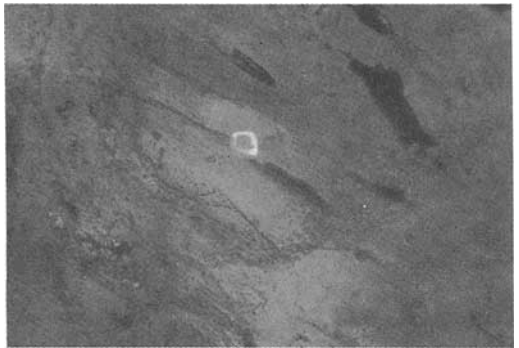


Fig. 19. Lechleitner synthetic ruby; doubly refracting crystal (most probably corundum) confined to the boundary between natural seed and synthetic overgrowth. Crossed polars, 75x.

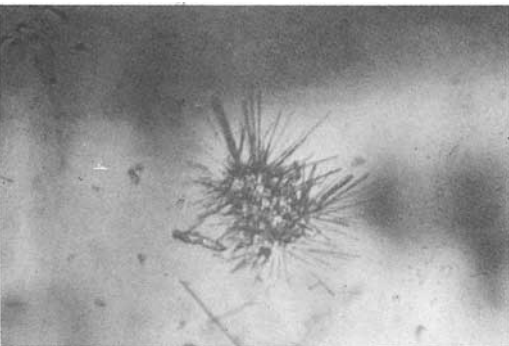


Fig. 20. Lechleitner synthetic ruby; synthetic overgrowth with needle-like inclusions. 100x.

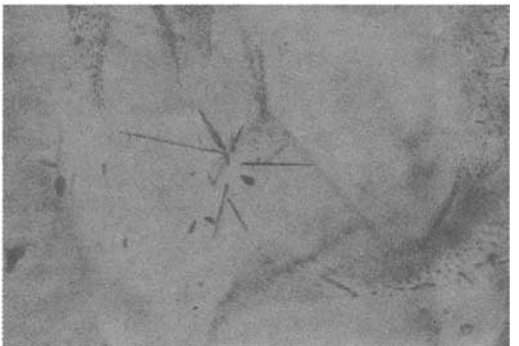


Fig. 21. Lechleitner synthetic ruby; synthetic overgrowth with needle-like inclusions. 95x.

Chatham synthetic rubies as well as Knischka synthetic rubies (Schmetzer, 1986a), similar inclusions which are also confined to the boundaries between subsequent growth zones were identified as corundum formed by spontaneous nucleation. This explanation is also applied to the identical type of inclusion in Lechleitner synthetic rubies. A new form of needle-like inclusion, which was not observed before in Lechleitner synthetic rubies containing Verneuil seeds, is pictured in Figures 20 and 21. At present, the composition of these needles is unknown.

### Conclusions

The new type of Lechleitner synthetic ruby consists of natural seeds of light coloured or colourless corundum, which are coated by a thin layer of synthetic flux-grown ruby. Due to the fact that natural inclusions are present in the seeds of the stones, a careful investigation of the synthetic overgrowth and the contact zone between natural and synthetic corundum has to be performed in order to determine the samples unequivocally. The investigation of trace elements, i.e. the chemical determination of residues of the flux by electron microprobe or X-ray fluorescence analysis as well as spectroscopic investigations are helpful in identification procedures.

### Acknowledgement

Financial support was received by grants of the Wirtschaftsministerium des Landes Rheinland-Pfalz, West Germany, as part of a project for applied research.

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[Manuscript received 16 December 1986 ]



# Colour-changing chromiferous tourmalines from East Africa

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East Africa is well known as a producer of various coloured tourmalines of gem quality. Occurrences of elbaite (Voi, Kenya), dravite (Osarara, Kenya) and uvite (Magadi, Kenya; Moshi and Gerevi Hills, Tanzania) are mentioned by Dietrich (1985). Furthermore red (Bank, 1974), light-brown, yellow, green (Bank, 1975) and golden-yellow (Hänni *et al.*, 1981) as well as red dravite (Dunn, *et al.*, 1975) from Kenya are described in gemmological literature.

Occurrences of green tourmalines in East Africa are commercially important. Three groups can be distinguished by their type of coloration:

1. vanadiferous green tourmalines from Gerevi Hills, Tanzania (Bassett, 1953; McKie, 1955; Webster, 1961);
2. chromiferous green tourmalines (Bank and Berdesinski, 1967; Crowningshield, 1967/1968); and
3. vanadium-chromium-tourmalines from Umba Valley, Tanzania (Zwaan, 1974).

Most of the green tourmalines from East Africa were described as vanadium-coloured members of solid-solution-series between dravite and uvite (Schmetzer and Bank, 1977)

dravite  $\text{Na Mg}_3 \text{Al}_6 [(\text{OH}, \text{F})(\text{OH})_3(\text{BO}_3)_3 \text{Si}_6 \text{O}_{18}]$   
 uvite  $\text{Ca Mg}_3 (\text{Al}_5 \text{Mg}) [(\text{OH}, \text{F})(\text{OH})_3(\text{BO}_3)_3 \text{Si}_6 \text{O}_{18}]$   
 formed by replacement of sodium and aluminium by calcium and magnesium.

Schmetzer (1978) mentioned green vanadiferous and chromiferous dravites from Tanzania (Gerevi Hills, Umba Valley) and Kenya (Kwale District, Tsavo Park, Lualenyi) as well as uvite from Landanai, Tanzania. Bluish-green dravites from East Africa are described by Dunn (1978).

In a large number of green tourmalines from East Africa (probably from Lelateta, Tanzania) one of the authors (H.B.) has found some stones showing a distinct change of colour from green in daylight to brownish-red or red in artificial light.

This special optical effect, found in gemstones like alexandrite, garnet, corundum, spinel, zircon, fluorite, kyanite and diaspore, has, to the authors' knowledge, never before been described in tourmalines.

The colour-changing tourmalines from East Africa show the following gemmological properties:

$$n_o = 1.644 - 1.645$$

$$n_e = 1.622 - 1.623$$

$$\Delta n = -0.022$$

$$D = 3.04 - 3.06 \text{ g/cm}^3$$

pleochroism: brownish-green or yellowish-green to emerald-green

For chemical analyses with an electron microprobe (Cameca microbeam) two samples of 5.41 and 1.73 ct were selected:

	sample 1 5.41 ct	sample 2 1.73 ct
SiO <sub>2</sub>	35.29	34.87
Al <sub>2</sub> O <sub>3</sub>	33.57	31.73
MgO	11.13	11.40
CaO	1.95	2.63
Na <sub>2</sub> O	1.53	1.39
Cr <sub>2</sub> O <sub>3</sub>	0.36	0.64
V <sub>2</sub> O <sub>3</sub>	0.04	0.06
TiO <sub>2</sub>	0.18	0.48
total	84.07	83.20

Data in wt.-%

The results of chemical investigations proved the samples to be chromiferous dravite-uvite mixed crystals with slight excess of uvite. The uvite portions amount to 55 and 65% respectively. The vanadium contents are low but in the range of detection limit of the microprobe.

Spectroscopical studies yielded typical absorption spectra of chromiferous minerals. Absorption bands caused by Cr<sup>3+</sup> possess maxima at 606 and 450 nm.

### Acknowledgements

Financial support was given by grants of the Wirtschaftsministerium des Landes Rheinland-Pfalz, FRG, within a project for applied research. Microprobe analyses and spectroscopical investigations were carried out at the Institut für Geowissenschaften, University of Mainz, West Germany.

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[Manuscript received 14 January 1988]

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## A note on the Barkhausen effect

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Minster's technique of using the Barkhausen effect to identify synthetic diamonds<sup>1</sup> is a very ingenious approach. The ferromagnetic nickel inclusions causing this effect are, of course, derived from the solvent used in diamond synthesis<sup>2</sup>. It should be noted, however, that the literature shows that it is possible to synthesize diamond by using non-ferromagnetic solvents such as platinum<sup>3</sup> which would then give a false negative result. In addition, one might obtain a false positive result from the reaction of a natural diamond containing ferromagnetic inclusions such as magnetite<sup>3</sup>. Accordingly, great caution must be used in interpreting the results of a Barkhausen-effect test.

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[Manuscript received 8 January 1988]

## Crystalline and organic

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Talking to a mixed audience of retail jewellers and gemmologists recently on the history of pearls, I found myself explaining that, for the major part of my laboratory career, I had concentrated upon coloured stones in jewellery. I considered myself fortunate to have what I then considered the most interesting aspect of practical gem testing in a trade laboratory. Despite my concentration upon coloured stones, it was inevitable that some pearl lore penetrated. Our purpose-built X-ray generating set was constantly in use for pearls, YAGs, diamonds, green grossulars, Vernueil synthetics and so on.

During the holiday periods I did a certain amount of X-ray pearl testing so that, despite my emphasis that I was a coloured stone man, I did in fact know something about pearls.

Following the retirement and death of colleagues, it was inevitable that the important section of laboratory work, pearl testing, should continue, and I became the 'pearl man' at the laboratory. Having now embraced the pearl testing side of the laboratory's activities I found that I was achieving a name and some expertise in this particular discipline. I enjoyed watching the details appear in the developing dish as the negatives yielded their exposure secrets. These were mostly shadowgraphs or radiographs. The lauegrams could be even more exciting. When a large suspect pearl weighing close to a hundred grains was sent for testing accompanied by a request for urgent treatment, tension mounted as the negatives showed a worrying 'halo' pattern.

Negative, yet an indication that I was dealing with a blending of two distinct components, just as surely as if they were as different as crystals and organics.

At the talk to the mixed audience I hoped to stimulate an interest in the history of pearls and an appreciation of the marvel of nature which the lowly pearl-bearing oyster achieves. The origin of pearls has been to a very considerable extent well defined. The 'grain of sand' theory is fast disappearing, in company with other die-hard phrases such as semi-precious.

What has always impressed me in the history of a

pearl's arrival is the part played by the epithelial cells of the thin-skinned mantle which covers the soft viscera of the oyster. These cells produce a waterproof organic covering of conchiolin, which has an SG of 1.34. They then secrete the secondary layer of bio-mineralized calcite as a prismatic layer with an SG of 2.71. The inner lining of nacreous mother-of-pearl (aragonite) has an SG of 2.93.

