ISSN: 0022-1252 XVIII (7) 581-676(1983)

Vol. XVIII No. 7 July, 1983

THE JOURNAL OF GEMMOLOGY

and

PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

GEMMOLOGICAL ASSOCIATION
OF GREAT BRITAIN
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:* **01-606 5025**

THE JOURNAL OF GEMMOLOGY
AND PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

Vol. XVIII No. 7 JULY 1983

TOPAZ AND ANDALUSITE MINING IN BRAZIL

By P. K. RUPLINGER, B.Sc., F.G.A.
Sandy, Utah, U.S.A.

Brazil is one of the greatest gem sources in the world. Within a short radius of Belo Horizonte alone, most of the world's popular and unusual gems can be found. This article will look at two of these stones, the prized 'Imperial' topaz and the less known andalusite.

Next to aquamarine, Brazil is probably most noted for its production of topaz. Topaz is encountered in several localities, but the finest stones, known as 'Imperial topaz', come from the area of Ouro Preto, about three hundred kilometres north of Rio de Janeiro. Stones from this area are typically yellow, varying to brown. The finest colours have a lively peach hue, and unusual colours demanding very high prices have tinges of red, orange, or purple. Stones from other areas in Brazil, not considered 'Imperial', are commonly blue and command much less in price.

'Imperial topaz' parent earth runs in a north-easterly mountain range approximately five kilometres wide and at least fifty kilometres long. The stones are found in several varieties of

ISSN: 0022-1252 XVIII (7) 581 (1983)

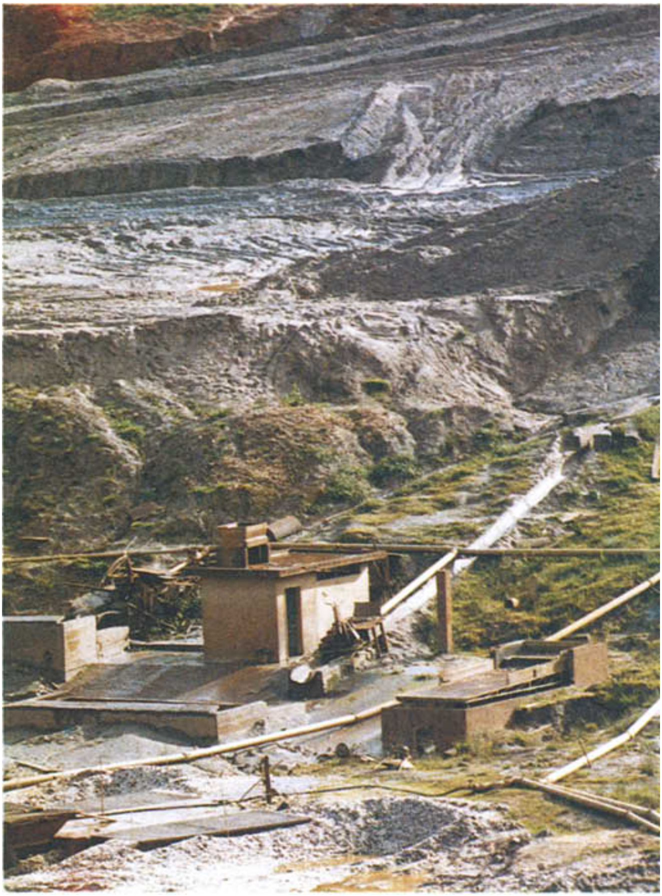


FIG. 1. At the Capao Mine topaz-bearing earth is tumbled down a trough: the topaz is separated by hand.

matrix including haematite, quartz, pegmatite, clay and kaolin. Dolomite, gold, bauxite and iron ore are also mined in the area. In colonial times the area was one of the world's greatest gold producers.

There are several large topaz-mining ventures in the Ouro Preto area. The major operation is near the small town of Rodrigo Silva, at the Capao Mine (Figure 1). Here Imperial Topaz Minerals and Industries Ltd has a substantial operation removing the entire

FIG. 2. Free-lance miners work in teams and live in small huts constructed of mud and sticks.

side of a mountain. As work progresses, a drilling team continually makes test holes probing the earth to guide the correct path of excavation.

Five bull-dozers remove fifty to seventy feet of overburden, exposing a light blue parent earth. At the bottom of the mountain a small river is dammed and several pumps pump thousands of litres per minute to the top where water washes overburden to a settling pond. The bull-dozers then scrape and push parent earth into a holding bin. From the bin it is washed down a trough. The tumbling action separates the crystals from parent earth. Landing on a screen with other stones they are separated by hand.

Seven hundred cubic metres of parent earth are processed on an average day. The mining operator was not at liberty to say how many grams of topaz are retrieved. The mine has contracts to sell its better quality stones through specific channels. Most of it is cut in Belo Horizonte and exported to Europe.

In addition to commercial operations there are hundreds of free-lance miners (Figures 2, 3 and 4). Using only hand tools, they are confined to river bottoms but find exceptionally fine stones.

FIG. 3. Free-lance miners dig in river bottoms near Ouro Preto for excellent quality topaz.

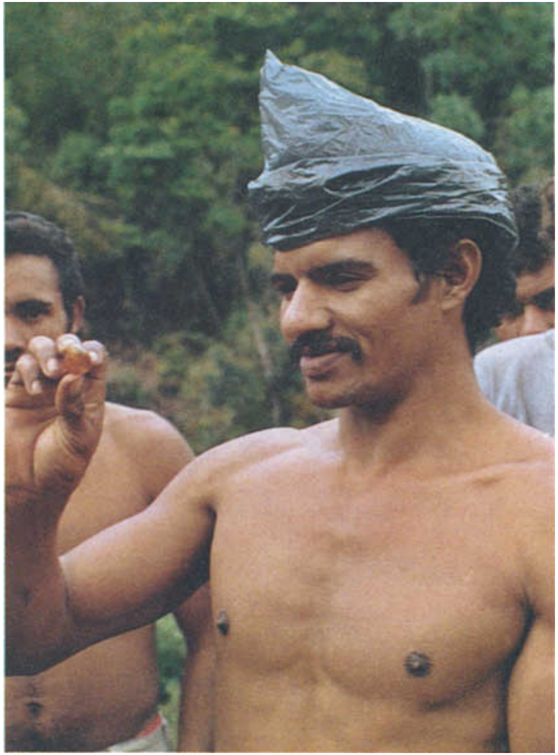


FIG. 4. This miner is especially proud of a ten gram topaz. River-bottom stones of this size are unusual.

FIG. 5. Topaz in haematite matrix.

FIG. 6. Topaz growing out of a quartz crystal.

FIG. 7. Topaz produced by seven men in one week.

Unlike the excellent crystals which are found by commercial operations in parent earth (Figures 5 and 6), the stones found in river bottoms are rounded pebbles, but much freer of imperfections.

A group of seven men working for a week will typically find six stones weighing three to five grams each (cf. Figure 7). On Saturday they take these to Belo Horizonte or Ouro Preto, where they sell them for US$ 15.00 to 40.00 each. Once cut they may sell for as high as US$ 100.00 per ct, but most sell for 15.00 or less. Brazilian lapidaries do remarkable faceting, considering that it is all done by eyesight, without the aid of calibrated dop mounts (Figures 8 and 9).

Topaz from the Capao Mine appears to have constants representative of established figures for yellow topaz. Several

FIG. 8 and FIG. 9. Brazilian lapidaries do excellent work without the aid of calibrated dops.

FIG. 10. Andalusite is found in sandy gravel under about two metres of clay. Water seeps back almost as fast as it is pumped out of the pit.

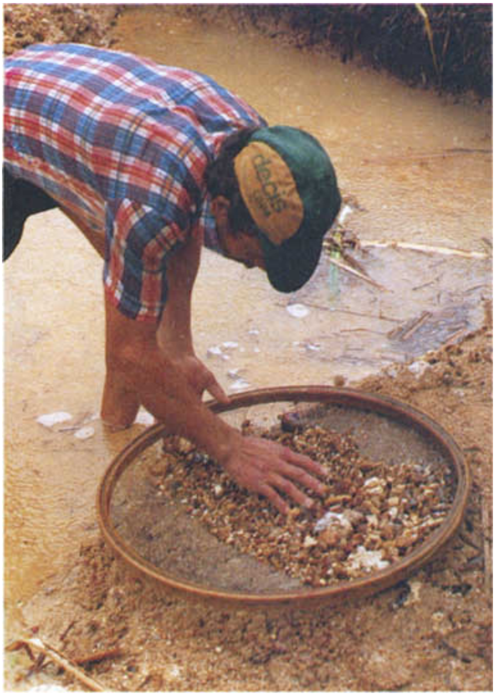


FIG. 11. Andalusite is found by carefully looking through washed gravel.

FIG. 12. Poor quality andalusite mined in one week by four workers.

stones randomly selected and tested were shown to have the following average values. All were light amber in colour.

Specific gravity	3.52±0.02
RI (sodium light)	1.630±0.002–1.639±0.002
Dispersion	0.015±0.002

No clearly visible absorption was observed in any stone.

Brazilian mining operators are required to submit exact reports on production, but everyone knows that documented mining as well as exportation figures are a small portion of reality. With this in mind, the Brazilian government has estimated actual exportation values of most gem stones. The value of exported topaz is represented overleaf., Brazilian Exportation of Topaz in US$ 1000

	1970	1971	1972	1973	1974	1975
Rough	34.9	55.4	39.1	50.5	45.4	35.3
Faceted	185.5	147.2	476.3	1417.3	1300.9	1038.0

	1976	1977	1978	1979	1980	1981
Rough	41.1	82.7	129.4	160.3	126.2	103.6
Faceted	746.7	923.9	1632.4	2913.6	3912.7	3358.9

Approximately 350 kilometres east of this topaz region is Santa Teresa, a small town noted for production of andalusite. Despite its remarkable trichroism, andalusite has never been a very popular stone. Even in Brazil it is seldom encountered. Most is exported to Europe. It shows three distinct colours, red, yellow, and green with the dichroscope, and, when properly oriented, a cut gem will display a dramatic colour-change when tilted slightly. Unfortunately, most stones are cut with no consideration for this effect.

Andalusite is mined in river beds in several locations not far from the town. In Brazil mines are not owned, but leased from the government. Ten kilometres outside of Santa Teresa is a typical operation. Four miners and a cook live in a small shack a short distance from the diggings. The operator lives in Santa Teresa and has another business. The workers systematically excavate sections of river bottom which are approximately three metres square. The stones lie below an extremely dense ground cover of ferns, about sixty centimetres of steel-mesh-like roots, and one and a half or two metres of clay (Figure 10). At this level the clay turns to sandy gravel which contains scattered smoky quartz stones, frequently as large as 100 grams, and much less frequently andalusite (Figure 11).

Some areas of river bottom tend to produce better than others. The mine operator is successful depending on how he selects the areas to excavate. Work is entirely by hand with the exception of two single-cylinder gasoline* pumps, which seem to pump only slightly faster than water seeps back into the pit. The pumps use one litre of fuel per hour. Gas costs US$ 0.80 per litre. Two or three workers stand in the pit sifting through sand and gravel. The

---

**Anglice* petrol.—Ed.

unpleasantness of the chilling water is exceeded only by the danger of snakes, which frequently kill workers.

In a four hour visit to a mining area worked by two men, they produced about fifty grams of very poor quality andalusite (cf. Figure 12), worth almost nothing. Occasionally, however, a large clear stone of good colour in the five to six gram size may be found. Such a stone will sell for US$ 120.00 to $150.00. Workers are paid in proportion to production. The operator sells his stones in Victoria.

Unlike river-bottom topaz, which is found in rounded pebbles, andalusite is usually found in a habit recalling its original crystal form. The edges are often slightly rounded, but the almost square prism shape is usually recognizable (Figure 12). Andalusite from Santa Teresa appeared to have RI and SG within the ranges of most established standards, but the dispersion, as determined by the author,* seemed to be slightly higher. Several stones randomly selected yielded the following averages. All were olive green in colour.

Specific gravity	3.17±0.03
RI (sodium light)	1.633±0.003–1.647±0.003
Dispersion	0.019±0.002

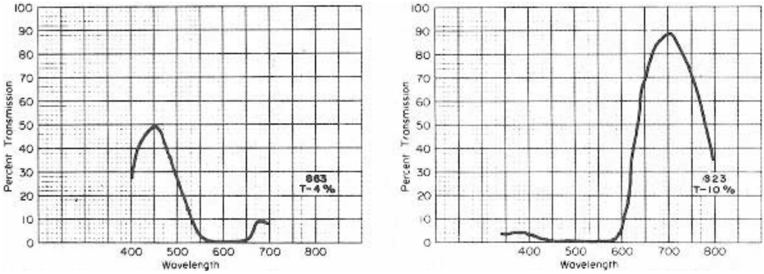
No clearly visible absorption was observed in any stone.

As with other stones from Brazil, andalusite has no exact mining or exportation reporting. Because it is a less popular stone, the government has not attempted to estimate its exportation.

[Manuscript received 20th February, 1982.]

---

*Dispersion was determined with a GIA refractometer, high intensity lamp, and red and blue filters approaching the Fraunhofer B and G lines. Wavelength transmissions of these two filters are shown below.



A NEW GEMSTONE VARIETY FROM TANZANIA

By Prof. Dr E. GÜBELIN, C.G., F.G.A., and Dr K. SCHMETZER,†*

*Meggen, Lucerne, Switzerland. †Heidelberg, West Germany.

INTRODUCTION

Very similar to other gemmiferous countries such as Brazil, Burma, and especially Sri Lanka, which have been such prolific and apparently inexhaustible sources of choice gemstones for centuries and even millennia, East Africa—Kenya and Tanzania in particular—is developing into a surprisingly rich source of an increasing wealth of gemstones.

Apatite cat's-eyes have been known from Brazil and India, and now there is a new source: Tanzania. Whereas the nature of the parallel fibres (the cause of the cat's-eye effect) had not been determined before because of the extreme fineness of the fibres in apatite cat's-eyes from Brazil and India, the relatively coarse acicular inclusions in these newly-discovered apatite cat's-eyes from Tanzania inspired a microprobe analysis of their nature.

THE SPECIMENS

Recently, on the native market in Nairobi, several kilos of cuttable crystal fragments of yellowish-green, green, greenish-brown to red-brown colour were offered as feldspar. These specimens were claimed to originate from the Umba Valley in north-east Tanzania, a region which has become famous recently for the multitude of its gemstones. Some of these samples were transparent, but the majority contained fine fibrous inclusions of parallel orientation, which indicated that a cabochen cut would produce beautiful cat's-eyes. This proved to be true indeed (Figure 1), as the resulting cut gems not only displayed a clearly defined chatoyancy but in their general appearance, including their colour, compared most favourably with the best chrysoberyl cat's-eyes from Sri Lanka.

ISSN: 0022-1252 XVIII (7) 592 (1983)

FIG. 1. A greenish-yellow and a reddish-brown apatite with fine cat's-eye effect, which is produced by scattering of light on goethite fibres. Umba Valley, Tanzania. Long axis of oval cabochon = 15mm.

FIG. 2. Densely concentrated fine goethite fibres of reddish and brownish coloration and in parallel alignment cause chatoyancy on yellowish-green, cabochon-cut apatite. 8 ×

FIG. 3. Extremely fine goethite fibres causing chatoyancy on a green apatite cat's-eye are superposed by black blebs of haematite. 12 ×

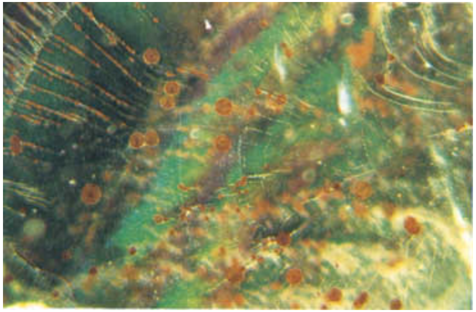


FIG. 4. Brown, disc-like concretions of radially arranged goethite fibres are secondary formations often occurring in fractures. 15 ×

GEMMOLOGICAL TESTS

A primary diagnosis with the polariscope showed all these specimens to be uniaxial, thus banishing the idea that they were biaxial feldspar. The x-ray examination then proved that they were apatite, and the following properties were manifested:

Refraction: The readings obtained by means of the Spinel-Refractometer lay between $n_\varepsilon = 1.632 - 1.636$ and $n_\omega = 1.636 - 1.640$, with a very constant birefringence of $n_{\varepsilon-\omega} = -0.004$.

Dichroism: The colours parallel and vertical to the crystallographic *c*-axis showed as a break-up of the colour-combinations, which could be seen even with the naked eye, of: ε = yellowish and ω = greenish, ε = yellow and ω = green, ε = brownish and ω = greenish, ε = reddish and ω = brown. Occasionally a zonal coloration was observed.

Absorption Spectrum: Viewed through the hand spectroscope, the typical sharp lines in the yellow region caused by didymium were observed (these are lines of the rare earth-elements praseodymium and neodymium, appearing between 570 and 590 nm; vide Anderson, 1953-56; and Grisafe & Hummel, 1970). By means of these absorption lines, apatite could have been recognized at first sight.

Density: The density appeared to be influenced to a certain extent by the density of the fibrous inclusions, as it varied between 3.22 and 3.35 with an average of 3.225 g/cm^3.

