ISSN: 0022-1252 XIX (8) 649-744 (1985)

Vol. XIX No. 8 October, 1985

THE JOURNAL OF GEMMOLOGY

and

PROCEEDINGS OF THE
GEMMOLOGICAL
ASSOCIATION
OF GREAT BRITAIN

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SAINT DUNSTAN'S HOUSE, CAREY LANE
LONDON, EC2V 8AB

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

Saint Dunstan's House, Carey Lane, London EC2V 8AB
(By Goldsmiths' Hall) *Telephone:* **01-726 4374**

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Vol. XIX No. 8 **OCTOBER, 1985**

AVE ATQUE VALE

In this final number of his editorship, the old Editor looks forward with pleasure and with entire confidence to the first number of Volume XX solely edited by his successor, who has been of so much help to him in the last difficult ten months.

The new Volume will be in a new larger format, but not so large as to make it unwieldy when bound. This will remove the constraints of the old (present) format, which served the Association well for 38 years, but which recently made it difficult to accommodate the large Figures, Maps and Tables, which have increasingly been required by contributors. So let us look forward to welcoming the *Journal of Gemmology* in its new livery next year.

It is always sad to preside over an end. I vacate my editorial chair and say farewell to the old-style *Journal* with feelings of some grief, and there have been two sad disappointments in this last year of my editorship. The continued long delays in the issue of each quarterly number of the *Journal*, mainly due to printing difficulties, have been deplorable and the failure of the Basil Anderson Appeal

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Fund to reach its target in a year even more so. When the appeal was launched in October 1984, I confidently expected it to be fully subscribed by Easter 1985. It seemed almost inconceivable that out of the thousands of gemmologists throughout the world there would be less than fifty who would be anxious (and financially well able) to honour the memory of the great man, to whom they owed so much, to the extent of at least five hundred pounds. Apparently not so, however: the fund now stands at £22005 and a list of subscribers to date appears on pages 739 to 742 below—only 266 in all (187 from Great Britain and 79 from overseas)—and a number of well-known names in the world of gemmology and the jewellery trade are conspicuous by their absence. Now is the time for the defaulters to make good their default, so that the new Editor may be able to report in January that the target of £25000 has been reached (and, it is to be hoped, exceeded) and the good name of gemmologists throughout the world redeemed.

The last number of the *Journal* edited by Gordon Andrews was that of January 1973. A comparison of my first number (Vol. VIII, No. 6, April 1973, containing 18 pages of articles with 4 figures in black-and-white, 37 abstracts and book reviews (14 pages) and 8 pages of Association Notices) with this my last number (Vol. XIX, No. 8, October 1985, containing 71 pages of articles with 27 figures/maps in black-and-white and 30 in colour, 68 abstracts and book reviews (13 pages) and 7 pages of Association Notices) exemplifies the remarkable progress made by our science of gemmology in the last twelve years. I am confident that the difference between next January's number and the last of Alan Jobbins's editorship (many years hence, I hope) will be no less significant.

J.R.H.C.

NOTES FROM THE LABORATORY

By KENNETH SCARRATT, F.G.A.

The L.C.C.I. British Gem Testing Laboratory

The nature of some items sent to the Laboratory for examination can at times be a little surprising. In fact two items we received via the National Association of Goldsmiths some months ago for testing must be rated fairly high on anyone's scale of unusuality.

The two items we received (see Figure 1) were described as '... a pearl in two parts which was found in a squid just after the war in Switzerland.' With the unaided eye a superficial examination of the areas along which this 'pearl' had apparently parted, revealed a structure that, whilst not being the same as a normal sectioned pearl structure, was sufficiently close to it for a first impression to be formed that possibly these could be two part pearls (Figures 2 and 3). Try as we might, though, the two 'parts' could not be matched to form a whole sphere.

Both pieces may be described as having translucent high domed 'outer' surfaces and transparent low domed surfaces on what was thought to be the area along which they had parted. The smaller measured 6.60 × 2.18 mm and weighed 0.26 ct, and the larger was 6.84 × 4.56 mm and weighed 0.66 ct.

Upon examination it was found that both allowed x-rays to pass more easily than any known pearl, and that their hardness was less than 3 on Mohs's scale.

Following much discussion about their possible identity and finding ourselves somewhat lost for ideas, one of our number said, in a casual manner, 'they are probably the poor squid's eye-balls'.

With this in mind it was decided that the most probable place we might find an answer was within the molluscs department of the Natural History Museum. Here F. C. Naggs was able, just from our description on the telephone, to say that they were probably the eye lenses of a squid. Following the telephone call Mr Naggs allowed us to compare these with known (somewhat larger) specimens in the Museum which confirmed their identity.

Apparently larger squids' eye lenses were used in Peru to replace the eyes of mummies. The mummies were then left in the sitting position in order that they might gaze upon the public.

* * *

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FIG. 1. Translucent high-domed side of squid's eye lenses; 6.60 × 2.18 mm (left); 6.84 × 4.56 mm (right).

FIG. 2. Transparent low-domed side of squid's eye lenses (see also Figure 1).

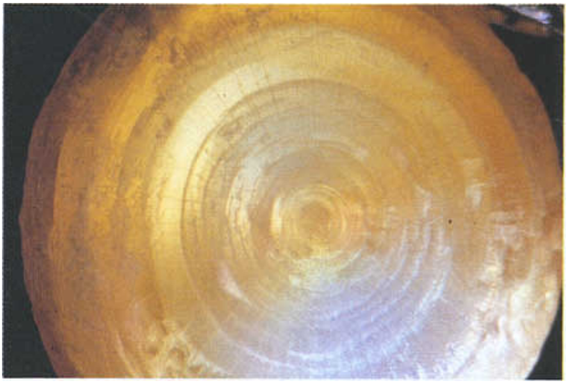

FIG. 3. Structure seen in transparent side of squid's eye lens (see Figure 2).

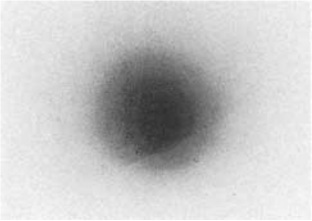

FIG. 4. Autoradiograph of a radium-treated green diamond. The stone was held in contact with x-ray type film for a period of 24 hours.

FIG. 5. A radium-treated green diamond weighing 2.66 ct (see Figures 4 & 6).

Radium treated diamonds are not seen all that often today, but once in a while, particularly when someone's estate is being settled, one does turn up.

One which surfaced recently was radioactive to the extent that it exposed a piece of photographic printing paper to a small degree, after being in contact with it for only 15 minutes. The result of the stone being in contact with an x-ray film for 24 hours is shown in Figure 4. Apart from its degree of radioactivity, though, this stone was interesting also because it was possible to speculate upon its pre-irradiation appearance.

The stone weighed 2.66 ct and measured 8.51 × 8.33 × 5.08 mm and, as may be seen in Figure 5, had a deep green colour. When examined under the microscope, however, what was probably the original colour of the stone became evident in the form of distinct internal brown colour zoning (Figure 6).

With this brown zoning in mind, when the absorption spectrum was examined, whilst quite clear evidence of radiation damage could be seen in that the GR1 (741 nm) band was present (Figure 7), it was also possible to theorize upon the possible cause of the 503 nm band and the associated bands on its short-wave side. If the original colour of the stone was brown, it could be that in this case they are a product of natural causes.

* * *

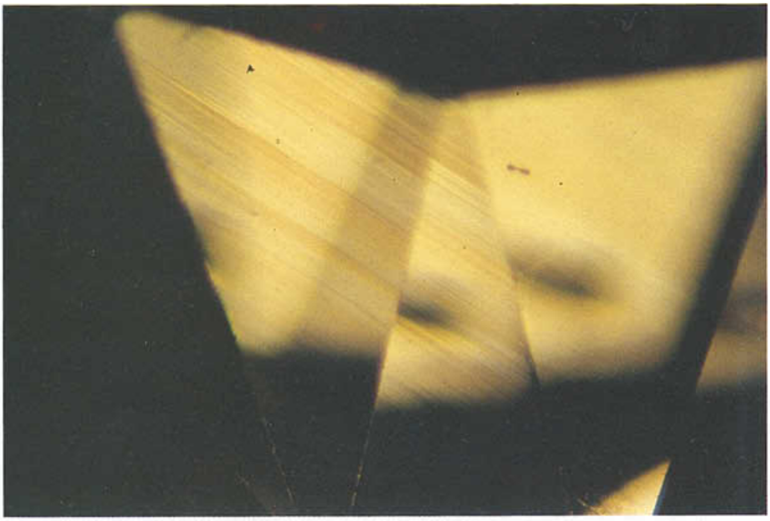

FIG. 6. Brown colour zoning seen below the green 'skin' of the radium-treated diamond in Figure 5.

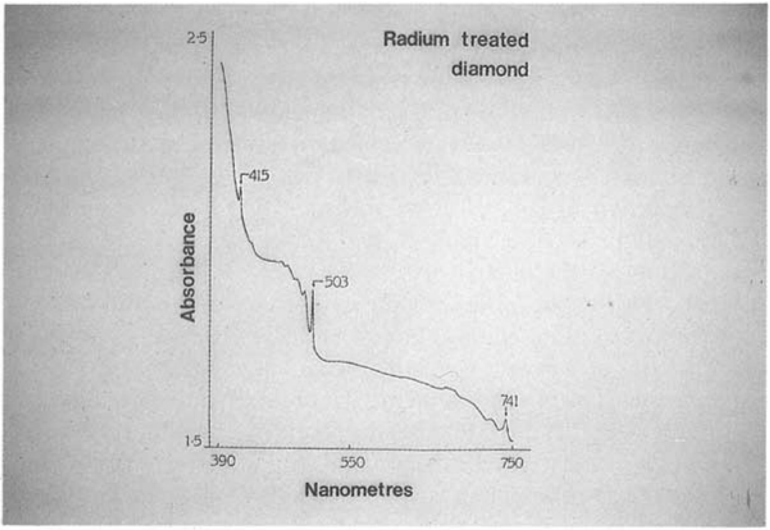

FIG. 7. The absorption spectrum at approximately 120K of the radium-treated green diamond in Figure 5.

FIG. 8. A zircon weighing 2.10 ct in which the colour had altered from blue to a 'dirty colour' which was in parts brown and in other parts green.

FIG. 10. The same zircon as depicted in Figure 8 following heat treatment.

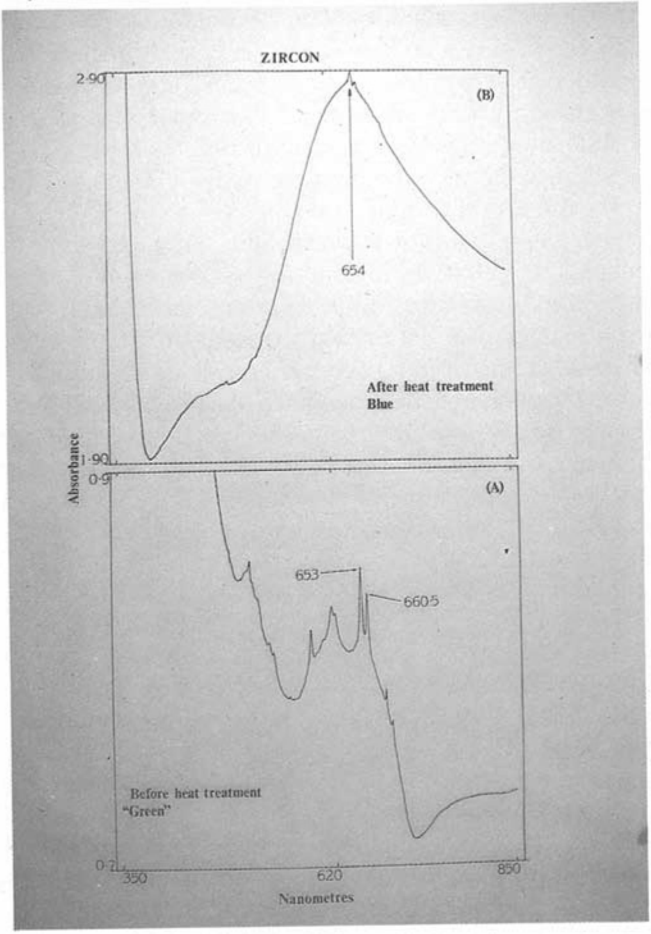

FIG. 9. (a) The absorption spectrum of the zircon as seen in Figure 8 (before heat treatment).

(b) The absorption spectrum of the zircon as seen in Figure 10 (after heat treatment).

As most gemmologists are only too well aware, there have been occasions when heat treated blue zircons have altered from this nice and somewhat characteristic colour to a not so nice 'dirty green or brown'.

Normally we would not involve ourselves in attempting to return such a stone to its previous blue colour, but when we were asked recently (entirely at the owner's risk), we agreed to try. Our main reason for agreeing, though, might be interpreted as a little selfish.

We were, at that time, putting the Basil Anderson (Pye-Unicam PU8800) spectrophotometer 'through its paces', and this seemed a suitable direction in which to take our investigations.

The stone as delivered to us had a fairly 'dirty' colour, as may be seen from Figure 8. Its weight was 2.10 ct and it measured 7.73—5.62 × 4.00 mm. Figure 9a is the recorded absorption curve corresponding to the appearance of the stone in Figure 8. The span of the curve is 0.2A (absorption units).

In the attempt to regain its blue colour, the stone was buried in a charcoal filled small crucible, and this was placed into a furnace. The temperature inside the furnace was raised slowly up to 900°C and then brought down again slowly to room temperature.

When the stone was removed from the charcoal following this treatment, it had the overall appearance of a nice blue, although as may be seen from Figure 10 the colour was concentrated in zones.

Following this alteration to its colour, the stone's absorption spectrum was recorded once more and the somewhat modified curve depicted in Figure 9b was resultant. The span of the curve in this case is 1A.

* * *

Some heat treated rubies and sapphires are providing the gemmologist with a whole new class of inclusions with which he must familiarize himself.

One of the most striking examples of these inclusions was provided recently by a heat treated blue sapphire, which, because of the intense 450 nm complex in its absorption spectrum, is probably of Australian origin.

As may be seen in Figure 11, instead of the blue colour appearing throughout the majority of the stone, in this case the colour has concentrated in small blobs, in areas which probably contained 'silk' and 'feathers' prior to heat treatment.

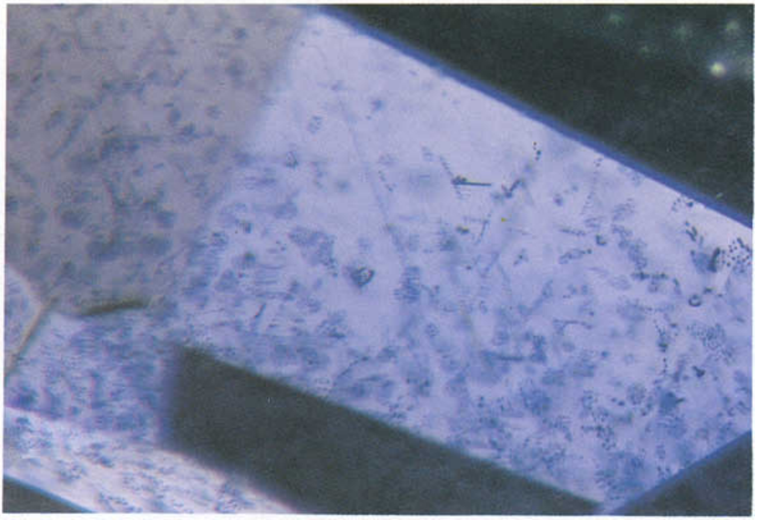

FIG. 11. Inclusions in heat-treated blue sapphire probably of Australian origin.

*   *   *

In a talk given to members of the Gemmological Association during April 1984 those present were warned of the unusual magnetic properties of a new form of haematite from Brazil, and the material has also been described in this and other journals.(1,2) Apart from being attracted to a magnet this 'magnetic haematite' is also different from the well-known Cumberland material in its type of fracture surface (see Figures 12 and 13) and because the polished surface is usually quite pitted.

Those who deal in haematite now accept this new material as haematite and, whilst there is still the problem of differentiating between magnetic haematite and the haematite imitation 'hemetine',(3) the trade no longer reject material as not being haematite merely because it is magnetic.

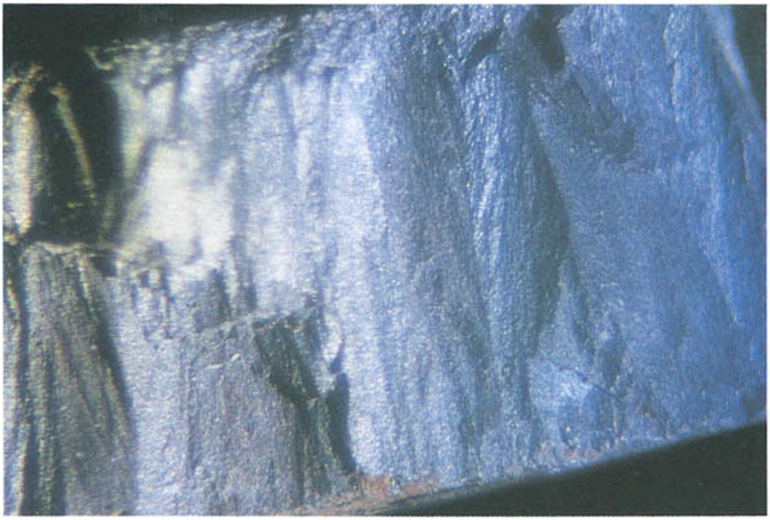

FIG. 12. The fracture surface of Cumberland haematite.

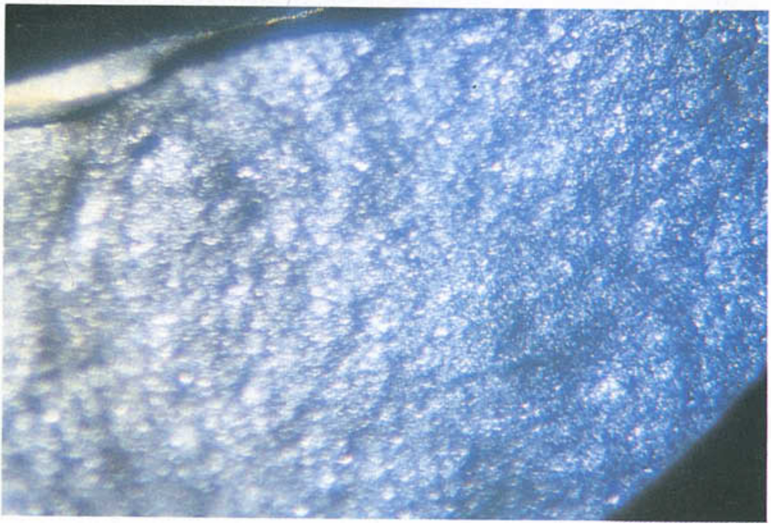

FIG. 13. The fracture surface of 'magnetic haematite.'

Earlier this year two opaque black beads were submitted to the Laboratory for examination as possibly magnetic haematite but in the event were found not to be haematite but a substitute of a kind that we have not met before. Apart from having a good surface polish as compared to the pitted appearance of the magnetic haematite, both beads were distinctly magnetic in that they were strongly attracted to each other and they also attracted iron fillings. The average of three SG determinations on one bead was 4.96, whilst the average for the second was 4.80. The streak in both cases was black.

X-ray powder diffraction analyses carried out by Toby Rappitt pointed towards the beads being a barium iron oxide man-made product similar to that described in JCPDS file 27-1029.

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[*Manuscript received 11th June, 1985.*]

A NOTE ON THE HISTORY OF DIAMOND SYNTHESIS

By K. NASSAU, Ph.D.

Box 517, Bernardsville, NJ. 07924, U.S.A.

> *'Is there any other point to which you would wish to draw my attention?'*
> *'To the curious incident of the dog in the night-time.'*
> *'The dog did nothing in the night-time.'*
> *'That was the curious incident,' remarked Sherlock Holmes.*
> *Silver Blaze;* Sir Arthur Conan Doyle

INTRODUCTION

In a recent book review of *Diamond*, by G. Davies,(1) P. G. Read comments: '. . . it is satisfying to see that the Swedish company ASEA is credited with the first confirmed synthesis of diamond (rather than General Electric of America), a fact missing from some books, particularly those of American authors!'(2)

Being one of these authors, a clarification may be appropriate. I hesitate to disagree with Mr Read, since he also reviews one of my own books (gratifyingly favourably!) on the very next page.

To begin, let me make two points. First, in my article(3) and in my book (4) (in a footnote on page 179), I did briefly refer to the existence of the ASEA experiments, with at least some explanation of the circumstances, but without attributing priority to their work or considering it to be a significant step in the progress toward a successful synthetic diamond industry. Perhaps I have never been explicit enough in giving the detailed reasoning behind my own, and indeed most scientists', evaluation of this work; hence this brief note to clarify a relatively subtle historical point. Second, Read states that the ASEA synthesis was 'confirmed;' I myself have not been able to locate any report of an independent repetition of the ASEA experiment.

THE BACKGROUND

The setting of these events, as detailed by me elsewhere,(3,4) I consider to be important. Many workers had tried to synthesize diamond over the centuries and a number of these workers had claimed success; most of these claims were made in all sincerity, based on the difficulty of identifying tiny fragments of products. The most persistent worker was Sir Charles Parsons (1854-1931),

ISSN: 0022-1252 XIX(8) 660 (1985)

inventor of the steam turbine, who spent a significant part of his fortune over a more than thirty-year period in attempting to duplicate earlier claimed results as well as trying new approaches of his own.(1,4) At first he claimed success, but later came to realize the truth and authorized C. H. Desch to report that no diamonds had ever been made in the laboratory; the details surrounding this confusing report have been given by Lonsdale.(5)

So here we have the setting: many discredited reports and tremendous excitement as ever-improving technology is applied by workers such as P. W. Bridgman at Harvard University and competing groups at industrial research laboratories, such as those of the General Electric, Carborundum, Norton, and ASEA companies.

Work on high pressure synthesis began at ASEA (Allemanna Swenska Elektriska Aktiebolaget) at Västerås in Sweden in 1942. In 1953 Halvard Liander and Erik Lundblad used a high pressure cubic press built by B. Von Platen to contain the ingredients of a *thermite* type reaction to apply high pressure and high temperature to a carbon-containing composition. Only after G.E. had announced their successes did the ASEA group report that this equipment had produced some very small diamond particles.