This feat of producing both crystalline and organic materials of quite different specific gravities by the skin tissues of this lowly creature with no head, no brain, no eyes and very elementary nervous system, is truly a wonder of nature.

If by chance the oyster is invaded by a parasitical worm (cestode/trematode) it entombs in it a sac or cyst. It covers the skeletal remains with conchiolin which hardens to become the nucleus of a pearl. The subsequent overlapping layers which envelope the nucleus are platelets of rhombic aragonite in groups of three. These have a pseudo-hexagonal structure which, when penetrated by a beam of X-rays, yield the well-known six spot pattern seen in lauegrams of natural pearls.

As gemmologists we tend to think in terms of crystals and gemstones. I like to think that from 1925 when Basil Anderson was invited to investigate the problem of the new Japanese cultured pearl that here began the real assault and study of both crystalline and organic materials.

B.W. Anderson was brought up with a background of mineral and geological knowledge and a family link with the nitrate deposits of Chile. Nevertheless he was a man who appreciated organic products. Like other keen gardener/gemmologists he preferred food from soil unadulterated by chemicals, not even powdered apatite as a fertilizer! Having inherited B.W. Anderson's role in the laboratory I turned from crystalline gemstones to the first gems in gemmology, pearls. They are unique in requiring no aid from man, being ready furnished with beauty, rarity and 'orient'. They remain unique examples of a crystalline/organic homogenous gem.

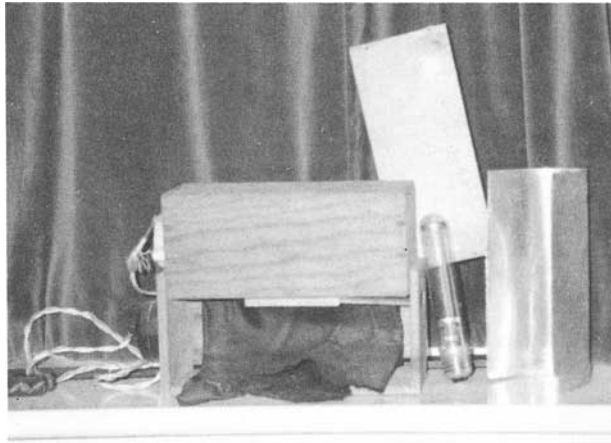
[Manuscript received 30 October 1987]

## Another low cost accessory

*The late J.R.H. Chisholm, MA, FGA*

At the end of the recent article by Hugh Crawford, FCA (*Some low cost accessories*, J.Gemm., 1986, 20, 4, 240-1), the Editor expressed his willingness to receive descriptions of other inexpensive gem-testing accessories made by readers. Thirty-three years ago I described one such in a paper (*Simple photomicrography*, J.Gemm., 1954, IV, 5, 217-23) illustrated by my then thirteen year old eldest son (now FRPS, but still an amateur), and

from the photographs (Figures 1 and 2) the ultra-violet light box is simply constructed of plywood (glued together). The object it is desired to illuminate is placed in the lower (open) half of the box, which is loosely lined with black velvet: the UV light bulb is in the upper half of the box underneath a bent sheet-aluminium reflector and the light passes from the upper to the lower half through a  $2\frac{1}{2} \times 1\frac{1}{8}$  inch opening: under this is fixed a holder



two years before that I had described another inexpensive accessory (*Live-box techniques*, J.Gemm., 1952, III, 7, 279-81), but it was not made by me and second-hand "live-boxes" are probably not obtainable so cheaply now as they were then.

The present article describes a piece of apparatus also made more than thirty years ago. As can be seen

into which a piece of Wood's glass can be slid. I fear that the UV light bulb and Wood's glass may not now be obtainable so cheaply as they were thirty years ago, but to make the rest of the apparatus should not even now cost many pennies.

[*Manuscript received 12 November 1987*]

## Gemmological Abstracts

BALITSKI, V.S., BUBLIKOVA, T.M., SOROKINA, S.L., BALITSKAYA, L.V., SHTEINBERG, A.S., 1987. Man-made jewelry malachite. *Gems & Gemology*, 23, 3, 152-7, 9 figs (3 in colour).

Silky, banded and bud-like [botryoidal] malachite is being made in the USSR by crystallization from aqueous solutions in sizes ranging upwards from 0.5kg. Vases up to 8kg, produced in Sverdlovsk, were exhibited in 1984. This material is an exact counterpart of natural malachite and can be detected, so far, only by thermal analysis – a destructive test. [Abstracter is puzzled that a mineral which is mined in great quantity to be smelted as an ore of copper should be worth synthesizing. The mineral is surely plentiful?]

R.K.M.

BANK, H., HENN, U., BANK, F.H., 1987. A new alexandrite deposit in Brazil. *Gold-schmiedezzeitung*, 9, 91-2.

A find of alexandrite has been made at Era Nova, near Belo Horizonte, Minas Gerais, Brazil. Some stones show a colour change from green, blueish-green, blue or brownish-green to violet or red. RI is given as 1.741-1.745 and 1.751-1.755 with a DR of 0.007-0.010. The SG is 3.71-3.78. The deposit is reported to be secondary, the specimens being recovered from river gravel.

M.O'D

BERNER, R.A., LANDIS, G.P., 1987. Chemical analysis of gaseous bubble inclusions in amber: the composition of ancient air. *American Journal of Science*, 757-62.

Gaseous inclusions in two separate samples of amber from the Dominican Republic were analyzed by quadrupole mass spectrometry. It is concluded that the inclusions represent ancient air modified by the partial reaction of O<sub>2</sub> with amber to produce CO<sub>2</sub>, by the addition of small amounts of hydrogen gas and hydrocarbons from amber decomposition and, in the case of the Dominican amber, the addition of excess argon during burial in sediments. This effect was not shown in control samples of Baltic amber. It is suggested from the data that Eocene and Oligocene atmospheres were not appreciably different from those of today as far as N<sub>2</sub>, O<sub>2</sub> and Ar are concerned.

M.O'D

BROWN, G., 1987. Spodumene. *Wahroongai News*, 21, 4, 25-7, 3 figs.

A compilation from authoritative sources of facts on this interesting gem species, including the new deep violet-blue variety from Afghanistan. [RIs are incorrectly summarized as 1.66-1.75, gamma reading should be 1.675.]

R.K.M.

BROWN, G., 1987. Jade and opal news from South Australia. *Wahroongai News*, 21, 4, 28, 1 map.

Estimated 60,000 tonnes of nephrite, including a rare black variety, considered recoverable at Cowell, SA.

New opal finds at Zorba and Halley's Comet mines in Coober Pedy area are shown roughly, and none too readably, on a sketch map. Brief news of productive areas at Mintabie and Andamooka from *Mineral Industry Quarterly* (S. Australia) No. 43.

R.K.M.

BROWN, G., 1987. Iolite. *Wahroongai News*, 21, 5, 20-3, 6 figs.

Facts on iolite or cordierite, a gem blessed with more names than most, from several authorities.

R.K.M.

BROWN, G., 1987. Taaffeite – an update. *Wahroongai News*, 21, 5, 25-7.

Facts of this rare gem, discovered in 1945 by Count Taaffe of Dublin, and the confusion between the original rather erroneous micro-chemical analysis and the more accurate electron-probe assessment by Karl Schmetzer in 1983, thanks to which the 'new' gem, taprobanite, is now identified as a red form of taaffeite.

R.K.M.

BROWN, G., 1987. Rhodochrosite. *Wahroongai News*, 21, 5, 16-19, 5 figs.

Facts on another ornamental gem species culled from half a dozen reputable sources. Usually massive, it cuts handsomely as pink and white cabochons, but scalenohedra and rhombohedra are found which will facet, allowing for softness (4) and three directions of perfect cleavage. [The ordinary ray (1.812) is above the range of the refractometer and the extraordinary ray (here

quoted as 1.60) can appear disconcertingly as a single reading at any point between 1.60 and the top of the scale, depending on the direction tested.] R.K.M.

BROWN, G., 1987. Fluorite. *Wahroonga News*, 21, 12, 22-5, 5 sketched figures.

A good account of this common but beautiful mineral which is the no. 4 standard for Mohs' hardness and too soft for convenient use in jewellery. It is best known in the form of massive purple/white Blue John, which comes from Derbyshire. Rare gem qualities in other colours are cut for collectors. [Green massive material is often used for carved figures in China. A drawing of interpenetrant cubes has shading suggesting diagonal striation which does not occur in this mineral. Vicinal striation does occur, but approximates to cube edge directions.] R.K.M.

BROWN, G., 1987. Gem enstatites. *Wahroonga News*, 21, 7, 23-5.

A rather complex compilation of facts from two authoritative sources. R.K.M.

BROWN, G., 1987. A new opalized fossil find. *Wahroonga News*, 21, 12, 5.

The editor of WN quotes from Mineral Industrial Quarterly that an opalized part of a skeleton of a 3 metre long plesiosaur has been found near Coober Pedy. He speculates whether this invaluable scientific find will succumb to commercial considerations and end as calibrated opal cabochons? [A pity if it does!] R.K.M.

BROWN, G., KELLY, S.M.B., 1987. An interesting copal resin necklace. *Australian Gemmologist*, 16, 7, 263-6, 7 figs in colour.

Various inclusions and other features seemed natural and suggested copal, but distant vision RI was approximately 1.60, instead of 1.54, and reactions to LUV and SUV light were not as expected. Possible explanations are offered, but doubt must remain. R.K.M.

BROWN, G., SNOW, J., 1987. Gemmological jottings. *Australian Gemmologist*, 16, 7, 267-70, 12 figs in colour.

Deals with natural turquoise beads colour-enhanced by dyeing and waxing; a plastic imitation walrus tusk scrimshaw, proved by blebs of plastic left in recesses; a Japanese synthetic opal which did not readily show 'lizard skin' or 'chicken wire' colour patches, or the columnar structure seen in Gilson type stones; imitation gold coral found to be a plastic-coated mixture of golden, 'thorny' coral and colourless plastic, with included bubbles; a

thermal diamond probe, the Diamond Beam (batteries or mains), which identified diamond efficiently (beep and red light) while simulants give no response, but are not identified. R.K.M.

BROWN G., SNOW, J., 1987. Gemmological study club reports. *Australian Gemmologist*, 16, 8, 287-92, 18 figs in colour.

Describes a white opal triplet; a bog oak cameo; unusually translucent turquoise; a plastic imitation ivory brooch; coated plastic imitation pearls and a Biwa cultured pearl necklace. R.K.M.