Inspection through the Microscope: All the above mentioned properties fall within the normal bounds, and together with the x-ray analysis, they provide absolute proof that the specimens examined are indeed apatite. However, the unusual factor is the cat's-eye effect, caused by the scattering of light as it impinges on the fibres of the inclusions, and an examination with the microscope showed that these inclusions consist of fine fibres or needles, partly blackish and partly reddish in colour (Figure 2). The orientation of these fibres is parallel to the crystallographic *c*-axis of the hexagonal apatites, which is easy to recognize when examining the conoscopical image. Some of the fibres were fortunately coarse enough to be analysed by means of the electron microprobe.

THE MICROPROBE ANALYSIS

A qualitative analysis of two polished thin slabs of the material by means of the electron microprobe, showed in the case of 15 needlelike inclusions that only iron was present. The diameter of these needles was however too small in most cases for the area to be excited by the electron beam of the microprobe, wherefore only a few of the thicker needles allowed a quantitative analysis of the iron. These measurements disclosed an iron compound corresponding with the composition FeOOH, which occurs in nature as goethite or lepidocrocite. Whereas the former usually crystallizes as needles, the latter appears rather as platelets, so that the analysed needles must therefore be goethite.

These fibres described previously, are intercalated with larger formless masses (Figure 3). Analysed by the electron microprobe, these inclusions also proved to be iron, but because of their fineness, a quantitative analysis was only possible with one grain. This was found to be haematite

Furthermore, red-brown discs of goethite fibres in radial arrangement were observed in some of the samples (Figure 4). These discs, which have often been found before in many apatites (Gübelin, 1974), are found almost without exception in fissures, and thus had formed as secondary or epigenetic inclusions. As a point of interest, these inclusions indicate that even after the relatively large quantities of iron were used up in the formation of goethite and haematite inclusions, the growth-chamber of these apatites was still rich in iron.

It is to be hoped that more of these exquisite apatite cat's-eyes from Tanzania will find their way onto the gem market, especially so since their beauty may easily vie with finest chrysoberyl cat's-eyes from other sources.

REFERENCES

Anderson, B. W., & Payne, C. J. (1956): The Spectroscope and its applications to Gemmology: Parts 33 and 34, *Gemmologist*, **25**, 298, 82-3; 299, 101.

Grisafe, D. A. & Hummel, F. A. (1970): Crystal chemistry and color in apatites containing cobalt, nickel, and rare earth ions. *Am.Miner.*, **55**, 1131-45.

Gübelin, E. (1974): *Internal World of Gemstones*, p.21. ABC Edition, Zurich.

[*Manuscript received 10th February, 1983.*]

MORE UNCOMMON GEMSTONES

By MICHAEL O'DONOGHUE, M.A., F.G.S., F.G.A.
Sevenoaks, Kent

In the January 1980 issue of this *Journal** I gave a brief account of a number of gemstones not commonly encountered, with the comment that the best plan when acquiring an unusual mineral is to refrain from fashioning it. Since that MS was prepared in August 1978 I have acquired several other rare species, safely faceted before I could obtain the crystals; the stones may be of interest to readers.

Probably the most unusual of the stones is the manganese borate, chambersite. Containing some chlorine, it is found in only one place in the world, a brine in a gas storage well at Barber's Hill Salt Dome, Chambers County, Texas. Material has to be recovered by divers and when it is found can be seen to form tetrahedral shapes. The colour of my faceted stone (the mode of fashioning is dictated by the original crystal from which the points are sawn and polished) is a mauvish-grey, closer to some Madagascar kornerupine than to any other mineral, though confusion is unlikely to arise. Chambersite has a hardness of about 7 and a specific gravity of 3.49; refractive indices are 1.732-1.744.(1) Weight of stone 0.06 ct.

Hodgkinsonite takes its name from H. H. Hodgkinson, of Franklin, New Jersey, a locality name which immediately suggests zinc or manganese. In this case manganese and zinc make up a silicate with the composition $MnZn_2SiO_5.H_2O$. This is an attractive pink transparent stone with a hardness of about 4½, specific gravity of 3.95 and refractive indices 1.720-1.746. Crystallizing in the monoclinic system, hodgkinsonite forms stout prisms or acute pyramids. It is found with the classic Franklin minerals willemite, franklinite and calcite, with other species. There is a faint reddish or pink luminescence under long-wave ultraviolet light.(2,3) Weight of stone is 0.13 ct.

Still in the North American continent, boleite is found at Boleo, Baja California, Mexico. It occurs as fine single crystals of a

---

**J.Gemm.*, 1980, XVII (1), 7-9. 'Some Less Common Gemstones'.

ISSN: 0022-1252 XVIII (7) 596 (1983)

bright rich blue, though most material is opaque. My stone, weighing 0.14 ct, is best examined with a microscope. Boleite is $Pb_9Ag_3Cu_8Cl_{21}(OH)_{16}.H_2O$. It is a member of the tetragonal system, forming pseudo-cubes. The hardness is about 3½ and the specific gravity just over 5. Refractive indices are 2.05 and 2.03 for the ordinary and extraordinary rays respectively. It occurs as a secondary mineral in lead and copper deposits and is associated with other secondary lead minerals. The crystals are sought by collectors.(4)

Hauyne is best known to gemmologists as one of the minerals which make up lapis lazuli. It is probably less well known that there are fine royal blue transparent crystals (grains would be a better description) in the area of the Laacher See in West Germany; excellent sanidine is also found here. Hauyne is $(Na,Ca)_{4-8}[Al_6Si_6O_{24}](SO_4,S)_{1-2}$. It is a member of the cubic system and has a hardness of about 5½ with specific gravity 2.5. Refractive index is near 1.50. It occurs in alkaline igneous rocks with another rare mineral, leucite, also cut as a gemstone from time to time. With the minerals sodalite and nosean it forms part of the sodalite group. Some hauyne is reported as showing an orange luminescence but my specimen does not show it.(5)

Milarite (not to be confused with millerite) has the composition $KCa_2AlBe_2(Si_{12}O_{30}).H_2O$ and is a member of the hexagonal system. The name is taken from the Swiss location of Val Milar, though it is now known that the mineral is not in fact found there. It forms yellowish-green crystals and all faceted crystals are from either Mexico or Namibia—mine is from the latter country. It is found in vugs in granites or in syenites and has a hardness of about 5½. Specific gravity is about 2.5 and refractive index 1.52-1.55. The weight of my specimen is about 0.10 ct.(6)

REFERENCES

1. Honea, R. M. & Beck, F. R. *Am.Miner.*, **47**, 665-71, 1962.
2. Palache, C. United States Geological Survey *Professional Paper*, **180**, 108-11, 1935.
3. Hardie *et al, Am.Miner.*, **49**, 415-20, 1964.
4. Palache *et al, Dana's System of Mineralogy,* 7th edn, vol. 2, 78-9, 1951.
5. Deer, W. A., Howie, R. A. & Zussman, J. *Rock-forming Minerals,* 1st edn, vol. 4, 289-302, 1963.
6. Vlasov, K. A. *Mineralogy of the Rare Elements,* vol. 2, 108-11, 1966.

[*Manuscript received 14th February, 1983.*]

THE LABORATORY MOVES

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

The heading of this article can be accepted as singular or plural. Singular, perhaps, because it is in fact an unusual and interesting event, new to some. Plural because it has happened before, each move being in itself a formidable undertaking and representing an era in the history of the Laboratory.

Since I am writing for gemmologists, perhaps I may be allowed the assumption that by the Laboratory, of course, I mean the Gem Testing Laboratory of the London Chamber of Commerce and Industry. At least that is its recent title. Such moves, apart from being milestones in lab history, also represent a new outlook and thinking as well as a new address. I have mentioned this latter fact before in talks and articles (on pearls and cultured pearls) 'that gemmology in Great Britain owes a lot to the Japanese and the team of B. W. Anderson and C. J. Payne.'

The Laboratory was not originally conceived as a gem-testing laboratory but as a pearl-testing station to combat the cultured pearl threat to the vast and important pearl trade extant in the twenties. When B. W. Anderson was engaged in 1925 he was a young graduate of University of London King's College. He knew nothing of pearls. The venture was not at first the Laboratory of the London Chamber of Commerce but a laboratory whose furniture, fixtures, fittings, etc. were subscribed for personally by the leading pearl merchants of the day. Later it was decided that to give the Laboratory a soundly based official representation it should be administered by the London Chamber of Commerce. This cachet served to remove from it any possible criticism of bias, etc., towards any particular founder member. This was the strength of the Laboratory, ensuring its utter independence. It may well be that it was hoist with its own petard in not searching for other means of income when testing fees and income from membership fell well below the requirements of salaries, rent, etc.

The first Laboratory premises were in Diamond House, Hatton Garden, from 1925 to 1929. These were somewhat simple premises with minimal equipment, but were the base whence

ISSN: 0022-1252 XVIII (7) 598 (1983)

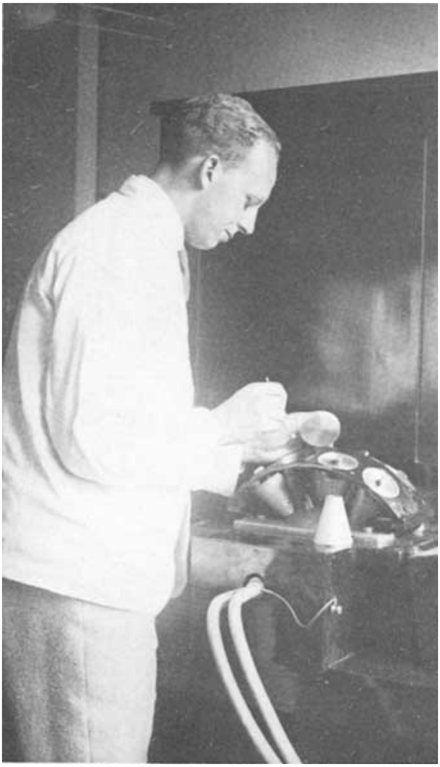


FIG. 1. B. W. Anderson positioning pearls for lauegrams on the 1929 x-ray generating set.

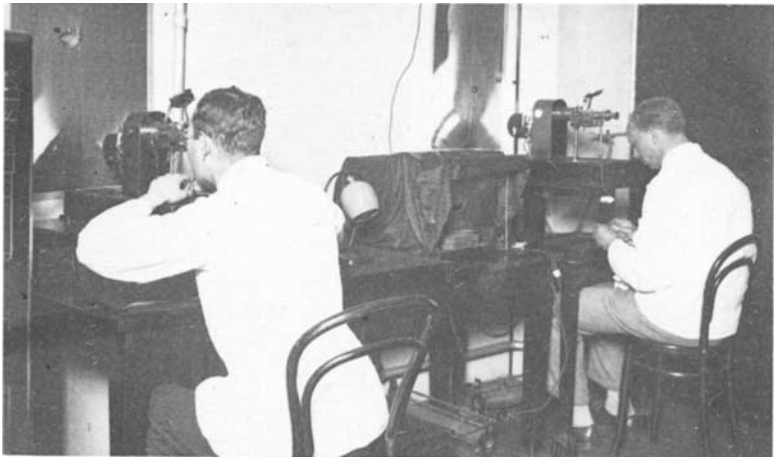


FIG. 2. C. J. Payne (left) and B. W. Anderson (right) testing drilled pearls by endoscope (usually in darkness).

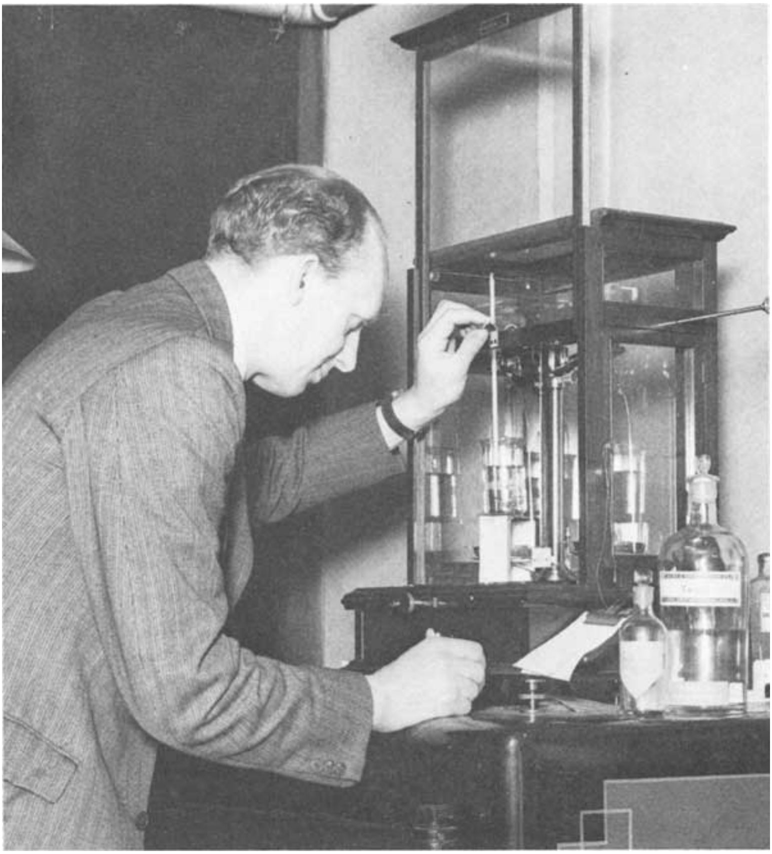


FIG. 3. B. W. Anderson doing a hydrostatic weighing.

gemmology research began. The most important move in the Laboratory's history was made in 1929, when new premises at 55 Hatton Garden were opened on 1st July. An x-ray generating set for the testing of undrilled and part-drilled pearls, which had been ordered in 1928, was successfully installed and proved satisfactory (Figure 1). In October of that year the premises were inspected by Lord Herbert Scott, Sir Geoffrey Clarke and other officers of the Chamber. In that first year at 55 Hatton Garden, over 45 000 pearls were tested; these contained a larger proportion of cultured pearls than in the previous years' testing (Figure 2). From that

FIG. 4. B. W. Anderson using spectroscope with microscope.

Laboratory and from Diamond House came the work on gemstones which was largely made possible by the world slump conditions of the late twenties and early thirties. The drop in the pearl market was tremendous and left the two graduates of London University, B. W. Anderson, B.Sc., and C. J. Payne, B.Sc., virtually unemployed within their laboratory. This period proved of great benefit to research on many aspects of gemstones, earlier textbooks having been produced by virtually re-hashing older books and quoting incorrect figures and characteristics. These mistakes were discovered by Anderson and Payne, and more careful routine work followed (Figure 3). At that time they were given considerable support by public-spirited merchants who foresaw the necessity for research in their trade.

To C. J. Payne goes the credit for devising the light-gathering method using the microscope tube for the study of spectra (cf. Figure 4).

B. W. Anderson produced his famous thirty-nine articles on the absorption spectra of gemstones, which are universally accepted as standard today. Thus the pearl-testing station which originated from the cultured-pearl threat inadvertently benefited the gemstone trade. The war years intervened at 55 Hatton Garden (Figure 5). C. J. Payne joined the Territorials and left Anderson to carry on the Laboratory, plus working as an active member of the Auxiliary Fire Service.

After the war a pile-up of work awaited clearance, together with mountainous stocks of small calibré rubies and sapphires. Additional staff of Robert Webster, F.G.A., and myself were taken on in 1946.

Following the very noisy explosion and blowing of the x-ray set in March 1948, a new set was planned and ordered. The new x-ray set had an inbuilt viewing chamber for the observation of fluorescence and phosphorescence. Altogether it was a vast improvement on the old 1929 set (Figure 6).

The Laboratory moved to new premises in 1954 at number 15 Hatton Garden. This address, being most central in Hatton Garden, was to us at that time the most enjoyable. It was a partitioned basement with good facilities for endoscope and dark room work at the rear. The front had two very reasonable windows of a sub-basement elevation, affording considerable light plus fire escape. A very narrow cell-like room, just wide enough for my desk at one end, faced the door with a small window at which trade members called to deliver and collect goods. Thus I was constantly in touch and, of course, on view. This contact gave me a considerable knowledge of people in the trade and vice versa. It was from here that Robert Webster retired, causing the first break in a

FIG. 5. No. 55 Hatton Garden (centre) during the war years (Laboratory on second floor).

team of four which had lasted twenty-five years. Later C. J. Payne retired, causing us to engage new staff. These, of course, by necessity, needed to be young men. When I now look at their photographs they do indeed seem young—what they thought of 'we four' must be imagined.