THE PROBLEM

At this point I naturally wish to draw attention to the 'curious incident of the dog' that 'did nothing in the night-time' of the quotation at the beginning of this note. For, what happened after this very significant achievement of the ASEA workers in 1953? Where were the public announcements which would have brought them much acclaim? In this 'curious incident' it appears that, apart from a brief report in the ASEA Journal in 1955,(6) nothing was said in public for seven years until a report was read on 13th April, 1960, and published later that year.(7) By that time there had already appeared a whole series of announcements and publications from G.E. workers starting in 1955;(8) one of these reports(9) is cited in the 1960 ASEA paper. The ASEA workers wrote(7) that they had meanwhile switched to electrical heating, similar to that used by the G.E. workers.

As I have previously written, 'certain principles have been developed over the years for evaluating scientific accomplishments and attributing priorities. For example, the claim of a successful experiment cannot be fully accepted until it has been duplicated by other experimenters, following the published descriptions of the technique. It is obviously the claimant's fault if inadequate descriptions do not permit a successful duplication, and the claims will then have to be discounted.

'If more than one experimenter claims priority in an achievement, then independent proof of achievement at the time claimed is essential. Patent applications and/or publication of reproducible experimental details, examination of the product by independent experimenters, deposition of the "secrets" in a sealed document (as was done by Verneuil)(3)—all these have been used to establish priority of inventions. The patent system is a protection for the inventor and his firm, so that it is not necessary to resort to keeping one's secret so as to protect an invention.'(3)

It is in view of these considerations that scientists and historians generally do not give priority to the ASEA work, but date the first confirmed synthesis of diamond to the 1955(8) and subsequent G.E. reports, where a process was described in detail that could be and was duplicated, first independently by others at G.E. and soon thereafter by others elsewhere, thus meeting all the criteria for acceptance as a valid achievement. It should be noted that Davies too, in describing the G.E. experiments, says: 'For the first time there could be no doubt that diamonds had been made in the laboratory.'(1) Two pages later he says: 'Ironically, diamonds had already been made . . . two years earlier.' He goes on to describe the ASEA experiments in detail, not, however, explaining what was ironic; possibly he too feels puzzlement at 'the dog' that 'did nothing in the night-time.'

SOME SPECULATIONS

It is possible to speculate on the reasons why ASEA did not publicly claim success in 1953. There are several possibilities; only the two I consider most probable are here discussed:

1. It may be that the lack of control over the hazardous and unpredictable *thermite* process was so discouraging (and that this process was so destructive to the high pressure equipment) that it was realized at the time that this approach was impractical and not worth pursuing or patenting. Announcement of the achievement may then have been withheld so as not to give competing workers information which might have helped them. From the industrial

research point of view, I consider this the most probable scenario. It is regrettable that the work was not publicized in 1955 after the G.E. news release on 15th February: Lundblad's statement 'we thought we had time' cited by Davies(1) explains the lack of a previous announcement, but the subsequent long delay was critical.

2. It is also possible that the presence of diamond in the product of the 1953 experiment was not recognized at the time and that only after the 1955 announcement of G.E. were the specimens taken off the shelf for re-examination and then identified. Such a sequence has happened often enough in science.

Be all this as it may, these then are the reasons for my attributing priority to the G.E. diamond synthesis work in my writings; it is certainly not from any lack of belief in the ASEA results, nor from any jingoistic attitude. The conventional criteria for the attribution of priority of invention, as discussed above, are merely being followed; in addition, because of the lack of timely publication, the early ASEA work had no effect on the subsequent development of diamond synthesis. Other scientists and historians who have investigated the sequence of events in detail have usually taken the same point of view.

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[*Manuscript received 13th June, 1985.*]

THE KATLANG PINK TOPAZ MINE, NORTH WEST FRONTIER PROVINCE, PAKISTAN.

By WILLIAM H. SPENGLER, A.G., F.G.A.

Asian Institute of Gemological Sciences, Bangkok

Ruins of a civilization two thousand years in the past lie scattered around the hilltops skirting the Katlang valley. The ruins were monasteries, once sentinels in a line stretching from Sarnath to Bamiyan and beyond, in an area where Bhuddism flourished at an early period. In present day Pakistan, the valley floor is covered with lush green fields crossed by irrigation canals, dotted with villages, and accented by mosques and minarets among the houses. From a vantage point on the southern fringe a small hillock surrounded by fields can be seen isolated from the others. It contains a treasure unknown to the ancients – fine crystals of pink topaz.

The hillock would be forgotten like the remaining ruins near its crest but for the recently discovered deposits there. Katlang, near Mardan in the North West Frontier Province, lends its name to the mining project in which the Gemstone Corporation of Pakistan (Gem C P) is now engaged. The deposits on the hill have only been widely known about since the early 1970s and the exact circumstance of their discovery is so far unrevealed. Presumably local farmers from the adjacent village of Ghundow discovered the topaz crystals at the surface near the top of the hillock, where the first trenches were excavated. These easily accessible deposits were privately mined until the Gem C P began seriously considering the project in 1980.

At 68 metres above the valley floor, the top of the knob-shaped hillock is 503 metres in elevation above sea level. The formation is a major eastward plunging anticline consisting of metamorphosed limestones. The limestone strata originated on the bed of the Tethys Sea which at one time lay between the Asian continent and the Indian Subcontinent. Tectonic collision of these two masses resulted in the formation of the surrounding mountains, and the greater Himalayas to the north and east. The dip of the limestone strata is to the north. In combination with related igneous activities, the associated crystals formed from pneumatolytic processes, when

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FIG. 1. View (WNW) of Katlang Valley from the Jamal Ghari Ruins. The foothills in the foreground at the right are the location of the recently discovered Shakertangi topaz deposit.

FIG. 2. View (N) of Katlang Valley from the Jamal Ghari Ruins. The hillock containing the Katlang Mine can be seen at the indicated point near the edge of the valley.

FIG. 3. View (NW) of Katlang Valley from the Jamal Ghari Ruins. The hillock containing the Katlang Mine can be seen at the indicated point near the edge of the valley.

FIG. 4. West side of the hillock. Trenches and tailings can be seen covering the hillside. One of the compressors can be seen in the shed at the base of the hill.

FIG. 5. A small pocket opening at the start of the first tunnel is inspected.

FIG. 6. One of the larger trenches.

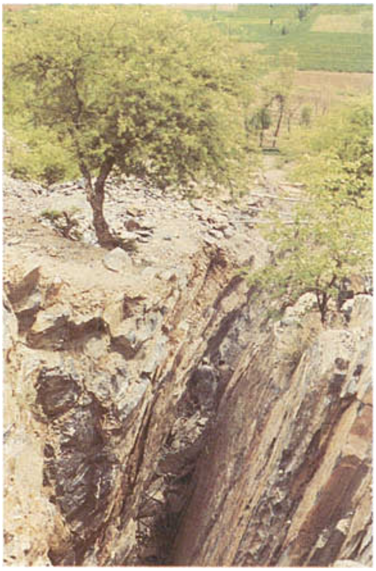

FIG. 7. A trench from the top of the hillock.

FIG. 8. Drilling prior to setting charges.

FIG. 9. A pneumatic drill hose snakes over ruin remains.

the mineralized veins intruded through strike faults and tension gashes into the folded limestone strata. Where growing space permitted, and if spared the pressures of refolding, the topaz is found as euhedral crystals among associated crystalline quartz, calcite, mica and talc.

On the eastern face of the hillock nearly a dozen major trenches have been laboriously carved. Several other minor trenches penetrate to about 15 metres beneath the hill's surface. Due to the depth of the trenches and the possibility of general collapse of the surrounding limestone, further excavation in the larger trenches has become unfeasible. As a result, the Gem C P mining engineers have made the decision to begin tunnelling into the veins. The first tunnel has only recently been started.

The project utilizes an appropriate combination of manual labour and light power equipment. Two compressors on the site power pneumatic drills and hammers. Due to the compaction of the limestone, blasting with dynamite is conducted extensively though care is taken not to set charges near visible veins or pockets. The miners use the pneumatic hammers and hand tools to follow the crystallized veins. Crystals are immediately deposited into lockboxes under supervision of security personnel, while debris is carried off in large wheelbarrows to the dump sites. About two dozen labourers make up the work force. The Gem C P project staff includes a geologist and mining engineer, mechanics, security and administrative personnel.

According to Gem C P staff geologist Syed Iftikhar Hussein, production at the mine has been steadily increasing since the Gem C P started work there. In February '81 – '82 about 10000 ct were recovered. For February '82 – '83 an increase to 17000 ct was accompanied by about 150 crystal specimens of exceptional quality intended for the collector market. Another significant increase in production followed in February '83 – '84 with 28000 ct in addition to 180 collector specimens.

The material mined at the hillock is graded into four categories. Exceptional crystals, unflawed and of a fine pink colour, compose grade A. About 10% of the production is of this quality over all, though some pockets have yielded up to 60% grade A material. Grade B material is transparent, lightly to moderately flawed, with good pink colour: 30% of the production falls into this category. Another 30% being highly flawed pieces of moderate to

FIG. 10. Three euhedral crystals.

FIG. 11. Gem of 37 ct and prismatic crystal. (*Gem Corp. of Pakistan*)

FIG. 12. Large prismatic crystal of 135 grams. (*Mr Issa Jaffar*)

poor colour, are included in grade C, and opaque material classified as Grade D constitutes the balance.

The properties of four pink crystals purchased in the vicinity and tested in the laboratory of the Asian Institute of Gemological Sciences in Bangkok, as well as properties of other specimens reported to have come from the mine, are as follows:

	RI			Birefringence	SG
Author (Four crystals)	1.630	1.632	1.640	0.010	3.52
Petrov, Schmetzer & Bank	1.632	1.633	1.641	0.009	NA
Arem	1.632	1.636	1.641	0.009	3.53

The pleochroism seen in the author's crystals is pink/pink/colourless. There is no distinctive absorption spectrum. Under short-wave ultraviolet light the specimens fluoresce white, and they are inert under long-wave. The euhedral crystals exhibit the ‹110›, ‹120›, ‹140› prism faces, ‹011›, ‹021› brachydomes, ‹111› dipyramid faces, and ‹001› pinacoid. There are no crystal inclusions visible in the specimens though there appears to be liquid contained in cracks.

The colour of the Katlang crystals has been previously described (Petrov, Schmetzer & Bank, 1977) as violet. The pleochroism was noted as yellow, violet with red and violet with blue. Following x-ray examination the material was shown to be OH rich consisting of approximately 15% fluorine. The violet colour was stated to be due to Cr^{+3}. The abundance of OH relative to fluorine is similarly shown by the generally high RI and low SG for topaz.

At the Gem C P Headquarters in Peshawar, there is a fine 37 carat gem, which the Managing Director, Brig. Kaleem ur Rehman Mirza, allowed the author to photograph along with an accompanying crystal. Mr Issa Jaffar, a Karachi dealer, allowed the author to photograph a large prismatic crystal of 135 grams. Dr Joel Arem has two cut pieces pictured in his *Color Encyclopedia of Gemstones*, one of 12.5 ct and another of 36 ct. A 2.4 inch specimen in matrix is pictured in M. Pierre Bariand's *The Wonderful World of Precious Stones in their Natural State.*

The Katlang mine obviously produces a fine variety of topaz, but, as it is the only producing source for pink material in the region, an erratic supply is to be expected in the near future. Other topaz deposits have been located. Most notably, a recent discovery (summer 1984) of pink and violet material at Shakertangi, 20 kilometres south of Katlang, appears promising. As the highly mineralized mountain areas of northern Pakistan are steadily prospected, further deposits of topaz, as well as deposits of many other gem species, will surely come to light.

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[*Manuscript received 2nd November 1984.*]

THE OCCURRENCE OF BOTRYOIDAL AND GEM-QUALITY NEPHRITE IN MONTEREY COUNTY, CALIFORNIA.

By THOMAS R. PARADISE, B.Sc., F.G.A., G.G.

San Francisco, Ca 94133, U.S.A.

ABSTRACT

In an obscure beach cove (see Figure 1) along the California coastline, roughly one hundred kilometres south of the city of Monterey, numerous boulders and pebbles of relatively fine nephrite may be found. The locale is found between the capes of San Martin and Plaskett Point and may be reached by simple trails down steep cliffs. While simple collecting is possible, an understanding of the area's geological history and surface eases the difficulty in locating the nephrite. Discovered as peculiar yet indicative botryoidal masses and weathered chunks, the jade is of a fine quality with minor colour variegation and translucency and an absence of noticeable inclusions.

GEOLOGY

Extending from an area north of San Francisco one hundred and forty kilometres or so, to the south well within the heart of Southern California, the San Andreas Fault zone separates major and distinctive rock groups, each belonging generally to different continental and oceanic plates. The fault system trends north-west to south-east and acts as a plane of movement for these two plates (see Map 1). Excessive fault movement has caused a linear correlating rock displacement of hundreds of kilometres with the westernmost portion aside the fault displaying uplifting of hundreds of metres (Norris *et al*, 1976).

The tremendous turmoil and mobile activity due to the shifting continental and oceanic plates and the intervening fault system has caused a great forced elevation of large masses of sedimentary material into a jumbled, disorderly assemblage of sandstone, shale, chert, limestone and conglomerates termed the Franciscan Formation. Initially, during the Jurassic Period (180 million years ago), aqueous sedimentary rocks were deposited in a stratified manner, composed predominantly of silts, sands and unsorted rock debris. Fifty million years later, however, during the Cretaceous Period, this troughed sedimentary rock collection was disrupted and forced into folded and faulted masses, due to compressional tectonic processes (Page, 1978). During the Jurassic Period, it is believed that the San Andreas Fault zone acted in a more vertical direction, than one currently horizontal, due to confronting and

ISSN: 0022-1252 XIX(8) 672 (1985)

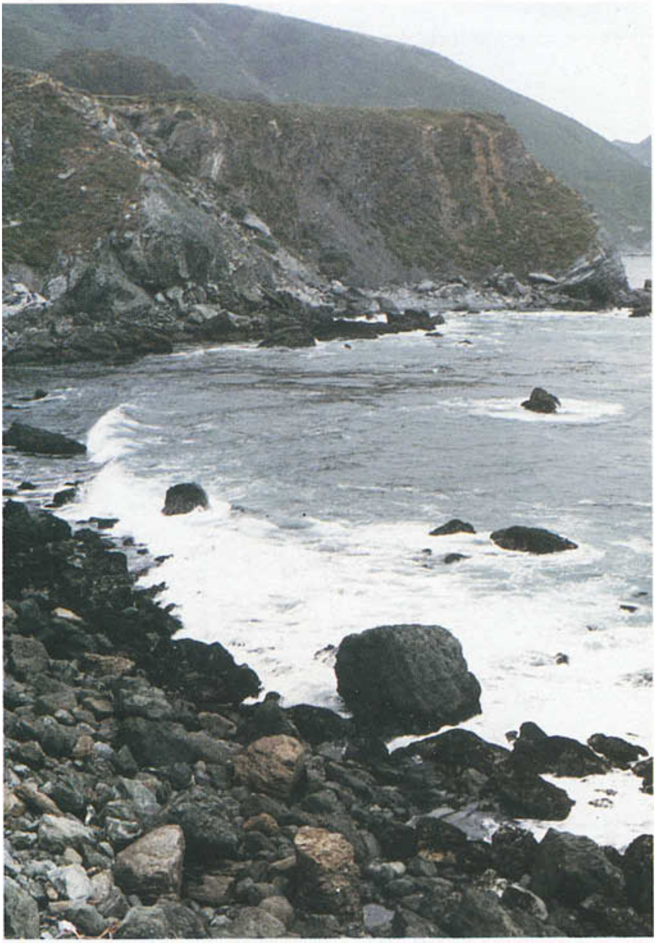
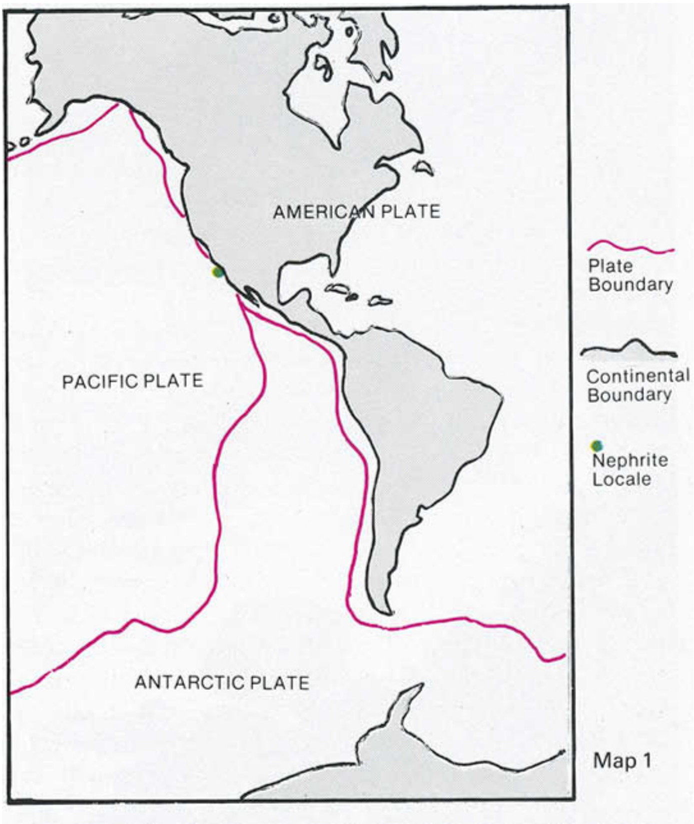


FIG.1. Southward view from Plaskett Point (10.00 a.m.)

disrupting rather than evasive and sliding continental and oceanic plates. With the two plates charging head-on, the eastern plate initially buoyed atop the advancing western oceanic plate. As the western plate, called the Salinian Block, glided beneath, it scoured the ocean's floor unearthing a dark-coloured siliceous rock rich in iron and magnesium (peridotite) and forcing it under high pressures and relatively low temperatures into the Franciscan mélange. Peridotite is the general rock type thought to have derived from the earth's mantle. It is from this material that our nephrite ultimately developed.



Map 1

The low temperatures and high pressures were responsible for hydration and conversion of the peridotite into serpentinite. The action of local alkaline solutions is believed to be responsible for the subsequent change into nephrite from the serpentinite. In this paper the terms peridotite and serpentinite describe the more massive and general rock units composed predominantly of olivine and serpentine materials.

MINERALOGY

The chemical similarities and order of development of the nephrite from the peridotite are easily understood through the examination of the various yet related chemical compositions:

Peridot $(Mg, Fe^{+2}, Ni, Mn^{+2})_2SiO_4$
Serpentine $(Mg, Fe^{+2}, Ni)_3Si_2O_5(OH)_4$
Actinolite $Ca_2 (Mg, Fe)_5, Si_8O_{22}(OH)_2$
Tremolite $Ca_2Mg_5Si_8O_{22}(OH)_2$

Nephrite is a varietal mineral name for a fibrous, compact isomorphic product of the actinolite-tremolite series. Actinolite has an indicative green colour, while the tremolite is typically white or greyish. These two minerals combine to form a complete range from white to greenish-black, depending on the amount of each specific mineral present. Both minerals form in a needle-like habit (acicular), so their combining to form a fibrous variety can be reasonably understood. Ideally, nephrite consists of a randomly oriented intergrowth of crystalline fibres, but in the Monterey County occurrence, it forms in botryoidal masses of the fibred material. Here the rocks found not only contain the nephrite but serpentine, actinolite, tremolite, soapstone and "seminephrite"– a weathered form which exhibits all visual characteristics of the nephrite but lacks the toughness and hardness (Crippen, 1951).