BROWN, G., SNOW, J., LAMB, J., 1987. A new treatment for turquoise. *Australian Gemmologist*, 16, 8, 307-9, 6 figs in colour.

Paraffin wax treatment for porous turquoise has been known for a long time although not much seems to have been written about it. This paper describes further deception by painting on black 'matrix veins' with a mixture of wax and Indian ink, which can be scraped off. R.K.M.

CAMPBELL, I.I.C., 1987. Four stones of interest. *South African Gemmologist*, 2, 4, 3-5, 4 figs in colour.

Four stones recently examined and illustrated are two simulations of emerald, a Zambian emerald with interesting inclusions and a tanzanite with unusual surface features. M.O'D.

CASSEDANNE, J.P., SAUER, D.A., 1987. La topaze impériale. (Imperial topaz.) *Revue de Gemmologie*, 91, 2-9, 16 figs in colour.

Occurrences of fine quality topaz in the Brazilian state of Minas Gerais are described. M.O'D.

CLUNAS, C., 1987. Jade carvers and their customers in Ming China. *Transactions of the Oriental Ceramic Society*, 50, 69-85, 7 figs.

A study of textual material not long known in the West has provided new light on the work of the jade carver in the Ming period, 1368-1644 and on the people who commissioned work from him. No references have been found to the tactile importance so often ascribed to jade - that seems to have been a later fashion - but visual effects are clearly of great importance. M.O'D.

FALLICK, A.E., JOCELYN, J., DONNELLY, T., GUY, M., BEHAN, C., 1985. Origin of agates in volcanic rocks from Scotland. *Nature*, 313, 6004, 672-4, 2 figs.

Isotope ratios,  $^{18}\text{O}^{16}\text{O}$  of silica and D/H of bound water are presented for agates from Lower Devonian lavas. These ratios are distinct from those obtained from agates from Tertiary lavas but the

two ratios are linearly correlated and plot along a single line approximately parallel to the line defined by present-day meteoric waters. The data suggest that bound waters associated with the agates have preserved their hydrogen isotope ratios since agate deposition: this supports arguments that the water content is of genetic significance.

M.O'D.

FENNER, C., 1987. Blackfellow's buttons. *Wahroonga News*, 21, 6, 6-7.

Abstracted from *Mostly Australian*, a book published in 1945, this deals with the black glass tektites found in southern and western Australia, and makes a case for their origin having been a single meteoric shower.

R.K.M.

FRITSCH, E., MISIOROWSKI, E.B., 1987. The history and gemology of Queen conch 'pearls'. *Gems & Gemology*, 23, 4, 208-21, 15 figs in colour.

An excellent and well illustrated paper on this infrequently encountered rare 'pearl'. Although usually below 10 carats in weight, they have occasionally been found up to 45 carats. Apart from colour the most valuable feature is the so-called 'flame' structure seen beneath the surface of the best 'pearls' which are found in the Queen conch, *Strombus gigas*, which is now a protected species so supplies are diminishing. 'Conch' is correctly pronounced 'konk' [despite the fact that most people seem to use the soft 'ch' ending]. They are non-nacreous and should not be regarded as true pearls, hence the quotes used for 'pearl'. Colour ranges from deep to pale pink, through brown and yellow to white, with a regrettable tendency for the pinks to fade on prolonged exposure to strong sunlight. A broad absorption around 500nm indicates an organic colour, so fading should be no great surprise. SG averages at 2.85, higher than for coral (2.65) which can be confused with conch 'pearl'. This paper deals only with the *S. gigas* 'pearls', although there are other univalves known as conchs which, with other pink shells, may produce pink or other coloured 'pearls'.

R.K.M.

FRITSCH, E., ROSSMAN, G.R., 1987. An update on color in gems. Part 1: introduction and colors caused by dispersed metal ions. *Gems & Gemology*, 23, 3, 126-39. 15 figs in colour.

This first of three parts explains a difficult subject in reasonably simple terms. Quantum mechanics are mentioned but not explained. Colour is different according to the nature of the colorant ion, its valency, and the composition of the host mineral. The co-ordination with 4, 6, or 8 neighbouring atoms also affects it. Differences in these factors in various crystal directions are among the causes of pleochroism.

R.K.M.

FRYER, C.W., ED., CROWNSHIELD, R., HURWIT, K.N., KANE, R.E., 1987. Gem Trade Lab notes. *Gems & Gemology*, 23, 3, 164-8, 12 figs in colour.

Alexandrite from a new find in Minas Geraes, colour change similar to fine Russian stones, properties consistent with published figures, some cat's-eyes seen, illustrated in *Gems & Gemology*, 23, 2. A 2.67ct green marquise diamond had small darker green areas and was highly radioactive, suggesting recent exposure to radium and that the stone could be a health hazard. An intense yellow, treated diamond showed strong Cape absorption; fluorescence in chalky greenish-yellow; chilled in liquid N, the stone showed 594nm line strongly proving radiation treatment; probably a natural Cape treated to increase the colour.

Spectacular triple link 'Imperial' jadeite earrings proved natural in colour; unusual quality to use in such a wasteful design. X-rays proved silver nitrate used to colour black cultured pearl necklace; natural blacks fluoresce under LUV, these were inert. A large button-shaped pearl had a diamond watch inset into its back; question whether this was a blister pearl or a whole pearl not resolved.

A scenic quartz from Massachusetts, with a three dimensional 'picture' caused by jasper-like inclusions is illustrated. A deep orangeish-yellow, heat-treated sapphire is described and illustrated.

An extremely rare cat's-eye sillimanite (fibrolite) was almost black in colour, with RI 1.66-1.68; these can be nearly colourless, violet, grey or this dark form. An unusual brownish-grey taaffeite of 0.61ct was examined by the Los Angeles laboratory, RI 1.720-1.726 [high birefringence?]. A green cat's-eye chrome tourmaline from Umba River, Tanzania, gave a strong red through the Chelsea filter. Most items illustrated.

R.K.M.

FRYER, C., ED., CROWNSHIELD, R., HURWIT, K.N., KANE, R.E., 1987. Gem Trade Lab notes. *Gems & Gemology*, 23, 4, 232-7, 13 figs in colour.

A modified brilliant faceted amber is described as unusual; another amber was shown to be composite, pieces of broken (amber?) beads held in a plastic matrix. 'Riverstone' beads, neither coral nor marble, were shown to be calcium carbonate. Corundum doublets were found in two important, bezel-set cluster rings, synthetic ruby and sapphire pavilions with natural sapphire crowns. Red fluorescence of synthetic emeralds to LUV is discussed and a specimen in which flux inclusions fluoresced yellow is illustrated; yellow fluorescing oil suggests an oiled natural emerald, but some synthetic emeralds are known to have been oiled.

Dyed quartzite beads simulated mottled jadeite; another dyed quartzite necklace resembled fine



green jadeite. A natural black Tahitian cultured pearl (20 x 18mm) was the largest seen by that Lab. Another calcareous, non-nacreous, concretion was from a 'thorny oyster' and had 'flame' structure as seen in clam and conch shells. A very large drop cultured pearl with a 12mm pre-drilled centre was proved to be of freshwater origin by its strong X-ray fluorescence. Heat treated natural rubies showed shallow spall cavities where material had 'blistered' off in treatment, some filled with a glass-like substance, one had acquired a spot of gold probably during setting. Synthetic rubies are not often heat-treated but some may be quench cracked to imitate fractures in natural stones, unusually these may spall and show other signs of the treatment apart from cracking [which does not require very high temperatures].

A new feature is added to this edition of Lab notes, quoting abstracts from items 25, 15 and 5 years ago. R.K.M.

GRAZIANI, G., GÜBELIN, E., MARTINI, M., 1987. The Lennix synthetic emerald. *Gems & Gemology*, 23, 3, 140-7, 10 figs in colour.

Grown by flux-fusion at atmospheric pressure, the crystals are described as short hexagonal prisms with predominant basal pinacoids. [The one illustrated, and all those seen earlier by abstracter, were octagonal and provided excellent preforms for emerald-cut stones. So far no one seems to have queried this unnatural shape for a hexagonal crystal, or offered any explanation of how it was achieved.] RIs vary slightly around 1.559 for *e* and 1.562 for *w*; birefringence 0.003 to 0.004, darker areas had the higher values; SG about 2.66; absorption similar to that of natural emerald plus 477nm in the *c* direction; good red through Chelsea filter. Inclusions plentiful, wisp-like veils, irregular opaque flux often with peripheral 'frames' of included crystals, tubes or rods parallel to the *c* axis, colour zones due to growth stages, included phenakite, etc. Superficial resemblance to poor quality, heavily-included natural emerald can cause problems. Veils and wisp-like inclusions are diagnostic. R.K.M.

GÜBELIN, E., 1987. Diagnose des nouvelles synthèses d'émeraude. (Diagnosis of new syntheses of emerald. *Revue de Gemnologie*, 92, 5-7, 11 figs in colour.

Features of the Lennix synthetic emerald are described and illustrated (the first of a set of papers). M.O'D.

GÜBELIN, E., 1987. Diagnose des nouvelles synthèses d'émeraude. 2nd part. (Diagnosis of new synthetic emeralds.) *Revue de Gemnologie*, 93, 7-11, 19 figs in colour.

Emeralds of artificial origin are discussed. Those illustrated are the Biron and two Soviet products, one flux-grown, the other hydrothermal. M.O'D.

GÜBELIN, E.J., 1987. The genesis of mineral inclusions in gemstones. *Gem Bulletin, Stockholms Gemmologiska Förening*, 2, 1-28, 31 figs.

A chapter from the author's book *Photoatlas of inclusions in gemstones\** is reproduced. M.O'D.

GÜBELIN, E., 1988. Lightning Ridge. *Lapis*, 13, 2, 15-30. 37 figs (34 in colour).

A beautifully illustrated and exhaustive account of the classic Australian opal field at Lightning Ridge in New South Wales. M.O'D.

HÄNNI, H.A., SCHWARZ, D., FISCHER, M., 1987.

Die Smaragde der Belmont-Mine bei Itabira, Minas Gerais, Brasilien: Vorkommen und Charakteristika. (The emeralds of the Belmont Mine near Itabira, Minas Gerais, Brazil: their occurrence and characteristics.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, 36, 1/2, 33-49, 22 figs (3 in colour), 4 tables, bibl.