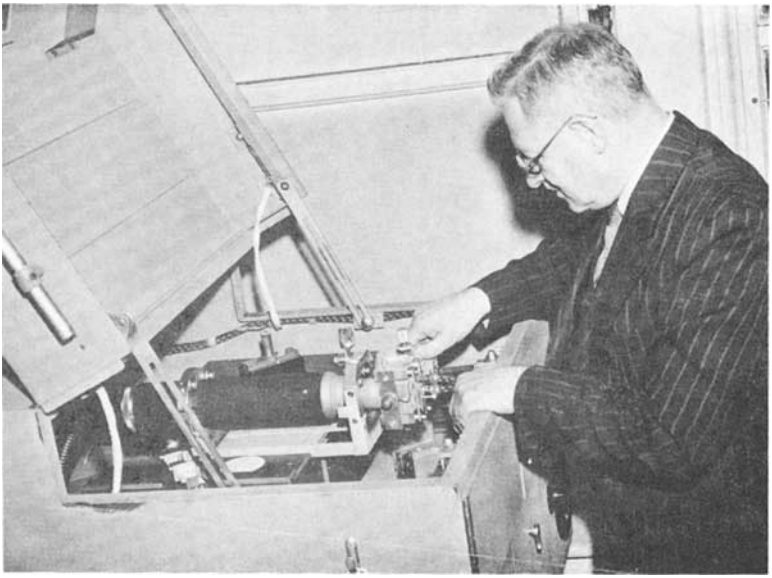


FIG. 6. Robert Webster operating the present x-ray set for undrilled pearls.

Up to this time at 15 Hatton Garden, until our next move, the Laboratory had been one hundred per cent gemmological, i.e. the investigation and detection of gemstones, synthetics and artefacts, pearls, cultured pearls and imitation pearls. The biggest and saddest blow came with the eventual retirement of B. W. Anderson in 1971.

We had tenure of 15 Hatton Garden until Christmas Day 1971 and removed from there just after Christmas. To me it was a real and final break with my immediate past and colleagues, the end of an era. We had, again, a new laboratory to furnish, fresh staff to teach, interior alterations to suffer, whilst still providing a service to the trade. These were for me the hardest years of all, having suffered considerably from a long bout of shingles in the head and having lost my old and irreplaceable colleagues.

Staff came and went, the new Laboratory at 36 Greville Street, again a basement, suffered as did 15 Hatton Garden from flooding, debris and damp. Much improvement was introduced by warm-air ventilation and pavement lights replaced, etc. Perhaps one of the biggest alterations in policy was that of the acceptance of diamond grading under the auspices of C.I.B.J.O. The Laboratory became the officially recognized C.I.B.J.O. laboratory for Great Britain. Again, not only new but extra staff were engaged and much more expensive equipment purchased. Security printing (certificates) and extra security precautions were necessary. The concept of gem merchants entering our inner hall and ringing the bell for attention disappeared. Crime statistics made T.V. screening and security imperative. Attending C.I.B.J.O. meetings on nomenclature and technical help towards correct wording of trade regulations made additional demands on the Laboratory. To say simply that the old order changeth is an understatement. With new demands and changed policies plus younger staff, it is inevitable that yet again, with the once more 'new move', new address, the Laboratory will function in a new role.

The Laboratory now includes diamond grading as part of its services; and teaching courses have courageously been launched within the Laboratory. These latest changes have been an attempt to increase income over that gained solely by fees from gem testing.

It was whilst at a meeting that I noted the lack of knowledge among some participants of the contributions that the Laboratory has made to the good of the trade and gemmological knowledge. One question was, 'What has the Laboratory to do with education?'—meaning 'why are they starting classes, etc?' One wonders where classes, instructors, invigilators, examiners and the supply of suitable questions for examinations or the checking of examination stones would have been, had it not been for such stalwarts of the Laboratory staff as B. W. Anderson and Robert Webster. Those two people must have instructed and inspired many of today's instructors—perhaps some of the more recent gemmologists may not have had the benefit or pleasure of such inspiration. Nevertheless the basis of most of modern gemmological knowledge stemmed from the Laboratory at 55 and 15 Hatton Gardens.

Because the Laboratory never started off by making profits from its knowledge, it has never been able to make enough money by its fees from gem testing or fees from membership. It has undoubtedly had considerable and consistent help from De Beers, from the National Association of Goldsmiths, the Gemmological Association, and the British Jewellers' Association, among others, plus several individual acts of generosity by its own members. Although it is a trade orientated laboratory, it is not supported by the entire jewellery trade, i.e. no general levy is enforced or asked for. The trade without the Laboratory would not have progressed far.

The trade proper and gemmologists in general throughout the world have benefited from freely published findings of densities, structure in synthetics, the whole range of absorption spectra of gemstones, refractive index/indices measurements, contact liquids for refractometers, the Chelsea filter, crossed filter techniques, fluorescence and phosphorescent effects by x-ray and ultraviolet excitation, cooling techniques to enhance fugitive spectra in diamonds, etc. Many observations on structures in natural brown diamond and much work on the spectra of diamond stemmed from 55 and 15 Hatton Garden.

With the new move in mind* and concern for the well-being of the Laboratory I have written these few lines, hoping that when and if the Laboratory in its work and researches needs help, the response will come, not only from the trade, but also from gemmologists in other walks of life. Yes, the Laboratory has had a lot to do with theory and practical gemmological education.

[*Manuscript received 10th November 1982.*]

---

*This article was intended by Mr Farn to appear as closely as possible to the opening date of the Laboratory's newest premises, which are on the third floor of 27 Greville Street and were officially opened on 16th February 1983.—Ed.

J.Gemm., 1983, XVIII, 7

NATURALLY-COLOURED AND TREATED YELLOW AND ORANGE-BROWN SAPPHIRES

By Dr K. SCHMETZER, * *G. BOSSHART, Dip.Min., G.G.,*† *and Dr H. A. HÄNNI, F.G.A.*‡

*Mineralogisch-Petrographisches Institut der Universität Heidelberg, West Germany.†Swiss Foundation for the Research of Gemstones, Zurich, Switzerland.‡Mineralogisches Institut der Universität Basel, Switzerland.

ABSTRACT

Natural yellow, orange and orange-brown sapphires owe their colour to colour centres and/or to trace elements (Fe^{3+}, Ti^{3+}, Cr^{3+}). Similar colorations can be achieved in synthetic corundums by Ni^{3+} and Cr^{3+} as well as by an additional annealing procedure. With colourless or pale yellow natural corundums, comparable hues can be obtained by irradiation or by annealing. Both types of treatment (irradiation or annealing) generate colour centres which cause a continuous increase of light absorption from orange to the blue end of the visible spectrum. They also produce a broad absorption band at approximately 21 500 cm^{-1} (465 nm). These treated natural corundums appear in intense yellow to orange-brown colours. While the colour centres, artificially induced by irradiation, are extremely unstable, the colour centres created by annealing do not heal out on further heating up to 1000 °C. For use in jewellery annealed stones can thus be considered colour-stable.

With regard to absorption, the irradiated or heated corundums differ little from naturally-coloured light yellow sapphires from Sri Lanka, apart from the generally stronger absorption in the violet and ultraviolet regions. On the contrary, intensely yellow to yellow-brown sapphires exhibit a pronounced iron or iron-chromium spectrum and synthetic yellow to orange corundums show a nickel or nickel-chromium spectrum. The inclusions of annealed golden yellow sapphires present the same modified characteristics as those encountered in heated corundums of the other hues.

In practical gemmology, the problem of identifying irradiated as well as synthetic yellow and orange-brown corundums has repeatedly been a matter of discussion (Oughton, 1970; McColl, 1970; McColl & Oughton, 1971; Schiffmann, 1981). The present study compares the results of an investigation on a *new type of golden-yellow corundums* (on one side) with the well-known natural and synthetic yellow and brown sapphires (on the other side). These new stones have been on the gem market for some time, occasionally offered by the dealers as corundums of 'treated' yellow to orange-brown colour. Colorations similar to these treated ones are shown by untreated natural yellow corundums known to originate from Sri Lanka, Thailand, Tanzania and Australia and

ISSN: 0022-1252 XVIII (7) 607 (1983)

TABLE 1. Causes of coloration of yellow, orange and orange-brown corundums

	Colour	Colour causes	Colour after heating to 500 °C	Colour after irradiation with x-rays
untreated natural corundum	pale yellow[a]	colour-centres ± Fe^{3+}	colourless*	more intensely yellow-orange
	pink-orange[a] (padparadshah)	colour-centres + Cr^{3+} ± Fe^{3+}	pink (pale ruby)	
	intensely yellow[b,c,d]	Fe^{3+} + Ti^{3+} Fe^{3+} + Cr^{3+} Fe^{3+} + Ti^{3+} + Cr^{3+}	unchanged	
	yellow-orange to orange-brown[d]	Fe^{3+} + Cr^{3+}	unchanged	
annealed natural corundum	intensely yellow, yellow-orange or orange-brown	colour centres	unchanged	more intensely yellow, orange or brown
irradiated natural corundum	intensely yellow, yellow-orange or orange-brown	colour centres	colourless*	intensely yellow, yellow-orange or orange-brown
synthetic corundum, in part annealed, doped with Ni ± Mg, Fe, Ca Cr ± Mg, Fe, Ca Ni + Cr ± Mg, Fe, Ca	yellow or yellow-orange†	Ni^{3+} or Cr^{3+} or Ni^{3+} + Cr^{3+} ± colour-centres (produced by annealing)		

Sources: a Sri Lanka, b Australia, c Thailand, d Tanzania

*Occasionally a residual pale yellow coloration is visible (Fe^{3+}).

†Further possibilities of yellow coloration of synthetic corundums are conceivable. In a yellow-orange specimen of Verneuil corundum Ca and V were detected experimentally (in the absence of Ni and Cr).

TABLE 2. Chemical data for natural and synthetic yellow and orange sapphires, in weight % (atomic absorption spectroscopy*)

Source	Colour	Mg	Cr	Mn	Fe	Ni	Spectrum
Sri Lanka	pale yellow	0.008	0.004	0.002	0.05	0.011	Fig. 1c
Sri Lanka	pale yellow	0.010	0.005	0.002	0.11	0.004	Fig. 1b
Anakie, Australia	intensely yellow	0.008	0.004	0.002	0.75	0.007	Fig. 4b
Umba, Tanzania	intensely yellow	0.015	0.008	0.004	0.50	0.006	Fig. 5a
Umba, Tanzania	intensely yellow	0.007	0.012	0.003	0.42	0.003	Fig. 5b
synthetic sapphire, Verneuil (annealed?)	light yellow	0.010	0.013	0.004	0.04	0.011	Fig. 7a
synthetic sapphire, Verneuil (annealed?)	orange	0.006	0.016	0.003	0.02	0.007	Fig. 7b

*$Ti < 0.05$; $V \nless 0.005$; $Ca < 0.05$ (in all specimens); the vanadium contents of the samples are near the limit of detectability of the method used; in small concentrations vanadium reinforces the colour due to Cr^{3+} (Schmetzer & Bank, 1981).

by the padparadshah variety from Sri Lanka. The golden-yellow colours also are comparable to those of artificially irradiated yellow to orange-brown sapphires as well as to the coloration of synthetic yellow to orange-brown corundums by Verneuil, produced by the addition of nickel or nickel plus chromium (Recker, 1973). The colours of the latter can be intensified by an additional heat treatment. A compilation of the various types of natural and synthetic yellow, orange and orange-brown corundum and of the origin of their colours is presented in Table 1 (cf. Schmetzer & Bank 1980, 1981). New analytical data are given in Table 2.

Natural pale yellow corundums are coloured by colour centres and so far are known to the authors to originate only from Sri

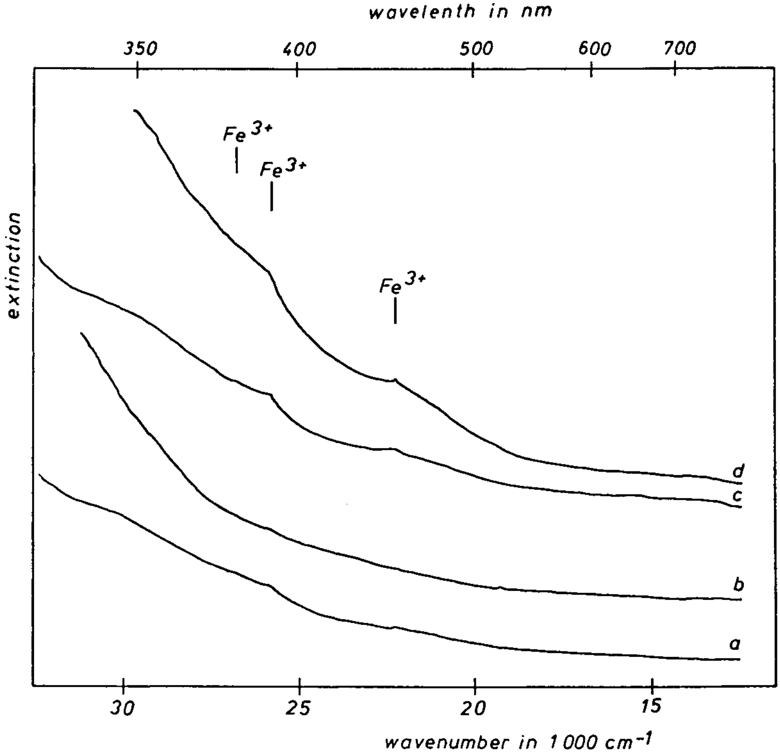


FIG. 1. Absorption spectra of pale yellow naturally-coloured corundums from Sri Lanka.

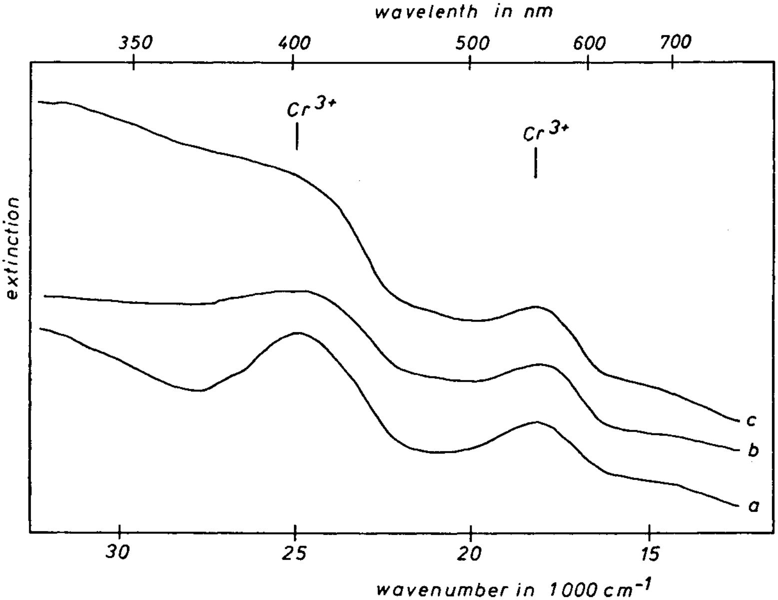


FIG. 2. Absorption spectra of the pink-orange corundum variety padparadshah from Sri Lanka.

Lanka. In the visible region their absorption continuously rises from orange to violet without showing any pronounced absorption maximum. Frequently weak Fe^{3+} absorption bands can be observed (Figure 1) which, however, have no distinct effect on the colour due to the low Fe contents of about 0.005 to 0.11% (Harder 1969, cf. also Table 2). The chromium contents of these yellow corundums are too low to clearly influence the colour (Harder 1969; Table 2). Sapphires containing higher proportions of Cr^{3+} (Figure 2) or Cr^{3+} and Fe^{3+} (Figure 3) and showing the absorption spectrum of light yellow corundums from Sri Lanka, caused by colour centres, are coloured pink-orange and called padparadshahs. Heat treatment at 500 °C heals out the colour centres of the described yellow and pink-orange stones. Specimens without chromium are practically colourless, those with chromium show the typical red of pale rubies. According to trade views, untreated natural yellow and orange sapphires are colour-stable.

Another type of *yellow sapphire* comes from Thailand and Australia. Stones from these sources show iron contents between

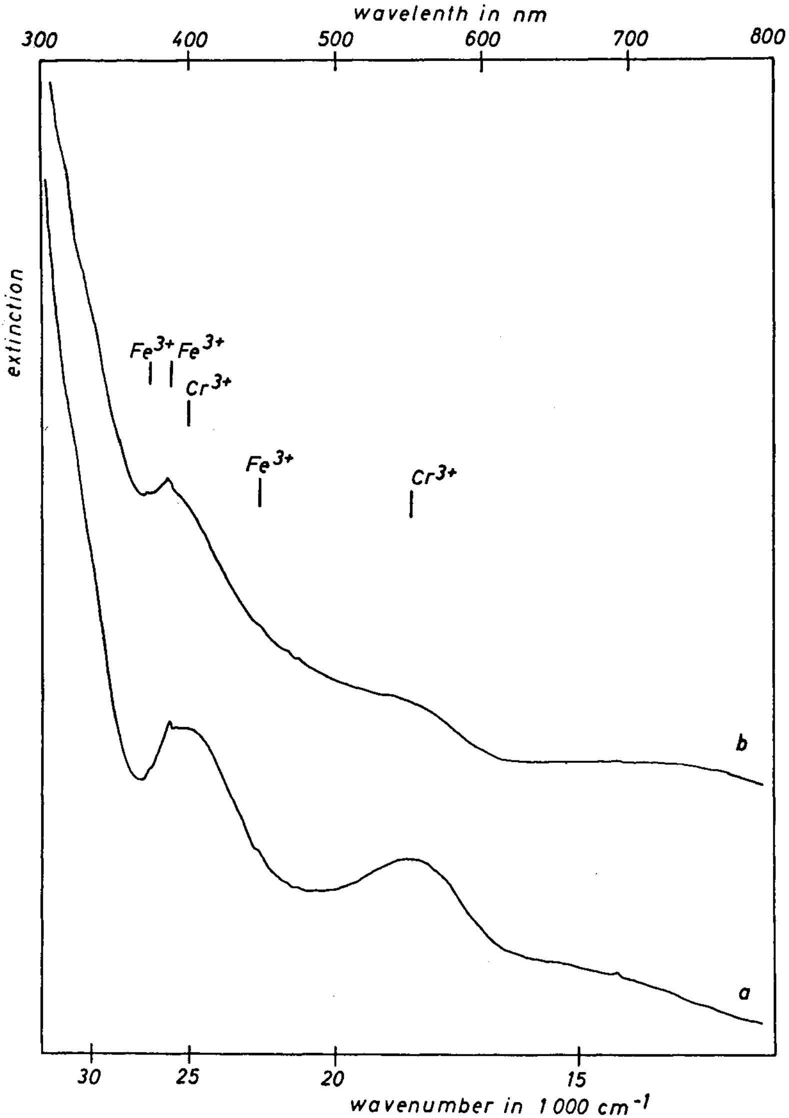


FIG. 3. Absorption spectra of the pink-orange corundum variety padparadshah from Sri Lanka.