Mylonitization (the relatively high pressure and low temperature grinding of rocks) is a process involved in the complex steps of mineral alteration (see Figure 2). Originally, with the scouring and pushing of the peridotite as well as the great stretching, folding and twisting of the mass, it was forced into a hydrous state because of its oceanic proximity. It was then that subsequent alkaline pore solutions, rich in calcium, magnesium and iron, completed the conversion from the intermediate step of serpentine to the end product—nephrite. Mylonitization caused the physical change and altered botryoidal shape, while the migrating fluids affected only the chemical composition. Mylonitization can manifest itself visually as large rock units (kilometres in size) having a lenticular form or as microscopic particles obviously squeezed together and lamellar in structure or orientation. It is because of this shearing force that the nephrite from the Monterey occurrence shows signs of sliding and/or flattening to some extent. Often the nodules found, either imbedded in the host serpentinite or loose below the cliffs, exhibit an oval or oblate shape. It is also within these zones of shearing and schistosity that the greatest abundance of the nephrite nodules may be found; while in the more solid and less solution-accessible areas of the serpentinite lesser amounts of

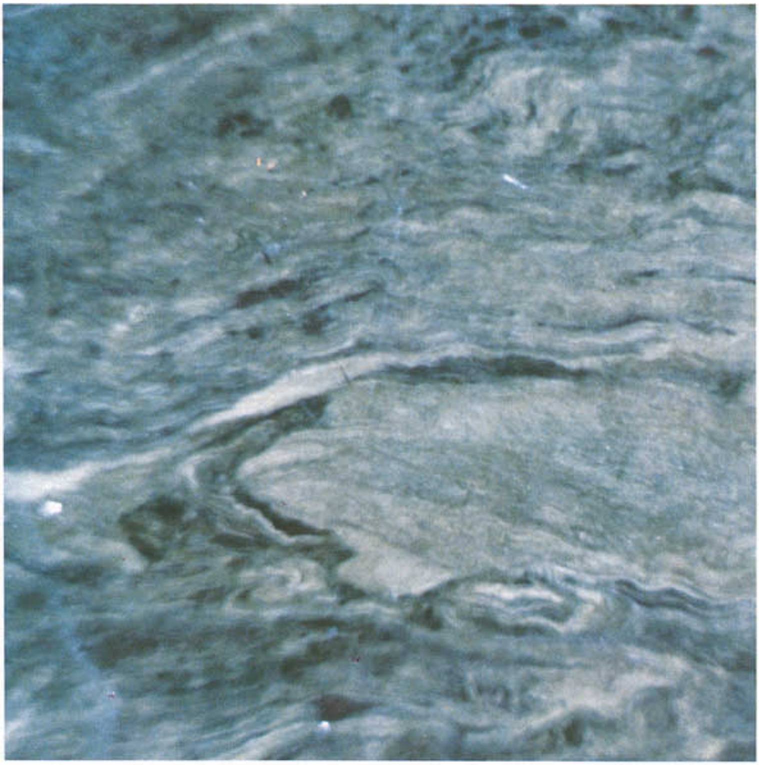
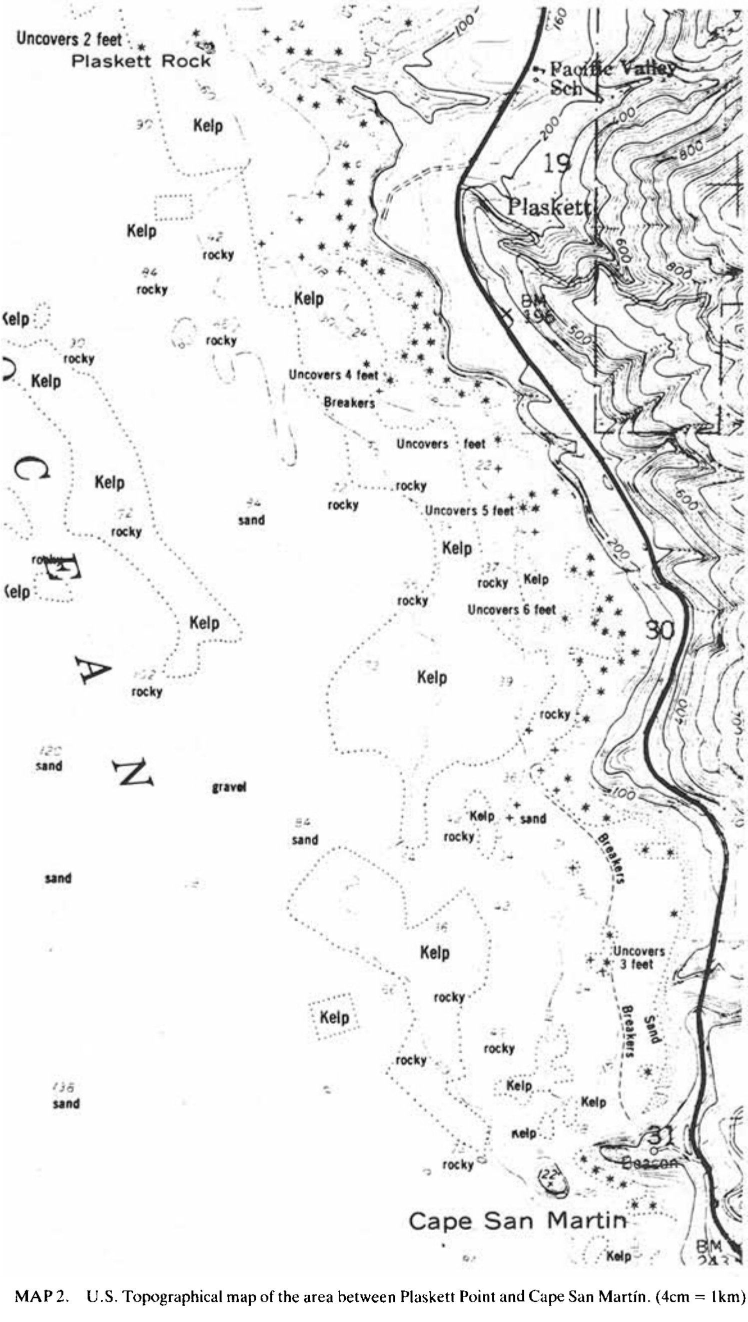


FIG.2. Close up of Mylonite Structure in Nephrite (2x)

the jade are found. The chemical replacement that then occurs is due to the varying accessibility of the serpentines to the mobile alkaline pore solutions (Crippen, 1951).

In the Monterey County nephrite occurrence, with the exception of the nephrite, most of the minerals found in or associated with the serpentinite are found in massive, unsorted and often jumbled groups. The nephrite, however, is consistently located as a compact monomineralic unit. Peculiar yet indicative of the Monterey materials is its botryoidal form. Combined nodular masses of nephrite are found at the beach area typically in the vicinity of its serpentine origin. Having developed its botryoidal habit, it becomes evident under magnification that the nodules either grew outwardly and into one another or were forced



MAP 2. U.S. Topographical map of the area between Plaskett Point and Cape San Martín. (4cm = 1km)

together. It is this compact and unusual grouped nodular mass that has become the trademark of nephrite from this locale. Normal weathering and wave action are subsequently responsible for the separation of the tough nephrite from its less resistant serpentine host.

GEOGRAPHY (see Map 2)

Approximately one hundred kilometres south of the city of Monterey on the California coastline (a fine two hour drive) lies Jade Cove, between Plaskett Point and Cape San Martín. This area extends a distance of roughly three kilometres with the beach varying from sixty to four hundred metres down from the California Highway One. Numerous trails may be taken from the roadway down steep cliffs to the beach area where the nephrite is located. The cliffs vary in height from thirty to eighty metres and are considerably treacherous in some areas. Though a great deal of the area is overlain with soil, it is from the greenish coloured cliff areas that the jade has eroded and may then be found either *in situ* or in the detritus below. It must be noted that the materials may only be legally removed if found below the mean high water level. It is then advisable to visit the area after having carefully studied the tide charts and planning the trip accordingly.

It is a task trying to locate the nephrite nodules, since once wet many of the associated rocks look like the nephrite. Once wetted the typical waxy green appearance of the jade cannot be used as a distinguishing characteristic, so the author found it valuable that the rocks in question be hefted for comparative density and tapped with a hammer for comparative hardness. Most of the associated rocks show inferior characteristics to those of the jade. (See Figure 3.)

Between the two coastal capes, the beaches vary in width from two to twenty metres at low tide, and at this time all of the smaller coves are accessible. Here, the tidal action has separated the tougher jades from the serpentinite and in the process has often given the nodules a polished appearance. In some cases, however, the nephrite has become so weathered that it has taken on a "skin", a layer of reddish-brown oxidized material. The author noted numerous specimens that had been passed over by unknowing collectors because of this weathered surface obscuring the inner nephrite. The skin exhibits a lesser hardness and more granular texture than the nephrite it is concealing.

GEMMOLOGY

The nephrite from the Monterey County area shows all the physical properties typical of nephrite from any locality, but its unusual botryoidal form and absence of noticeable inclusions allow it to stand apart. At its best, the botryoidal oddity is said to take on the appearance of a corn cob, though typically the nodular bundles consist of only two to ten nodules each. The Monterey nephrite also exhibits an unusual absence of inclusions. According to Bergsten (1964) nephrite from Alaska and Wyoming both contain numerous and noticeable pyrite and/or chromite octahedra. The jade, however, from this locale seems to contain no crystalline inclusions, only a minor mylonitized/lensed structure apparent under magnification.

The nephrite collected also exhibits typical colour varying from dark and waxy greenish-coloured boulders to light green nodules. Though the nephrite exhibits a moderate to poor translucency, in unusual cases it was located having a very fine semi-transparency in minor thicknesses (see Figure 4). Two oval cabochons of nephrite were cut and both show moderate translucency and fine even colour-distribution with a good polish. It is here that the absence of inclusions allows for little or no micro-particle undercutting, with the micro-mylonite structure affording only minor variable colour, hardness and translucency.

CONCLUSION

The trek down some California coastal cliffs into the Jade Cove area of Monterey County brings one to not only a beautifully simple place, but one also rich in geological and gemmological history and discovery. Here natural erosion has exposed large serpentine masses and separated from it nodules of nephrite onto the beach or into the sea. Much of the material is found as botryoidal forms, indigenous to this area, or as wave-polished pebbles or weathered chunks. At low tide the keen observer and collector may unearth numerous fine specimens of this unusual and attractive jade. Pieces of various greenish tones, translucency, shape and size make the search rewarding with each new discovery stimulating further search.

FIG.3. View southward showing exposed serpentinite/nephrite cliffs (11.00 a.m.)

FIG.4. Thin section close-up showing nephrite translucency (3mm thickness: 3× magnification)

An understanding of the geology of the area not only makes for a greater appreciation of the mineral development and processes, but also aids in the search for the nephrite. It is through this knowledge that the Monterey County nephrite in its unusual botryoidal form or simple pebble occurrence may be a pleasurable trip and task worth undertaking.

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[*Manuscript received 22nd August 1984.*]

COLOURLESS CHRYSOBERYL—NATURAL OR SYNTHETIC?

By Dr KARL SCHMETZER

Institute of Mineralogy and Petrography,
University of Heidelberg, West Germany

ABSTRACT

The physical and chemical properties of two colourless chrysoberyl specimens which were said to come from Sri Lanka, were investigated in order to clarify their natural or synthetic origin. The data of the two chrysoberyls were compared with those of natural colourless, yellow, brown, and green chrysoberyl specimens of different localities and with the properties of synthetic alexandrites of three producers. Some of the properties of the two colourless chrysoberyls of unknown origin do not prove them to be either natural or synthetic (refractive indices, colour, chromium and iron contents, inclusions, colour change due to x-ray irradiation). However, unlike all natural specimens which were investigated in this research project, including a natural colourless chrysoberyl from Burma, no Ga was found by x-ray florescence analysis to be present in the two colourless samples under investigation. The results may, therefore, indicate a synthetic origin of the samples.

INTRODUCTION

Chrysoberyl is coloured by various amounts of iron and chromium; traces of vanadium are also present in natural samples. Crystals containing predominantly traces of iron are yellow, yellowish-brown or brown. The colour of the green variety of chrysoberyl, called alexandrite, is due to admixtures of chromium and iron, and yellowish-green crystals also contain certain amounts of both iron and chromium, the colour-producing trace elements. However, the chromium content is significantly smaller in yellowish-green crystals. Colourless chrysoberyl is mentioned as a rare gem material from Burma, and, obviously, only a few specimens are known (Arem, 1977; Webster & Anderson, 1983).

Colourless chrysoberyl, which is said to come from Sri Lanka, was first described as a cut gemstone of 2.13 ct by Müllenmeister (1980). The colourless crystal was identified by optical methods, later confirmed by the author using x-ray powder diffraction. The refractive indices of the colourless chrysoberyl were given as n_x1.740 and n_z1.750. These values are extremely low for chrysoberyl compared to the values of ordinary chrysoberyl and alexandrite crystals of different localities ($n_x \approx 1.744–1.749$,

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ISSN: 0022-1252 XIX(8) 682 (1985)

$n_z \approx 1.754–1.759$). The low refractive indices of the colourless chrysoberyl are understood assuming extraordinarily low iron and chromium contents, which is self-evident from the lack of colour of the gemstone. However, no definite proof for the natural origin of the sample of H. J. Müllenmeister was given in the publication mentioned.

Discussing this problem with some colleagues, a second colourless chrysoberyl was identified in the collection of Dr E. Gübelin, of Meggen, Switzerland. This gemstone of 8.26 ct, which was bought about ten years ago as a cut gemstone from Sri Lanka, was also submitted for the present investigation.

Looking through the gem material available in the collection of Dr H. Bank, of Idar-Oberstein, two small yellowish chrysoberyl specimens from Sri Lanka were found, but no additional colourless sample from this locality could be supplied for examination.

In fact, no colourless chrysoberyl of undoubtedly natural origin was available at this state of investigation. One very pale green stone of 4.99 ct from Burma was later localized at the Institute of Geological Sciences,* London. Three nearly colourless but very pale green chrysoberyls of Burmese origin are in the collection of the British Museum (Natural History), London. One nearly colourless, very pale green rough tabular crystal, 16×12×4 mm in size and 12.89 ct in weight, is preserved in the collection of the National Museum of Natural History (Smithsonian Institution), Washington, D.C., U.S.A. (NMNH 139974); this specimen was also submitted for the present investigation.

For the sake of comparison, cut gemstones of yellow, yellowish-green and brown coloration from Sri Lanka and Brazil were supplied, as well as alexandrites of various colour intensities from Russia, Zimbabwe, Brazil, and Tanzania.

Synthetic chrysoberyl has been grown by various methods including flux growth, Czochralski, Verneuil flame-fusion, hydrothermal growth, and floating zone techniques (*cf.* Elwell, 1979; Nassau, 1980; O'Donoghue, 1983). Up to now, only chromium-containing alexandrites have been commercially available on the gemstone market. The first stones of cuttable size were produced by the firm Creative Crystals, of Danville, U.S.A. (Liddicoat, 1972-1973) from a flux in the Li_2O-MoO_3 system and by

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*Now known as the British Geological Survey.—Ed.

the Czochralski method (Cline *et al.*, 1975; Morris & Cline, 1976). However, the inclusions of the synthetic material indicate that only flux-grown samples were cut for gem purposes (Liddicoat, 1972-1973; Eppler, 1974). The alexandrites grown by the Czochralski method are of great importance in laser devices (Morris & Cline, 1976; Walling *et al.*, 1979; Bukin *et al.*, 1981; Sevast'yanov *et al.*, 1981).

A second type of synthetic alexandrite which is grown by the Czochralski method has been produced since 1976 for gem purposes by the firm Kyoto Ceramic, of Kyoto, Japan (Ohguchi, 1981). Most recently, a third type of synthetic alexandrite was introduced by the firm Suwa Seikosha, of Nagano-Ken, Japan. According to the producer, these crystals are manufactured by the floating zone technique. At present, to the knowledge of the author, no synthetic colourless chrysoberyl has appeared on the gemstone market. However, it is evident that colourless chrysoberyl may be produced by one of the methods mentioned above, omitting the colouring dopants (chromium and iron oxides) in the nutrient material for the production of alexandrite (*cf.* Farrell & Fang, 1964; Bonner & Van Uitert, 1968; Cline *et al.*, 1975). Therefore, an investigation of the two cut colourless chrysoberyls of 2.13 and 8.26 ct available at present to the author in order to clarify the nature of the samples was necessary.

RESULTS

Optical Properties

The refractive indices of the colurless chrysoberyl samples were measured as follows:

cut gemstone of 2.13 ct n_x 1.739, n_z 1.748
cut gemstone of 8.26 ct n_x 1.739, n_z 1.748
rough Burmese crystal n_x 1.738, n_z 1.747.

The very pale green stone of the Institute of Geological Sciences has refractive indices of n_x 1.741, n_z 1.748 (E. A. Jobbins, private communication 1984), the three crystals of the British Museum (Natural History) have refractive indices lower than 1.740 (P. G. Embrey, private communication 1984). All yellow, yellowish-green and green chrysoberyl specimens tested for this investigation have refractive indices in the range which is given in gemmological textbooks.

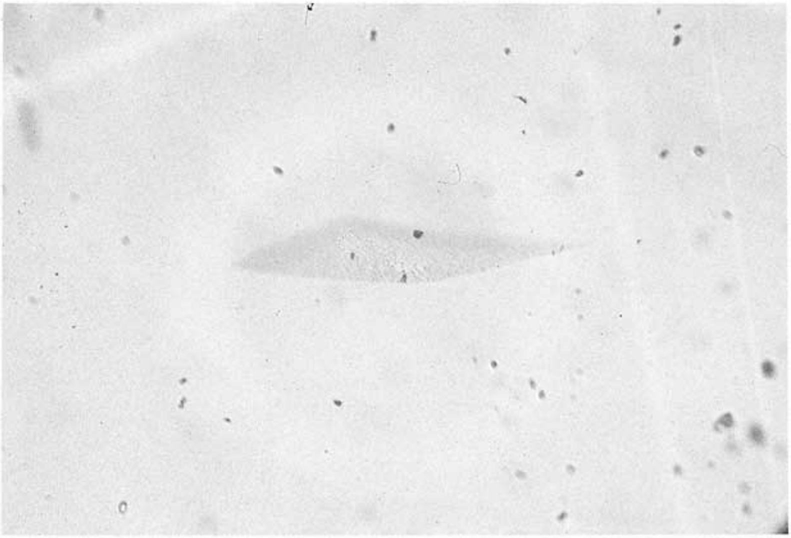

FIG. 1. 'Fingerprint' inclusion consisting of small spherical particles in colourless chrysoberyl of unknown origin (sample of 8.26 ct. collection of E. Gübelin). 55×.

Inclusions

Both colourless gemstones which were said to have come from Sri Lanka are extremely pure crystals. Both samples show straight parallel growth bands, which is common for natural and flux grown chrysoberyl. The gemstone of 8.26 ct has a small 'fingerprint' inclusion (Figure 1) consisting of small spherical particles. No mineral inclusions were observed in either of the two.

The rough Burmese crystal has several mineral inclusions: rounded crystals (zircon?) surrounded by a 'halo' of fractures (Figures 2,3) and double refractive tabular crystals with high interference colours (calcite?) surrounded by a liquid feather (Figures 4,5). In addition, the crystal has a liquid-filled tube and a thin tabular negative crystal.

Spectroscopic Data

In the absorption spectra of the colourless gemstones of unknown origin no distinct absorption bands were observed. The nearly colourless, very pale green Burmese crystal has a very weak chromium spectrum, which is already known in detail from the investigations of alexandrites from different localities.

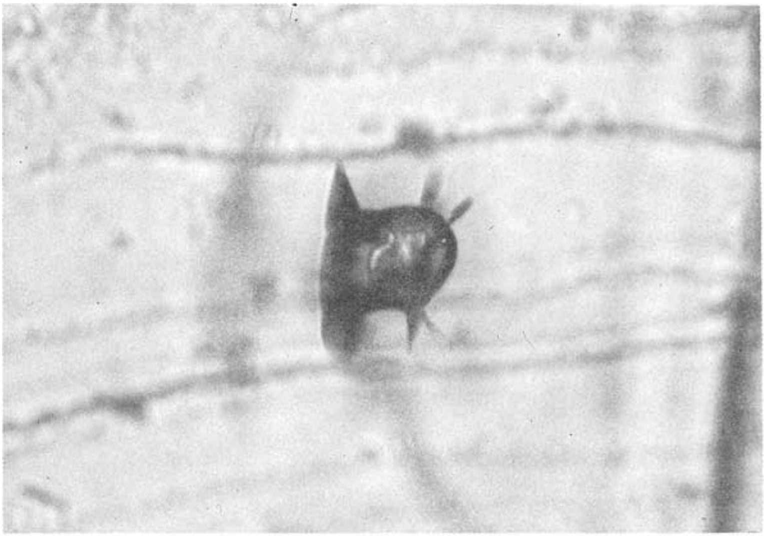

FIG. 2. Rounded crystal (zircon?) surrounded by a 'halo' of fractures in nearly colourless, very pale green chrysoberyl from Burma (tabular crystal, Smithsonian collection). 95×.

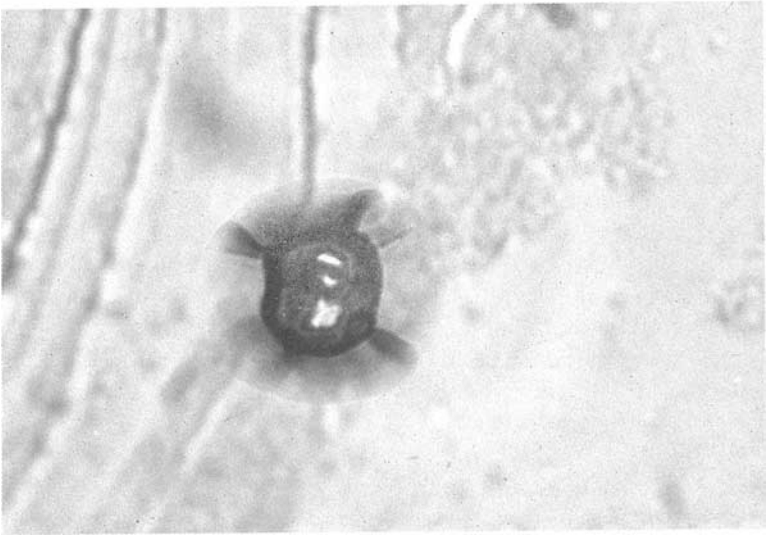

FIG. 3. Rounded crystal (zircon?) surrounded by a 'halo' of fractures in nearly colourless, very pale green chrysoberyl from Burma (tabular crystal, Smithsonian collection). 100×.

The absorption spectra of yellow and brown chrysoberyls show distinct iron bands; all natural alexandrites have absorption bands of chromium and iron, and yellowish-green chrysoberyl specimens show the iron absorption spectrum of yellow or brown samples and weak chromium bands (*cf.* Farrell & Newnham, 1965; Hassan & El-Rakhawy, 1974; Schmetzer *et al.*, 1980).

In synthetic alexandrites the absorption bands of chromium and iron (synthetic alexandrites produced by Creative Crystals and Suwa Seikosha) or a chromium spectrum without iron bands (synthetic alexandrites produced by Kyoto Ceramic) were measured. According to Ohguchi (1981), the synthetic alexandrites of Kyoto Ceramic may also contain certain amounts of vanadium as a dopant.

Chemical Data

Non-destructive chemical analyses by x-ray fluorescence reveal only a very small iron content in the cut colourless gemstone of 2.13 ct. The x-ray fluorescence spectra of both colourless chrysoberyl specimens of unknown origin did not show a distinct signal for Ga. However, in all natural chrysoberyl specimens investigated (the colourless Burmese crystal, yellow, brown and yellowish-green samples from Sri Lanka and Brazil, and alexandrites of the localities mentioned before), in addition to the signals of colouring trace elements (Fe and Cr), a distinct Ga content was observed. In synthetic alexandrites of all three producers, no Ga was found.

Colour Change due to Irradiation

All three colourless samples revealed, after x-ray fluorescence analysis, an intensive golden brown colour. The colour of some light yellow chrysoberyl specimens from Sri Lanka changed to an intensive golden brown after x-ray fluorescence analysis. The colour of dark brown or intensive green samples appeared unchanged to the eye after x-ray fluorescence analysis.

All colour changes were found to be completely reversible after exposure to a fibre optic illuminator for about five minutes. After illumination, the stones were colourless or slightly yellow again.