An English version of this article was published in the *Journal of Gemmology*, 1987, 20, 7/8, 446-56.

E.S.

HOCHLEITNER, R., WEISE, C., 1987. Die Himalaya Mine der Mesa Grande in Kalifornien. (The Himalaya Mine near Mesa Grande in California.) *Lapis*, 12, 10, 11-32, 20 figs (12 in colour).

The Himalaya mine in southern California is now once more producing fine quality pink and multi-coloured tourmaline crystals. Details of the history of the mine are given. M.O'D.

HUGHES, R.W., 1987. The plastic coating of gems. *Australian Gemmologist*, 16, 7, 259-61, 9 figs in colour.

Among cheap stones from Burma were faceted quartz, colourless star corundum, and pale jadeite coated with red or green plastic to imitate much more valuable gems. Magnification revealed peeling of plastic, gas bubbles, swirls of colour, etc. R.K.M.

KANE, R.E., 1987. Inamori synthetic cat's-eye alexandrite. *Gems & Gemology*, 23, 3, 158-62, 5 figs in colour.

Kyocera Corporation has produced the first commercial cat's-eye alexandrite. History of chrysoberyl synthesis is outlined. This cat's-eye is probably from a Czochralski pulled crystal. Broad eye of moderate intensity, greyish-green in daylight, dark purplish-red in incandescent light, slightly oily dullness, otherwise apparently clean. Faint

\*Reviewed in *Journal of Gemmology*, 1987, 20, 5, 312-3.

six-ray star seen down eye-streak direction, this does not occur in the natural stone. Microscope showed vague rippled striations parallel to the long axis of the stone. Natural cat's-eyes contain ultra-fine growth tubes or needles quite different from anything seen in these synthetics. R.K.M.

KELLY, M.B., 1987. Notes from the Lab. *Wahroongai News*, 21, 3, 13, 1 fig.

An antique gold mounted suite was set with foil-backed yellowish-green and green cabochons which were identified as prehnite – possibly imitating chrysoprase. R.K.M.

KELLY, R., 1987. The art and skill of the lapidary: cabochon cutting. *Wahroongai News*, 21 : (a) part 1, 2, 18–19; (b) part 2, 3, 10–11; (c) part 3, 5, 17–19.

(a) The first paper of the series. (b) Advice on selection of rough. (c) Selecting the best equipment for capping. Some sound advice from a very expert cutter. R.K.M.

KELLY, R., 1987. Facets. *Wahroongai News*, 21, 6, 10–11.

Brief but sensible advice on this subject. R.K.M.

KEMP, J., 1987. Jade. *Wahroongai News*, 21, 8, 15–20, 1 fig.

An interesting paper which deals with nephrite and jadeite and with a long list of imitants. R.K.M.

KOIVULA, J.I., 1987. Gem news. *Gems & Gemology*, 23, 3, 172–6, 8 figs in colour.

A heavily cracked and included diamond had apparently been filled to minimize cracks. Reportedly treated in Israel by high temperature and pressure, with a secret filler; a number of such stones have been seen. A 64.83 ct pear-shaped diamond auctioned by Christie, Manson & Woods in New York is illustrated. No price quoted.

An iridescent andradite cabochon was bought in Hong Kong as black opal; colour play is in zones which echo the original rhomb-dodecahedron; a 44.59ct example is illustrated; this new gemmological material is thought to come from Sonora, Mexico; iridescent garnet was known before, but this seems to be an outstanding example. Emeralds impregnated with plastic have been found by a Japanese laboratory; more durable than oiling, the unknown plastic can still penetrate only where cracks reach the surface of the stone. Kunzite from a new source in Sri Lanka is reported. 'Rainbow moonstones' from India have been identified, by Dr Hänni of Basel, as labradorite feldspars. Orangeish-brown quartz cat's-eyes from Belo Horizonte, Minas Gerais, show exceptionally fine chatoyancy, sometimes with a hint of asterism.

Quartz with included marcasite, pyrite, chalcopyrite, silver and gold, from Zacatecas, Mexico, is being cut as beads and sold as solvernite. A new ruby locality in Afghanistan is reported. Mr Bleck says that Sri Lankan rubies are being heated in an open fire to drive off blue over-tones; and that some cat's-eye zircons have had the eye induced by melting feldspar onto the rough back of the zircon cabochon. R.K.M.

KOIVULA, J.I., Ed., 1987. Gem news. *Gems & Gemology*, 23, 4, 238–42, 6 figs in colour.

Diamonds from a kimberlite pipe are reported from Mato Grosso, the first such mine in Brazil. A rare and complex diamond Mohs-Rose twin is illustrated. The 64.83 ct diamond described in Gem news (*Gems & Gemology*, 23, 3) fetched US\$6,380,000 at Christie's.

Itabira mine, Minas Gerais, is producing an impressive quantity of fine alexandrites when not interrupted by strife among the local miners. 'Siberian' amethyst has been found at Rainbow Lode mine at Red Feathers Lakes, Colorado, some in gem quality. Adularescence in amethyst from Artigas, Uruguay, has been called the 'Lowell' effect after its discoverer. H.S. Pienaar has introduced the 'Stellenbosch Index', or SGI, as a new method of teaching the basics of gemmology. A star sapphire also had colour change from blue to blueish-purple in incandescent light. Natural strontium titanate has been found in Mongolia. Thaumassite, a complex hexagonal compound of hydrated calcium silico-carbide and sulphur, was found, in a South African shipment of minerals, in gem quality, but a hardness of 3.5 makes it unsuitable for jewellery. A pocket of gem topaz has been found at Conway, New Hampshire.

We are warned that short-wave UV filters can deteriorate with time and become opaque. Newest short UV lamps have 'life-time' filters. Efficiency can be checked with scheelite, benitoite or [hopefully] 'even a small synthetic yellow Ib diamond'.

R.K.M.

KOIVULA, J.I., 1987. Goethite inclusion alteration during heat conversion of amethyst to citrine. *Australian Gemmologist*, 16, 7, 271–2, 2 figs in colour.

Heating amethyst to 350°C changed golden goethite inclusions to brown/red hematite with some fracturing of the host quartz due to release of water. Such hematite pseudomorphs plus fracturing indicate heat treatment. R.K.M.

KOIVULA, J.I., 1987. Pronounced flow structure in Australian opal. *Australian Gemmologist*, 16, 7, 257–8, 1 fig. in colour.

A boulder opal showed clear evidence of flow

structure with curved layering of colour-play areas. The phenomenon is not uncommon, but is rarely as obvious as this. R.K.M.

KOIVULA, J.I., 1987. Pyrite in Canadian ammonite. *Australian Gemmologist*, 16, 8, 304-7, 4 figs in colour.

Pyrite is sometimes the replacing mineral in these beautiful fossils [cf Dorset Lias, England]. The author describes it in ammonites from Alberta, Canada, and has taken the trouble to prove the mineral chemically. The Canadian fossils are protected by law, so complete fossils may not be used for jewellery, although broken ones can be so used. R.K.M.

LOOCK, G.W., 1987. Chrysoberyll aus Orissa, Indien. (Chrysoberyl from Orissa, India.) *Lapis*, 12, 12, 11-15, 14 figs (8 in colour).

Fine crystals of chrysoberyl, mostly twinned, are found at a number of mines in the State of Orissa, India. Well-formed trillings are fairly common and other minerals of ornamental interest include amethyst, zircon and topaz. M.O'D.

NASSAU, K., 1987. Irradiated gemstones – could the ice be hot? *Lapidary Journal*, 41, 5, 41-6, 3 figs (1 in colour).

The possibilities of gemstones retaining latent radioactivity after treatment to alter or enhance colour are discussed. Actual amounts of radiation so far observed are minimal but care needs to be taken with some topaz, spodumene and diamond. M.O'D.

NASSAU, K., VALENTE, G.K., 1987. The seven types of yellow sapphire and their stability to light. *Gems & Gemology*, 23, 4, 222-31, 8 figs in colour.

Deals in detail with (1) light stable natural yellows; (2) natural or irradiated yellows with fading colour centre; (3 & 4) iron-containing unheated and heated yellows which are stable; (5) yellows obtained by surface diffused Fe or Ni – stable; (6) synthetic yellows – stable; (7) irradiated synthetics – unstable. Unexpectedly natural yellows can fade when heated to less than 200°C, but colour can be restored by exposure to light. R.K.M.

NIEDERMAYR, G., 1986. Bleiberg, Carinthia, Austria. *Mineralogical Record*, 17, 6, 355-69, 33 figs (12 in colour).

Bleiberg is one of Europe's classic locations for lead and its minerals. The gemmologist, however, will be most interested in the occurrence of lumacelle, first described in 1793. This material, whose play of colour comes from fossil shell

fragments, is found in the argillaceous Raibler beds which overlie the Wetterstein complex. M.O'D.

OBENAUER, K., 1987. Über Merkmale des Quellens und Schwindens bei der Chalcedon-Bildung. (On the role of swelling and contraction in chalcedony formation.) *Aufschluss*, 38, 247-52, 5 figs (1 in colour).

Details of the formation of chalcedony are given with especial reference to the way in which growth allows the material to expand and contract. M.O'D.

O'DONOGHUE, M., 1987. Gems and gemmology. *Watchmaker, Jeweller & Silversmith*, September 1987, 51-3.

Chief attention is paid to amber, jet and their simulants; there are also notes on synthetic jadeite and synthetic ruby, a substitute for lapis lazuli and details of interesting specimens on display at the 1987 Tucson gem and mineral fair. At the fair it was reported that tsavorite had virtually disappeared from the market and that chatoyant kornerupine was being offered as chatoyant quartz. (Author's abstract.) M.O'D.

O'DONOGHUE, M., 1987. Adelstenar som Försvinner i Natten. (Gemstones that pass in the night.) *GME Bulletin*, Stockholm Gemmologiska Förening, 1987/1, 12-13.

A brief description of manganooan sugilite is given. (Author's abstract.) M.O'D.

OLLIVER, J.G., 1987. A review of jade in South Australia. *Australian Gemmologist*, 16, 8, 283-6, 9 figs, 6 in colour.

This deals with Cowell nephrite deposits. Geology; estimated potential of this 6 × 3km area are discussed optimistically. R.K.M.

READ, P.G., 1987. Birth of a science. *British Jeweller*, June 1987, 74-7, 90, 5 figs in colour.