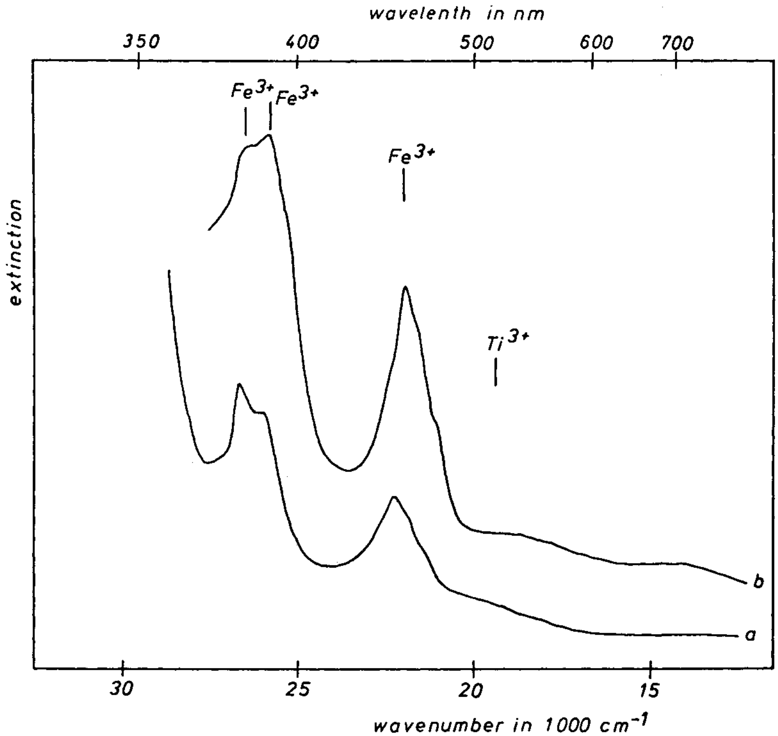


FIG. 4. Absorption spectra of golden yellow naturally-coloured sapphires from (a) Thailand, (b) Anakie, Australia.

0.5 and 0.75% Fe (Harder 1969, cf. also Table 2), which thus lie distinctly above those of the light yellow corundums from Sri Lanka. The cause for the coloration of these intensely yellow corundums is a combination of Fe^{3+} and (to a lesser extent) Ti^{3+}; here Cr^{3+} traces virtually are not colour-efficient (Figure 4). Since the valence of Fe^{3+} and Ti^{3+} cannot be changed on heating up to 500 °C (and higher temperatures), the colour of such specimens is stable under the conditions mentioned. Corundums from Umba, Tanzania, present definite amounts of Cr^{3+} in addition to the comparable Fe^{3+} percentages (Table 2). Specimens with small amounts of chromium are yellow (Figure 5), crystals with high chromium concentrations are yellow-orange to orange-brown in colour (Figure 6). As yet sapphires of this type have been noted only from Umba, Tanzania. Heating up to 500 °C does not alter the described colours.

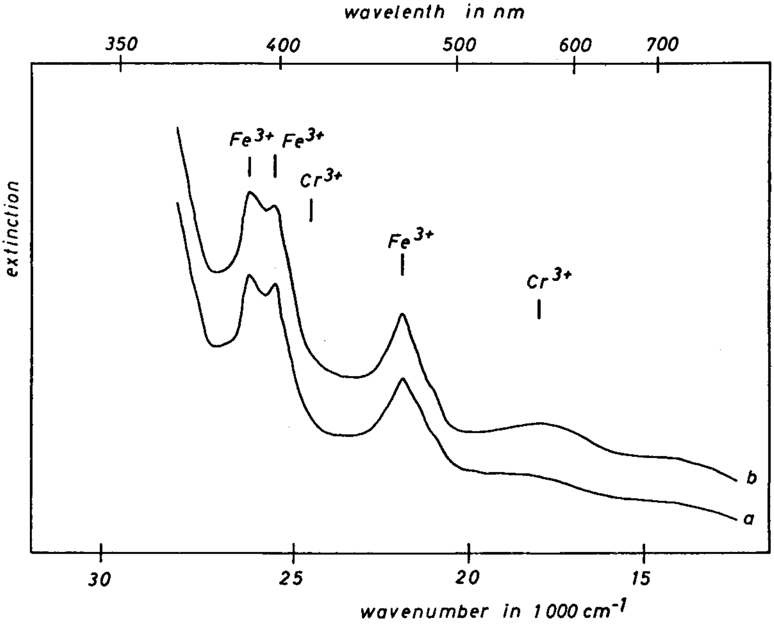


FIG. 5. Absorption spectra of yellow naturally-coloured sapphires from Umba, Tanzania.

Synthetic sapphires exhibit similar hues to those of natural sapphires although the latter mostly have other causes of coloration. The yellow colours of Verneuil synthetics are produced by Ni^{3+}, while orange hues are brought about by Cr^{3+} and Ni^{3+} (Figure 7, Table 2). By the addition of divalent cations (Mg^{2+}, Fe^{2+}, Ca^{2+}) and by subsequent annealing the colours of the commercially grown synthetic stones can be intensified, according to information on hand (cf. Table 1).

It has been known for quite some time that x- or γ-rays produce bright yellow and yellow-orange hues with originally pale yellow or almost colourless sapphires from Sri Lanka. The improved colours, however, become unstable when exposed to daylight (Pough & Rogers, 1947). Similarly after short-term heating to 500 °C the colour centres created by irradiation can be healed out too: the heated stones ordinarily turn completely colourless. Therefore the finding came as a surprise that the colour of *the new type of 'treated' sapphire,* which is indistinguishable

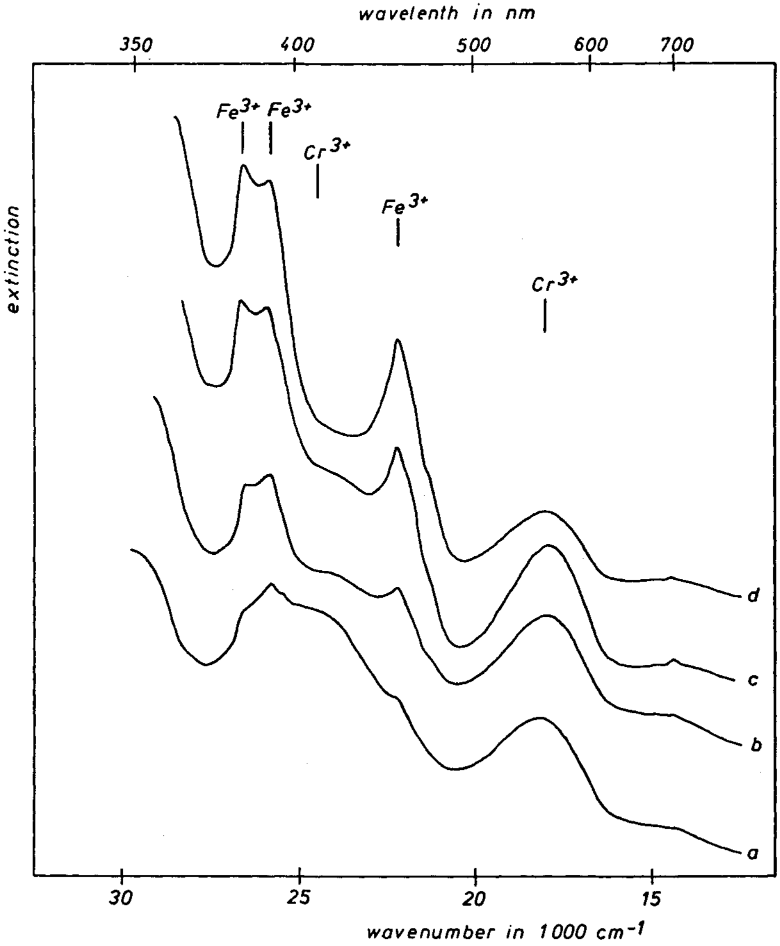


FIG.6. Absorption spectra of orange-brown naturally-coloured sapphires from Umba, Tanzania.

from the irradiated one in terms of colour, remained stable on heating at 500 °C and even up to 1000 °C. An irradiation could thus not be the cause of the strong yellow or orange coloration.

The examination of the *inclusions* of some rough and cut stones which in part stemmed directly from the corundum cookery in Thailand produced the following results (Figures 8 to 11):

— clouds of tiny inclusions mostly concentrated in certain zones and of turbid appearance under the microscope.

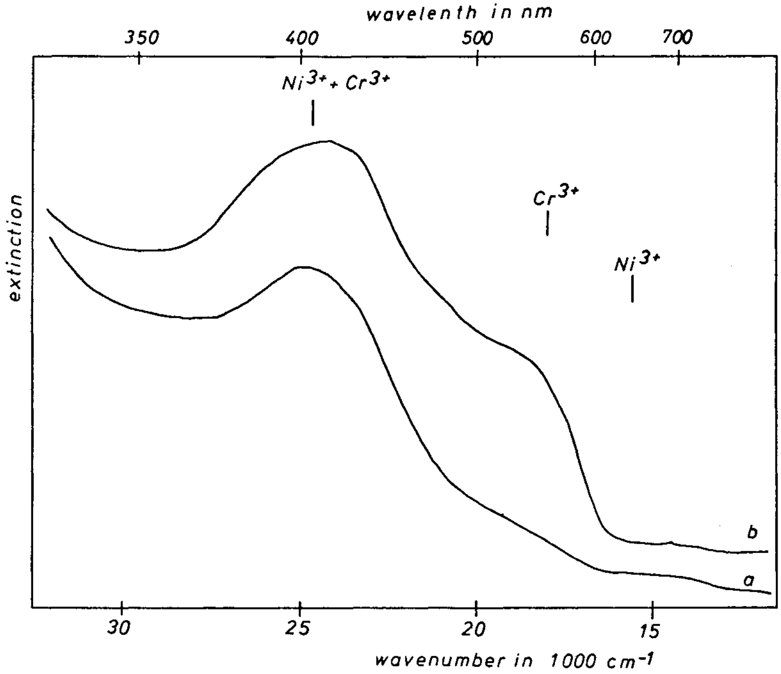


FIG. 7. Absorption spectra of synthetic corundums by Verneuil, (a) light yellow, (b) orange.

- small oval reflective tension fissures showing a more or less wide, white rim and resembling atolls. Frequently they contain a tiny mineral grain which might have caused the fissure during the heat treatment.
- spherical white aggregates of a spiky surface, occasionally surrounded by a healed tension fissure.
- larger healing cracks (feathers) with drop-shaped to tube-like cavities.
- altered fibre-like zonal structures with oriented inclusions (rutile, hollow tubes?).

The inclusions of these golden-yellow corundums thus exhibited the characteristics of the types of inclusion found in annealed natural corundums (Nassau, 1981; Crowningshield & Nassau, 1981; Hänni, 1982). A heat treatment as described recently in several articles (Gunaratne, 1981; Nassau, 1981; Crowningshield & Nassau, 1981; Harder, 1982) therefore can also be considered proven for the specimens of the new yellow type. According to Harder (1982), temperatures above 1550 °C are applied in the annealing process for yellow sapphires, but no explanation for the cause of the yellow coloration can be given at the present time. Possibly it is related to the resorption of pre-existent mineral inclusions during annealing. Chemical analyses (microprobe, x-ray fluorescence) indicate limited contents of Fe and sometimes also of Cr and Mg. Already before the heat treatment, these elements were present in some form inside the crystal (as inclusion constituents or on Al sites of the corundum lattice) and became colour-efficient by the strong annealing. A diffusion treatment by Cr and/or Ni as described by Nassau (1981) can be excluded for the specimens at disposal, because they were rough stones or else no signs of such a treatment were observed microscopically for the cut specimens.

The absorption spectra of burnt orange-brown corundums (Figure 12 a to c) show increasing absorption in the visible range from orange to violet as well as a broad absorption band with a peak position near 21 500 cm^{-1} (465 nm). Consequently the spectra are identical with the spectra of irradiated vividly orange to orange-brown sapphires (Figure 12 e, f) which were colourless or pale yellow before irradiation like the corundums of the type represented in Figure 1. The absorption spectra of annealed or irradiated yellow to orange-brown corundums thereby differ clearly from the Fe-Cr spectra of natural yellow, orange or orange-brown sapphires (Figure 2 to 6). By subsequent additional irradiation of the annealed yellow corundums, their coloration can be reinforced. The absorption spectra of such heated and irradiated corundums exhibit the same characteristics as the spectra of solely annealed or solely irradiated sapphires (Figure 12 d). A second heat-treatment heals out the colour centres additionally produced by the irradiation. The coloration and the intensity of the absorption bands correspond to the status before irradiation (after the first annealing), which means that the stones still are yellow-orange to orange-brown in colour.

The influence of the various *colour centres* on the optical properties of rubies and sapphires as well as the methods of their creation in synthetic corundums have been discussed in a considerable number of papers. While formerly synthetic chromiferous corundums (rubies) were of primary interest due to their importance for laser techniques (e.g. Flowers & Jenney, 1963;

FIG. 8. Clouds of tiny inclusions and reflective, marginally structured tension fissures in an annealed yellow corundum; 40×.

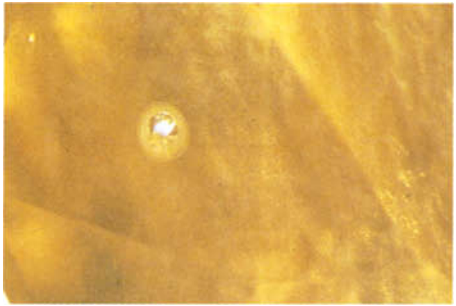


FIG. 9. Plate-like tension fissure resembling an atoll, in an annealed yellow corundum; 30×.

FIG. 10. Healing fissure of drop-shaped and tubular cavities in an annealed yellow corundum; 40×.

FIG.11. Fibre-like altered, oriented inclusions and plate-like tension cracks in an annealed yellow corundum; 10×.

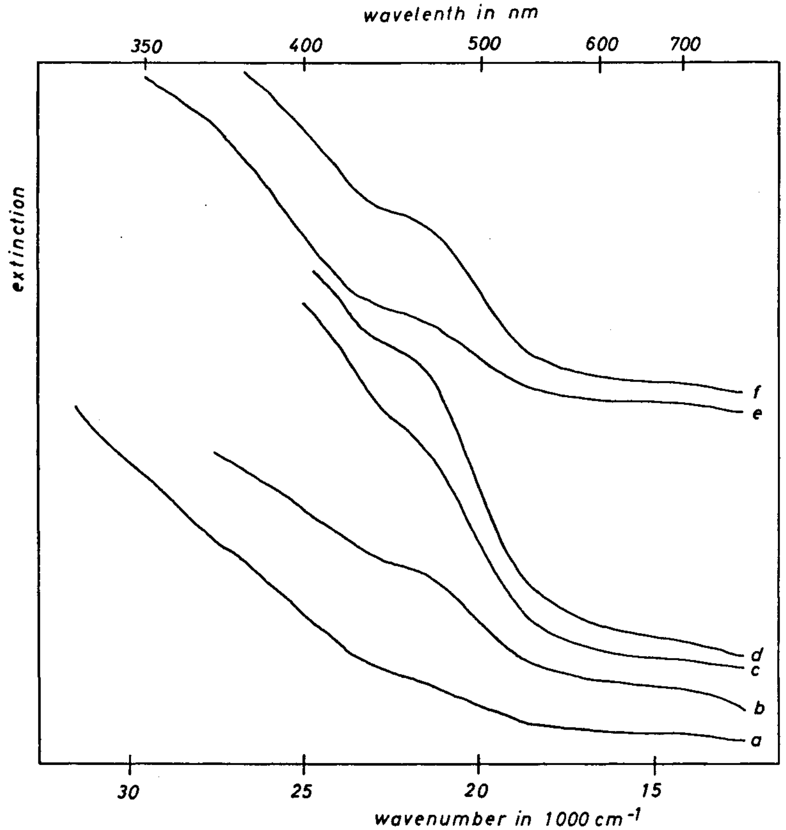


FIG. 12. Absorption spectra of treated yellow, yellow-orange and orange-brown sapphires; (a,b,c) annealed corundums, (d) sample b additionally irradiated, (e,f) originally pale yellow, irradiated corundums from Sri Lanka.