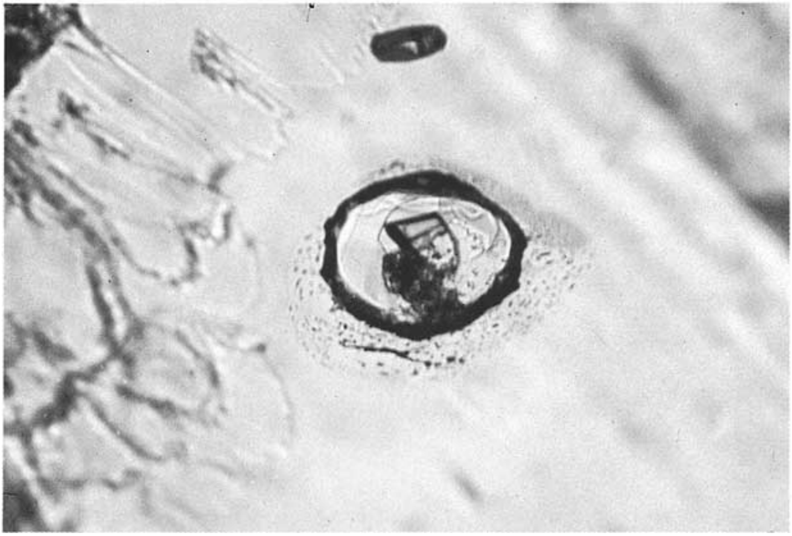

FIG. 4. Tabular crystal (calcite?) surrounded by a liquid feather in nearly colourless, very pale green chrysoberyl from Burma (tabular crystal, Smithsonian collection). 70×.

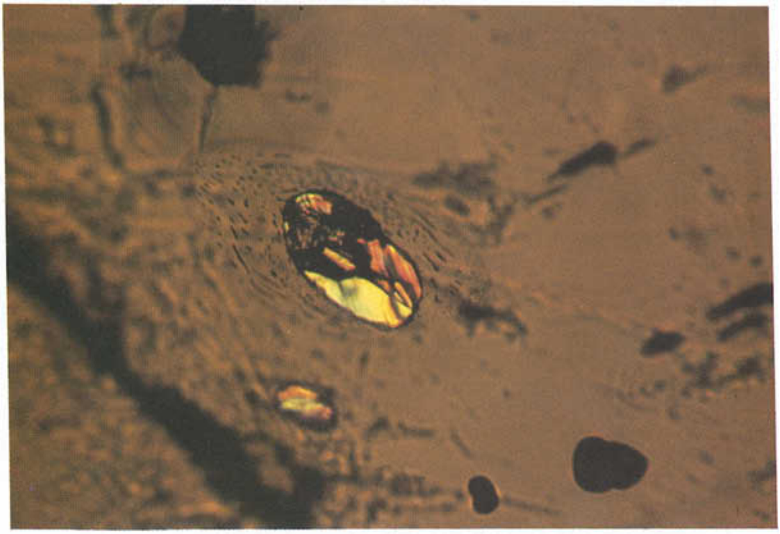

FIG. 5. Tabular crystal (calcite?) surrounded by a liquid feather in nearly colourless, very pale green chrysoberyl from Burma (tabular crystal, Smithsonian collection). Crossed polarizers, 65×.

Discussion

The nearly colourless, very pale greenish chrysoberyl crystal from Burma (Smithsonian specimen NMNH 139974) with mineral inclusions and refractive indices of n_x 1.738, n_z 1.747, is undoubtedly of natural origin. The investigation of this sample indicates that colourless chrysoberyl of natural origin without distinct trace element contents of Fe and Cr and with low refractive indices as determined for the two samples of unknown origin does exist. However, such natural samples, at present, are known to originate only from the Mogok stone tract in Burma. Colourless chrysoberyl from Sri Lanka may exist, too, but has not yet been reported.

The microscopic investigations of the two colourless samples under discussion indicate that the stones could be extremely pure natural materials or extremely pure flux grown samples. The microscopic examination did not reveal the properties of crystals grown by the Czochralski or floating zone technique which are produced by Kyoto Ceramic and Suwa Seikosha of Japan. The synthetic alexandrites of Kyoto Ceramic show curved striations, and the alexandrites of Suwa Seikosha reveal growth inhomogeneities and an irregular shift structure.

The presence of Ga indicates alexandrites of natural origin (Ohguchi, 1981). Quantitative Ga determinations in natural alexandrites reveal an enrichment of about 300-1200 ppm Ga (Ottemann, 1965; Ottemann *et al.*, 1978). As shown in this research project, all natural alexandrite and chrysoberyl samples investigated including the colourless sample from Burma revealed a distinct Ga signal by x-ray fluorescence analysis. On the contrary, both colourless chrysoberyls of unknown origin did not contain Ga in diagnostic quantities. No residues of a flux were found in these samples or in synthetic alexandrite samples of Creative Crystals, which were grown from Li_2O-MoO_3 flux according to the description of the producer (Cline *et al.*, 1975).

The colour change of the two colourless samples after x-ray fluorescence analysis is similar to the colour change described for synthetic alexandrite of Kyoto Ceramic by Bank (1982). Therefore, this colour change was first thought to indicate the synthetic origin of the samples. However, a reversible colour change both of the colourless Burmese crystal and of the yellow or yellowish-green samples from Sri Lanka also was found after x-ray fluorescence analysis.

In summary, both colourless chrysoberyl samples of unknown origin reveal physical and chemical properties, which may indicate extremely clean natural or flux grown crystals (refractive indices, inclusions, iron and chromium contents, reaction to x-ray irradiation). A distinct Ga content was not found in either of the two samples; Ga, however, was observed in all natural samples investigated. Properties, which indicate an undoubtedly natural origin of the two colourless samples, were not found.

The colourless chrysoberyl in E. Gübelin's collection was bought about ten years ago. At that time, the production of flux grown synthetic alexandrite for gem purposes was already established. Unfortunately, no information about possible production of colourless synthetic chrysoberyl for gem purposes is known by the author to be available, and no information was given by Creative Crystals.

ACKNOWLEDGMENTS

The author is grateful to H. J. Müllenmeister, of Markt Schwaben, West Germany, to Prof. E. Gübelin, of Meggen, Switzerland, to Dr J. S. White, of the Smithsonian Institution, Washington, D.C., U.S.A., and to Prof. H. Bank, of Idar-Oberstein, West Germany, for the loan of chrysoberyl and alexandrite specimens.

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[*Manuscript received 28th October, 1984*]

PERIDOT FROM RATNAPURA DISTRICT, SRI LANKA

By MAHINDA GUNAWARDENE, F.G.A., D.Gem.G.

Im Sierling 2, 6580 Hettenrodt, West Germany.

INTRODUCTION

Sri Lanka is one of the greatest gemmiferous localities in the world and is famous for the occurrence of common and rare gemstones of various kinds.

Since the discovery of gem sinhalite in the island (Claringbull & Hey, 1952) the great gemmologist B. W. Anderson (1952) found that most of the stones marketed in Sri Lanka as peridot were sinhalite. However, during a recent visit the author discovered a few samples of cut and uncut peridots of gem quality.

The preliminary identification was done after polishing a facet for refractive index determination on a few samples. According to the refractive indices and the quite large birefringence the samples were confirmed as peridot rather than diopside as thought before.

The peridots found in the Ratnapura area, Sri Lanka, were investigated in detail, including a chemical analysis. It was desirable to publish the results of this investigation since the occurrence of gem peridot in Sri Lanka has not yet been reported in the gemmological or mineralogical literature.

FIG. 1. These peridots from Ratnapura represent some of the best colour found in Sri Lanka. The stones range in weight from 5 to 12 ct.

ISSN: 0022-1252 XIX(8) 692 (1985)

CHEMISTRY

The chemical analysis of the Sri Lanka peridot was performed by electron microprobe. The results are given in Table 2, in comparison with data of peridots from several other localities, as indicated in Table 1. The calculation of the Fo/Fa ratios show that gem peridots are situated between approximate 92.5%-88.5% Fo with 7.5%-11.5% Fa molecules. The concentrations of Mn and Ca are fairly low. The sample from Sri Lanka contains a slightly higher amount of MnO (0.27%) compared with the other gem peridots. Its composition may be expressed by the formula:

$$Mg_{1.77}\,Fe_{0.22}\,Mn_{0.01}\,Si_{1.00}\,O_{4.00}$$

TABLE 1. *List of peridot samples referred to in this paper.*

1. Arizona	(Dunn, 1974)
2. Arizona, Chinlee Valley	(Dunn, 1974)
3. Arizona, Fort Defiance	(Dunn, 1974)
4. Arizona, Rice Station School	(Dunn, 1974)
5. Mexico	(Dunn, 1974)
6. Mexico, Chihuahua	(Dunn, 1974)
7. Island of Zabargad (Egypt)	(Kurat *et al.*, 1982)
8. Island of Zabargad (Egypt)	(Stockton & Manson, 1983)
9. Burma	(Stockton & Manson, 1983)
10. Norway	(Stockton & Manson, 1983)
11. Tanzania, Usambara Mountains	(Stockton & Manson, 1983)
12. Sri Lanka, Ratnapura	(present work)

PHYSICAL PROPERTIES OF SRI LANKA PERIDOT

The attractive colour of peridot is a distinct olive green, which may vary according to the amount of Mn^{2+} and Fe^{2+} cations present. The Mn^{2+} and Fe^{2+} content is considered responsible for the darkening of the colour (read also Gübelin, 1981). The stone from Sri Lanka (Figure 1) contained a relatively high amount of FeO (10.81 wt %) and MnO (0.27 wt %) compared with other samples.

TABLE 2. *Chemical analyses comparison of Sri Lanka peridot with material from other localities.*

Locality:	Arizona				Mexico		Zabargad		Burma	Norway	Tanzania	Sri Lanka
	1(a)	2(a)	3(a)	4(a)	5(a)	6(a)	7(b)	8(c)	9(c)	10(c)	11(c)	12(d)
Composition												
SiO_2	41.11	41.57	41.39	41.62	41.96	41.32	41.60	41.07	40.25	41.19	40.62	40.62
TiO_2	0.02	0.01	0.02	0.01	*	0.01	*	*	*	*	*	*
Cr_2O_3	0.04	0.03	0.04	0.04	0.06	*	*	*	*	*	*	*
FeO**	9.07	10.37	9.71	8.67	8.67	8.62	9.60	8.14	10.16	6.94	7.74	10.81
MnO	0.09	0.12	0.11	0.18	0.10	0.14	0.10	0.11	0.15	0.06	0.12	0.27
MgO	49.49	48.47	48.50	48.34	49.39	49.80	49.70	50.44	48.90	51.63	51.26	48.11
CaO	0.09	0.09	0.10	0.10	0.16	0.06	*	0.04	*	*	*	0.14
NiO	*	*	*	*	*	*	0.33	0.38	0.31	0.29	0.39	*
Total	99.91	100.66	99.87	99.43	100.34	99.95	100.33	101.18	99.77	100.11	100.13	99.95

(a) Dunn (1974)

(b) Kurat *et al* (1982)

(c) Stockton & Manson (1983)

(d) present work (kindly analysed by Dr H. Hänni)

*below the detection limit of the microprobe

**the total iron is calculated as FeO

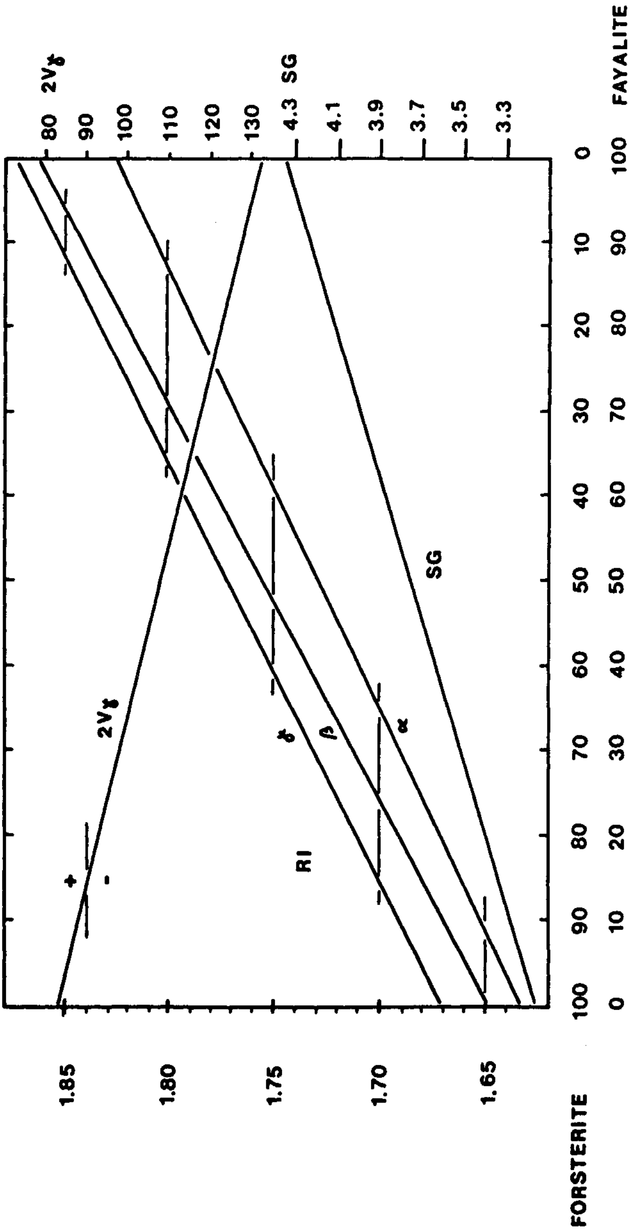

FIG. 2. Variations of 2V angle, specific gravity and refractive indices for the forsterite-fayalite series (after Deer *et al.*, 1982).

TABLE 3. *Optical and physical data of gem peridots from different localities.*

Locality:	Arizona (I)	Arizona (II)	Arizona (III)	Mexico (IV)	Mexico (V)	Zabargad (VI)	Burma (VII)	Australia (VIII)	Tanzania (IX)	Sri Lanka (X)
Refractive indices										
n_α	1.653	1.652	1.652	1.652	1.652	1.652	1.656	1.653	1.650	1.651
n_β	1.669	1.671	1.668	1.671	1.668	1.668	1.671	1.671	1.658	1.660
n_γ	1.690	1.689	1.689	1.688	1.685	1.690	1.692	1.690	1.684	1.690
Birefringence	0.037	0.037	0.037	0.036	0.033	0.035	0.036	0.037	0.034	0.039
Optical character	B+	B−	B+	B−	B+	B−	B+/−	B+	B+	B+
Specific gravity	3.35	3.34	3.34	3.33	—	3.28	3.35	3.39	3.25	3.36
Fo:Fa ratio	91:9	89:11	90:10	91:9	91:9	—	—	—	—	89:11

I-V	After Dunn (1975)
VI and X	the author
VII	after Gübelin (1975 & private communications)
VIII	after Brown & Bracewell (1982)
IX	after Stockton & Manson (1983)

As well as the colour, the high refractive index of peridot is also caused by the amount of Fe^{2+} percentage. With increasing iron content the axial angle $2V_\gamma$ increases and the optical character turns to negative at 15 molecule % of *fayalite*. Simultaneously n_β is altered slightly away from n_α towards n_γ (Bowen & Schairer, 1935). The relationship between the optic axial angle and the refractive indices after Deer *et al.* (1982) is shown in Figure 2. The refractive indices and specific gravity are given in Table 3 as are molecule ratios and the physical data comparisons (see also Figure 3). Visible light spectrophotometric examination of the Sri Lanka peridot was conducted on a Pye Unicam SP8-100 UV-VIS spectrophotometer. The recorded spectrum (Figure 4) shows similar peaks to that of tephroite at approximate wavelengths of 610, 550, *500* and *450* nm (Stidham *et al.*, 1976).

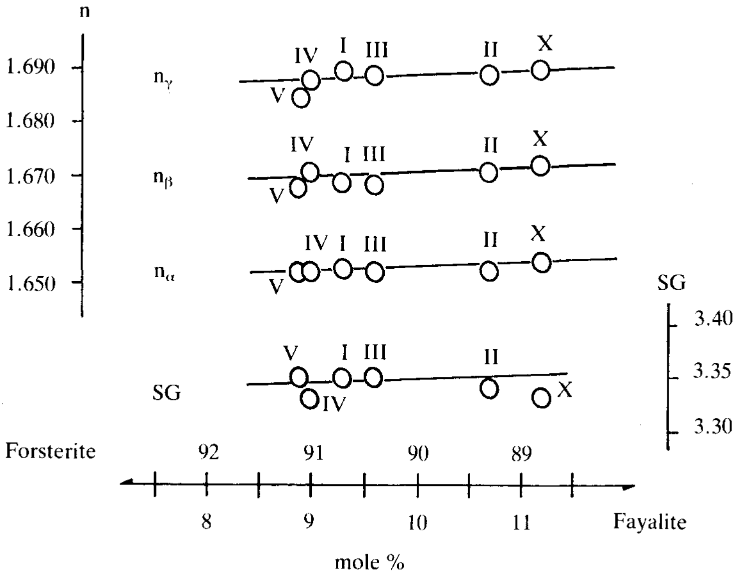

FIG. 3. Some of the samples taken from Table 3 to demonstrate the variations of physical properties in gem peridots in relation to their forsterite and fayalite ratio.

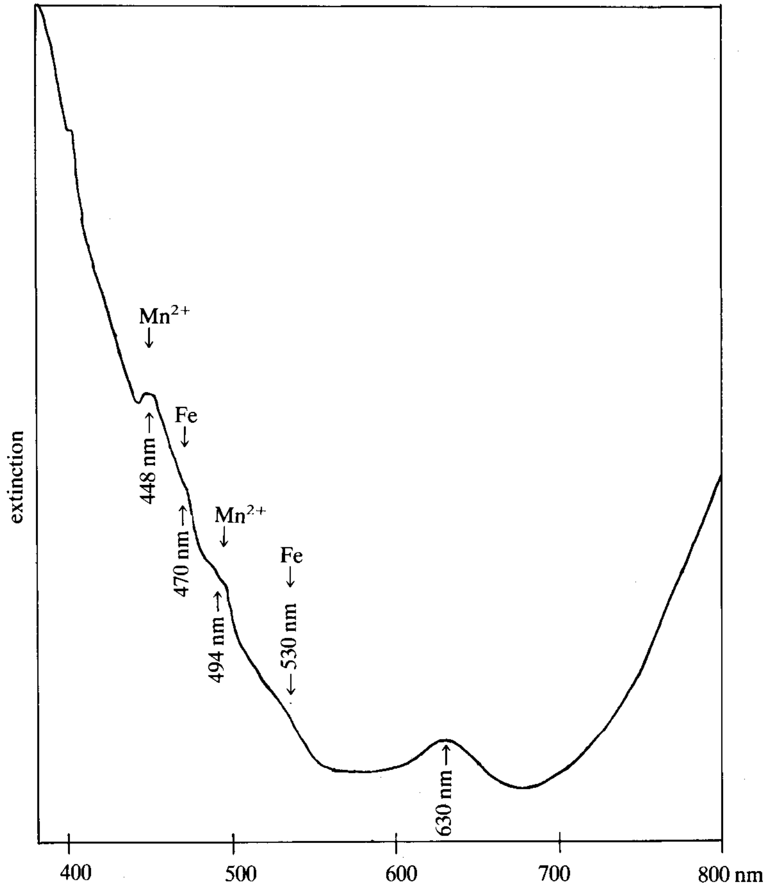

FIG. 4. The absorption spectrum of Sri Lanka peridot within the visible wavelength range of 400 to 800 nm.

INCLUSIONS IN SRI LANKA PERIDOT

Microscope investigations revealed the presence of dark reddish-brown to black euhedral to anhedral crystals as shown in Figure 5. Dunn (1974 & 1978) reported the occurrence of chromian spinel as an inclusion in peridots from Arizona and Mexico. The exposed inclusion just below the surface of the stone from Sri Lanka (Figure 6) was analysed with the electron microprobe and the results obtained are given in Table 4. This analysis showed the inclusions in Sri Lanka peridot to be a member of the spinel mixed

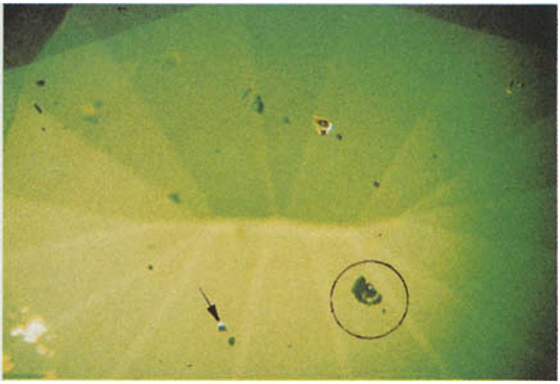

FIG. 5. Euhedral (arrowed) as well as anhedral (circled) spinel inclusions in gem peridot from Ratnapura, Sri Lanka. (15×).

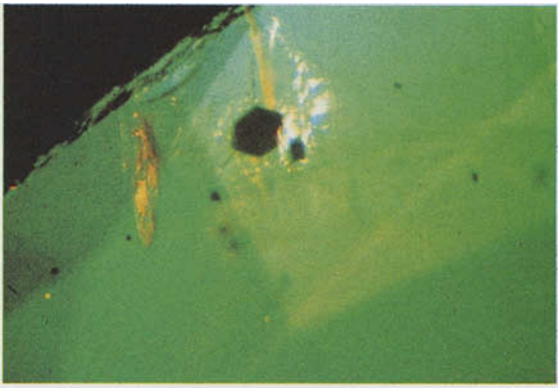

FIG. 6. Flat crystal of iron-rich spinel inclusion showing a pseudohexagonal contour. Note also the tension fissures surrounding the crystal. (40×).

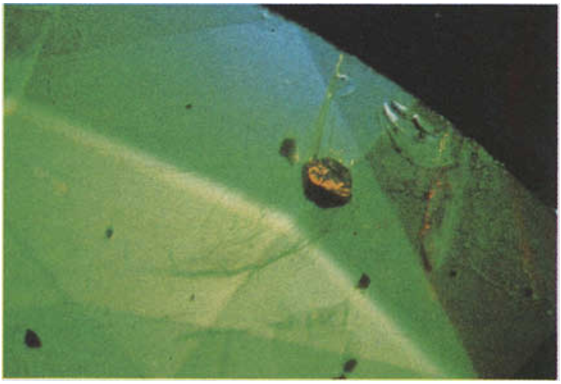

FIG. 7. Smoke-like veiling in Sri Lanka peridot. (40×).