To coincide with the hundredth anniversary of the *British Jeweller*, this article traces the development of the science of gemmology over the last 100 years in terms of the personalities of the period, the emergence of gem test instruments, newly discovered gem species and the evolving techniques of gemstone synthesis and identification. (Author's abstract.) P.G.R.

ROBERT, D., 1987. A propos d'une analyse d'émeraude synthétique. (Concerning an analysis of a synthetic emerald.) *Revue de Gemmologie*, 93, 12.

Further notes on the Lennix emerald are given to supplement the points made by Gübelin in his

paper in *Revue de Gemmologie*, 92. M.O'D.

ROUGHGEMS LTD., 1987. Charoite. *Wahroongai News*, 21, 12, 29.

An account of this rare, one locality, attractively grained violet-purple hydrated calcium-potassium-silicate metasomatic rock. A beautiful addition to the ornamental materials list which could be more widely exploited. R.K.M.

RUNDLE, F.A., 1987. Colour grading coloured stones. *Wahroongai News*, 21, 7, 2-8.

An excellent review of the problems and difficulties of this subject, and of two American colorimetric methods of defining colour: the GIA ColorMaster and the American Gemological Laboratories' Color Scan Charts. R.K.M.

RUSKONE, E., 1987. La taille des pierres de couleur. (The cutting of coloured stones.) *Revue de Gemmologie*, 92, 15.

The first part of a paper on the cutting of coloured stones. The history of the process is introduced. M.O'D.

RUSKONE, E., 1987. La taille des pierres de couleur, 2nd part. (The cutting of coloured stones.) *Revue de Gemmologie*, 93, 13-17, 4 figs in colour.

General discussion of the history and techniques employed by the lapidary. M.O'D.

SCHÄFER, W., 1987. Himmlische Tränen. (Heavenly tears.) *Schmuck und Uhren*: 10, 35-8; 11, 36-8, 7 figs (1 in colour).

A description of the emerald mines of Colombia. M.O'D.

SCHMETZER, K., HENN, U., 1987. Synthetic or imitation? An investigation of the products of Kyocera Corporation that show play-of-color. *Gems & Gemology*, 23, 3, 148-51, 3 figs in colour.

Investigates whether these are synthetic opal or opal simulants. Authors found that they contained no water and therefore do not match natural opal. They propose they should be called simulants and not synthetics. R.K.M.

SHIGLEY, J.E., FRITSCH, E., STOCKTON, C.E., KOIVULA, J.I., FRYER, C.W., KANE, R.E., HARGETT, D.R., WELCH, C.W., 1987. The gemological properties of De Beers gem-quality synthetic diamonds. *Gems & Gemology*, 23, 4, 187-206, 23 figs in colour.

With so many eminent authors this has to be an important paper.

GIA Research Department examined 14 synthetic type 1b diamonds grown by De Beers, 8 crystals

up to 5.23 ct and 6 faceted stones up to 0.90 ct. The paper is the first report on these in gemmological literature.

Colours range from dark brownish-yellow, through bright yellow to greenish-yellow, grown in a multi-metal melt which is both flux and catalyst. De Beers say that no faceted stones have been marketed, nor do they intend doing so. Growth experiments have been directed entirely towards high technological needs. However, some Sumitomo synthetic diamonds have appeared on the open market so identification has considerable significance.

Gemmologically the De Beers diamonds can be detected as synthetic by short-wave fluorescence, which is yellow in the brownish and greenish stones, with slight phosphorescence in the latter; by absence of absorption lines expected in natural yellow stones; by geometric zoning of colour and of internal graining; by clouds of minute white inclusions which fog some of the darker stones; by some larger inclusions of flux metal; and by crystal surface defects, which may be found as naturals on cut stones, which are specific to the synthetics. Infrared spectra indicate that the synthetics are all type 1b, rare in natural yellow diamonds, which are usually type 1a.

The authors are confident that synthetic diamonds of this type can be detected with ease, but express some reservations whether diamonds with lower nitrogen content, e.g. the more difficult colourless stones, should they ever be made on a commercial scale, would be detectable. [It seems only fair to emphasize that production of synthetic diamonds in cuttable gem quality does seem still to be a very expensive undertaking, possibly justified only for use in vastly important scientific applications. To date that seems to be the object of these exercises.] R.K.M.

SNOW, J., 1987. Care and use of gemmological instruments. *Wahroongai News*, 21 : (a) 2, 10-11; (b) polariscope, 3, 9-11; (c) the figure-o-scope, 4, 14-15, 3 figs; (d) the refractometer, 5, 14-15; (e) the microscope, 6, 10-11.

(a) Logically, Mr Snow starts with the eye, for without this natural organ gemmology could hardly exist. He then gives sound advice on the use of the hand lens. (b) Sound, basic instruction on the polariscope and good advice. (c) An Australian version of the conoscope, similar to the polariscope but using oblique light to give interference figures. Line drawings do not convey the expected figures too well. (d) More very sound advice, this time on the refractometer, from an expert gemmologist. (e) Brief but sensible advice on the microscope.

R.K.M.

SNOW, J., 1987. The Chelsea filter. *Wahroongai News*, 21, 8, 8.

A short account of this well-known gemmological aid. The author says that natural emeralds appear pink or green through the filter. [In my experience emeralds which do not show pink give an ash-grey residual colour, not green, despite what textbooks may say. Any 'emerald' appearing green through the filter is not an emerald!] R.K.M.

SNOW, J., 1987. Helpful hints with practical work. *Wahroongai News*, 21, 9, 26-7.

Logical approach to testing three different stones with further suggestions for such problems. All good sound advice. R.K.M.

SNOW, J., 1987. The Kerez effect. *Wahroongai News*, 21, 12, 15-18.

A full account of a multiple RI effect seen in certain tourmalines, which the abstracter reported in 1967 and named after the friend who had first noticed it. Others have written about it since and are quoted here. Suggestions are made for a possible further investigation, including attempts to reproduce the effect by controlled heating of tourmalines. [The dark green tourmalines exhibiting this multiplicity of readings are rare, possibly from a unique locality, and it is perhaps unwise to assume that heat, however applied, will necessarily give rise to the effect in any suitably coloured tourmaline.] R.K.M.

SNOW, J., BROWN, G., 1987. LWUV fluorescence of gemstones: a photographic review. *Australian Gemmologist*, 16, 8, 269-300, 16 figs in colour.

About 100 gems were grouped by species with their imitants and photographed in white fluorescent light and then in long-wave UV light. The resultant pairs of slides are often informative – possibly of the variability of fluorescent colour, which may be responsible for the often differing descriptions of the phenomenon in various tests. R.K.M.

STEIN, I., 1987. Opal triplets. *Wahroongai News*, 21, 8, 21-2.

An account which suggests that moulded glass tops (frangible!) are largely being used in place of quartz in making these cheap versions of opal. R.K.M.

STEIN, I., 1987. Opal triplets, cutting by hand. *Wahroongai News*, 21, 9, 15-17, 4 figs.

Advice on cutting and assembly. R.K.M.

STEIN, I., 1987. Machine cutting of opal triplets. *Wahroongai News*, 21, 10, 17-18, 5 figs.

Describes the Bilki saw which has 120 close-set blades vibrating 1400 times a minute, producing opal slices about 0.25mm thick. The ultra-thin blades are charged with silicon carbide grit and wear very rapidly. Basically this is an update of the primitive mud-saw. [The line diagrams would be more readily understood if annotations could be typed instead of scribbled freehand!] R.K.M.

SUNAGAWA, I., 1986. Morphology of diamonds. *Morphology and Phase Equilibria of Minerals*, Sofia: IMA Vol. 2, 195-207.

Observations on morphology and surface microtopography of diamond crystals of three different origins are summarized and the observations are critically analysed in the light of present understanding of the growth mechanisms and morphology of crystals. The three types of diamond are: (1) natural diamond, including both single-crystals and polycrystalline aggregates. Both ultramafic suites (in kimberlite) and eclogite suites are discussed. All natural diamonds are grown from the solution phase of silicate compositions under diamond stable conditions; (2) synthetic diamond grown by static high  $P$  under diamond stable conditions. They are grown from metal-carbon solution phases; (3) synthetic diamond grown by pyrolysis or chemical vapour deposition processes of  $\text{CH}_4$  or  $\text{C}_2\text{H}_2$  under  $P < 1$  atm. and high  $T$  conditions. They are grown under diamond unstable conditions from the vapour phase. Analysis of growth rates vs chemical potential provides information concerning the mutual relations among polycrystalline aggregates, dendritic, hopper and polyhedral crystals. Analysis of morphological characteristics of single crystalline diamonds and their surface microtopographs are based on the extent to which their morphologies deviate from the theoretical morphology. J.M.H.

THEMELIS, T., 1987. Diamonds from Venezuela. *Lapidary Journal*, 41, 4, 59-69, 5 figs (1 in colour).

Maps and descriptions are given for Venezuelan diamond. M.O'D.

THEMELIS, T., 1987. Burmese taaffeite. *Lapidary Journal*, 41, 5, 19, 2 figs in colour.

Among the inclusions noted are red crystals, perhaps of spinel; various parallel acicular crystals of unknown species and fingerprint or feather-like droplets resembling those in Burmese blue sapphire. Colourless transparent hexagonal crystals with a slightly rounded outline were noted in another specimen. M.O'D.

THEMELIS, T., 1987. Girasol effect. *Lapidary Jour-*

nal, 41, 6, 19, 2 figs in colour.

A particular colour effect seen in some Mexican opal is described. M.O'D.

THROWER, C., STEANE, D., 1987. Notes on Tasmanian gemstones. *Australian Gemmologist*, 16, 6, 223-4.

Large very dark sapphires from Weld River area were too flawed and twinned for heat treatment to lighten colour. Upper Gordon River stones also strongly twinned with some asterism. No gem quality. Colours light blue to black.

Fragments of alexandrite found with sapphires at Weld River, some with chatoyancy.

Low quality turquoise found at Back Greek, at Beaconsfield and on north-west coast, usually as thin veins in slate, porous with white soft patches.

R.K.M.

TILLANDER, H., 1987. Diamantschliff im 17. Jahrhundert. (Diamond cutting in the seventeenth century.) *Jahrbuch der Kunsthistoriker Sammlungen in Wien*, 81, 169-84, 191 figs.

The essay describes the development of diamond cuts in the 17th century. Cuts developed during the period include the Taille en Seize, V-cut and the Hybrid half-rose cut. The rose cut itself is also discussed. M.O'D.