Schultz, 1964; Hoskins & Soffer, 1964; Standley & Vaughan, 1965; Arkhangelskii *et al.*, 1967, 1969; Sviridov, 1968; Borer *et al.*, 1970; Sidorova *et al.*, 1972, 1973; Sandreyev *et al.*, 1973; Bessonova *et al.*, 1974; Kvapil *et al.*, 1981), more recently a series of studies deals with the optical properties of undoped corundums following heat-treatment and/or irradiation as well as of corundums doped with divalent cations, e.g. Fe^{2+}, Mg^{2+}, Ca^{2+}, Be^{2+} (Gamble *et al.*, 1964; Bartram *et al.*, 1965; Gorban' & Kondratenko, 1972; Kvapil *et al.*, 1972, 1973; Govinda, 1976; Lee *et al.*, 1977; Lee & Crawford, 1978; Kulis *et al.*, 1979, 1981). Without specifying the nature of the colour centres, described in the various articles but not yet entirely explained in detail, it may be stated that colour centres with absorption maxima in the visible and UV similar to those mentioned here can be produced in synthetic corundums as well. The colour centres in synthetic crystals are created by doping with divalent cations and/or chromium and a subsequent annealing at high temperatures or by subsequent irradiation of the crystals. The absorption bands produced by annealing synthetic corundums can also be intensified by a subsequent irradiation. The radiation-induced colour centres heal out on heating e.g. to 500 °C while those of annealed, doped corundums are fairly stable.

The cation or the various cations necessary to form colour centres in the heated natural corundums examined in this study, cannot be indicated at present. Natural corundums usually show several di- and tri-valent cations as impurities, but only in trace amounts (cf. Harder, 1969; Table 2). In the annealed yellow sapphires in question, traces of Fe were identified by non-destructive analytical methods (XRF and microprobe analyses, both in energy- and wavelength-dispersive mode). The concentrations of other cations like Cr, Ni, and Mg used to dope synthetic crystals only occasionally were found within the limits of detectability of the applied methods. As Table 2 demonstrates, trace amounts of Cr and Mg were detectable in all natural corundums analysed with the aid of the more sensitive atomic absorption spectroscopy. These results are also valid for annealed yellow corundums so that the presence of several cations (e.g. Mg, Fe, Cr) in minor concentrations can be assumed. So far it is a matter of uncertainty, if the colour centres are created during the annealing process by a divalent cation like Fe^{2+} or Mg^{2+}, by a trivalent cation like Cr^{3+} or Fe^{3+} or by several di- and tri-valent cations.

The *distinction* of annealed or irradiated natural corundums from yellow to orange-brown corundums and synthetic corundums is possible on the basis of their spectroscopic and microscopic characteristics compiled in Figures 1 to 12. A diffusion treatment is discernible by optical examination (Hänni, 1982).

The annealing of pale yellow corundums leads to stable colorations. According to CIBJO *nomenclature* this treatment is a practice tolerated by the trade and has not to be declared explicitly. This stands in contrast to the diffusion-treatment of corundums, which must be indicated without exception.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Dr R. Ledig, of Stuttgart, as well as to the companies of Gebr. Bank, Alfred Hahn and Gebr. Leyser, of Idar-Oberstein, for the loan of untreated sapphires as testing material. We are especially indebted to Mr R. Naftule, Rana Gems S.A., of Geneva, and to Mr Anuphab 'Chonk' Chinudompong, of Chantaburi, Thailand, who placed annealed corundums at our disposal. Translation by G. Bosshart.

REFERENCES

Arkhangelskii, G. E., Morgenshtern, Z. L. & Neustruev, V. B. (1967): Colour Centres in Ruby Crystals. *Phys. Stat. Sol.,* **22,** 289-95.

Arkhangelskii, G. E., Morgenshtern, Z. L. & Neustruev, V. B. (1969): Effect of Colour Centres on the Cr^{3+} Spectrum in Ruby. *Phys. Stat. Sol.,* **36,** 451-7.

Bartram, R. H., Swenberg, C. E. & Fournier, J. T. (1965): Theory of Trapped-Hole Centers in Aluminum Oxide. *Phys. Rev.,* **139,** A941-51.

Bessonova, T. S., Stanislavskii, M. P., Tumanov, V. I. & Khaimovmalkov, V. Ya. (1974): Induced absorption and thermoluminescence of leucosapphire and ruby after electron irradiation. *Opt. Spectrosc.,* **37,** 398-400.

Borer, W. J., Günthard, Hs. H. & Ballmer, P. (1970): Solid State Reactions and Defects in Verneuil Laser Rubies. *Helv. Phys. Acta.,* **43,** 74-92.

Crowningshield, R. & Nassau, K. (1981): The heat and diffusion treatment of natural and synthetic sapphires. *J.Gemm.,* **XVII,** 528-41.

Flowers, W. & Jenney, J. (1963): Effects of γ-Irradiation on the Performance of a Ruby Laser. *Proc. I.E.E.E.,* **51,** 858-9.

Gamble, F. T., Bartram, R. H., Young, C. G., Gilliam, O. R. & Levy, P. W. (1964): Electron-Spin Resonances in Gamma-Ray-Irradiated Aluminum Oxide. *Phys. Rev.,* **134,** A589-95.

Gorban', I. S. & Kondratenko, P. A. (1972): Colour centers in corundum crystals. *Sov. Phys.—Solid State,* **13,** 3101-2.

Govinda, S. (1976): Coloration and Luminescence in Pure and Chromium-Doped Al_2O_3 Single Crystals Irradiated with X-Rays at Room Temperature. *Phys. Stat. Sol.,* (a) **37,** 109-17.

Gunaratne, H. S. (1981): 'Geuda sapphires'—their colouring elements and their reaction to heat. *J.Gemm.,* **XVII,** 292-300.

Hänni, H. A. (1982): Zur Erkennung diffusionsbehandelter Korunde. *Z.Dt.Gemmol.Ges.,* **31,** 49-57.

Harder, H. (1969): Farbgebende Spurenelemente in den natürlichen Korunden. *N.Jb.Miner.Abh.,* **110,** 128-41.

Harder, H. (1982): Qualitätsverbesserung von Edelsteinen, insbesondere von Korunden, durch Wärmebehandlung ('Brennen'). *Aufschluss,* **33,** 213-26.

Hoskins, R. H. & Soffer, B. H. (1964): Observation of Cr^{4+} in α-Al_2O_3. *Phys. Rev.,* **133,** A490-3.

Kvapil, J., Perner, B., Kubelka, J. & Kvapil, Jos. (1981): The Role of Iron Ions in Laser Ruby. *Cryst. Res. Tech.,* **16,** 1159-64.

Kvapil, J., Perner, B., Súlovský, J. & Kvapil, Jos. (1973): Colour Centre Formation in Corundum doped with Divalent Ions. *Kristall und Technik,* **8,** 247-51.

Kvapil, J., Súlovský, J., Kvapil, Jos. & Perner, B. (1972): The Influence of Dopants and Annealing on the Colour Stability of Ruby. *Phys. Stat. Sol.,* (a) **9,** 665-72.

Kulis, P. A., Springis, M. J., Tale, I. A., Vainer, V. S. & Valbis, J. A. (1981): Impurity-Associated Colour Centres in Mg- and Ca-Doped Al_2O_3 Single Crystals. *Phys. Stat. Sol.,* (b) **104,** 719-25.

Kulis, P. A., Springis, M. J., Tale, I. A. & Valbis, J. A. (1979): Recombination Luminescence in Single Crystal Al_2O_3. *Phys. Stat. Sol.,* (a) **53,** 113-19.

Lee, K. H. & Crawford, J. H., Jr. (1978): Additive coloration of sapphire. *Appl. Phys. Lett.*, **33**, 273-5.

Lee, K. H., Holmberg, G. E. & Crawford, J. H., Jr. (1977): Optical and ESR Studies of Hole Centers in γ-Irradiated Al_2O_3. *Phys. Stat. Sol.*, (a) **39**, 669-74.

McColl, D. H. (1970): A method for differentiation of natural and synthetic yellow sapphires. *Aust. Gemmol.*, **10**, 9-11.

McColl, D. & Oughton, J. H. (1971): More confusion with synthetic yellow sapphire. *Aust. Gemmol.*, **11**, 3-5.

Nassau, K. (1981): Heat treating ruby and sapphire: technical aspects. *Gems Gemol.*, **17**, 121-31.

Oughton, J. H. (1970): Yellow sapphire natural or synthetic. *Aust. Gemmol.*, **10**, 5-8.

Pough, F. H. & Rogers, T. H. (1947): Experiments in x-ray irradiation of gem stones. *Am. Miner.*, **32**, 31-43.

Recker, K. (1973): Zur künstlichen Herstellung von Schmucksteinen. *Z.Dt.Gemmol.Ges.*, **22**, 145-78.

Sandreyev, D. V., Arsenyev, P. A., Mareyeva, Z. G., Mayer, A. A., Tolchinsky, R. M. & Farschtendiker, V. L. (1973): Some Defects Appearing in Chromium Doped Al_2O_3 Monocrystals as a Result of Thermal Treatment. *Kristall und Technik*, **8**, 957-63.

Schiffmann, C. A. (1981): Unstable colour in a yellow sapphire from Sri Lanka. *J.Gemm.*, **XVII**, 615-18.

Schmetzer, K. & Bank, H. (1980): Explanations of the absorption spectra of natural and synthetic Fe- and Ti-containing corundums. *N. Jb. Miner. Abh.*, **139**, 216-25.

Schmetzer, K. & Bank, H. (1981): The colour of natural corundum. *N. Jb. Miner. Mh.*, **1981**, 59-68.

Schultz, G. V. (1964): Colour change of a ruby crystal when irradiated by intense light. *Phys. Lett.*, **9**, 301-3.

Sidorova, E. A., Volynets, F. K. & Kordev, E. A. (1972): Colour centers in γ-irradiated ruby containing vanadium. *Zh. Prikl. Spectros.*, **17**, 781-5 (in Russian).

Sidorova, E. A., Volynets, F. K. & Scepurov, N. A. (1973): Orange color of ruby. *Zh. Prikl. Spectros.*, **18**, 829-33 (in Russian).

Standley, K. J. & Vaughan, R. A. (1965): Spin-lattice relaxation of the Cr^{3+} ion in orange ruby. *Proc. Phys. Soc.*, **86**, 861-4.

Sviridov, D. T. (1968): About the Possible Role of Cr^{2+} and Cr^{4+} Ions in Ruby. *Kristall und Technik*, **3**, 661-4.

[*Manuscript received 20th October, 1982.*]

TAAFFEITE OR TAPROBANITE—A PROBLEM OF MINERALOGICAL NOMENCLATURE

By Dr KARL SCHMETZER

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

ABSTRACT

By chemical and crystallographic investigations of samples originating from Sri Lanka, U.S.S.R. and China, the identity of the natural Be-Mg-Al-oxides taaffeite and taprobanite, named by Anderson *et al.* (1951) and Moor *et al.* (1981) respectively, was established. For both minerals a formula of $BeMg_3Al_8O_{16}$ is valid; all samples investigated were found to be hexagonal with lattice parameters of $a_o \approx 5.7$, $c_o \approx 18.3$Å, space group $P6_3mc$ (extinction rule hhl: $l = 2n$).

The problem of a correct naming of this mineral species (taaffeite or taprobanite) leads to a general question of descriptive mineralogy: has a definition of a mineral by its type material priority over a definition by its original description? The consequences of both procedures for the commonly used system of mineralogical nomenclature are discussed.

Due to a vote of the Commission on New Minerals and Mineral Names of the International Mineralogical Association a definition of a mineral species by its type material has priority over a definition by its original description. A second vote of the Commission decided, that for the hexagonal mineral corresponding to the chemical formula $BeMg_3Al_8O_{16}$ the name taaffeite should be used in future.

In October 1945 Count Edward Charles Richard Taaffe bought a parcel of 50 or more cut stones from a Dublin jeweller, all of which were broken out of old jewellery. During the gemmological investigations of these stones, which were determined as zircons, opals, garnets, quartzes, spinels, rubies, sapphires, and emeralds, an unusual bluish-violet stone resembling spinel in its colour was found by Count Taaffe. This gemstone had a distinct double refraction and, therefore, could not be a spinel. The sample was given to B. W. Anderson in London for further investigations, leading finally to the description of a new mineral species, which was named taaffeite in honour of its discoverer (Anderson *et al.*, 1951).

Taaffeite was the first mineral, which was found for the first time in form of cut gemstones, originating probably from Sri Lanka. Natural taaffeite crystals from localities in China, U.S.S.R. and Australia became available later between 1963 and 1977. However, these crystals were very small in size, and material

ISSN: 0022-1252 XVIII (7) 623 (1983)

suitable for cutting was not found in the rock samples from these countries. As already mentioned above, taaffeites from Sri Lanka resemble spinels in their bluish-violet colour. A distinction of both minerals, however, can easily be done with the gemstone refractometer by means of the small double refraction of 0.004 of taaffeite. It is known that several individuals of cut taaffeites were discovered in parcels of spinel from Sri Lanka. Therefore, such gemstones are often systematically searched with the polariscope and refractometer for taaffeite, which is one of the rarest gem minerals presently known.

At the time of the original description of the new mineral taaffeite (Anderson *et al.,* 1951), only two cut samples of this rare gemstone were known: as already mentioned, the first taaffeite of 1.42 carats was found in 1945 by Count Taaffe in Dublin, and a second stone of 0.87 carats was found in 1949 by C. J. Payne in London. The quantitative chemical analysis of only 6 mg(!) substance and the x-ray single crystal and powder data, which were published by Anderson *et al.* (1951), were mainly carried out with fragments of Count Taaffe's stone (holotype specimen of taaffeite). From this specimen, a cut stone of 0.56 carats remained, which was kept in the private collection of Count Taaffe (Figure 1); for further details of the history of this gemstone compare a recently published paper by Mitchell (1982). Only two additional cut taffeites became available between 1951 and 1974: a stone of 0.84 carats was found in 1957 by R. Crowningshield in New York, and a bigger sample of 5.34 carats was discovered in 1967 by an American collector (cf. Liddicoat, 1967; Mitchell, 1967; Anderson, 1968, 1974).

The most important chemical and physical data given in the original description of taaffeite by Anderson *et al.* (1951) are set out in Table 1. According to these values, taaffeite is a hexagonal Be-Mg-Al-oxide, whose formula can be derived from spinel by a replacement of one half of the Mg-atoms by Be: 4 × the formula unit of spinel $MgAl_2O_4$ leads to the formula $Mg_4Al_8O_{16}$; the taaffeite formula is given by Anderson *et al.* as $Be_2Mg_2Al_8O_{16}$.

In order to understand some of the decisions of the following period, it has to be mentioned, that after 1951 no further chemical or x-ray data of taaffeite from Sri Lanka were published. Under these pre-conditions, i.e., with the knowledge of the publication by Anderson *et al.* (1951), a cut gemstone of red colour from Sri

Lanka was offered in the trade as red taaffeite (Figure 2). The crystal showed the gemmological properties of taaffeite, e.g., refractive indices, density, hardness, and was bought by E. Gübelin, of Meggen, Switzerland. The investigations of this gemstone with modern analytical methods, which were not available in 1951, showed two distinct differences between the already published data of taaffeite from Sri Lanka and the red crystal (Moor *et al.*, 1981). By x-ray single crystal investigations a different extinction rule, i.e., a different space group, was observed. Chemical investigations gave a different composition, leading to a new formula for the red gemstone (cf. Table 1).

FIG. 1. Original taaffeite of Anderson *et al.* (1951), Sri Lanka; sample A6, 0.56 carats. *(Photo by E. A. Jobbins, London.)*

FIG. 2. Original taprobanite of Moor *et al.* (1981), Sri Lanka; sample A8, 0.33 carats. *(Photo courtesy of E. Gübelin, Meggen.)*

Deriving this new formula again from spinel, in contrast to the old analysis, only one fourth of the Mg-atoms have to be replaced by Be: 4× the formula unit of spinel $MgAl_2O_4$ leads to $Mg_4AL_8O_{16}$; the formula of the red gemstone is given by Moor *et al.* as $BeMg_3Al_8O_{16}$. Comparing some further properties of the new gemstone with the data published for taaffeite, no significant differences were found, e.g., in density, refractive indices, crystal system, lattice parameters, x-ray powder diffraction pattern (Table 1). The complete mineralogical description of the red gemstone was given to the Commission on New Minerals and Mineral Names of the International Mineralogical Association, and the new mineral taprobanite and its name were approved by the Commission in March 1980 (cf. Moor *et al.*, 1981). The red colour of the crystal, which had been the reason for the intensive investigations, was found to be caused by traces of 0.12% Cr_2O_3. This allochromatic

TABLE 1.

Chemical and physical data of taaffeite and taprobanite, taken from the original descriptions of Anderson *et al.* (1951) and Moor *et al.* (1981).