TABLE 4. *Chemical analyses of the spinel inclusions in Arizona, Mexico and Sri Lanka peridots.*

	Arizona sample No: 1	Arizona sample No: 2	Arizona sample No: 3	Arizona sample No: 4	Mexico sample No: 5	Mexico sample No: 6	Sri Lanka sample No: 12
SiO_2	0.12	0.11	0.11	0.10	0.19	—	—
TiO_2	0.27	0.18	0.29	0.52	0.10	0.11	1.11
Al_2O_3	45.46	36.55	34.43	34.91	31.68	46.34	31.93
Cr_2O_3	22.62	33.08	33.11	31.49	34.79	21.60	30.71
FeO	11.95	14.68	14.59	13.75	13.33	12.38	20.32
MnO	0.16	—	0.19	0.18	0.19	0.23	—
MgO	17.71	16.39	15.48	16.57	16.28	18.67	16.31
CaO	0.01	0.03	0.01	—	0.03	—	—
Totals	98.30	101.02	98.21	97.52	96.59	99.33	100.38

samples are from Table 1

the total iron is calculated as FeO

accuracy of data ± 2% relative

crystal series (spinel-magnetite-chromite) similar to those reported in peridots from other localities (Dunn, 1974, 1978; Koivula, 1981). The inclusion is of a platy shape (i.e. an extremely distorted octahedron) showing a pseudohexagonal symmetry resembling mica platelets. The included crystals were often surrounded by tension fissures as shown in Figure 6. Although there were no other typical inclusions present, an effect similar to smoke-like veiling was found (Figure 7). A similar effect was reported by Koivula (1981) from San Carlos peridots. This may be due to lattice dislocations as mentioned by Kohlsted *et al.* (1976) or possibly to unmixing in the subsolidus region (Koivula, 1981).

Occurrence

The occurrence of gem peridot is mainly confined to basaltic rock types as reported from Zabargad Island (Kuart *et al.*, 1981), Arizona (Dunn, 1974), San Carlos (Koivula, 1981) and Mexico (Dunn, 1978).

In Sri Lanka the gem-bearing Highland Group consists mainly of metamorphic rocks of granulite facies. Pelitic, quartzofeldspathic, calcareous, basic and ultrabasic rock types are common in this Group (Munasinghe & Dissanayake, 1981). The presence of spinel inclusions in the gem from the island supports its origin in an ultrabasic igneous environment rather than in a metamorphic region in the Highland Group of rocks.

The exact source is unknown, but field evidence suggests that the locality may be somewhere between Pelmadulla and Kahawatta in the Ratnapura District. During a recent visit the author also examined one colourless olivine said to be found in the same area.

Conclusion

Peridot is not a new gemstone found in Sir Lanka. It is probable that most green sinhalites and/or diopsides found in this locality may be peridots. A careful refractive index determination would distinguish peridot from other confusing species.

Acknowledgement

The author would like to thank Dr Henry A. Hänni, of Basel University, Switzerland, for the microprobe and spectrum analysis and his valuable contributions to the original manuscript.

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[*Manuscript received 30th October, 1984.*]

EXCEPTIO CONFIRMAT REGULUM

By A.E. FARN, F.G.A.

The Laboratory, which celebrates its sixtieth anniversary in 1985, has changed its title. The first described the Laboratory's trade orientation. It was 'The Laboratory of the Diamond, Pearl and Precious Stone Trade Section of the London Chamber of Commerce'. Nearly fifty years later it took a fresh title; this was 'The Gem Testing Laboratory of the London Chamber of Commerce and Industry'. This succinct title lacked the import of the words, Diamond, Pearl, Precious Stones, and Trade. Succinct or not, the Laboratory continued to serve the trade then and now. Its earlier and original members comprised merchants, based chiefly in Hatton Garden with a few in the West End. It is a CIBJO recognized laboratory for the whole of Great Britain. Part of the work of the Director of the Laboratory is to assist in trade matters, particularly with nomenclature, thus maintaining trade and gemmological importance in this capacity with CIBJO. Its third (current) title is 'The British Gem Testing Laboratory'; its functions remain the same as before.

As gemmologists and readers of this *Journal* will appreciate, laboratory problems increase with the 'improvement' of methods of manufacture of synthetic stones and the activities in the bio-mineralization field. In particular large non-nucleated cultured pearls from marine oysters are presently proving troublesome. It must not be forgotten, however, that the original establishment was solely a pearl testing station, set up by a coterie of pearl merchants to combat the threat to the pearl trade by the Japanese spherical cultured pearl. Pearls came before gem testing. Time was available for research in the field of gemmology due to the world trade slump of the late twenties and early thirties of this century. In the pearl world, because of the cultured pearl, the late B.W. Anderson was recruited to find methods to detect them. The gemmological world was fortunate that Anderson could also devote time to the science of gemmology.

One of the most powerful weapons in pearl and gemstone testing is the use of x-rays. The purpose built, 'one-off', x-ray generating set in present use was designed by C.G. Osment, a radiological engineer working in close consultation with B. W.

ISSN: 0022-1252 XIX(8) 703 (1985)

Anderson. The set not only affords negative radiographs and lauegrams, but has a built-in viewing chamber. Here can be observed the fluorescence and/or phosphorescence under x-ray excitation of pearls, cultured pearls and other gem materials. The set can record on negative film the degree of transparency or opacity to x-rays that substances may possess.

The well-known transparency of diamonds to x-rays is often seen when a pearl mounted with diamonds is photographed. The diamonds appear as blank spaces, or 'holes', in the precious metal mount, and the pearls being much less transparent show their evanescent structures. C.A. Doelter advocated in 1894 (one year after Röntgen had discovered x-rays) that radiography be used in gem testing, particularly in the case of diamonds. A little later, Dr Herbert Smith produced his portable refractometer in 1905. Had not Dr H. Smith devised his instrument we might well have progressed and become versatile in transparency tests by controlled exposures of gemstones to x-rays. One could say that testing pearls and inadvertently gems as well by x-rays has been a 'revelation'! It was not, however, the primary purpose of this preliminary approach by way of titles or functions of the Laboratory to labour the importance of pearls and pearl testing! Neither was it to accentuate how much gemmology owes to the culturing of pearls. It was in fact to draw attention and interest to some laboratory activities or functions other than just gem testing.

Requests for help and information come from police forensic departments, Customs and Excise (but not the Inland Revenue), local authorities' weights and measures departments, and, of course, the 'media'. In trade enquiries nomenclature features strongly. Work with the G.A., N.A.G. and Coloured Stone Section of the British Jewellery and Giftware Federation helped considerably in the production of the famous C.I.B.J.O. 'Blue Book', and of course help was given to their other publication, 'Rules of Application for the Diamond Trade'.

Despite these efforts to tidy up nomenclature, 'hardy annuals' still put in an appearance. In earlier days we battled against such misuses as 'topaz quartz', where the adjective 'topaz' (for colour) was used to describe the noun 'quartz'. This has now disappeared, but the somewhat hardier 'semi-precious' occasionally surfaces. An obvious illogicality, one wonders how to define half-precious? Yet we know what is meant or implied by the term!

Another 'semi' met with in gemmological contexts is the word 'semi-conductor'. In electronics this is a near insulator. Semiconductors using germanium, silicon, selenium and silicon carbide are used in thermistors, rectifiers and photo-cells.

In other vein the Laboratory may be asked to advise or to carry out research on the effects certain adhesives have on soft, porous or organic gem materials. Answers are sometimes requested to such questions as 'Why have pearls darkened?', 'Why has a signet ring left a black mark on the wearer's finger?', or even the suitability of a title to a book! Basically, though, the Laboratory's role is gem testing.

Nomenclature must be the order of the day, i.e. the correct naming of stones and materials. Whilst we may regret the passing of a useful or pleasant sounding name, it is better in gemmology to be precise than poetic.

B.W. Anderson, as Director of the Laboratory, was a man dedicated to the correct use of words. In the earlier days of the Laboratory, pen carbon copies of written reports of texts were kept as permanent records. They contained extra details noted of cut, colour, characteristics, inclusions, fluorescence and phosphorescence (these were not on the customer's copy). B.W. Anderson read all of them as part of his administrative duty. All of us benefited by his observations on our descriptions and use of words.

I came across some notes of a talk he gave to his Post-Diploma class many years ago. It was on the subject of jade and jade-like materials, which in their turn had appeared at the Laboratory to be checked hopefully as jade.

The talk he gave was prefaced by a delightful dissertation upon the correct naming of stones; it ran as follows: 'In gemmology we seek so far as is possible to use as names for gemstones only those which can properly be applied to one stone only. In pursuance of this ideal we have had to abandon some attractive and long established names: e.g. 'chrysolite' ('golden stone') was as one time used for topaz, but now means peridot in America and chrysoberyl in England. Therefore it is ambiguous and should be avoided. Olivine is the name for peridot in British mineralogy, but was used so extensively for the green garnet that we find it better to use the terms peridot and demantoid and avoid olivine altogether. Jacinth (for orange zircon or garnet), although a beautiful word and an ancient name, is also best avoided. One name which covers two distinct minerals, however, we cannot easily avoid using, because of its prestige and unusual appeal. That word is Jade . . .'

Then followed a typically well researched lecture upon the jade-like materials as well as those two fascinating materials nephrite jade and jadeite jade. These two, which have different chemical formulae, and which are two distinct minerals, managed to escape the stringency of nomenclature requirements by worthily exemplifying the maxim 'exceptio confirmat regulum', or, as we might say in English, by being the exceptions that prove the rule.

[*Manuscript received 31st October, 1984.*]

AQUAMARINE FROM MT SURPRISE, QUEENSLAND, AUSTRALIA

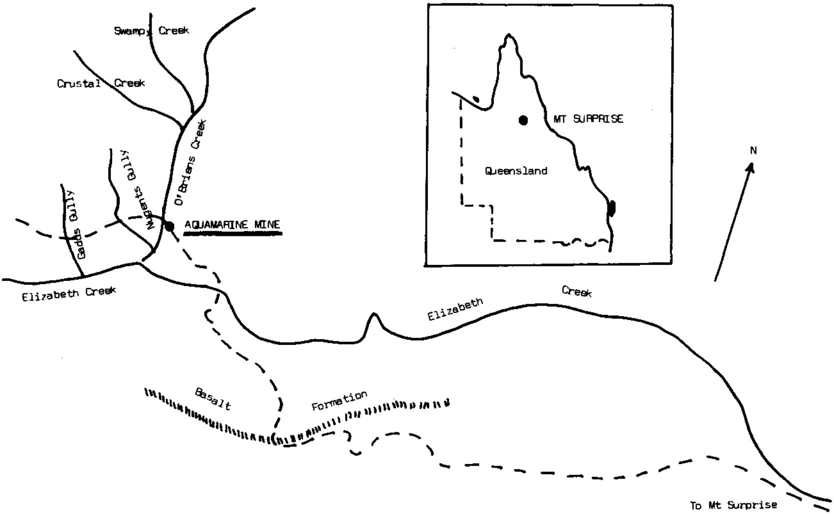
By GRAHAME BROWN, F.G.A.A., F.G.A., Dip.D.T., Dip.G.R., F.C.Gm.A.

Gem quality aquamarine is being commercially mined from the Mt Surprise gemfield, of Northern Queensland, Australia. The Mt Surprise gemfield is located (Map 1) 46 km to the ENE. of the small township of Mt Surprise.

The potential that this gemfield possesses, for yielding aquamarine, was first recorded in 1931 by Dunstan.(1) In his *Queensland Mineral Index & Guide*, Dunstan noted:

> AQUAMARINE
> '300 – Loc. Quartz Hill, on Elizabeth Cr, br of Einasleigh R.,
> Almaden – Georgetown Rd., 130 miles S.W. of Cairns.
> Co. Tate (ante) Ref B.D.'

The small scale commercial mining operation, that currently yields blue aquamarines, remarkably free from greenish or yellowish overtones, is located near O'Briens Creek. O'Briens Creek is a tributary of Elizabeth Creek, a larger stream that joins the westerly flowing Einasleigh River, which ultimately flows into the Gulf of Carpentaria.



MAP 1. Location of the O'Briens Creek aquamarine mine in the Mt Surprise gemfield of Northern Queensland.

ISSN: 0022-1252 XIX(8) 707 (1985)

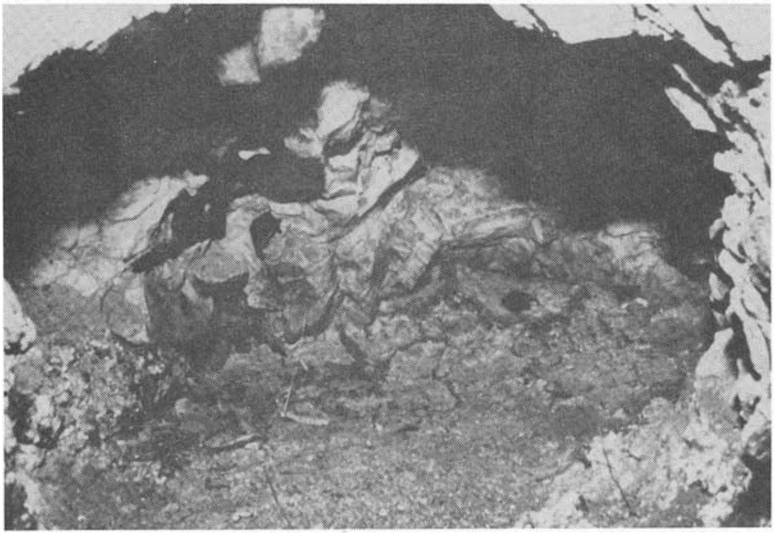


FIG. 1. An aquamarine-bearing vugh (approximately 1 m wide × 0.75m high) in the Elizabeth Creek Granite at O'Briens Creek.

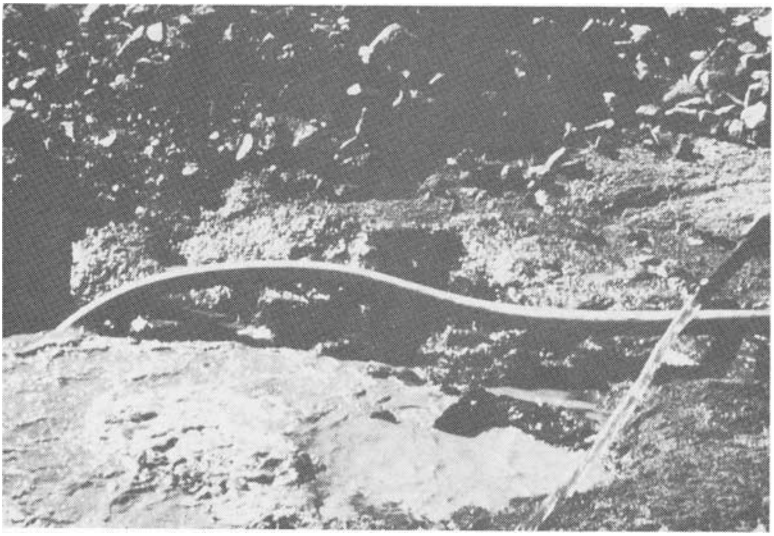


FIG. 2. Hydraulic mining for aquamarine-bearing vughs in the granite at O'Briens Creek. Note (lower right) the 4 cm diameter flexible pipe that was used to create muddy puddles above depressions in the granite surface.

Australian gemmologists should be well aware that the Mt Surprise gemfield is already known as a prolific source of gem-quality colourless, blue, and yellowish topaz.(2)

At the mine site, the aquamarine is found in vughs (Figure 1) in the Elizabeth Creek Granite,(3) which underlies the O'Briens Creek alluvials. To reach the aquamarine-bearing vughs, the overburden of soil, gravel, and small boulders must be completely removed from the underlying granite. This removal is accomplished by using a simple combination of mechanical and hydraulic mining techniques. Initially, light earth-moving equipment is used to remove the gross overburden. Once the granite surface has been roughly exposed, the residual overburden is removed by a simple and inexpensive form of hydraulic mining (Figure 2).

Water from O'Briens Creek is pumped, under pressure, on the surface of the granite, to create muddy puddles above depressions in the granite surface. The contents of these muddy puddles are then evacuated by means of a venturi (vacuum suction) system. Systematic repetition of this puddle creating – puddle evacuating mining cycle rapidly and inexpensively exposes the surface of the granite for inspection by the 2-3 man team that conducts this aquamarine mining operation (Figure 3).

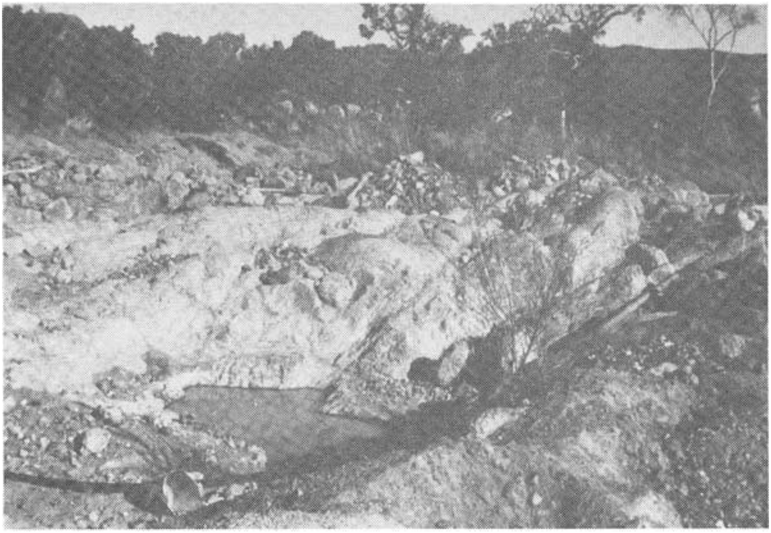


FIG. 3. A worked out portion of the aquamarine mine at O'Briens Creek, Northern Queensland.

If, and when, a vugh is located in the granite surface, its contents are carefully removed by hand and examined in detail for tell-tale evidence of either common beryl (an indicator mineral), or more hopefully aquamarine. Once each vugh has been completely evacuated, its walls are then systematically examined for the presence of any aquamarine crystals that may be attached to the walls of the vugh. Any crystals of aquamarine that are discovered, are carefully removed by hand and bagged for later sorting.

As only one or two aquamarine-producing vughs are usually located per year, the owner of this mine on O'Briens Creek has little difficulty marketing his production either as fine quality aquamarine crystal specimens or else as gem-quality aquamarine faceting rough.

GEMMOLOGICAL INVESTIGATIONS

In order that the gemmology of the aquamarine from O'Briens Creek, in the Mt Surprise gemfield, could be described, the owner of the mine supplied the author with a representative sample of the mine production.

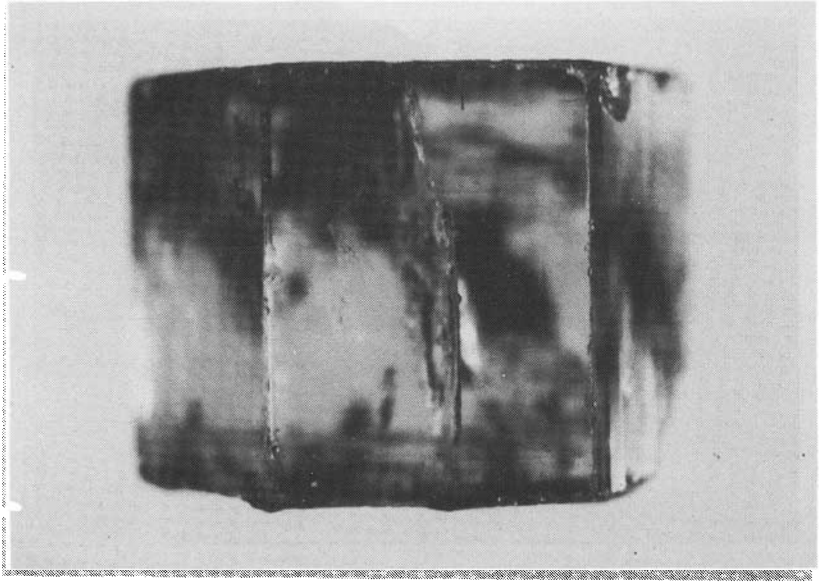


FIG. 4. A euhedral gem quality aquamarine crystal from O'Briens Creek. This crystal measures 30mm × 21mm.

After the specimens were sorted for quality and examined macroscopically, selected specimens were either faceted, or else had inspection facets placed on them. These faceting procedures allowed the selected aquamarines to be critically examined for internal inclusions. Finally, conventional gemmological physical and optical properties were determined for carefully selected specimens of gem-quality aquamarine.

The results of this investigation were then compared with the results of previous investigations into the gemmology of aquamarine from other world-wide localities.

Macroscopic Features

Aquamarine recovered from the O'Briens Creek mine occurred as:

* Well-formed crystals of gem-quality (Figure 4);
* Secondarily resorbed gem-quality crystals (Figure 5);
* Gem-quality crystal fragments;
* Crystals of non-gem quality; and
* Fragments of crystals of non-gem quality (Figure 6).

The euhedral crystals from this mine displayed a simple stoutish prismatic habit, with the hexagonal prism and the basal pinacoid forms predominating (Figure 4). Prism/pinacoid edges were occasionally truncated by small pyramidal forms.

Although 1 to 3ct aquamarines are commonly faceted from the available gem-quality rough, larger sized stones are occasionally obtainable.

Colours of the aquamarine from this mine tended to vary in hue from almost colourless to a medium to deep sky-blue colour. These bluish hues are naturally occurring; so no heat treatment(4) is required to colour-improve the O'Briens Creek aquamarines for the market place.

One rather surprising observation that was made concerning the intensity of the bluish hue displayed by these aquamarines was that both the specific gravity and the refractive index of the O'Briens Creek aquamarine increased with the increasing depth of blue colour.

The mean values reproduced below give some indication of this relationship.