TRT'YAKOVA, L.I., BENAVIDES, K.S., 1987. (Mineralogical and spectral colorimetric studies of emeralds from Chivor and Muzo deposits, Colombia.) *Zapiski Vses. Min. Obshch.*, 116, 6, 713-18. (Russian with English abstract.)

A series of emeralds from the Chivor and Muzo deposits has been studied and their chromatic characteristics established. Although there is some overlap, spectral differences are clearly seen between the emeralds from these two Colombian deposits. The chromophores are Cr<sup>+</sup> and V<sup>+</sup>.

R.A.H.

WALKER, G.S., 1987. A new 'spot reading' technique for the refractometer. *Australian Gemmologist*, 16, 7, 253-6, 2 figs.

For distant vision RI tests, suggests using a pinhole diaphragm held close to the eye and viewing from about 6cm instead of 30cm. Spot and scale are both in focus and more of the scale is seen. R.K.M.

WARD, F., 1987. Jade, stone of heaven. *National Geographic*, 172, 3, 282-315, 37 figs in colour.

Attractively illustrated general overview of the jade minerals and methods of fashioning them.

M.O'D.

WILKS, E.M., WILKS, J., 1987. Cleavage surfaces of diamond. *Industrial Diamond Review*, 47, 1, 17-20.

The (111) cleavage surfaces are generally smoother on the so-called Type II diamonds than on the much more common Type I diamonds. Such variations are due to the quite large variations of crystal structure arising from the presence of impurity atoms, and reflected in the irregular pattern of growth banding. R.A.H.

WILKS, E.M., WILKS, J., 1987. An unusual form of coated diamond. *Mineralogical Magazine*, 51, 5, 743-6.

On polishing an (001) surface on a colourless dodecahedral diamond of gem quality from Zaire, a marked step was observed between the central and outer regions. This distinction into core and coat was confirmed by X-ray topography and SEM techniques, and by differences in abrasion resistance and orientation of cleavage. These differences are ascribed to quite different growth conditions.

R.A.H.

## Book Reviews

APOSTOLESKU, R., 1987. *Caleidoscop mineralogic*. (Mineral kaleidoscope.) Editura Technica, Bucuresti, pp.246, illus. in black-and-white and in colour. Lei 22.50. [In Rumanian.]

Despite the popular sound of the title, this is a serious mineralogical textbook with very valuable references to Romanian minerals and their localities. Gem quality minerals are described and illustrated in colour at the end of the book. There is a bibliography and a chapter with questions and answers. M.O'D.

BALFOUR, I., 1987. *Famous diamonds*. Collins, London, pp.224, illus. in black-and-white and in colour. £15.00.

Based on a series of articles appearing in *Indiaqua*, this excellent book covers many of the best-known diamonds with illustrations and copious historical notes. There is a table to the world's largest stones, giving details of the stones and their whereabouts where known, a glossary and a useful bibliography. Although there are many accounts of celebrated diamonds extant, this one is carefully written and is based on records whose authenticity is sound. The price is most reasonable for so attractive and interesting a book. M.O'D.

BIRĂU, O., CIUHANDU, A., VANGHELI, D.A., 1986. *Safirul și rubinul*. (Sapphire and ruby.) Editura Facla, Timisoara, pp.170, illus. in black-and-white. Lei 19.50. [In Romanian.]

An exhaustive treatise on the ruby and sapphire varieties of corundum with particular reference to crystal structure as determined by X-rays. There is an excellent bibliography. M.O'D.

FIELD, L., 1987. *The Queen's jewels*. Weidenfeld and Nicolson, London, pp.192, illus. in black-and-white and in colour. £18.00.

More than one book has been assembled from photographs of the personal jewellery of Her Majesty the Queen but this is the most satisfactory one to appear so far. This book, too, includes a section on jewellery which is properly the property of the state as the crown jewels are also described.

The jewellery is described by stone so that there are sections on rubies, sapphires and diamonds,

among others. Considerable historical material is provided and the photographs are of high quality. Many are themselves of historical interest as their subjects include personages of previous generations. This is a well-produced book and well worth the very reasonable price. There is an excellent bibliography. M.O'D.

HADDLETON, M.E., 1987. *The Jewellery Quarter history and guide*. YBA Publications, Birmingham, pp.39, illus. in colour. Gratis.

A most delightfully produced guide to the happily rejuvenated Jewellery Quarter of Birmingham. M.O'D.

HARTMAN-GOLDSMITH, J., 1986. *Chinese jade*. Oxford University Press, Hong Kong, pp. xvi, 81, illus. in black-and-white and in colour. £6.95.

Forming part of the series *Images of Asia*, this short book is of good quality, describing the main features of the use made of the jade minerals by the Chinese. Particular reference is made to the nature of the artefacts and there is a useful bibliography. M.O'D.

LUZZATTO-BILITZ, O., 1987. *Antique jade*. Cassell, London, pp.153, illus. in colour. £4.95.

Translated from *Antiche giade*, published in 1966, this is a good short guide to jade artefacts and is well illustrated. M.O'D.

MATTHES, S., 1987. *Mineralogie*. (Mineralogy.) Springer-Verlag, Berlin, pp. xvii, 444, illus. in black-and-white. DM69.00.

The second edition of a work first published in 1983, the text deals not only with the major mineral species but gives a detailed account of mineral formation and rock types. Thus it is in no sense a replacement of Dana's *Manual of mineralogy* but rather a text which guides the reader through a good deal of material found normally only in journals. The section describing minerals starts the book and the remainder of the text covers the three major rock types, their petrology and mineralogy.

Each section has its own bibliography and there are some useful crystal drawings as well as high-quality photographs. M.O'D.



PIETRACAPRINA, A., BRIZZI, G., 1986. *La Sardegna e i suoi minerali*. (Sardinia and its minerals.) Editrice Mediterranea, Cagliari, pagination irregular, illus. in colour. Price on application.

Minerals from Sardinia are described in alphabetical order, each entry containing full details of the mineral concerned with notes on occurrences. Gem minerals include amethyst, fluorite and vesuvianite. Maps of important occurrences follow the descriptive section and then come notes on minerals and crystals in general, with a glossary. There is a short bibliography. The book is very well produced and particularly welcome. M.O'D.

SCHUBNEL, H.-J., 1987. *Pierres de lumiere et objets precieux*. (Shining stones and precious objects.) Editions Arthaud, Paris, pp.257, illus. in colour. F 495.00.

Though there are a number of books presenting fine jewelled artefacts with a general supporting text, this one is very well produced with many of the pictures new to publication. The book commences with a description of the use of gemstones in prehistory and among primitive societies, proceeding to the introduction of later objects from both East and West; particular attention is paid to the pieces emanating from Central America and this section also contains an account of gemstone carving. The remainder of the book discusses gemstones themselves with a useful note on gemstones in commerce. There is a short bibliography. M.O'D.

SPENCER, C., 1986. *Mineral wealth of Saudi Arabia*. Immel Publishing, London, pp.128, illus. in colour. £23.50.

Among the minerals with possible ornamental application found in Saudi Arabia are peridot, fluorite, selenite, gold, azurite, malachite, chrysocolla, tourmaline, garnet, amazonite and quartz.

M.O'D.

SYCHOVA, N., 1984. *Traditional jewellery from Soviet Central Asia and Kazakhstan*. Sovetsky Khudozhnik, Moscow, pp.179, illus. in colour. Price on application.

This is a well-illustrated and printed book with a text in Russian and English. Coral and turquoise are widely used and many stones are set in silver. A wide variety of styles has been chosen to give the reader a good idea of the range used over the period described and there is a short bibliography, in Russian only.

M.O'D.

SUNAGAWA, I., 1987. *Materials science of the earth's interior*. Terra Scientific Publishing Company, Tokyo, and D. Reidel Publishing Company, Dordrecht. pp. xv, 653. Illus. in black-and-white. Price on application.

This major work contains chapters on the mechanism of crystal growth and on the morphology of natural and synthetic diamond crystals. These chapters are followed by others on surface microtopographic and X-ray topographic study of octahedral crystal of natural diamond from Siberia and on synthesis researches of diamond. M.O'D.

## Proceedings of the Gemmological Association of Great Britain and Association Notices

### OBITUARY

**Mr E.J. Burbage, FGA** (D.1927 with Distinction), London, died on 18 January 1988, after a long illness. His collection of gemstones and minerals will remain on display at Haslemere Museum.

**Mr Leslie F. Cole, FGA** (D.1937 with Distinction), London, died on 6 December 1987 within a few days of his 81st birthday. A service was held at St Anthony's Church, Nunhead.

Fifty years ago Leslie Cole passed his examination in gemmology with distinction. It was a year when the list of successful candidates was almost entirely male and represented the coloured stone trade in many aspects of collectors, dealers and specialists. It was the era when Chelsea Polytechnic was the venue of trade gemmology, the classes were entitled 'Mineralogy for jewellers'. Leslie was acquainted with not only Chelsea Polytechnic but also with the Northern Polytechnic and Sir John Cass College. A close associate and friend of Robert Webster, he assisted at classes over a very long period and to within a year or so of his death.

He was also a member of the Council of the Gemmological Association for many years; one could say that Leslie Cole served the trade and gemmology for a lifetime. During the war years he served as a Special Constable in the war-torn capital. His retail experience included Wordleys the specialist shop in Birchin Lane in the City of London. His daughter has happy memories of accompanying her father on his Saturday morning clock winding tours of duty. After the closure of Wordleys he joined the old established jewellers Jay Richard Attenborough in Oxford Street. His last position was with Arthur Saunders of Southampton Row.

He will be remembered by generations of students of the London scene and by fellow Council members. His lifetime as a gemmologist spanned the vintage years of Anderson, Payne, Webster, Andrews and Wheeler, embracing the very gamut of gemmology.

A.E.F.

**Mr Xaver Saller, FGA** (D.1960 with Distinction), died on 18 December 1987.

With the death of Xaver Saller gemmology has lost one of its brightest stars. Very knowledgeable, always helpful, his death is a sad loss to all those who knew and worked with him and to the industry as a whole. He is survived by his wife, Doris, and daughter Silvia.