	Chemical Data [weight %]	
	Taaffeite	Taprobanite
Al_2O_3	70.0	73.63
Cr_2O_3		0.12
Fe_2O_3	5.9	
FeO		1.24
MgO	13.4	21.64
BeO	11.0	4.4
Formula	$Be_2Mg_2Al_8O_{16}$	$BeMg_3Al_8O_{16}$

	Physical Properties	
	Taaffeite	Taprobanite
Crystal system	hexagonal	hexagonal
Lattice parameters		
a_o[Å]	5.72	5.684
c_o[Å]	18.38	18.332
Extinction rule	001 1 = 2n	hhl 1 = 2n
Space group	$P6_322$	$P6_3mc$
Strongest lines in the x-ray powder diffraction pattern [Å]	4.57; 2.61; 2.43; 2.05; 1.476; 1.428	4.58; 2.595; 2.415; 2.043; 1.469; 1.421
Density [g/cm³]	3.613	3.605
Hardness	8	8
Refractive indices n_o	1.723	1.721
n_e	1.718	1.717
Double refraction	−0.005	−0.004

colour is, however, of no interest in the discussion of the nomenclature problems of this phase.

The published data of taaffeites from various localities are compared with those of the original descriptions of taaffeite and taprobanite (holotype material of taaffeite and taprobanite): for taaffeite from China and U.S.S.R. the extinction rule and space group of taprobanite are given; quantitative chemical analyses of taaffeite from both localities were not yet published in these descriptions (Peng & Wang, 1963; Kozhevnikov *et al.,* 1977). For taaffeite of an Australian occurrence only chemical data (microprobe analyses) are given (Teale, 1980). A calculation of these analytical data leads to the formula given for taprobanite rather than to the formula of taaffeite.

A third mineral, resembling taaffeite in its chemical composition, was described by Hudson *et al.* (1967) from a locality called Musgrave Ranges in Australia, and recently by Grew (1981) from Antarctica. This mineral is hexagonal (rhombohedral) with unit cell dimensions of a_o 5.68, c_o 41.1Å, and a formula of $BeMg_2Al_6O_{12}$. Both, unit cell dimensions and chemical formula, of this natural Be-Mg-Al-oxide are different from the data published for taaffeite and taprobanite. Using the proposal of the I.U.Cr.-I.M.A. Joint Committee on Nomenclature (Bailey, 1977) this mineral has to be called a polytypoid of taaffeite. For this mineral the mineral name musgravite was suggested referring to the type locality; a more detailed discussion of the nomenclature problem of this mineral is given elsewhere (cf. Schmetzer, 1981, 1983).

The initial stimulus towards a comprehensive investigation of taaffeites came from a brief note on 'new gemstones from Sri Lanka' (Gübelin, 1979). For this mineral the name taprobanite was published; the complete description of the new mineral species was given by Moor *et al.* (1981). Since the gemmological data of taaffeite and taprobanite (e.g., density, refractive indices) were almost identical, a possibility for an identification of some of the taaffeites in gemstone collections as taprobanites was theoretically seen. Beginning with four stones from the collections of E. Gübelin, Meggen, Switzerland, and of H. Bank, Idar-Oberstein, West Germany, (Table 2), chemical investigations were done by microprobe analysis, and space group determinations were carried out by x-ray single crystal techniques. Surprisingly, these investigations showed the four 'taaffeite' crystals to have the

TABLE 2
Samples

No.	Description	Locality	Collection
A1	cut gemstone of 2.71 ct.	Sri Lanka, probably from Niriella Village, Ratnapura, Sabaragamuwa	E. Gübelin, Meggen, Switzerland.
A2	cut gemstone of 3.15 ct.		E. Gübelin, Meggen, Switzerland.
A3	cut gemstone of 4.26 ct.		E. Gübelin, Meggen, Switzerland.
A4	cut gemstone of 0.75 ct.		H. Bank, Idar-Oberstein, W.Germany.
A5	cut gemstone of 11.24 ct.		E. Gübelin, Meggen, Switzerland.
A6	cut gemstone of 0.56 ct. original taaffeite of Anderson *et al.* (1951)		Owner: R. K. Mitchell, Orpington, Great Britain. Collection: Institute of Geological Sciences, London, Great Britain.
A7	cut gemstone of 2.03 ct.		B. Suhner, Herisau, Switzerland.
A8	cut gemstone of 0.33 ct. original taprobanite of Moor *et al.* (1981)		Owner: E. Gübelin, Meggen, Switzerland. Collection: Eidgenössische Technische Hochschule, Zürich, Switzerland.
A9	small fragment of 0.007 gm.		British Museum No. 1979,417, London, Great Britain.
A10	cut gemstone of 1.74 ct.		K. E. Wild, Kirschweiler, W.Germany.
A11	cut gemstone of 5.3 ct.		Smithsonian Institution No. G4509, Washington, D.C., U.S.A.
B	very small fragments of green crystals	Hsianghualing, Southern Hunan Province, China	R. Kristiansen, Torp, Norway. Smithsonian Institution No. 128386, Washington, D.C., U.S.A.
C	very small fragments, taaffeite intergrown with spinel	The Pitkäranta mining district, Lake Ladoga, Karelian S.S.R., U.S.S.R.	R. Kristiansen, Torp, Norway. Smithsonian Institution No. 134008, Washington, D.C., U.S.A.

FIG. 3. Various cut taaffeites, Sri Lanka; upper row left to right: sample A3, 4.26 carats; sample A5, 11.24 carats; sample of 4.08 carats, not investigated; lower row left to right: sample A1, 2.71 carats; sample A8 (original taprobanite), 0.33 carats; sample A2, 3.15 carats.
(Photo courtesy of E. Gübelin, Meggen; about natural size—millimetre scale at side.)

FIG. 4. Taaffeite, Sri Lanka; sample A4, 0.75 carats.
(Photo by M. Gunawardene, Idar-Oberstein.)

FIG. 5. Taaffeite, Sri Lanka; sample A7, 2.03 carats.
(Photo courtesy of E. Gübelin, Meggen.)

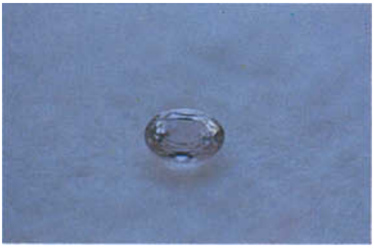


FIG. 6. Taaffeite, Sri Lanka; sample A10, 1.74 carats.
(Photo by M. Gunawardene, Idar-Oberstein.)

chemical formula and space group of taprobanite. In order to determine whether a mineral with the chemical and crystallographic data given for taaffeite exists at all, the investigation of further taaffeites from Sri Lanka and from samples originating from other localities was necessary (Table 2). Fortunately, the rest of the holotype specimens of taaffeite and taprobanite investigated by Anderson *et al.* (1951) and Moor *et al.* (1981) respectively were available. Some further cut gemstones from Sri Lanka, which were kept in different private or public collections were also given for investigation (Figures 3-6). In general, ten cut taaffeites or taprobanites and one small fragment of a rough crystal from Sri Lanka as well as some small fragments of crystals from China (Figure 7) and U.S.S.R. (Figure 8) were investigated by chemical and crystallographic methods (microprobe analyses and x-ray single crystal techniques). In addition to the ten cut taaffeites mentioned, four more cut stones were available, but analytical investigations could not be done on these samples. Only a few additional cut taaffeites are known to the author in mineralogical or gemmological collections. Therefore, at present, at least 20 cut taaffeites are known. Some of these crystals were discovered only recently in parcels of cut and rough spinels from Sri Lanka. Therefore, the discovery of more cut stones in the future has to be taken into account.

The results of the investigations of all taaffeite samples are only summarized in this paper (Table 3, cf. Schmetzer, 1981, 1983); all samples from Sri Lanka, China and U.S.S.R. were found to be hexagonal with unit cell dimensions of $a_o \approx 5.7$, $c_o \approx 18.3$Å. The extinction rule was determined as hhl: $l = 2n$ and leads to the space group given for taprobanite. The microprobe analyses gave a formula of $BeMg_3Al_8O_{16}$ for all samples; small amounts of Fe (samples from Sri Lanka), Fe, Mn, Zn (samples from China), and Zn, Fe (samples from U.S.S.R.) are found, replacing Mg in the crystal lattice of this mineral. Therefore, a general formula of $Be(Mg,Fe,Zn,Mn)_3Al_8O_{16}$ with $Mg > Fe,Zn,Mn$ is derived. These analytical results confirm the formula given for taprobanite, which is also valid for the holotype material of taaffeite and other taaffeites from Sri Lanka, as well as for all samples investigated from other localities.

Therefore, the minerals called taaffeite and taprobanite have to be considered as identical according to the rules of mineralogical

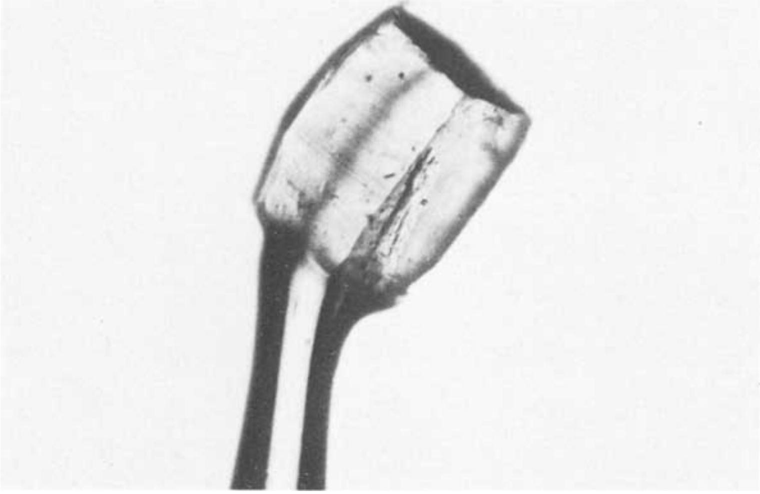


FIG. 7. Taaffeite, Hsianghualing, China; sample B.
(Photo by O. Medenbach, Bochum, 200×.)

nomenclature (the small difference in the chromium content and the different colour is of no significance for the mineral's name). In general, only one mineral name is used for a single mineral, and, therefore, the problem of a correct naming of this natural phase arose. Although similiar problems have been at times treated in the literature, no general vote of the Commission on New Minerals and Mineral Names of the International Mineralogical Association on

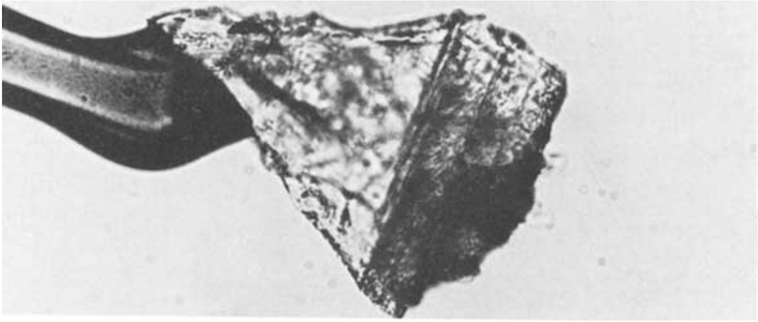


FIG. 8. Oriented intergrowth of spinel with taaffeite: (111) spinel ∥ (001) taaffeite, Pitkäranta mining district, U.S.S.R.; sample C; spinel is on the left, taaffeite on the right.
(Photo by O. Medenbach, Bochum, 200×.)

TABLE 3

Chemical and physical data of taaffeite from Sri Lanka, China, and U.S.S.R.

		Sri Lanka	China	U.S.S.R.
Chemical data [weight %]	BeO	4.4	4.31	n.d.
	MgO	20.07-21.32	14.27-14.79	17.17
	MnO	0.00- 0.11	2.87- 3.03	0.09
	CaO	0.01- 0.02	0.03- 0.05	0.01
	ZnO	0.00- 0.66	1.89- 2.78	4.27
	FeO	0.38- 2.00	5.52- 5.88	2.83
	Al_2O_3	72.61-74.05	69.84-70.16	71.37
	V_2O_3	0.00- 0.15	0.00- 0.03	0.15
	Cr_2O_3	0.00- 0.24	0.00- 0.02	0.17
	Ca_2O_3	0.05- 0.11	0.00- 0.13	0.10
	SiO_2	0.01- 0.11	0.02- 0.06	—
	TiO_2	0.00- 0.10	0.00- 0.09	0.09
Formula		Be $(Mg,Fe,Zn,Mn)_3$ Al_8 O_{16}		
Crystal system		hexagonal		
Lattice parameters [Å]		a_o 5.69±0.02	c_o 18.3±0.1	
Extinction rule		hhl l = 2n		
Refractive indices	n_o	1.721- 1.723(1)	1.747(2)	1.735(2)
	n_e	1.717- 1.718(1)	1.741(2)	1.726(2)
Double refraction		0.004- 0.005	0.006	0.009

n.d. = not determined

this general problem was made since the beginning of the Commission's work in 1962. Therefore, the chemical and physical data were given to the IMA Commission in April 1981 in order to solve the problem of mineralogical nomenclature. During the discussion of the general point of view included in the special problem with taaffeite and taprobanite, it was decided to be desirable to have a general first vote about the problem of the significance of the original description of a mineral, and later a second vote about the correct naming of the mineral corresponding to the formula $BeMg_3Al_8O_{16}$.

The general question of mineralogical nomenclature found in the taaffeite or taprobanite problem is, whether a mineral species is definable by its original description or by the type material used for the original description. If the definition of a mineral species is given by the original description, the mineral could be renamed in a later investigation with different experimental results. Certainly, this procedure would lead to great problems in the whole mineralogical nomenclature. If the definition of a mineral species is given by its original description alone, the deposition of type material in a public mineralogical collection, as usually done, is worthless. If the definition of a mineral species is given by the type material, a correction of the description by later investigations is possible without a necessity of renaming the species. Without a possibility of a correction of the original description every new technology, e.g., new analytical methods, would lead to a renaming procedure of parts of the mineral species already known.

For the decision on the general problem of mineralogical nomenclature described here, the members of the Commission were asked to vote about the following question. The precise formulation of this question was chosen under the influence of a general principle, given already by Dana (1868):

'Given that type material of a species exists, and that the original description is not so defective, that, in the opinion of the Commission, it bears no reasonable resemblance to the material, should the species be defined by the type material, or by the original description?'

The majority of the members of the Commission voted for the definition of a mineral species by the type material (cf. Embrey & Hey, 1970) and against the definition by the original description, unless the original description is so defective, that a recognition of the mineral by this description is impossible. This vote implies that errors in the original description can be corrected later in the future by reference to the type material and that errors cannot be held to discredit a mineral species. An example for such a procedure is given by Moore & Araki (1976) by the new determination of the chemical formula of the gem mineral painite.

By the vote on the priority of the type material over the original description, a decision over the priority of taaffeite or taprobanite was prepared. According to a second vote of the Commission the name taaffeite has priority and corresponds to the hexagonal mineral with the formula $BeMg_3Al_8O_{16}$. Should a mineral with a composition of $Be_2Mg_2Al_8O_{16}$ given originally for taaffeite, be discovered, a new naming procedure, consequently, has to be done. According to this vote, the name taprobanite is not to be used in future.

REFERENCES

Anderson, B. W. (1968): The First Two Taaffeites. A Historical Note. *Gems Gemol.*, **XII**, 259-62.

Anderson, B. W. (1974): Taaffeite. *J.Gemm.*, **XIV**, 104-7.

Anderson, B. W., Payne, C. J., Claringbull, G. F. & Hey, M. H. (1951): Taaffeite, a new beryllium mineral, found as a cut gemstone. *Mineralog. Mag.*, **29**, 765-72.

Bailey, S. W. (1977): Report of the I.M.A.—I.U.Cr. Joint Committee on Nomenclature. *Am. Miner.*, **62**, 411-15.

Dana, J. D. (1868): A System of Mineralogy, 5th edn. (XXIX-XXXIV: Nomenclature), London, Trübner & Co.

Embrey, P. G. & Hey, M. H. (1970): 'Type' specimens in mineralogy. *Mineral. Record*, **1**, 102-4.

Grew, E. S. (1981): Surinamite, taaffeite, and beryllium sapphirine from pegmatites in granulite-facies rocks of Casey Bay, Enderby Land, Antarctica. *Am. Miner.*, **66**, 1022-33.

Gübelin, E. (1979): Neue Edelsteine aus Sri Lanka. *Z.Dt.Gemmol. Ges.*, **28**, 194-6.

Hudson, D. R., Wilson, A. F. & Threadgold, I. M. (1967): A new polytype of taaffeite—a rare beryllium mineral from the granulites of central Australia. *Mineralog. Mag.*, **36**, 305-10.

Kozhevnikov, O. K., Dashkevich, L. M., Zakharov, A. A., Kashayev, A. A., Kukhrinkova, N. V. & Sinkevich, T. P. (1977): First taaffeite find in the USSR. *Dokl. Akad. Nauk SSSR, Earth Science Sections*, **224**, 120-1.

Liddicoat, R. T., Jr. (1967): Taaffeite Proves Largest. *Gems Gemol.*, **XII**, 212-15.

Mitchell, R. K. (1967): The world's largest taaffeite? *J.Gemm.*, **X**, 262.

Mitchell, R. K. (1982): 'Taprobanite' is Taaffeite. *J.Gemm.*, **XVIII**, 112-13.