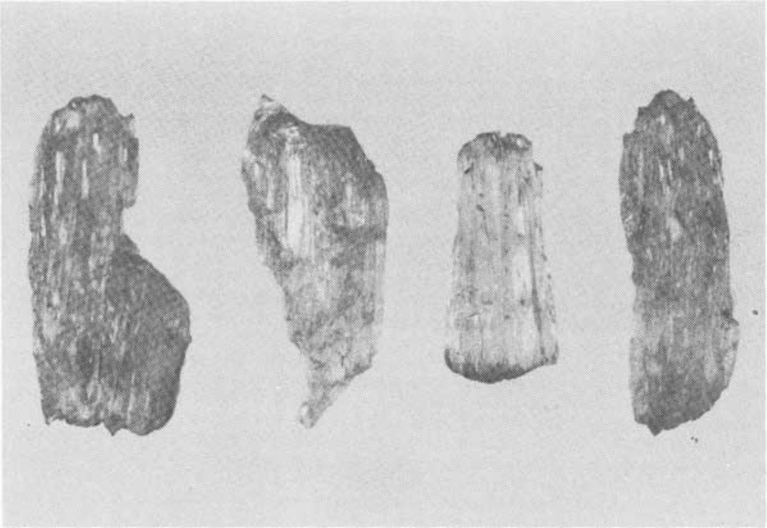


FIG. 5. Secondarily etched gem-quality aquamarine crystals from O'Briens Creek. These crystals average 25 to 30mm in length.

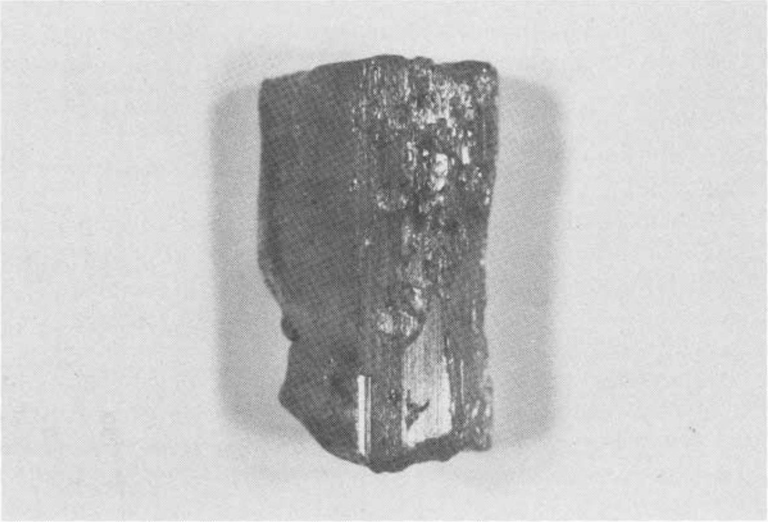


FIG. 6. A large fragment of non gem-quality aquamarine from O'Briens Creek.

	Light blue Aquamarine	Dark blue Aquamarine
Specific gravity	2.68	2.70
Refractive indices	ω 1.567 ε 1.562	ω 1.571 ε 1.566

Gemmological Properties

A detailed examination of the gemmological properties of these aquamarines from the Mt Surprise gemfield revealed no data of great significance as the O'Briens Creek aquamarine displayed physical and optical properties that were almost identical to those of other aquamarines from world-wide localities (see Table 1).

One slight difference in properties was nevertheless noted. Both the refractive index and the specific gravity of the O'Briens Creek aquamarine were located at the lower end of the recognized

TABLE 1. Gemmological properties of aquamarine from O'Briens Creek, compared with the gemmological properties for aquamarine cited by Arem.(6)

	O'Briens Creek Aquamarine	Aquamarine data from Arem(6)
SPECIFIC GRAVITY	2.7	2.68 – 2.80
DIAPHANEITY	Transparent	Transparent
LUSTRE	Vitreous	Vitreous
REFRACTIVE INDEX	ω 1.571 ε 1.566	ω 1.572/90 ε 1.567/8
BIREFRINGENCE	0.005	0.005 to 0.007
OPTIC SIGN	Uniaxial negative	Uniaxial negative
PLEOCHROISM	ω Pale yellowish green ε Blue	ω Colourless ε Blue
CHELSEA FILTER	Distinct green	Distinct green
LUMINESCENCE (UV)	Inert	Inert
ABSORPTION SPECTRUM	Not diagnostic	Not diagnostic

beryl range. Such an observation suggests(5) that the O'Briens Creek aquamarine may not be very rich in either water or alkaline earth elements.

Microscopic Features

To the gemmologist, the most interesting and rewarding feature of the O'Briens Creek aquamarine is the range and diversity of its microscopic inclusions. As most of the gem-quality aquamarine from this mine is at least eye-clean the beautiful patterns of typical beryl inclusions displayed by the O'Briens Creek aquamarine must be observed in included specimens at moderate magnifications. For this investigation, inclusions were recorded on a gemmological microscope, using transmitted light with magnifications that varied from ×20 to ×50.

Common inclusions noted during this microscopic investigation included the typical beryl tube-like inclusions ('tubes') (Figure 7), oriented parallel to the *c*-axis of the aquamarine combined with randomly oriented partly-healed internal fractures that are generally described as either 'feathers', 'veils' or 'fingerprints'.

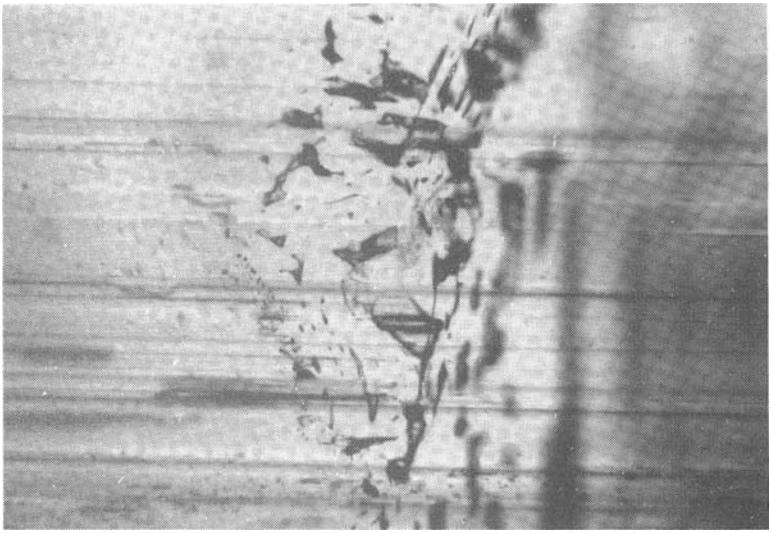


FIG. 7. Photomicrograph of the typical beryl inclusions commonly observed in the aquamarine from O'Briens Creek.
Note: 'tubes' running across the width of the illustration while randomly oriented 'veils' are seen approximately at right angles to the 'tubes'. (×25 magnification).

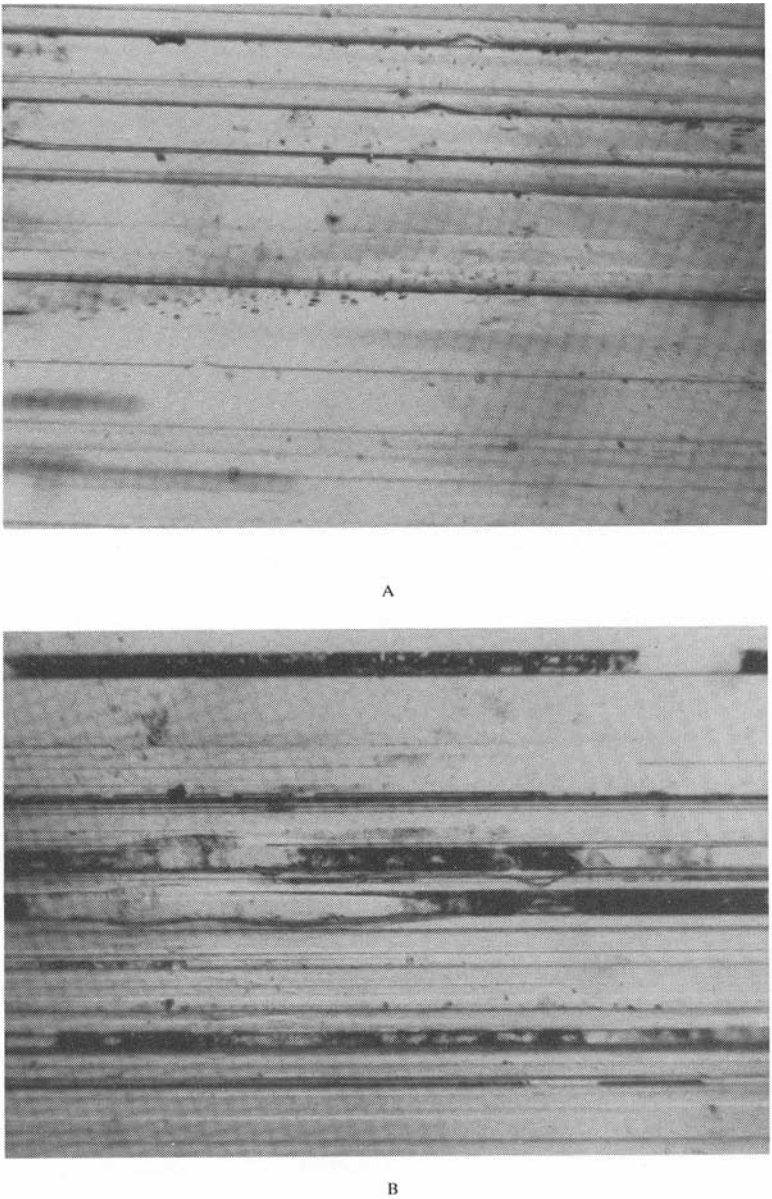


FIG. 8. Photomicrographs of aquamarine from O'Briens Creek, showing:
(A) Empty 'tubes' oriented parallel to the *c*-axis of the crystal
(B) 'Tubes' partly filled with epigenetic mineral 'stains'. (×25 magnification).

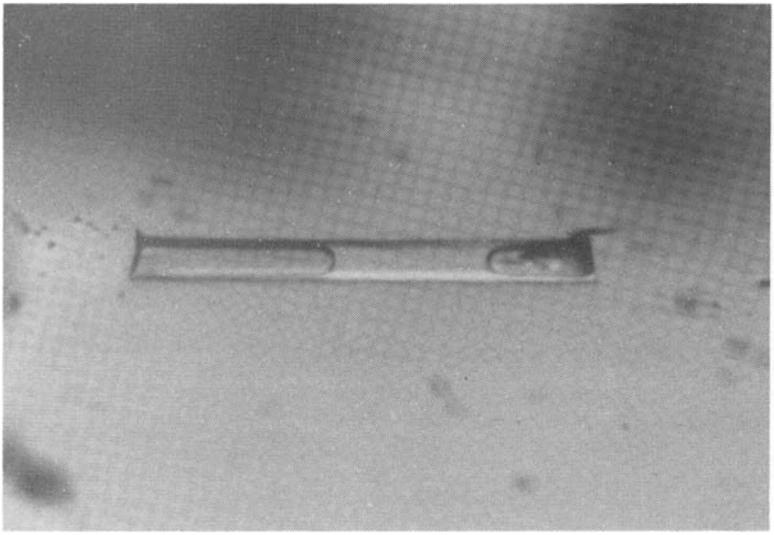


FIG. 9. Photomicrograph of a short two-phase 'tube' segment; such inclusions are responsible for the appearance of 'rain' in aquamarine from O'Briens Creek. (×50 magnification).

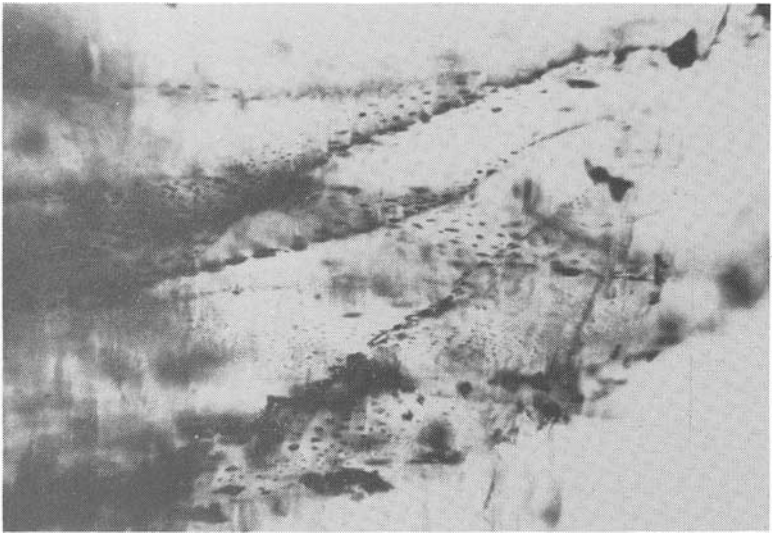


FIG. 10. Photomicrograph of a partly healed internal fracture ('feather', 'veil', or 'fingerprint') found in an aquamarine from O'Briens Creek. (×25 magnification).

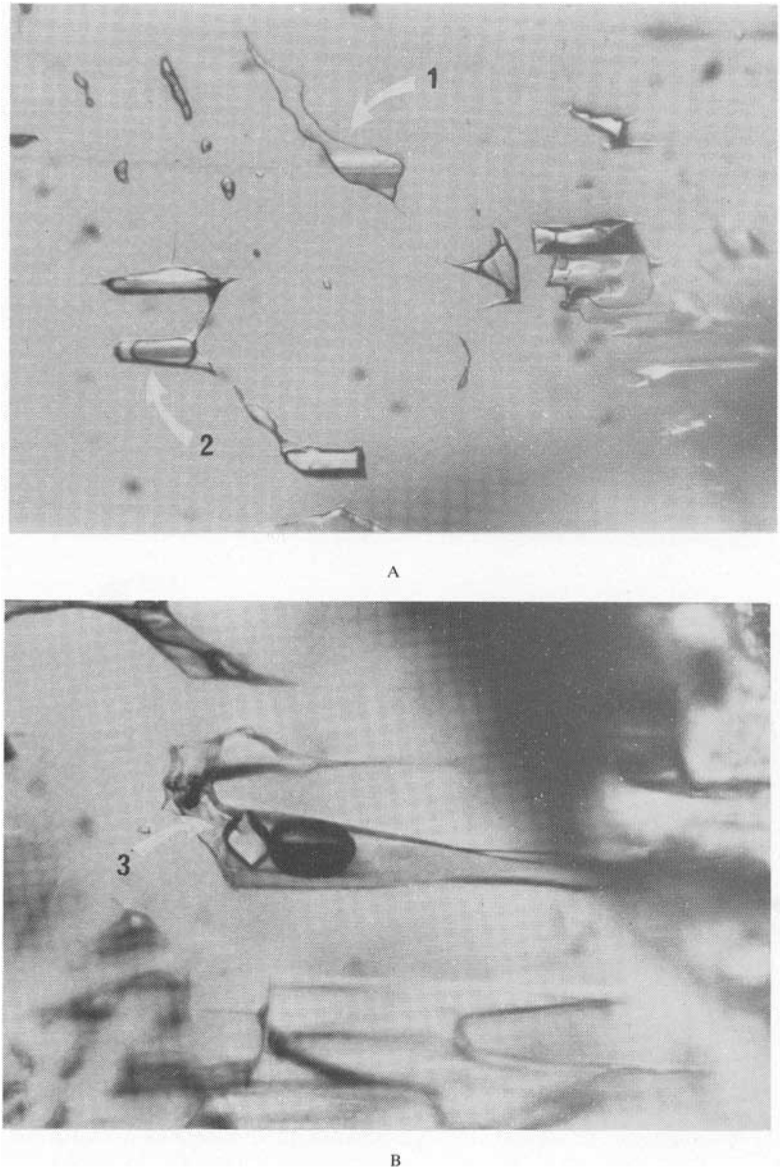


FIG. 11. Photomicrographs of the contents of 'veils' in aquamarines from O'Brien's Creek showing:
(A) a single phase inclusion (arrowed 1), and a two-phase inclusion (arrowed 2).
(B) a three-phase inclusion (arrowed 3). (×50 magnification).

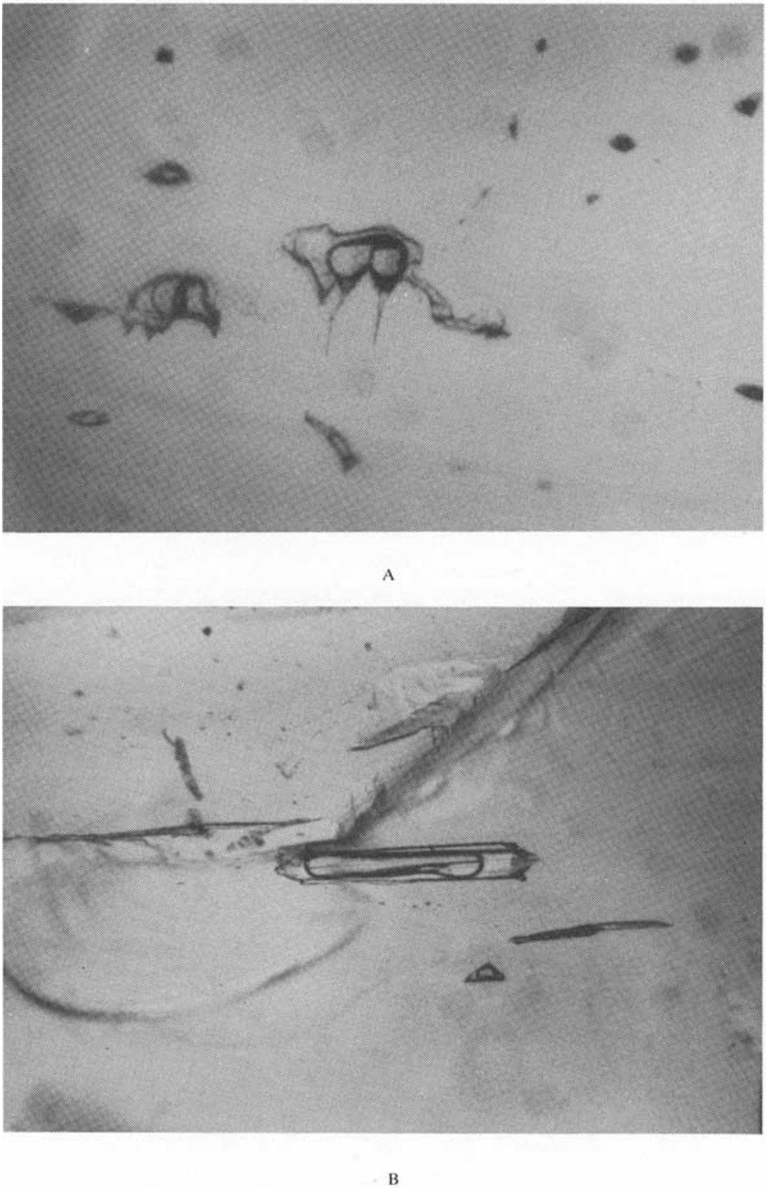
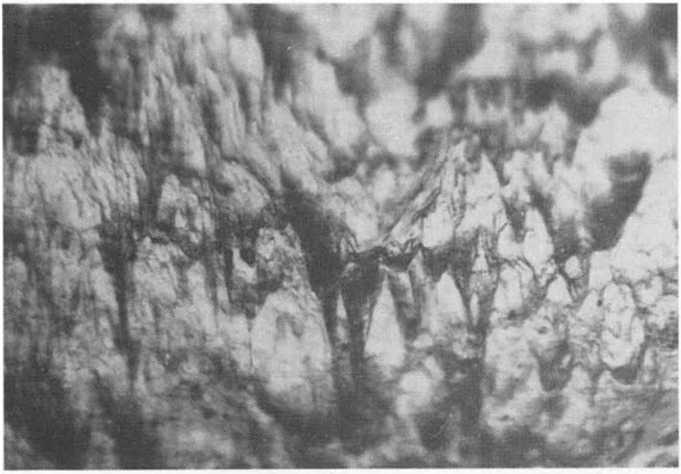
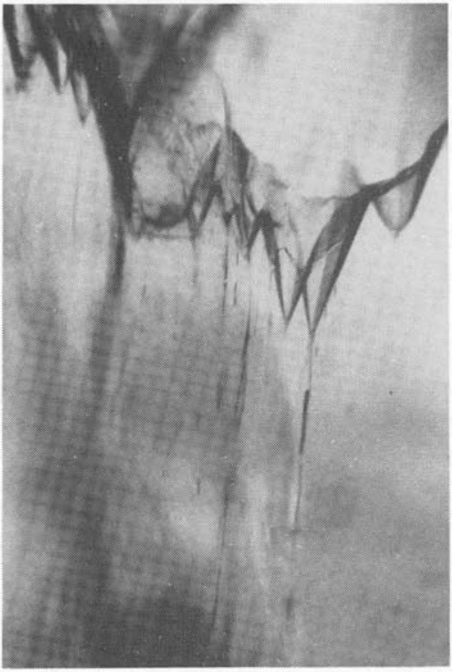


FIG. 12. Photomicrographs of aesthetically pleasing 'liquid' inclusions noted in the aquamarine from O'Briens Creek.
(A) Inclusions from a 'veil.'
(B) Inclusions in 'tubes.' (×50 magnification).



A



B

FIG. 13. (A) Photograph of the etch hillocks on the basal pinacoid of a secondarily etched aquamarine crystal from O'Briens Creek. (×15 magnification)
(B) Photomicrograph of the genetic relationship between 'tubes' (parallel to the c-axis) and etch pits (in the basal pinacoid) of an aquamarine crystal from O'Briens Creek. (×20 magnification).

FIG. 14. Photomicrograph of an aesthetically pleasing iron-rich mineral ingrowth in an aquamarine from O'Briens Creek. (×25 magnification).

It was additionally noted that the 'tubes' occasionally appeared to be empty (Figure 8A); but they were also observed to contain epigenetic mineral 'stains' (Figure 8B), or else two-phase (most likely liquid-gas) cavity fillings. Occasionally, these 'tubes' occur as shorter, two-phase segments (Figure 9). It is the frequent occurrence of these shorter 'tubes' that have been rather loosely termed 'rain'.(7)

'Feathers', 'fingerprints' or 'veils' (Figure 10) are the inclusions most frequently observed in O'Briens Creek aquamarine. As is well known, these inclusions are in fact partly healed, randomly oriented, conchoidal fractures which developed within the still growing crystal. Subsequent to their formation, these cracks have been partly repaired by infiltration and deposition from the growth solution that surrounded the growing crystal. In the aquamarine from O'Briens Creek, the cavity fillings in the partly healed internal fractures may be either single phase (liquid, gas, or solid), two-phase (liquid and gas) (Figure 11A), or three-phase (liquid, gas and solid) (Figure 11B).