Xaver Saller was a self-made man. He was born in Schmiedeweiden in Bavaria on 26 May 1904, lost his mother at the age of seven and his father at the age of twelve during the First World War. After leaving grammar school in Nürnberg, he went to the Technical Goldsmiths College in Pforzheim, and from then on worked in the jewellery trade. In 1951 under Professor Schlossmacher he took his German gemmological examinations and in 1960 he became an FGA. Xaver Saller was an Honorary President of the German Gemmological Association, and an honorary member of the Finnish and Japanese gemmological associations. He also contributed to various committees, including the nomenclature commission of CIBJO.

Together with his wife Doris he offered generous hospitality to his many friends. His house in Rottach/Egern is a delight. I am very saddened by the loss of an honourable man and good friend. E.S.

### GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to E.A. Thomson (Gems) Ltd, London, for the gift of two oval fluorolith cabochons.

### NEWS OF FELLOWS

After 38 years with the Gemological Institute of America and the GIA Gem Trade Laboratory, Bert Krashes announced his retirement near the end of 1987. He will continue to serve on the Board of Governors of the GIA.

Bert Krashes was born in New York City on 23 April 1923. He is married to Charlotte Frankel and has three sons and a daughter.

Mr Krashes was a bombardier in the United States Eighth Air Force during World War II. He became a prisoner of war, after being shot down and wounded over Europe. His formal education included the New York City public school system, New York University, and the Gemological Institute of America, from which he was graduated in 1949. Mr Krashes joined the staff of the GIA and the GIA Gem Trade Laboratory in 1949. He soon developed a reputation as an outstanding teacher, and became a much sought after speaker for the American Gem Society conclaves and for jewellers' groups all over the United States and Canada.



Bert Krashes.

In addition to earning his Graduate Gemologist diploma from the GIA, he also became a Certified Gemologist through the American Gem Society. In 1953 Krashes passed with Distinction the Diploma Examination of the Gemmological Association of Great Britain. In 1970 he was made an honorary vice president of the Gemmological Association of Canada. Together with his longtime colleague, Robert Crowningshield, Bert Krashes was honoured by the American Gem Society in 1983, by the presentation of its prestigious Robert M. Shipley award.

In his many years of dedicated service Bert Krashes earned the respect and admiration of those who had the opportunity to work with him. The diamond and jewellery industries have been enriched by his presence.

\* \* \*

On 18 November 1987 Mr Michael O'Donoghue, MA, FGS, FGA, organized and chaired a British Library Seminar on Earth Science Information Sources.

On 5 March 1988 Mr O'Donoghue gave a lecture entitled 'Gemstones' to the Kent Group of the British Iris Society.

### MEMBERS' MEETINGS

#### London

On 8 March 1988 at the Flett Theatre, Geological Museum, Exhibition Road, South Kensington, London SW7, Dr Margherita Superchi gave an illustrated lecture entitled 'The treasures of Milan Cathedral, the use of a pot-stone from Val Malenco and the alabaster of Volterra'. Dr Superchi's presentation was dedicated to the memory of Xaver Saller of Munich, West Germany, who died in 1987 (obituary p.117).

#### Midlands Branch

On 15 January 1988 at Dr Johnson House, Bull Street, Birmingham, Mr Alan Jobbins, FGA, gave an illustrated lecture entitled 'The gemstones of Brazil'.

On 19 February 1988 at Dr Johnson House Mr Alan Clark, FGA, of the Gem Testing Laboratory of Great Britain, gave an illustrated lecture entitled 'Future gemmology?'.

On 18 March 1988 at Dr Johnson House Mr D.J. Callaghan, FGA, Chairman of the Gemmological Association, gave an illustrated lecture entitled 'From gem to jewel'.

#### North West Branch

On 20 January 1988 at Church House, Hanover Street, Liverpool, Mr W. Stringer gave a talk entitled 'Diamonds'.

On 17 February 1988 at Church House Mr Jonathan Condrup of Sothebys gave a talk entitled 'Antique cameos'.

On 16 March 1988 at Church House Dr John Franks gave a talk on the Munich Gem Fair.

### COUNCIL MEETING

At a meeting of the Council held on 18 February 1988 at the Royal Automobile Club, Pall Mall, London SW1, the business transacted included the election to membership of the following:

#### Fellowship

Aresti, Tony, London. 1987

Bernat, Marcos, Barcelona, Spain. 1987

Brennan, John D., Birmingham. 1969

Chiu, Man K.A., Kowloon, Hong Kong. 1987

Corduff, Rosalie P.T., Stoke-on-Trent. 1987

Dale, Ann F., Kenner, La., USA. 1987

Dalmau Bafalluy, Mo Nieves, Barcelona, Spain. 1987  
 Drukker-Loth, Julia J.M., Huizen, Netherlands. 1987  
 Dufficy, Margaret H., San Rafael, Ca., USA. 1987  
 Ferrer Coma, Montserrat, Barcelona, Spain. 1987  
 Fillion, Marie M., Montreal, Que., Canada. 1987  
 Hakola, Arto K., Tornio, Finland. 1987  
 Lam, Jim M.K., Kowloon, Hong Kong. 1987  
 Marsh, Lesley F., Harare, Zimbabwe. 1987  
 Maupu, Françoise J., St Rambert en Bugey, France. 1987  
 Metaxas, George C., London. 1987  
 Minner, Loren M., Belen, New Mexico. 1987  
 Nakamori, Katsuyuki, Saitama-Ken, Japan. 1987  
 Offord, Nigel J., Chandlers Ford. 1987  
 Pitkanen, Marja-Leena A., Lahti, Finland. 1987  
 Roucouina, Catherine, Athens, Greece. 1987  
 Saminathan, Kannika, Ipoh, Malaysia. 1987  
 Scott, Doreen M., Liverpool. 1987  
 Silverman, Sivan J., Watertown, Ma., USA. 1987  
 Tang, Ho C.M.T., Hong Kong. 1987  
 Tapia Canadell, Laura, Barcelona, Spain. 1987  
 Thevathasan, Nuala A., Colombo, Sri Lanka. 1987  
 Wirman, Anna L., Saltsjö-Boo, Sweden. 1987  
 Zwack, Geraldine M., Bangkok, Thailand. 1987

#### Ordinary Membership

Admet, Alessandro, Milan, Italy.  
 Ahad, Sayed, Brentford.  
 Alfano, Angelo, London.  
 Andrews, Fern A., London.  
 Bassett, Marlene J., London.  
 Bignotti, Fabrizio, London.  
 Brink, Carl F., Crystal Falls, Mich., USA.  
 Cerrone, Mo., Hitchin.  
 Clark, Diane E., Letchworth.  
 Coote, George E., Sevenoaks.  
 Coulthard, Joan M., Windermere.  
 De Bevere, Dirk, Sutton.  
 De Michele, Vincenzo, Milan, Italy.  
 De Silva, Edirimuni J.B., Singapore.  
 Dryden, Kenneth E., Spalding.  
 Duprez, Bruno, Linselles, France.  
 Elliott, Lucy E.C., London.  
 Emden, Lee, High Wycombe.  
 Fong, Phoay H., Penang, Malaysia.  
 Foster, W. James, Arroyo Grande, Ca., USA  
 Gaston, Giuliani, Brasilia, Brazil.  
 Genis Sol, Eduard, Girona, Spain.  
 Gower, Sarah-Jane, Yiewsley.  
 Graham, Barry D., Glasgow.  
 Gullerud, Hanne, Nesoddtangen, Norway.  
 Hamblin, Frederick T., Brighton.  
 Hanna, David, Inverness.  
 Hirst, Jenny E., London.  
 Holmes, Irene V., Tadworth.

Hughes, Thomas H., Castro Valley, Ca., USA.  
 Ishikawa, Kyoko, Richmond.  
 Jain, Sanjay, London.  
 Jassinger, Alexandre I.J., Epsom.  
 Kwok, Suk Har, Hong Kong.  
 Kyriakidou, Katerina A., London.  
 Law, Patricia M., Cambridge.  
 Lipton, Lindsay, London.  
 Liyanage, D.C.S., Ashford Common.  
 McGowan, Marion, London.  
 Meade, Christopher, Cleckheaton.  
 Mussche, Eduard, Brussels, Belgium.  
 Newbould, Hans P.M., Surbiton.  
 Nunn, Robert A., Chesham.  
 Page, Steven, Hillingdon.  
 Parsons, Ann S., Kemsing.  
 Pattni, S., Southall.  
 Pedersen, Gunhild, Natland, Norway.  
 Petty, Mary A., London.  
 Piyasirikul, Soonthorn, Bangkok, Thailand.  
 Pople, Cecilia, Godalming.  
 Roberts, Anne M., Crawley.  
 Sadler, Anthony, Loughton.  
 Schunko, Christian, Oslo, Norway.  
 Shukla, Manjot, London.  
 Sim, Evelyn, London.  
 Sinclair, Anne L.K., Haslemere.  
 Skrablin, Lada-Lucia, London.  
 Slater, Garth, Hallingbury.  
 Solheim, Jan, Bønes, Norway.  
 Soriano Clemente, Marta, Spain.  
 Sparks, Deborah A., Ruislip.  
 Speake, Michael H., Tadworth.  
 Spencer, Stephen R., Nottingham.  
 Suzuki, Yoshio, Tokyo, Japan.  
 Teixeira, Luis F.C., Woking.  
 Thurlow, Stephen N.G., Billingshurst.  
 Torrens, Robert M., Crieff.  
 Tsouji, Nao, Richmond.  
 Urvik, Hilde, Oslo, Norway.  
 Whitby, Victoria M., Hindhead.  
 Winblad, Cathrine, Stockholm, Sweden.  
 Wu, Mei, London.

#### MEETING OF OFFICERS

At a meeting of the Officers of the Association held on 1 March 1988 the following were elected to membership:

#### Fellowship

Gotoh, Takeshi, Amsterdam, Netherlands. 1977  
 Harding, Richard W., Solihull. 1984  
 Hash, Daniel W., Watrous, Sask., Canada. 1987

#### Ordinary Membership

Baxter, Graham S., Plymouth.  
 Bucy, Rodger, Ellicott City, Ma., USA.

Butler, David J., Malmo, Sweden.  
 Carter, Geoffrey J., Carshalton.  
 Crevoshay, George, Newton, Mass., USA.  
 Doran, Sean F., Liverpool.  
 Harris, Raymond H.L., London.  
 Misson, Gary P., Oxford.  
 Monachino, Melinda, San Francisco, Ca., USA.  
 Nootenboom, Apollonius, Kingsland.  
 Nyah, Koufie, London.  
 Ogden, Anne-Marie, Bristol.  
 Pender, Patricia, Southport.  
 Pyne, Anne M., Bristol.  
 Rana, Ghulam A., London.  
 Schwarz, Dietmar, Ouro Preto, Minas Gerais,  
 Brazil.  
 Thevanayagam, Michael A.H.K., Washington.