Moor, R., Oberholzer, W. F. & Gübelin, E. (1981): Taprobanite, a new mineral of the taaffeite-group. *Schweiz. Min. Petr.Mitt.*, **61**, 13-21.

Moore, P. B. & Araki, T. (1976): Painite, $CaZrB[Al_9O_{18}]$: Its crystal structure and relation to jeremejevite, $B_5[\square_3Al_6(OH)_3O_{15}]$, and fluoborite, $B_3[Mg_9(F,OH)_9O_9]$. *Am. Miner.*, **61**, 88-94.

Peng, C. C. & Wang, K. J. (1963): Discovery of a compact structure with 8-layers. Crystal structure analysis of taaffeite. *Scientia Sinica*, **12**, 276-8 (in Russian).—*Kexue Tongbao 1963*, 70-1 (in Chinese).

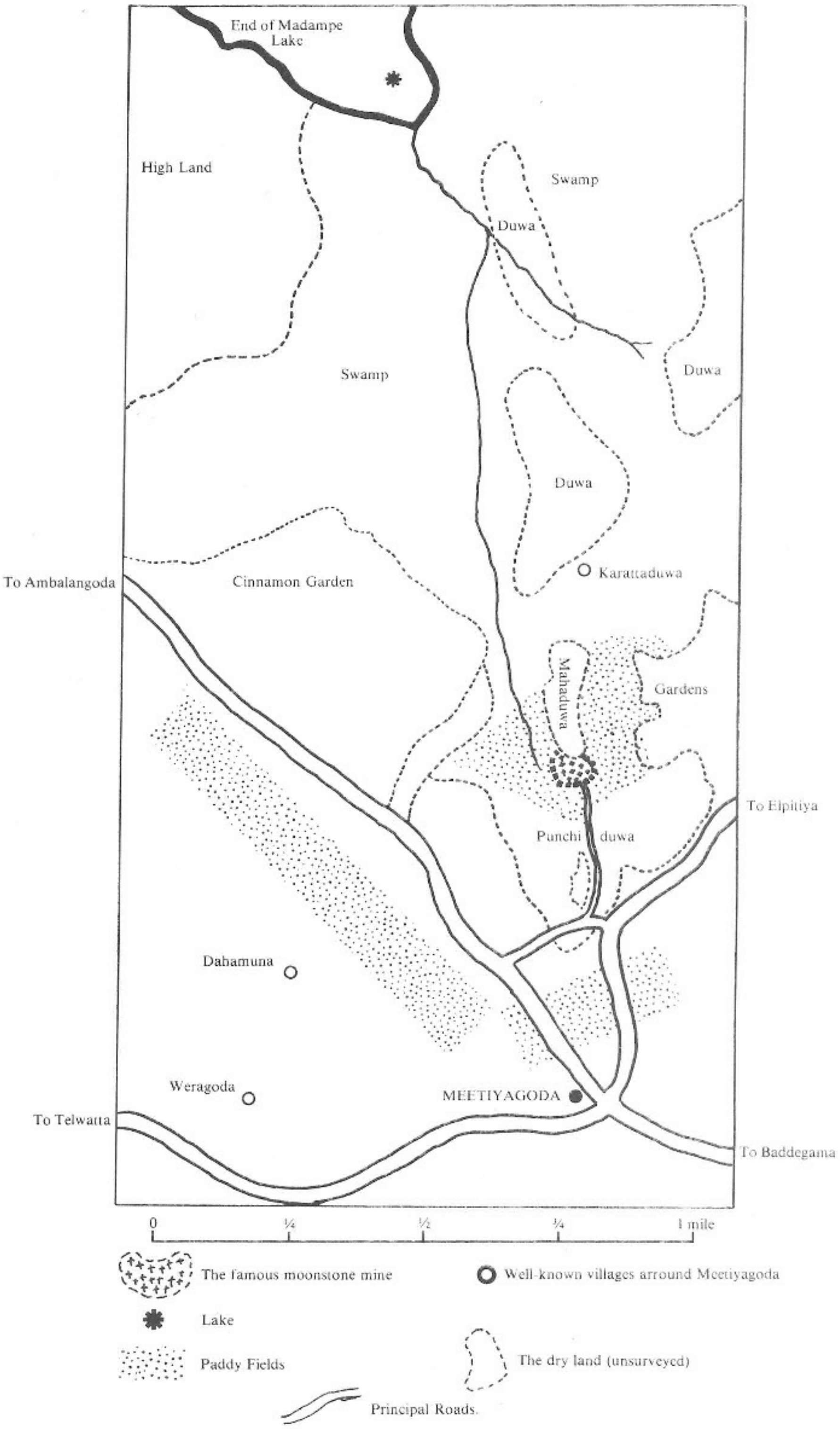
Schmetzer, K. (1981): Zur Mineralogie ternärer Oxide im System BeO-MgO-Al_2O_3. *Naturwissenschaften*, **67**, 471.

Schmetzer, K. (1983): Crystal chemistry of natural Be-Mg-Al-oxides: taaffeite, taprobanite, musgravite. *N. Jb. Miner. Abh.*, **146**, 15-28.

Teale, G. S. (1980): The occurrence of högbomite and taaffeite in a spinel-phlogopite schist from the Mount Painter Province of South Australia. *Mineralog. Mag.*, **43**, 575-7.

[*Manuscript received 21st December, 1982*]

Map 1. Plan showing the area near Meetiyagoda where the famous gem mines are located. *(M. Gunawardene)*



Map 2. Plan showing the moonstone, marcasite and pyrite occurrence at Meetiyagoda. In comparison with Map 1 the mining area is very small. *(M. Gunawardene)*

PYRITE AND MARCASITE OCCURRENCE IN SRI LANKA WITH SPECIAL EMPHASIS ON MEETIYAGODA GEM FIELD

By MAHINDA GUNAWARDENE, F.G.A., D.Gem.G.
Deutsche Gemmologische Gesellschaft, Idar-Oberstein, West Germany

INTRODUCTION

Gems have gained a significant position in the economic and social life of Sri Lanka during the past few years. The gem industry has yielded unprecedented fortunes to individuals' earnings as no other minor commodity had done before. Interest in gemstones and gemmology has gained recognition among trade and individuals. In recent years many new gem findings have been reported from the Island of Sri Lanka which have received world-wide interest (Gübelin, 1979; Gunawardene & Hänni, 1981; Zwaan, 1981; Hänni & Gunawardene, 1982 a & b).

In September 1981 the author visited the famous moonstone mine at Meetiyagoda near the south-west coast of the Island. Careful observations within the mines and the clay soil of the area revealed an occurrence of distinct minerals, such as pyrite, marcasite and feldspars adhering to the parent rock. The natives introduced the 'gold-like' material by the local term *diya rathran,* meaning 'water gold'. Dealers of the area have already made arrangements to trade this new material to foreign tourists at high prices as a rare gem of the country. The subject of this paper is the occurrence of pyrite and marcasite in Sri Lanka with special reference on these gem deposits at Meetiyagoda.

CHEMISTRY AND CRYSTAL STRUCTURE

Pyrite and marcasite are two structural modifications of similar chemical composition, FeS_2. Theoretically a weight percentage of about 46.6 iron (Fe) and 53.4 sulphur (S) are reported (Komotauer, 1981). Fe can be replaced by Ni, Co, or As, while Cu, Zn, Ag, Ti and Au may be present in very minute quantities as impurities. Samples from Sri Lanka showed the presence of S and Fe, and no impurities were detected on a larger scale by a chemical test under Energy-Dispersive X-ray Fluorescence (EDS-XRF).

The cubic mineral pyrite is more stable in structure than the rhombic marcasite. The former can commonly crystallize as

ISSN: 0022-1252 XVIII (7) 635 (1983)

hexahedron or cube {100}, pentagonal dodecahedron or pyritohedron {210}, octahedron {111}, or a combination of many cubic forms. About 60 different crystal forms of pyrite have been reported, including single and combined forms. It belongs to the *Diploidal class* $-2/m\ 3^-$ of the isometric system and shows a lower symmetry $3A_2$, $4A_3$, 3P and C (after Dana, 1944). This lower symmetry has resulted, due to oscillation during formation. Marcasite rarely shows pure single crystals. Combined crystals are common. The atomic structures of pyrite and marcasite are shown in Figures 1a and 1b respectively.

Since they are both of similar chemical composition, the environmental conditions can cause an epitactic growth of marcasite and pyrite. Material from Sri Lanka was confirmed as marcasite by x-ray powder diffraction. The resulting lines were compared with data from the PDF values. Beside the strong marcasite pattern, similar to PDF 3-799, a faint superimposed pyrite pattern was observed. This confirms that these two minerals may form intergrown aggregates of fine lamellar structure (see also Dana, 1944). Figures 2a and 2b show the twinning structures of marcasite on pyrite and pyrite on marcasite respectively. The externally visible features are shown in Figures 3a and 3b respectively.

PHYSICAL PROPERTIES

The appearance of pyrite and marcasite is almost similar. Both these opaque minerals show a metallic lustre with a yellowish body

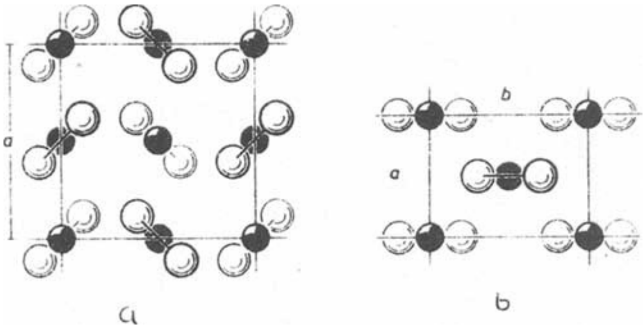


FIG. 1. Atomic orientation of (a) pyrite, parallel to the 4-diagonal directions of the cube, and (b) marcasite, parallel to 2-diagonal directions of the rhombic lattice projected at (001).

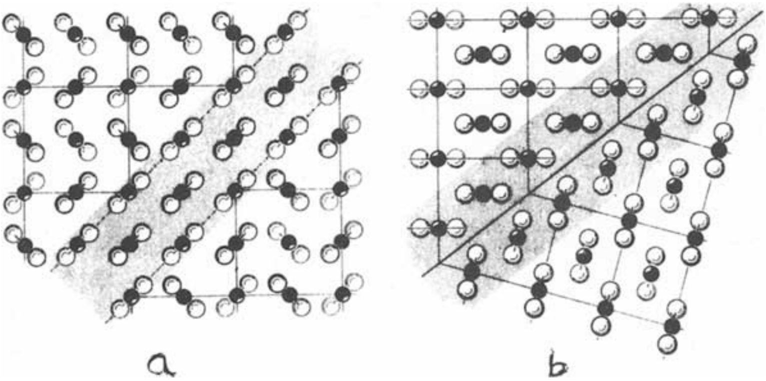


FIG. 2. Twinning of (a) marcasite on pyrite and (b) pyrite on marcasite. The twinning plane is indicated with dotted background.

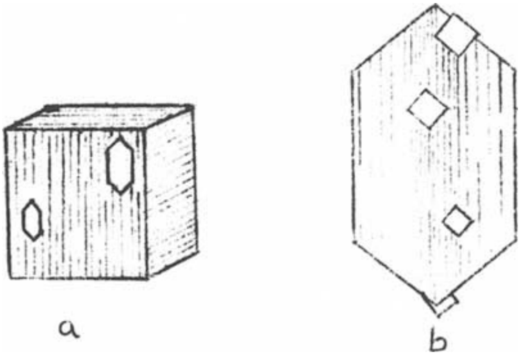


FIG. 3. External appearance of twinning of (a) marcasite on pyrite and (b) pyrite on marcasite.

colour. The specific gravity determination of few samples from this new discovery in Sri Lanka, under controlled conditions, gave values between 4.95 and 5.15. On comparing these with literature values the difference was insignificant.

GEOLOGY

The most abundant and wide-spread sulphide mineral is pyrite. Though it is a well-known hydrothermal mineral its occurrence in pegmatites, in sedimentary beds and even in contact metamorphosed zones is not a rarity. In Sri Lanka pyrite and marcasite occur in quartz veins (at Ragedara), in pegmatites (the Galle group of rocks including Meetiyagoda) and in limestone (at Timbalketiya). These occurrences were neglected by the natives until the new find at Meetiyagoda.

A classical place of moonstone occurrence is Meetiyagoda, located about 6.8 km east of Ambalangoda in the southern province of the Galle district (Gübelin, 1968). The locality is in a large area of swampy land at about sea level continuing into Madampe Lake, 3.4 km to the north, known as Dahamuna near the village of Weragoda (Map 1).* The hard dry land masses in the swamp are known as *duwas* (islands) by the natives. Cultivation of cinnamon and coconut is carried out in the *duwas,* and the swamps are used for paddy cultivation during the dry season. The whole of the commercially important gem mining is carried out on a small *duwa* adjoining the swamp (Map 2).* The gemmy area is under dispute among the land owners, giving rise to many law-suits, settlements of which are still unknown.

Geologically the area is well known for clay minerals, particularly kaolinite, montmorillonite and the micaceous clay minerals. Associated with the clay minerals are a large number of accessory minerals, which have an important influence on the properties of the clays in which they occur. They include the hydroxides of aluminium (gibbsite—$Al(OH)_3$; boehmite, γ-AlO.OH, and diaspore, α-AlO.OH). Quartz, feldspar, mica, pyrite, marcasite, rutile, ilmenite, monazite, zircon, tourmaline, garnet, calcite and dolomite are the other minerals found in this wet-zoned clay deposit (Geological Survey, 1982). Rare occurrences of corundum and spinel are reported from this area (Parsons, 1907).

MINING METHODS

The gem bearing gravel is reached by sinking 20 to 30 metres deep pits in the swamp. The methods are still primitive, and modernization would not be profitable where the gemmy area is concerned. Private traders own the whole mining operation, and the cutting is done in Galle, which is not far from the original locality. The sifting and washing of the gemmy gravel are shown in Figures 4 and 5.

---

*Maps 1 and 2 are inset between pp. 636 and 637.—Ed.

FIG. 4. Vertically sunk pit mining at Meetiyagoda. *(Photo: M. Gunawardene.)*

FIG. 5. The milky colour of the river after washing the gem-bearing clay gravel. *(Photo: M. Gunawardene.)*

ACKNOWLEDGEMENTS

The author is grateful to Dr H. A. Hänni, F.G.A., of the Mineralogical Institute, University of Basel, and to Mr Athula Mudunkotuwa, of the Geological Survey Department of Sri Lanka, for EDS-XRF analysis and valuable documentation respectively: and last, but not least, to Mr J. R. H. Chisholm, F.G.A., for his valuable suggestions made on the maps.

REFERENCES

Dana, J. D. & Dana, E. S. (1944) *The System of Mineralogy,* vol. 1, 7. John Wiley and Sons, New York.

Geological Survey Department. (1982) Personal communications.

Gübelin, E. (1979) Neue Edelsteine aus Sri Lanka. *Z.Dt.Gemmol.Ges.,* **28**, 4, 194-6.

Gübelin, E. (1968) *Die Edelsteine der Insel Ceylon,* Gübelin, Lucerne.

Gunawardene, M. & Hänni, H. A. (1981) First Occurrence of Gem Sphene in Sri Lanka. *J.Gemm.,* **XVII**, 6, 381-5.

Hänni, H. A. & Gunawardene, M. (1982 a) Ferroaxinite—Another New Gem from Sri Lanka. *J.Gemm.,* **XVIII**, 1, 20-7.

Hänni, H. A. & Gunawardene, M. (1982 b) Untersuchungen an Titanit, einem für Sri Lanka neuen Edelstein. *Z.Dt.Gemmol.Ges.,* **31**, 1/2, 65-70.

Komotauer, S. K. (1981) Pyrit und Markasit, FeS_2. *Mineralien Magazin,* **5**, 11, 484-96.

Parsons. (1902) *Mineral Survey.* Geological Survey Dept., Colombo, Sri Lanka.

Powder Diffraction File, (1974) published by Joint Committee on Powder Diffraction Standards. International Center for Diffraction Data, Swarthmore, Pa 19081, U.S.A.

[*Manuscript received 28th August, 1982.*]

A NEW GEM HOLDER

By Dr ROBERT M. YU, F.G.A., G.G.

Physics Dept., University of Hong Kong

Gem holders incorporated in gemmological microscopes are usually crocodile clips. They cover parts of the gem from view and tend to squeeze out the gem. This article describes a new G-clamp type gem holder which does not have the shortcomings of the conventional gem holders. Moreover with this new holder a round brilliant stone may be held by its table and culet so that its girdle may be observed through 360° without taking it out of the holder.

The construction of the new gem holder is schematically shown in Figure 1. To mount a gem the plunger (P) is pulled back by pulling the knob (K). After the gem has been put in place, (K) is released. The spring (S) will press the plunger (P) and the gem securely against the G-clamp base (B). If the gem is held between its table and culet, as shown in Figure 1, all parts of the girdle may be successively brought into view by holding the G-clamp steady and rotating the knob (K) through 360°. The gem will follow the plunger (P) and rotate about its axis. Figure 2 is a photograph of a diamond held by its table and culet. Figure 3 shows an oval cut ruby held by its girdle.