A close examination of the morphology of the 'tubes' and the 'veils', found in the O'Briens Creek aquamarine, is to be strongly recommended. At the moderate magnifications obtainable with the gemmological microscope, a great variety of aesthetically pleasing forms will be revealed to the interested observer (Figures 12A, 12B refer).

Another interesting observation made during this microscopic phase of the investigation, concerned the relationship between the etch hillocks, located on the basal pinacoidal faces of the secondarily etched aquamarine crystals (Figure 13A), and the tube-like inclusions that appeared to be genetically related to the apices of these etch pits (Figure 13B). Figures 13A and 13B would seem to indicate that preferential etching does occur in those areas of a growing crystal that can be considered to be structurally weak. In the etched specimens examined, maximum etching seemed to occur when the tube-like inclusions penetrated the basal pinacoidal faces of the crystals. This observation is in accordance with the researches of Roedder.(8)

Although of little gemmological significance, highly coloured ingrowths of iron oxide (?) minerals were frequently associated with some of these etch-induced defects. While aesthetically pleasing (Figure 14), these inclusions would inevitably be removed during faceting; so they are of little practical significance in gem identification.

CONCLUSION

The O'Briens Creek aquamarine deposit, in the Mt Surprise gemfield of Northern Queensland, yields attractive gem-quality blue aquamarine, that does not require colour improvement by heat treatment. Although the gemmological properties of this aquamarine are not unique, this aquamarine does possess a suite of beryl inclusions that are aesthetically pleasing, and require more detailed investigation.

ACKNOWLEDGEMENTS

The author wishes to thank the following who have assisted him with this project:
Provision of specimens: K. Raddatz.
Provision of photographs and information: H. & H. Bracewell.
Preparation of specimens: R. & S. Kelly.

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[*Manuscript received 25th January 1985.*]

GEMMOLOGICAL ABSTRACTS

AINES (R.D.), KIRBY (S.H.), ROSSMAN (G.R.) *Hydrogen speciation in synthetic quartz.* Physics and Chemistry of Minerals, **11**, 5, 204-12, 9 figs, 1984.

The dominant hydrogen impurity in synthetic quartz is molecular H_2O. H-OH groups are also found. Molecular H_2O concentrations in synthetic quartz crystals studied range from less than 10 to 3300 ppm and decrease smoothly by up to an order of magnitude with distance from the seed. Observed OH^- is probably associated with cationic impurities as in natural quartz. M.O'D.

BAILLARGEAT (C.) *La Granatenkogl.* (The Granatenkogl.) Monde et Minéraux, 68, 16-18, 5 figs (2 in colour), 1985.

The Granatenkogl is in the Tyrolean Alps of Austria and can be reached from the winter resort of Obergurgl. Crystals of pyrope-almandine garnet up to 5cm in size have been found; they show rhombic dodecahedral and icositetrahedral forms with combinations of the two. M.O'D.

BANK (H.). *In memoriam Basil William Anderson.* Z.Dt.Gemmol.Ges., **34**, 1/2, 3-5, 1 fig, 1985.

Obituary, mentioning that Basil Anderson was made an honorary member of the Deutschen Gemmologischen Gesellschaft. E.S.

BANK (H.) *Farblose Cordierite und Cordierit-Katzenaugen aus Sri Lanka.* (Colourless iolites (cordierites) and iolite cat's-eyes from Sri Lanka.) Z.Dt.Gemmol.Ges., **34**, 1/2, 79-80, bibl., 1985.

The iolite cat's-eyes were cut from a grey-colourless piece of rough material, the cat's-eye effect being caused by its fibrous nature: RIs $n_x = 1.530$, $n_y = 1.534$, $n_z = 1.539$, DR 0.009, SG 2.58. The colourless transparent cut iolites showed RIs of $n_x = 1.527$, $n_y = 1.532$, $n_z = 1.536$, DR 0.009, SG 2.55. These seem to be the lowest recorded RIs for iolites. The specimens also have a very low Fe content. E.S.

BRACEWELL (H.), BROWN (G.). *Amazonite from the Koppio district – South Australia.* Aust.Gemmol., **15**, 11, 404-8, 10 figs (6 in colour), 1985.

An account of the Baila Hill deposit on Eyre Peninsula, visited by Bracewell in 1982, which yields a mostly bluish-green amazonite variegated by albite intergrowth, and largely ruined by blast mining methods. R.K.M.

BROWN (G.). *The colours of fluorite.* Wahroongai News, **19**, 4, 18-22, 1985.

Explanations, culled from various sources, of the causes of colour in this material, which has possibly the widest colour range of any mineral. Atomic gap locations entrapping electrons, oxygen atoms which have lost electrons due to natural irradiation, or even the inclusion of stray atoms of yttrium or of samarium are said to be responsible for the different colours. R.K.M.

BROWN (G.). *The abalone and its pearls.* Aust.Gemmol., **15**, 11, 400-3, 1985.

A general account which establishes that such pearls are rare, usually very baroque, and hollow. Illustrated by a tooth-shaped pearl which was compared with sharks' teeth. R.K.M.

BROWN (G.). *Identifying Gilson's polycrystalline lapidary materials.* Aust.Gemmol., **15**, 11, 413-17, 3 figs, 1985.

Gilson turquoise, lapis and coral examined and identified by a number of physical and visual features. R.K.M.

BROWN (G.). *Seiko Synthetics.* Aust.Gemmol., **15**, 11, 418-20, 2 figs, 1985.

Account based on technical information from Suwa Seikosha Co. Japan. Emeralds grown by flux growth; corundum, chrysoberyl, including alexandrite, by floating-zone growth. Floating-zone gives synthetics a swirled colour distribution and irregular flow lines. Seiko rubies display 'rectilinear parting and their padparadscha corundums and alexandrites glow strongly red under LWUV, whereas most natural stones of these species are inert. Flux grown Seiko emeralds fluoresce green in UV light and most stones have RI and SG values within the range expected for flux material. In all cases the microscope will provide the principal clue to their nature. R.K.M.

CASSEDANNE (J.). *Andalousite et scapolite de Espirito Santo (Brésil).* (Andalusite and scapolite from Espirito Santo, Brazil.) Revue de Gemmologie, 82, 21-5, 11 figs (8 in colour), 1985.

Andalusite is found at Santa Teresa, a small town about 50km north-west of the state capital, Vitória. The site is also known as Serra do Prego. Prismatic crystals are found in gravels and weigh from 2 to 8g. The colour is a yellowish-pink with a green inclining to olive. Scapolite is found at Aracruz and is recovered from a pegmatite. The stones are honey- or caramel-coloured. M.O'D.

COHEN (A.J.), MAKAR (L.N.). *Differing effects of ionizing radiation in massive and single crystal rose quartz.* Neues Jahrbuch für Mineralogie, **11**, 513-21, 3 figs, 1984.

X-irradiation of single crystals of rose quartz intensifies the absorption band due to interstitial Ti^{3+} and gives a deeper rose colour. Massive rose quartz treated in the same way gives three absorption bands related to Al^{3+} trapped-hole impurity colour centres. These grow so intense with increase of irradiation that the specimen turns black. Massive rose quartz has a higher Al^{3+} and alkali ($Na^+ + Li^+$) content than single crystals. M.O'D.

Currier (R.H.). *Natural fading of amethyst*, (letter). Gems Gemol., **XXI**, 2, 115-16, 1 fig. in colour, 1985.

One half of an amethyst crystal group from Rio Grande do Sul, Brazil, kept in dark for three years, retained its colour, the other half, exposed to Californian sun for the same length of time, faded badly. R.K.M.

Dirlam (D.M.), Misiorowski (E.B.), Thomas (S.A.). *Pearl fashion through the ages*. Gems Gemol., **XXI**, 2, 63-78, 15 figs (13 in colour), 1985.

A concise review of the use of pearls in jewellery from classical times to the present day. Nicely illustrated. R.K.M.

Drees (B.). *Mineraliensammeln in Australien*. (Mineral locations in Australia.) Lapis, **10**, 6, 13-21, 14 figs (10 in colour), 1985.

Among the species described are sapphire, agate, opal and malachite. M.O'D.

Fallick (A.E.), Jocelyn (J.), Donnelly (T.), Guy (M.), Behan (C.). *Origin of agates in volcanic rocks from Scotland*. Nature, **313**, 6004, 672-4, 2 figs, 1985.

Isotope ratios are given ($^{18}O/^{16}O$ of silica and D/H of bound water) for agates from Lower Devonian lavas. These differ from those in Tertiary lavas. Data imply that the bound waters associated with the agates have preserved their hydrogen isotope ratios since agate deposition and, as a consequence, that the water content is of genetic significance. The inference is that agates of both ages were formed at low temperature (around 50°C) from fluids with at least a component of meteoric origin. M.O'D.

Fryer (C.W.), ed., Crowningshield (R.), Hurwit (K.N.), Kane (R.E.). *Gem Trade Lab Notes*. Gems Gemol., **XXI**, 2, 108-14, 21 figs (19 in colour), 1 table, 1985.

Amber found with metallic sulphide inclusions; amethyst with crystal (natural?) and 'breadcrumb' (synthetic?) inclusions could not be allocated to either category with certainty; five diamonds break in cutting – why?; blue diamond with colour banding conducted electricity more readily along colour zones; a carved fluorite mistaken for amethyst was badly etched by sulphuric acid 'pickle'. Rare cat's-eye hexagonites were examined; a Gilson synthetic opal had outer edges of colourless plastic; a yellow-green Mexican opal, with a marked flow structure and with traces of radioactivity, fluoresced brightly in UV light. Fancy coloured pearls from China were shown to be of tissue-nucleated, cultured, freshwater origin; metal-cored, plastic imitation pearls were found; a dark red-grey quartz cat's-eye also described. A diffusion-asteriated sapphire lost part of its surface star on repolishing; an unusual dark green scapolite cat's-eye is described; a large paste 'pink topaz' had veils of bubbles looking like 'finger-print' inclusions; three small translucent zircons, reputedly from Sri Lanka, had well-developed cat's-eyes, and strong absorption spectra. All are illustrated. R.K.M.

Fryer (C.W.), Koivula (J.I.). *The eyepiece pointer: a useful microscope accessory*. Gems Gemol., **XXI**, 2, 105-7, 3 figs (2 in colour), 1985.

Describes a simple device which can easily be built into a microscope eyepiece to provide a pointer to a specific feature in a stone. The specimen needs to be adjusted to coincide with the pointer which is not itself movable. R.K.M.

FUMEY (P.). *Le pipe d'Argyle.* (The Argyle pipe.) Revue de Gemmologie, 82, 18-20, 5 figs, 1985.

The newly-discovered Argyle diamond pipe in Western Australia is described. M.O'D.

GÜBELIN (E.J.). *Le identificación de los nuevos rubíes sintéticos.* (Identification of the new synthetic rubies.) Gemologia, **21**, 63/64, 5-27, 42 figs (41 in colour), 1984.

An English version of this article was published in *J.Gemm.*, 1983, **XVIII**, 6, 477-99. E.S.

GÜBELIN, (E.). *Identification des nouveaux saphirs synthetiques et des saphirs traites.* (Identification of new synthetic sapphires and of treated sapphires.) Revue de Gemmologie, 82, 9-14, 31 figs (27 in colour); 83, 11-13, 17 figs in colour; 1985.

An article in two parts describing blue and yellow synthetic and treated sapphires with illustrations of characteristic inclusions and immersion phenomena. M.O'D.

GÜBELIN (E.). *Properties of ornamental stones and their gemmological identification.* Aust. Gemmol., **15**, 10, 334-87, 1985.

This important compilation of facts first appeared in Z.Dt.Gemmol.Ges., 30 (1981) and was abstracted by Mrs E. Stern (*J. Gemm.*, **XVIII**, 1, 79) to whom I am indebted for checking this English version against the original German script. A few items have been added and there has been some rearrangement under the heading of cryptocrystalline quartzes. A valuable paper comprising the whole of this issue of the magazine. R.K.M.

HENN (U.) *Eudialyt aus Kanada.* (Eudialite from Canada.) Z.Dt.Gemmol.Ges., **34**, 1/2, 76-8, 1 graph, 1 table, bibl., 1985.

The gem quality eudialite is found in a new locality in Kippaw in Quebec. The transparent crystals were pinkish red, the colour caused by manganese. The high zirconium content might lead to a new source of zirconium. RI varied between 1.600-1.601 and 1.596-1.597, DR 0.004. A graph shows absorption spectrum and a table compares chemical composition of eudialites from Canada and Sweden. E.S.

HENN (U.). *Untersuchungen an Kornerupin und Sinhalit von Elahera, Sri Lanka.* (Examination of kornerupine and sinhalite from Elahera, Sri Lanka.) Z.Dt.Gemmol.Ges., **34**, 1/2, 13-19, 2 graphs, 2 tables, 6 photomicrographs, bibl., 1985.

The new occurrence lies in the Central Province, about 13km south-east of Elahera, yielding mainly garnets, also sapphires, spinels and tourmalines and additionally kornerupine and sinhalite. The kornerupines are bluish-green to greenish-brown crystals with a diameter of about 2cm; SG 3.34-3.36, RI 1.668-1.680, DR 0.012. They show characteristic inclusions for kornerupine from Sri Lanka. The sinhalite is olive green, RI 1.669-1.704, DR 0.035, SG 3.48-3.49; inclusions are liquid or two-phase and clouds of negative crystals. E.S.

Hochleitner (R.) *Dendriten- und Landschaftsachate.* (Dendritic and landscape agate.) Lapis, **10**, 6, 27-9, 9 figs (8 in colour), 1985.

Fine examples of both types of agate are illustrated. M.O'D.

Hoisch (T.D.). *The solid solution chemistry of vesuvianite.* Contributions to mineralogy and petrology, **89**, 2/3, 204-14, 4 figs, 1985.

The solid solution in vesuvianite is examined, taking chemical trends and cation abundances in 22 microprobe analyses. Two structure refinements indicate 50 filled cation sites per formula. Site occupancies have been resolved by optical and Mossbauer studies and stoichiometric abundancies of Si and Ca + Na show 18 and 19 per formula, filling all 4- and 8-fold sites respectively. The four six-fold A sites are filled with Al. Solid solution mainly occurs within the eight 6-fold AlFe sites (Al, Mg, Fe^{2+}, Fe^{3+}, Ti) and one 5-fold B-site (Mg, Fe^{2+}, Fe^{3+}). Eight independent substitutions are known. M.O'D.

Horn (P.). *Moldavite-ihre Entstehung bei der Rieskatastrophe.* (Moldavites – their origin by cataclysm.) Lapis, **10**, 6, 22-6, 6 figs (3 in colour), 1985.

The moldavite area extending from east of Stuttgart to south-east Czechoslovakia is described with illustrations of some of the specimens found. M.O'D.

Iacconi (P.), **Caruba** (R.). *Trapping and emission centres in x-irradiated natural zircon. Characterization by thermoluminescence.* Physics and Chemistry of Minerals, **11**, 5, 195-203, 8 figs, 1984.

The TL of natural zircon is characterised by two main peaks at 155± 4 and 378± 7 K. Three kinds of emission have been observed: a band from 400 to 380nm; a series of maxima at 760, 662, 580 and 480nm; and a band at 285nm; These are shown to be due to a host lattice mechanism, Dy^{3+} and OH^- groups respectively. M.O'D.

Kanka (A.). *Achate von Schweighausen im Schwarzwald.* (Agate from Schweighausen in the Black Forest.) Lapis, **10**, 5, 17-21, 8 figs in colour, 1985.

Fine quality agate is found in the Schweighausen area of the Black Forest, West Germany. Specimens are described and illustrated. M.O'D.

Koivula (J.I.), **Keller** (P.C.). *Russian flux-grown synthetic emeralds.* Gems Gemol., **XXI**, 2, 79-85, 8 figs in colour, 2 tables, bibl., 1985.

A new synthetic using a lead vanadate flux and crucible rotation, this has much in common with other flux-grown synthetic emeralds. Low constants: RI 1.559-1.563, SG about 2.65. Inclusions typical of type: veil-like finger-prints, two-phase, and metallic platinum from the crucible. These stones contained a little MgO, not found in other flux-melt emeralds. Authors warn that changes in growth process, as in all synthetic methods, could affect gemmological testing properties. [Reaction under emerald filter not given, but with 0.2% of iron residual red may be suppressed.] R.K.M.

Koivula (J.I.), **Misiorowski** (E.), eds. *Gem News.* Gems Gemol., **XXI**, 2, 118-20, 1985.

A new diamond area in Guinea contains six pipes and alluvial diggings, high gem-quality yield expected, production scheduled to begin in April this year.

Kimberley (S. Africa) diamonds, dated by radiation analysis of rare earths in contained garnets, are calculated to have formed 3.1 to 3.5 billion years ago. Yield of Australian Argyle diamond mines is falling as the alluvial deposits are depleted. In Canada two kimberlite pipes in British Columbia are to be explored. Australian gemmologists report 'exceptionally beautiful' diamonds discovered in mainland China. Despite some indications of possible kimberlite, a tiny diamond crystal found in a gold placer near Fairbanks, Alaska, is thought to have been transported from afar by geological agencies. R.K.M.

LORENZ (I.), SCHMETZER (K.). *Möglichkeiten und Grenzen der röntgenographischen Untersuchung von Perlen.* (Possibilities and limits in the x-ray investigation of pearls.) Z.Dt.Gemmol.Ges., **34**, 1/2, 57-68, 2 figs, 2 tables, bibl., 1985.

X-ray investigation of pearls uses either direct radiography, x-ray diffraction techniques or the luminescence under x-rays. The authors describe a diffraction camera which allows examination of diffraction patterns in exactly defined angles to each other. A single pearl from a necklace can be looked at by the addition of a special holder. Using all three techniques almost all pearls can be identified. Difficulties were found in distinguishing Keshi cultured pearls from natural sea water pearls, and also in differentiating a small part of non-nucleated cultured freshwater pearls from natural freshwater pearls. E.S.

MATTSON (S.M.), ROSSMAN (G.R.). *Ferric iron in tourmaline.* Physics and Chemistry of Minerals, **11**, 5, 225-34, 10 figs, 1984.

Red Fe^{3+}-rich and black Fe^{3+}, Fe^{2+}-rich tourmalines were examined by optical and Mossbauer spectroscopy, with a view to determining the optical characteristics of Fe^{3+} in tourmaline. Prominent optical absorption features at 485 and 540nm are assigned to transitions of multiple exchange-coupled Fe^{3+} pairs in several site combinations. M.O'D.

MEYER (H.O.A.). *Genesis of diamond: a mantle saga.* Am. Miner., **70**, 3/4, 344-55, 2 figs, 1985.

The author postulates that diamond growth was not always continuous and stones did not always grow in similar chemical environments. A model for diamond growth based on various properties is proposed, and it is suggested that some diamonds may be products of recycled subducted carbon, while others may have been formed by magmatic or metasomatic processes from primordial material. Most diamonds will probably have been formed in the Archaean or Proterozoic. Host rocks are grouped into eclogitic and ultramafic (peridotitic). M.O'D.

MOON (A.R.), PHILLIPS (M.R.) *Asterism – no mystery: A response to 'Asterism – the great enigma'.* Aust.Gemmol., **15**, 11, 395-9, 6 figs, 1985.

Physicists reply to an earlier paper by Connellan & Pozzebon, putting the subject on a much sounder scientific basis. R.K.M.

MOREAU (M.). *Camées et intailles.* (Cameos and intaglios.) Revue de Gemmologie, 83, 15-17, 4 figs, 1985.

A brief résumé of the manufacture of cameos and intaglios. M.O'D.

NASSAU (K.). *Miscellaneous gemstone treatments, part 1.* Lapidary J., **39**, 2, 254-62, 11 figs (7 in colour), 1985.

The paper deals with chemical treatments and impregnation and is based largely on the author's *Gemstone Enhancement* (Butterworths, London, 1984). M.O'D.

NEUMANN (E.), SCHMETZER (K.). *Mechanism of thermal conversion of colour and colour centres by heat treatment of amethyst.* Neues Jahrbuch für Mineralogie Monatshefte, 6, 272-82, 2 figs, 1984.

Heat-treated amethyst shows two absorption bands, that of green prasiolite at 13800cm^{-1} and that of yellow or brown quartz centred in the UV. Both bands have been assigned to Fe^{2+}(I$_6$) colour centres and are probably due to iron-containing particles (Fe_2O_3). It has been found that the relative intensities of the green prasiolite band and the band due to iron-bearing particles and giving the yellow colour are strongly variable. The thermal conversion of colour in amethyst by heat treatment therefore depends upon the relative intensities of both absorption bands. Where the formation of the 13800cm^{-1} band dominates over the formation of the band centred in the UV the violet is converted to green. Where the formation of iron-bearing particles dominates the formation of the Fe^{2+}(I$_6$) colour centres, the yellow or brown colour is developed. It is still not known how both colour centres in different concentrations are developed. M.O'D.

O'DONOGHUE (M.). *Mininoticias.* (Brief notes.) Gemologia, **21**, 63/64, 28-47, 1984.

Spanish translations of extracts from the abstracter's Gemmological Newsletter and Synthetic Crystals Newsletter.

(Author's abstract.) M.O'D

PEARCE (T.H.), THOMAS (M.). *Laser-induced fluorescence in minerals: preliminary results.* Canadian Mineralogist, 22, 379-82, 2 figs in colour, 1984.

Visible radiation from an argon-ion laser induces fluorescence in minerals. From 70 mineral species (150 samples) tested 29 species (61 samples) gave fluorescence. Most minerals showing a fluorescence under UV will show it with laser excitation (488nm line in the argon-ion laser) but colours are usually different.

M.O'D.

PEARSON (G.). *Bush amethyst.* Aust.Gemmol., **15**, 11, 408-9, 1985.

A purple glass from old bottles found in arid regions was shown to contain little iron and up to 0.5% manganese. Similar glass irradiated with x-rays for an hour turned a deep purple. It is suggested that long exposure to UV in sunlight has produced similar coloration. No physical constants are given. R.K.M.

POIROT (J.-P.). *Application de la radiographie en bijouterie-joaillerie.* (Application of radiography to jewellery and the jewellery trade.) Revue de Gemmologie, 82, 15-17, 11 figs, 1985.