#### CORRIGENDA

On p.49 above, first column, for 'Brillo, Douglas', read 'Brill, Douglas'.

On p.52 above, 2nd column, Katsuyuki Nakamori, Saitama-Ken, Japan, was omitted from the list of those who qualified in the Diploma section of the 1987 Examinations in Gemmology.

## AMENDMENT TO PROGRAMME OF LONDON EVENING MEETINGS 1988

Would members please note that the meeting that was to have been held on Tuesday 24 May has been cancelled.

The October meeting at which Clive R. Burch will be giving a lecture entitled 'A review of inclusions in synthetic gemstones' will be held on **Monday 10 October 1988** and not on 11 October as notified in the January issue of *the Journal*.

## Letter to the Editor

*From James E. Shigley and Carol M. Stockton*

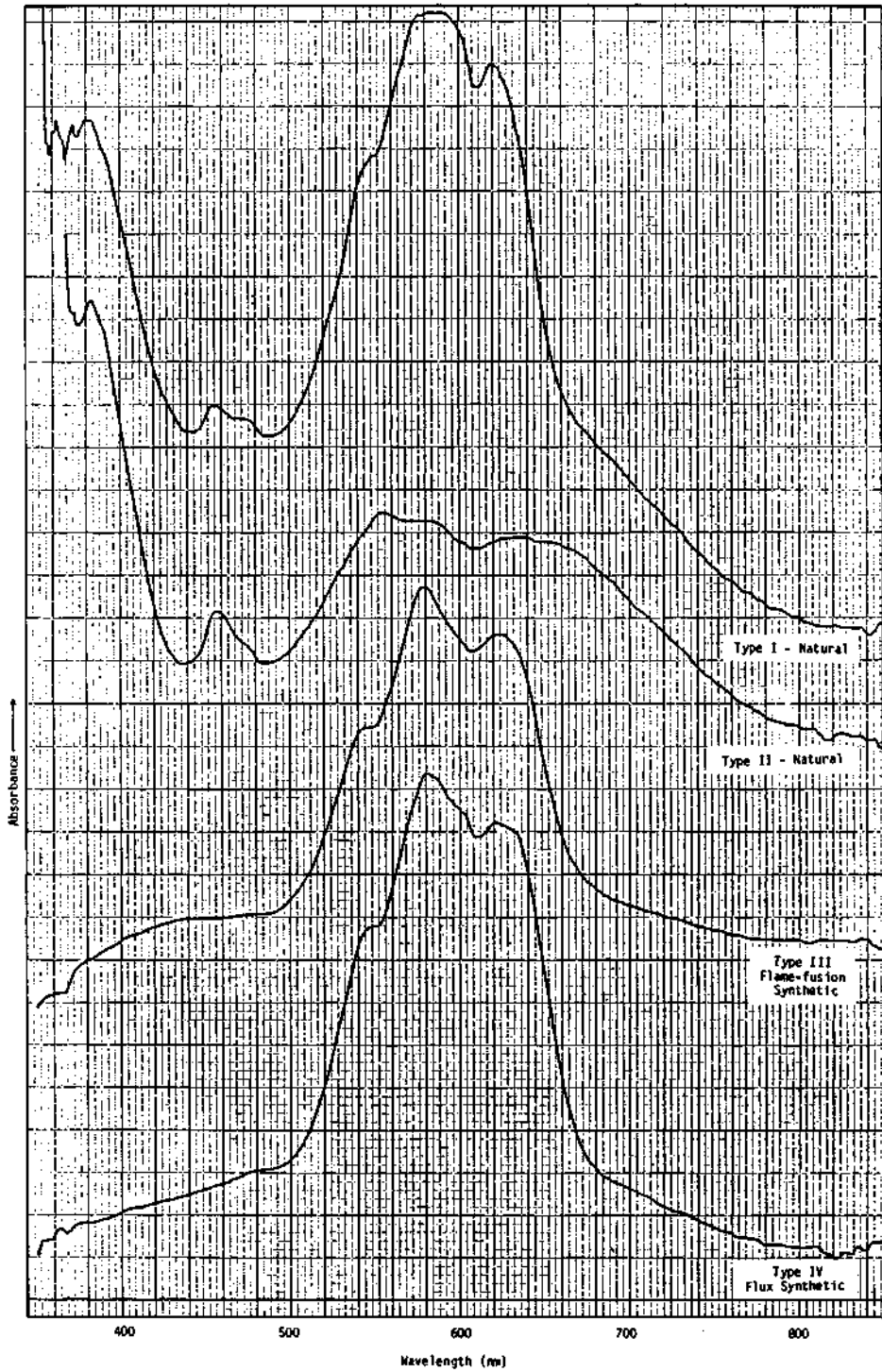
Dear Sir,

The article 'Blue spinel from the Hunza valley, Pakistan' by R.R. Harding and F. Wall that was published in the July/October 1987 issue of *The Journal of Gemmology* includes a comparison of the spectra of these new blue spinels with that of a cobalt-containing one published in our article 'Cobalt-blue gem spinels' in the Spring 1984 issue of *Gems & Gemology*. Figure 2 of Messrs Harding and Wall's article clearly shows that their spectra and our do not correspond. However, this is because the spectrum from our 1984 article has a non-linear wavelength scale similar to that seen in a prism spectroscope. The spectra published in the 1984 article were obtained from an old single-beam spectrophotometer system that has since been superseded at GIA Research by a Pye-Unicam 8800 dual-beam instrument. Nevertheless, we must apologize for having neither explicitly stated that the scale in our 1984 article was non-linear nor having provided a better scale (simplified for lack of space, as we recall) in our original figure, although the non-linearity could be deduced by correlating labelled bands with those of the hand spectroscope images printed alongside.

In order to set the record straight, we are sending you linearly-scaled spectra (in absorption, this time) from the same four stones originally illustrated. We would be grateful if you could publish this letter and these four spectra in order to provide a better comparison for those obtained by Harding and Wall as well as for future gemmological researchers. As far as we can tell, under the circumstances, comparison of the spectra of the Hunza valley blue spinels with that (now comparable) of the type I cobalt-containing blue spinel from Sri Lanka reveals the presence of cobalt as a colouring agent as well as chromium and (possibly) titanium, as stated by Harding and Wall.

Yours etc.,  
 James E. Shigley and Carol M. Stockton

10 December 1987  
 GIA Research Department, Santa Monica, Ca., USA.



Absorption spectra of four blue spinels.

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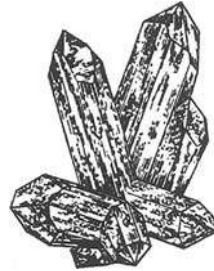


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## A computer program for gem identification

The GEMDATA Package by Peter Read (see p.66 for full details) is available through the Gemmological Association at £75.00 plus postage, packing and VAT\* (\*UK only at £11.25).

Postal rates are as follows: £3.50, UK and Eire; £4.00, Europe; £6.00 rest of the world.

To order your Package use the form below.

To: Gemmological Association of Great Britain, Saint Dunstan's House, Carey Lane,  
London EC2V 8AB.

Please supply ..... copies of the GEMDATA package.

\*I enclose remittance £ ..... /debit my credit/charge card

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**MINERALOGY AND MUSEUMS London July 5-6 1988**

**An International Conference organized by the British Museum (Natural History) and the Mineralogical Society of Great Britain and Ireland.**

The Conference will discuss how the mineralogical work of museums can best serve the requirements of industry, science, universities, the amateur mineralogist and the general public. It will be of interest to all museum research workers, curators, designers, mineral collectors, gemmologists and educationalists.

Three keynote speakers will lead sessions on the themes:-

**COMMUNICATION  
AND  
DISPLAYS**  
Dr H Bari  
Strasbourg

**ACQUISITION  
AND  
CURATION**  
Dr J S White  
Smithsonian Institution

**RESEARCH DIRECTIONS  
AND  
NEEDS**  
Dr J A Mandarino  
Royal Ontario Museum

A number of invited speakers will also take part in these sessions which will be followed by an open session. Poster displays are welcomed.

Registration will be £15 for members of the Mineralogical Society, otherwise £20.

Further details from:

Dr Paul Henderson, Mineralogy and Museums Conference, Department of Mineralogy,  
British Museum (Natural History), Cromwell Road, London SW7 5BD

## AN EXCITING NEW OPPORTUNITY IN GEMMOLOGICAL EDUCATION

**The Gemmological Association has launched a whole new programme of short practical courses in gemmology.**

The courses have been designed for the Association by Ken Scarratt and will be held at the Gem Testing Laboratory in London. The aim is to give practical instruction and experience to students studying gemmology, particularly those preparing to take the FGA examination by home study, and updates specialized courses for all gemmologists.

Various types of one-day courses are being offered during 1988, the dates of which are:

<b>19 and 20 May</b>	<b>Practical diamond grading examination revision</b>
<b>16 and 17 June</b>	<b>Practical gem testing examination revision</b>
<b>5 July</b>	<b>Organic gem materials, including amber and pearls</b>
<b>29 September</b>	<b>Diamond grading</b>
<b>27 October</b>	<b>Jade, turquoise, lapis lazuli and their simulants</b>
<b>24 November</b>	<b>Ruby and sapphire</b>

The National Association of Goldsmiths are also arranging courses on practical gemstone knowledge at the Laboratory. **These are to be held on 13 May, 7 July and 7 October 1988.**

Each course is limited to 8 participants and is offered at the low charge of £55 plus VAT (including lunch). The courses are open to all students and members of the Association who would like to take a short refresher course.

To book for the courses, please use the coupon below and enclose the necessary remittance.

To: Paula Jennings, Gemmological Association of Great Britain, Saint Dunstan's House, Carey Lane, London EC2V 8AB

Please reserve ..... place(s) for the course to be held on ..... (Date).

Enclosed is my remittance for £ ..... The fee is £55 plus VAT (i.e. £63.25) per person, per course.

NAME .....

ADDRESS .....

Please use BLOCK LETTERS .....

# 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.



The Journal of  
Gemmology

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