A short account of the radiography of pearls is given. M.O'D.

PROCTOR (K.). *Gem pegmatites of Minas Gerais, Brazil; the tourmalines of Governador Valadares District.* Gems Gemol., **XXI**, 2, 86-104, 15 figs in colour, bibl., 1985.

A detailed account of this region and its gem products, illustrating mines, mouth-watering crystals and stones. The third paper in an enthusiastic series by a man who imports and sells such stones. R.K.M.

REBAN (J.). *Bohemian garnets.* Lapidary J., **38**, 12, 18-24, 10 figs (9 in colour), 1985.

The pyrope garnet occurrences in Czechoslovakia are described and illustrated. M.O'D.

ROUSE (J.D.). *Color grading issues: systems and standardization.* Lapidary J., **38**, 12, 1518-30, 9 figs in colour, 1985.

Useful overview of the different methods of colour grading with references to the standards and instruments used. M.O'D.

ROUX (J.E.). *World diamond production today.* Z.Dt.Gemmol.Ges., **34**, 1/2, 24-9, 1985.

The article is in English and is a summary of an address given by the author to the Annual Conference of the Deutsche Gemmologische Gesellschaft on the 30th September, 1984. Diamonds are produced in twenty countries. It has been said that ten million carats more were produced in 1983, but it is shown that most mines produced at the same rate as the previous rate, five produced less and five more, mainly in Australia. The countries producing more than a million carats per year are Angola, Australia, South Africa, Namibia, Botswana and Zaire. Less than that are mined in Brazil, Venezuela, Guinea, Sierra Leone, Liberia, Ivory Coast, Ghana, Central African Republic and Tanzania, and lastly India and Indonesia. E.S.

RUPASINGHE (M.S.). *Anreicherung von radioaktiven Elementen und Seltenen Erd-Elementen in Zirkon und Monazit aus Sri Lanka.* (Enriched radioactive elements and rare earth elements in zircon and monazite from Sri Lanka.) Z.Dt.Gemmol.Ges., **34**, 1/2, 69-75, 1 map, 3 tables, 2 graphs, bibl., 1985.

Due to presence of uranium and thorium some gems from Sri Lanka show measurable radioactivity, namely zircon and monazite, which has earlier been misidentified as zircon. Monazite contains about 40% rare earth elements. E.S.

RUPASINGHE (M.S.), DISSANAYAKE (C.B.). *The rare-earth element abundance in the sedimentary gem deposits of Sri Lanka.* Lithos, **17**, 4, 329-42, 3 figs, 1984.

REE in the gem placer deposits are highly enriched, particularly in the lighter elements. It appears that the progenitors for the REE are magmatic charnockite-granite associations, which are prevalent in the Highland group in which all Sri Lankan gem deposits are found. M.O'D.

SCHMETZER (K.) *Ein verbesserter Probenhalter und seine Anwendung auf Probleme der Unterscheidung natürlicher und synthetischer Rubine sowie natürlicher und synthetischer Amethyste.* (An improved sample-holder and its application to problems of distinguishing between natural and synthetic rubies as well as between natural and synthetic amethysts.) Z.Dt.Gemmol.Ges., **34**, 1/2, 30-47, 36 figs (30 in colour), 2 tables, bibl., 1985.

The basic principle of the holder is the combination of a vertical and horizontal rotating axis. The vertical axis has a dial with 360° subdivisions. The optical axis of a cut gemstone is placed parallel to the microscope axis facilitating determination of angles between crystal faces. Under crossed nicols, natural and synthetic amethysts show characteristic interference patterns. E.S.

SCHMETZER (K.). *Farbloser Chrysoberyll – natürlich oder synthetisch?* (Colourless chrysoberyl – natural or synthetic?) Z.Dt.Gemmol.Ges., **34**, 1/2, 6-12, 5 figs (1 in colour), bibl., 1985.

An English version of this article is published on pp. 682 – 691 above. E.S.

SCHMETZER (K.). *Minerals of the taaffeite group*, (letter). Gems Gemol., **XXI**, 2, 115, 1985.

Corrects earlier paper by M. Gunawardene (Gems Gemol., XX, 3, 159-63, 1984) in that some material quoted was musgravite and not taaffeite, while Russian samples were from East Siberia and not Lake Ladoga. R.K.M.

SCHMETZER (K.), BANK (H.). *Zink-haltiger Taaffeit aus Sri Lanka.* (Zinc containing taaffeite from Sri Lanka.) Z.Dt.Gemmol.Ges., **34**, 1/2, 20-3, 1 fig. in colour, 1 table, bibl, 1985.

An English version of this article was published on pp. 494-7 above. E.S.

SNOW (J.), SANDERS (J.), BROWN (G.). *Nakazumi star synthetic corundum.* Aust.Gemmol., **15**, 11, 410-12, 6 figs, 1985.

A study club report on several synthetic rubies and sapphires showing stars with tapered arms, irregular whitish opaque inclusions on surfaces, curved colour banding and many gas bubbles among the fine rutile needles. It is stated that ilmenite and haematite needles in natural black star sapphires are oriented at 90° to the lateral crystal axes while rutile needles in these synthetics are expected to orient parallel to those axes. [This may be true of natural stars containing rutile needles, but how do we determine the lateral axes in boule-grown material?] R.K.M.

STOCKTON (C.M.). *Unusual color-change garnet*, (letter). Gems Gemol., **XXI**, 2, 116-7, 1 fig in colour, 1 table, 1985.

A 4.58 carat trapeze-shaped, trap-cut pyrope/hessonite/spessartine garnet changed from yellow-green in fluorescent light to red-brown in incandescent light. RI 1.769, and spessartine spectrum – consistent with other colour-change garnets. Vanadium and not chromium thought to be the colorant. R.K.M.

VAN LAER (N.C.). *Boulder batholith pegmatites.* Lapidary J., **39**, 2, 242-7, 24 figs (12 in colour), 1985.

Describes pegmatite minerals, particularly quartz, occurring in the Butte area of Montana. M.O'D.

VARGAS (G. & M.). *A discussion of the Australian Ideal Design for round brilliants.* Aust.Gemmol., **15**, 11, 421-4, 1985.

Disposes of some arguments put forward by Connellan and Pozzibon in their paper published August 1984. Authors are cutters of long standing and do not accept C & P's computer-based findings. R.K.M.

ZIMMERNINK (W.G.). *Die optischen Anomalien der Granate erläutert an Beispielen aus der Skarnlagerstätte Santander, Peru.* (Optical anomalies of garnets explained with examples from the Skarn occurrence in Santander, Peru.) Z.Dt.Gemmol.Ges., **34**, 1/2, 48-56, 8 figs, 1 table, bibl, 1985.

In spite of their cubic symmetry, garnets often show birefringence. They also often show sector twinning, polysynthetic lamellae, octahedral lamellae, morphological zoning and chemical zoning. All these anomalies can be found in garnets from the Skarn Deposit in Central Peru. In all cases of birefringence, sector or dodecahedral twinning could be observed, although not always very clearly. When the crystals showed chemical zoning, dodecahedral twinning could be observed, at least in the anisotropic grossularite components. Polysynthetic lamellae were only found in crystals with octahedral twinning. E.S.

Gems in unlikely settings. Retail Jeweller, **23**, 601, 12, 1 fig. in colour, 25th July 1985.

The second (concluding) part of the report on the RJ's Study Tour of Pakistan. After flying back to Peshawar the group was received at the Gemstone Corporation H.Q., where the lapidary workshop and gem laboratory are described. The Katlang pink topaz mine was visited and is described. On the way home, a gold jewellery factory in one of the United Arab Emirates was visited. J.R.H.C.

Gem tribute to US girl. The Times newspaper, No.62, 238, p.8, 9th September 1985.

Workers at Mirny have named a Siberian diamond (to be added to the Kremlin collection) after the late Samantha Smith (American schoolgirl invited to Moscow in 1983 after writing to the Kremlin about her fears of war). J.R.H.C.

RJ pioneers new route on Pakistan gems trip. Retail Jeweller, **23**, 600, 4-5, 2 figs in colour, 11th July 1985.

The first part of a report of RJ's Study Tour of Pakistan describes in some detail geological formations and mining activities at the open-cast emerald mine near Mingora in the Swat Valley and adjacent underground Farouk and Islamia mines and the ruby mines in the Hunza area. Other mines in the Swat area, at Gujar Killi, Charbagh and Makhab, and in the Mahmand Agency, at Ar Gandaf, Tora Tiga, Prang Gar and Kirra Killi, are mentioned. J.R.H.C.

BOOK REVIEWS

BANCROFT (P.). *Gem and crystal treasures*. Western Enterprises and Mineralogical Record, Fallbrook, California, 1984. pp. 488. Illus. in black-and-white and in colour. $60.00.

Aimed primarily at the mineral collector, the promotional material preceding this book gave a picture which can now be seen as far from hysterical, since the book is quite magnificent both in conception and content. It covers many (one hundred) of the world's most celebrated mineral locations, including some gemstone ones, giving the mining history, details of the minerals recovered, family details which are particularly interesting, and notes on current access where possible.

The photographs are superb; there are several at each opening and while those in colour are of the high standard we now expect from *Mineralogical Record* those in black-and-white give so fascinating an insight into the way in which fine specimens came to light that they are almost more eye-catching than the coloured ones. The author has taken pains to track down many specimens in collections which are not always generally known, even to specialists, and some of the pieces, once seen, will no doubt be reproduced again. References to each locality are given at the end of the book, where there is also an index.

Since many of the minerals depicted are of gem quality, gemmologists are recommended to get this book, despite its fairly high cost (and weight). The cost is not really excessive when the work done is considered. M.O'D.

BECK (R.J.). *New Zealand Jade*, A.H. & A.W. Rees, Wellington, 1984. pp. 173. Illus. in black-and-white and in colour. Price on application.

An excellent and well illustrated account of New Zealand nephrite covering origins, geography, Maori history and folk-lore, cutting and lapidary in both traditional and contemporary styles, and many other aspects of this lovely material. A successor to Russell Beck's earlier work of the same name which was sub-titled 'The Story of Greenstone'. The author is the director of the Southland Museum and Art Gallery, Invercargill, and is himself a very skilled worker and a foremost expert in nephrite. This will be a valuable addition to the library of any gemmologist interested in this fascinating material. R.K.M.

CHANG (Shih-Lin). *Multiple diffraction of x-rays in crystals*. Springer, Berlin, 1984. pp. xi, 300. DM 148.

Forming number 50 of the Springer series in solid-state sciences this book discusses the implications of the presence in crystals of a three-dimensional arrangement of atoms and molecules giving more than one set of atomic planes which satisfy Bragg's Law and simultaneously diffract an incident x-ray beam. Multiple diffraction gives important information on the structure of the crystal. The treatment, as is inevitable, is largely mathematical but notes on experimental

techniques are provided. Case studies involving gallium arsenide and indium phosphide are useful in bringing the topic to life. There is an extensive bibliography.
M.O'D.

GREENHALGH (P.). *West African diamonds, 1919-83; an economic history.* Manchester University Press, Manchester, 1985. pp. xiii, 306. £25.00.

This survey of the activities of European firms in Ghana and Sierra Leone (and, to a lesser extent, other West African diamond producing countries) is based on a thesis submitted to the University of Birmingham. European firms searching for diamond had considerable effects on the land and labour of these countries and in many cases their own contribution is hard to find. This book examines the records of the companies and concludes that there has been something of a two-way traffic. A postscript outlines the recent, mainly unfavourable, trends in West African economies.

Each chapter has its own bibliography and there is also a general bibliography and an index.
M.O'D.

KLEIN (C.), HURLBUT (C.S.). *Manual of mineralogy, after J.D. Dana.* 20th edn. Wiley, New York, 1985. pp. xi, 596. Illus. in black-and-white and in colour. £19.75.

Larger than the previous edition, this weighty paperback includes more pictures, an expansion of the discussion of crystal chemistry, more on the classification of rock types and on crystal properties. There are approximately 200 descriptions of individual mineral species. The authors have based the structure of the whole book on crystal chemistry as an underlying theme.

The book, as before, is very well presented and can be highly recommended. The photographs are attractively reproduced. The bibliographies at the ends of each chapter have been updated and useful information is placed inside the covers at each end of the book; useful conversion tables found here are a boon.
M.O'D.

McGREGOR (A.). *Bone, antler, ivory and horn.* Croom Helm, London, 1985. pp. 245. Illus. in black-and-white. £35.00.

Directed primarily at the archaeologist this book is one of the few attempts to put these organic materials under some sort of close scrutiny in which their nature is related to their use. The book deals specifically with the use of the materials since the Roman period so that there is a large body of documentary evidence to survey and this is well presented here. Drawings in the text are well executed; there is an extensive bibliography, and details of finds are exhaustively given.
M.O'D.

NADELHOFFER (H.). *Cartier, jewelers extraordinary.* Thames & Hudson, London, 1984. Illus. in black-and-white and in colour. £25.00.

Hans Nadelhoffer is in a particularly good position in the context of this excellent book, since he is the jewellery expert at Christie's in Geneva, and it is from some of the many sale catalogues that some of the illustrations are taken. The firm of Cartier has been in existence close on one hundred years and the way in which the three main branches (Paris, London, New York) maintained a separate existence until their merger in 1979 is skilfully and even excitingly told. Details of the many famous designers who have worked for the firm are given but most of all it is the superb sets of colour plates that make this reasonably-priced book an essential member of the private library of the serious gemmologist. It is possible to trace the ways in which various stones rose in and fell from favour; fine details are given in notes to the chapters, and there is a short bibliography. M.O'D.

WEIBEL (M.). *Edelsteine und ihre Mineraleinschlüsse.* (Gemstones and their mineral inclusions.) ABC Verlag, Zürich, 1985. pp. 111. Illus. in colour. Price on appliction.

This most attractively-presented book is written with the assistance of Dr Edward Gübelin, who has supplied some of the photographs. Despite the title the book is not a text on inclusions alone but rather a concise review of the major gemstones with particular reference to their mineral inclusions and with valuable notes on how they were formed. Although the illustrations of inclusions are the first to catch the eye there are many pictures of cut gemstones which give an excellent idea of their colour (and along with this, possible causes of confusion, as is well seen in the plate showing a chrome tourmaline, a demantoid garnet and a tsavolite garnet). Another advantage of the book is the up-to-date information presented on the materials covered. M.O'D.

ZUCKER (B.). *Gems and jewels, a connoisseur's guide.* Thames & Hudson, London, 1984. pp. 248. Illus. in colour. £30.00.

This book gives an overview of the gems best known to the general public with notes on their history, anecdotes on famous stones, details of the best-known stones to come on the market and a certain amount of gemmological detail. Chapters are given to one stone in turn and there is a short bibliography. The coloured illustrations are quite good though the sizes of the objects depicted are not given. Unfortunately the poor knowledge of gemstones shown by the author somewhat militates against any possibilities of the book's being taken seriously in a gemmological context. There are many careless spellings, some of them betraying more fundamental areas of ignorance and many journalistic turns of phrase occupy space where a precise description would have been preferable. M.O'D.

ASSOCIATION NOTICES

OBITUARY

Mr A.F.C. de Klerk, F.G.A. (D. 1962), Bergen op Zoom, Netherlands, died on 13th April, 1985.

Mr W.R. Eldridge, F.G.A. (D. 1980 with Distinction), Kerrville, Texas, U.S.A., died on 23rd November, 1984.

Dr Bernard F. Martin, M.D., M.B., B.Ch., D.Sc., F.G.A., died on 31st August, 1985, aged 67. Dr Martin gained his Diploma and the Tully Medal whilst living in Sheffield in 1966. He later moved to Birmingham where he was Head of the Anatomy Department at the University, and was elected President of the British Society of Anatomists in January 1985. He submitted several papers to the Journal of Gemmology which formed one section of his work that gained him his Doctorate of Science in 1984. D.M.L.

GIFTS TO THE ASSOCIATION

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

Mrs Bernice Backler, Pinetown, South Africa, for a parcel of mineral specimens for study purposes.

Mr R. Holt, London, for three star sapphires and a garnet with an unusual crystalline inclusion.

NEWS OF FELLOWS

On 15th May, 1985, Dr J.B. Nelson, Ph.D., F.G.S., C.Phys., F.Inst.P., F.G.A., was elected to the Committee of the Colour Group of Great Britain. He hopes to be able to bring gemmologists and colour scientists a little closer together.

On 12th July, 1985, Dr Nelson gave a talk with demonstrations of crystals and crystal models on 'The structure and habit of gem minerals' to the Harrow and Ruislip Geological Society at the Cavendish Pavilion, Eastcote, London.

On 6th September, 1985, Mr M.J. O'Donoghue, M.A., F.G.S., F.G.A., gave a one-day course on gemstone recognition with the 10x lens to the jewellery departments of Liberty & Co. Ltd, London.

MEMBERS' MEETINGS

London

On 18th September, 1985, at the Royal National Hotel, Bedford Way, London, W.C.1, Mr Gerhard Becker gave an illustrated talk entitled 'Gem carving – a short review of the history and every facet of present day carving'.

Midlands Branch

On 27th September, 1985, at Dr Johnson House, Bull Street, Birmingahm, Mr D. Wilkins, F.G.A., gave an illustrated talk entitled 'Rescued from the scrap box'.

Midlands and South Yorkshire and District Branches

On 28th July, 1985, a joint meeting of the Branches was held. Members and friends visited Chatsworth House, near Bakewell, Derbyshire.

North West Branch

On 19th September, 1985, at Church House, Hanover Street, Liverpool 1, Dr R.W. Braithwaite gave a talk entitled 'The cause of colour in Blue John'.

COUNCIL MEETING

At a meeting of Council held on Wednesday, 19th June, 1985, at the Royal Automobile Club, London, S.W.1, the business transacted included discussion of a possible purchase of freehold property (which is not now proceeding).

LETTERS TO THE EDITOR

From Mr R. Keith Mitchell, F.G.A.

Dear Sir,

I have received a number of replies to my query regarding the pearl-like sections in the plaque described in my paper 'Something Strange'*, all of which provide more or less the same answer.

First there was a 'phone call from our Chairman, David Callaghan, who suggested that these might be 'cave pearls'.

This was followed by a letter from Mr A.D. Moss, who suggested that they were oolites, and by another from Dr Michel G.L. Errera, of Brussels, who sent me photostats of two works which described ooliths and pisoliths. (The difference between these is size; an oolith is up to 2mm in diameter, while a pisolith is the same concentric structure up to 10mm. But 'oolite' or 'oolith' is often used regardless of size. 'Cave pearls' are oolites.) Dr Errera also makes the point that human calculi (such as gallstones) are not attacked by dilute hydrochloric acid and do not have sand

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*J.Gemm., 1985, XIX (6), 498-9. – Ed.

grains as nuclei. The formations in question have quartz grains and other minerals as centres and do react to acid, so they must be of inorganic origin, i.e. 'cave pearls'.

Finally a letter arrived from Mr Andre Hettena, of the Museum d'Histoire Naturelle, Geneva, which again pressed the claim of oolites, and enclosed a photograph of several specimens from Grotte de Bramabian, Gard, France, and also a most beautiful cross section of a large oolite which had been specially cut by the Museum at the order of their Curator, Dr Jacques Deferne. This handsome specimen is 39mm in diameter. It reacts to acid and is fluorescent under UV light. The quartz nucleus is inert, but the lighter area immediately surrounding this fluoresces white, while the outer rings of the concretion, which are more sandy in colour, fluoresce less strongly. One thing quite evident from this specimen is that such 'pearls' do not have a nacreous outer surface, and so are not very pearl-like in appearance, despite the similarity of their structure to that of the pearl.

I am grateful to these correspondents, and thank all who have taken the trouble to reply to my query.

Yours etc.,
R. KEITH MITCHELL.

24th September 1985
Orpington, Kent.

From Mr D.J. Callaghan, F.G.A.
Gemmological Association of Great Britain

Dear Sir,

THE BASIL ANDERSON SPECTROPHOTOMETER APPEAL

As Chairman of the Appeal Fund I shall be most grateful if you would consider giving space to the publication of the list of subscribers since the Appeal was launched last November. As you will see there have been subscribers from all over the world and the total amount raised now approaches £20000*. The target for the Appeal is £25000 and I am publishing the list now in the hope that any person who may not be aware of the Appeal or who may have overlooked the original request will send a donation to me at the Gemmological Association, Saint Dunstan's House, 2 Carey Lane, London, EC2V 8AB.

I am sure that in general I am preaching to the converted when I say, in the year that sees the 60th anniversary of the foundation of the British Gem Testing Laboratory, how vital this modern British-made sophisticated instrument is to the present day and the future of gem testing.

Yours etc.,
D.J. CALLAGHAN,
Chairman.

9th August, 1985
London.

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*At the time of going to press, the amount raised is approximately £22005. – Ed.

THE BASIL ANDERSON APPEAL FUND

LIST OF CONTRIBUTORS

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CORRIGENDA

On p.569 above, in line 7 from foot, after 'Chatham (' add 'see'

On p.591 above, in line 1 of caption to Fig. 9, for 'right' read 'left'

On p.592 above, in line 15, for 'lower right' read 'lower left'

On p.595 above, Figs. 16 and 17 have been transposed: the redder Figure is Fig. 16 (transmitted and reflected light) and the Figure captioned as Fig. 16 is in fact Fig. 17 (reflected and reduced transmitted light)

On p.633 above, in line 1, for 'Austrlian' read 'Australian'

On p.647 above, in line 23, for 'stonges' read 'stones'


Gem Testing
B.W. Anderson

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.

Articles published are paid for, and a minimum of 25 prints of individual articles may be supplied to authors provided application is made on or before approval of proofs. Applications for prints should be made to the Secretary of the Association—not to the Editors—and current rates of payment for articles and terms for the supply of prints may be obtained also from the Secretary.

Although not a mandatory requirement, it is most helpful if articles are typed (together with a carbon copy) in double spacing on one side of the paper, with good margins at sides, top and foot of each page. Articles may be of any length, but it should be borne in mind that long articles are more difficult to fit in than short ones: in practice, an article of much more than 10 000 words (unless capable of division into parts or of exceptional importance) is unlikely to be acceptable, while a short note of 400 or 500 words may achieve early publication.

Vol. XIX
No. 8,
October, 1985

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