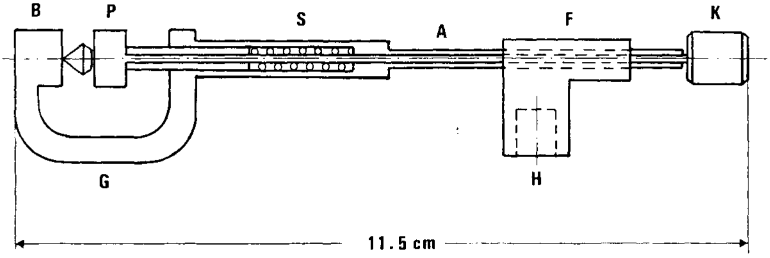


FIG. 1. Sketch of the gem holder.

ISSN: 0022-1252 XVIII (7) 641 (1983)

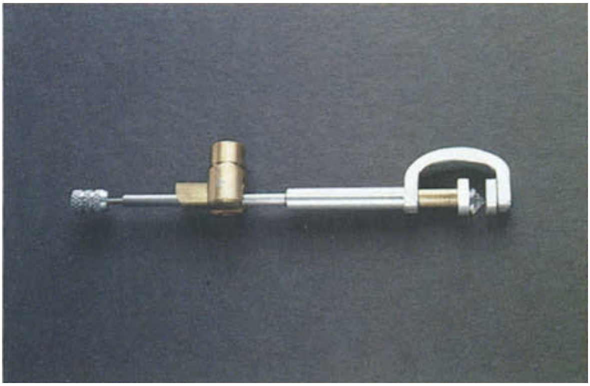


FIG. 2. Photograph of the gem holder holding a diamond by its table and culet.

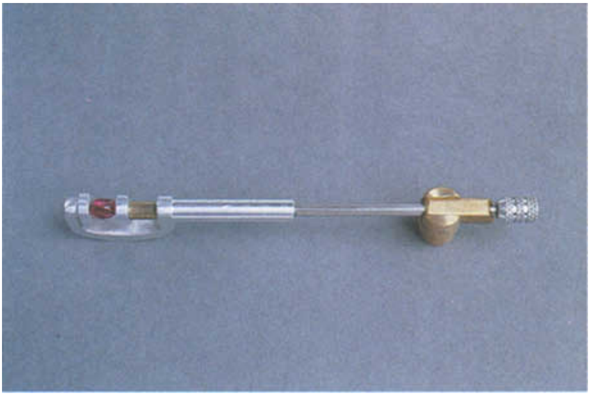


FIG. 3. Photograph of the gem holder holding an oval cut ruby by its girdle.

The arm (A) of the gem holder can slide in the fulcrum (F) which has a hole (H) to fit snugly on to a protrusion on the microscope stage. The fulcrum (F) also allows the gem holder to tilt up or down, but this mechanism is not shown in Figure 1.

[*Manuscript received 26th October, 1982.*]

THE GEMTEK GEMMOLOGIST—A TEST REPORT

By PETER G. READ, C.Eng., F.G.A.

Since my test report(1) on the Ceres DiamondProbe, which appeared in the *Journal of Gemmology* three years ago, many different versions of this type of instrument have been marketed, all of them exploiting the unique thermal properties of diamond as a means of distinguishing it from its various simulants.

While it has been claimed that these instruments indicate the degree of thermal conductivity of a stone, and although they have generally been described as thermal conductivity testers, there is both practical and theoretical evidence to support the idea that they are actually measuring thermal inertia.(2)

With the possible exception of the Ceres DiamondProbe, all of these instruments depend on the thermal energy from a probe tip being conducted through the stone under test into either a metal heat sink plate (for unmounted stones) or into the metal surround of the gemstone mount. This mode of operation is probably the reason for their classification as thermal conductivity testers.

In the case of the Ceres model, the provision of a sizeable panel meter makes it possible, with care, to differentiate not only between diamond and its simulants, but also between some of the simulants themselves. It is also possible, again with care, to detect differences in the meter readings for rolled gold, electroplated nickel silver/9 carat gold, 22 carat gold, 24 carat gold and sterling silver (other instruments such as the Rayner Diamond Tester can be calibrated against sample materials and used as comparators in the same way). Because of the variables of ambient temperature and sample size/temperature manufacturers of thermal gem testers are, however, reluctant to promote these less reliable test possibilities.

More recently, in the Gemtek 'Gemmologist' thermal tester (Figure 1), an attempt has been made to exploit the even smaller thermal differences between the non-diamond gems as a method of identifying them. To put the technical difficulties of such a feat into perspective, it is worth recalling that the thermal conductivity of diamond ranges from 1000 W/m/°C (for Type I material) to 2600 W/m/°C (for Type II material). The thermal conductivities of

ISSN: 0022-1252 XVIII (7) 643 (1983)

FIG. 1. The Gemtek 'Gemmologist'. Later models have the 'temp' and 'range' pre-sets accessible at the front edge of the control box.

diamond simulants, including both natural and man-made stones, range from 1.0 for glass to 40.0 for sapphire, and their separation from diamond is relatively easy.

What the 'Gemmologist' attempts, in addition to the relatively simple task of distinguishing between diamond and its simulants, is to differentiate thermally between gems having thermal conductivities in the much more limited range of 1.0 to 40.0 W/m/°C.

One of the problems associated with the design of thermal gem testers is the difficulty of producing reliable results over a wide range of both ambient and stone temperatures. With some testers this problem is minimized by the manufacturers, who specify a limited temperature operating range for the instrument and instruct the user to make the test with the gem raised to body temperature. Others have chosen room temperature as the test baseline, and stipulate that the gem's temperature is first stabilized by immersing the stone in room-temperature water. Still other manufacturers have chosen to increase the temperature of the probe tip to a point where the ambient and stone temperatures have much less effect on the test results. Unfortunately, this latter remedy can also result in burns to the skin, and may even damage some heat-sensitive gems.

With diamond-only thermal testers, perhaps the best test for reliability is to check whether the instrument will differentiate between a small diamond at body temperature and a large sapphire at room temperature (over a range of 18 to 25 °C), corundum being the nearest in thermal conductivity to diamond (40 W/m/°C).

As a further safeguard when using these instruments, particularly the less sophisticated ones, they are best treated as comparators, and their calibration checked against a known diamond and sapphire before each test.

In order to reduce the even more serious problems associated with detecting the differences between gems having thermal conductivities in the range 1.0 to 40.0 W/m/°C, the 'Gemmologist' uses a high test tip temperature, and requires that stones are first raised to near body temperature and tested within a limited ambient temperature excursion of ±3 °C. (The unit is factory-calibrated for operation over a range of 18 to 24 °C, but can be re-calibrated to suit individual operating environments). One other requirement is that the probe tip is applied at right-angles to the test surface with a constant pressure.

MEASURING TECHNIQUE

The method of operation of the Gemtek 'Gemmologist' is similar to that used in other thermal testers in that the instrument detects the temperature drop in a heated probe tip when this is applied to the surface of a gemstone. The technique of translating this temperature drop into a digital reading is, however, unique.

After the probe tip touches the gemstone, an internal circuit detects when the temperature of the tip has dropped to an initial pre-determined level. At this point a green signal lamp is extinguished and the output of an oscillator is switched into a counter/panel display unit. When the temperature of the probe has dropped to a second pre-set level, the output of the oscillator is switched off, a bleep note is sounded and the digital panel meter displays the total number of cycles of oscillation which have occurred between the initial and second temperature points. In effect, the instrument measures and displays the time taken for the probe tip temperature to fall from one pre-set level to another.

The operating temperature of the probe tip is set by means of a 'temp' adjustment, and the lower of the two temperature switching points is set by means of a 'range' adjustment. Both of these are accessible (in later versions of the instrument) as pre-set adjustments through the front edge of the control box, and instructions are provided which enable them to be set to suit individual operating environments.

OPERATING MODE

When the unit is first switched on, there is a warm-up period of between 30 seconds and 5 minutes (depending on calibration and ambient temperature). When the probe tip has reached its correct operating temperature, a green signal lamp lights. The 'reset' button is then pressed to set the counter display to zero. When making a test, the probe tip is applied to the gem's surface at right-angles and with sufficient pressure to retract the spring-loaded tip by about 1/32 of an inch. When the green lamp extinguishes, and the counter has completed its cycle count, the internal bleeper is pulsed and the number on the digital counter display indicates the relative thermal conductivity of the gem (a low number indicates high thermal conductivity).

Before the next test is attempted, the test probe must first be allowed to reach its operating temperature again (as indicated by the green lamp being energized) and then the 'reset' button is pressed to set the display to zero.

If the red 'too hot' lamp lights in between tests, the manufacturers advise that this can usually be ignored. However, if the red lamp has been on for more than five seconds, then the probe tip should be cooled by blowing on it gently until the red lamp just extinguishes. Too much cooling will also extinguish the green lamp, and further testing cannot begin until this lamp is energized again.

The manufacturers recommend that unmounted stones, or stones in lightweight mounts, should be tested on a metal heat sink or held in metal stone tongs or pliers. They also suggest that for best results the unit should be left switched on all day.

TEST RESULTS

The results of tests made with a range of gemstones and gem materials are given in Tables 1 to 3. The unit was calibrated before the sequence of tests in accordance with the 'User Calibration Instructions'. At the start of each set of ten tests, the sample was first raised to near body temperature by holding it in contact with the wrist for 30 seconds (as recommended by the manufacturers). The sample was then tested ten times in succession, with just sufficient pause between each test to allow the green lamp to light, but not the red one. The size of the stones tested varied from 0.75 carat to 4 carats (tests carried out over a larger size range showed that this factor did not affect the results).

TABLE 1—Gemtek Test Readings

	Sample					
Test No.	Diamond	Ruby	Sapphire*	Sapphire†	Blue Topaz	Blue Spinel
1	28	44	44	52	57	78
2	21	36	46	52	49	68
3	23	44	52	48	46	68
4	21	42	47	47	56	75
5	25	39	52	52	57	67
6	26	42	52	50	51	70
7	28	41	45	47	59	68
8	18	39	47	45	61	70
9	18	42	44	45	62	70
10	24	49	49	47	57	67
Average	23.2	41.8	47.8	48.5	55.5	70.1
Quoted Range	15-35	40-60	40-60	40-60	55-75	60-100

*Heat-treated (surface diffused) †Non heat-treated

TABLE 2—Gemtek Test Readings

	Sample					
Test No.	Gilson Emerald	Natural Emerald	Peridot	Blue Tourmaline	Aquamarine	Garnet
1	76	183	150	170	158	182
2	83	198	150	168	138	282
3	81	183	155	168	154	218
4	83	178	155	178	157	282
5	68	168	178	178	189	308
6	78	188	168	150	184	280
7	71	168	155	155	182	280
8	74	180	139	150	154	280
9	83	178	155	150	139	280
10	81	183	168	150	182	283
Average	77.8	180.7	157.3	161.7	163.7	267.5
Quoted Range	80-100	150-300	115-170	110-180	130-300	175-300

TABLE 3—Gemtek Test Readings

	Sample					
Test No.	Cubic Zirconia	Glass	Plastic	Aluminium	Sterling Silver	24 carat Gold
1	355	Off scale	No test	20	21	30
2	398			20	22	28
3	480			18	20	25
4	680			15	22	25
5	Off scale*			20	20	28
6				20	21	30
7				18	23	28
8				20	23	25
9				20	23	28
10				20	23	25
Average	—	—	—	19.1	21.8	27.2
Quoted Range	300-off scale	—	—	—	—	—

*Reading climbing as sample warms up under test.

† Insufficient heat transferred to initiate test.

Similar tests were made with aluminium, sterling silver and 24 carat gold. Although the 'User Instructions' indicate that heat-treated stones are likely to read 10 to 15 points higher than non heat-treated stones, this claim could not be confirmed with the limited number of samples available.

Further tests emphasized the importance of raising the test material to body temperature, particularly in the case of medium to poor thermal conductivity samples. Garnet, for example, varied from 258 at body temperature to 128 at 23 °C, and cubic zirconium oxide varied from 800 to 250. With corundum it was especially important to raise the stone's temperature above ambient to prevent it from producing a reading in the diamond range.

In contrast, high thermal conductivity materials, such as diamond and the metals, produced virtually the same results at both body temperature and ambient temperature (23 °C).

CONSTRUCTION

The unit is housed in a moulded 2-section plastic box whose dimensions are 110 × 190 × 90 mm. The probe is permanently connected to the control box, and the electronic/electrical components, including a bleeper unit, a voltage regulator, six transistors and eight integrated circuits are all mounted on a well made printed circuit board (Figure 2). The instrument is mains-operated via a plug-in 220/240 V, 50Hz adaptor.

CONCLUSIONS

During tests, the Gemtek 'Gemmologist' was able to separate ruby from garnet, aquamarine from blue spinel and topaz, and sapphire from blue tourmaline. It could also distinguish between natural emerald and flux-melt emerald.

In common with the reflectivity meter, however, many of the other gems had readings which overlapped each other, either because of the inherent thermal conductivity of the stones, or because of repeatability errors in the test results (see Tables 1 to 3).

For gems with an RI less than 1.81, the standard refractometer undoubtedly provides a more precise means of identification. However, for diamonds, diamond simulants, and for very small non-diamond gems, particularly those mounted in such a way as to make it impossible to check them either with a refractometer or on

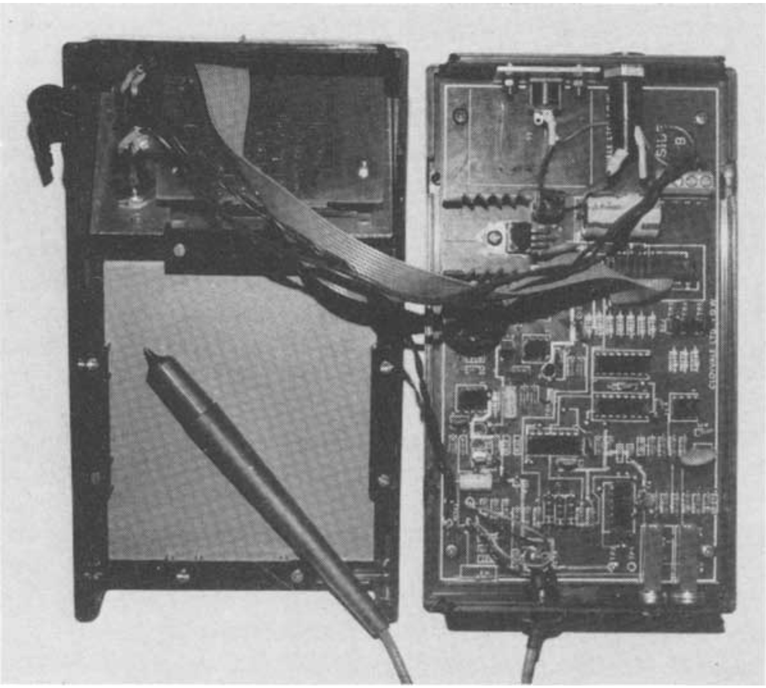


FIG. 2. An interior view, showing the various components mounted on the printed circuit board. The test probe can be seen lying in the left-hand section of the control box. The two calibration pre-sets at the lower right corner of the printed circuit are accessible to the user in later models.

a reflectivity meter, the 'Gemmologist', with its small probe tip, can provide additional identification data.

Although the instrument has been designed for use by non-gemmologists with a limited knowledge of gem materials, this is perhaps the type of user for whom the instrument's specialized operating requirements could easily produce misleading results.

REFERENCES

1. Read, P. G. Thermal Diamond Probes. *J.Gemm.*, 1980, **XVII** (2), 85-94.
2. Hoover, D. B. The Thermal Properties of Gemstones and their application to Thermal Diamond Probes. *J.Gemm.*, 1982, **XVIII** (3), 229-39.

[*Manuscript received 23rd September, 1982.*]

GEMMOLOGICAL ABSTRACTS

AMMERLAAN (G.). *De veelbezongen kracht van de Smaragd.* (The great power of the emerald.) Chronos, **32**, 11, 22-6, 7 figs (3 in colour), 1982.

A summary of the properties, recovery and use of emerald, with some notes on its synthesis. M.O'D.

ARGUNOV (K. P.), ZUEV (V. M.), NIKIFOROVA (T. M.), PRISHCHEPA (V. I.). *Korrozionnaya i regeneratsionnaya skul'ptura kristallov almaza.* (Corrosion and regeneration sculpture in diamond crystals.) Mineralogicheskii Zhurnal, **4**, 3, 66-70, 1 fig, 1982. (In Russian, with English abstract.)

Intense corrosion has been observed on coloured small individual crystals and on the facets (distinguished by a reduced structural density) of large diamonds, whereas the colourless forms of isometric aspect have been more subject to regeneration.

	Crystal Habit, %	
Macrodefects	*Octahedral*	*Rhombdodecahedral*
Graphite inclusions	43.5	51.8
Smoky-cinnamon colour	16.6	33.8
Etch canals	6.4	13.6
Shagreen sculpture	0.3	10.8
Split diamonds	24.6	31.6

	Number of crystals	*Sculpture, %*	
Crystal form	*examined*	*Regeneration*	*Corrosion*
Octahedra	527	26.0	15.0
Rhombdodecahedra	41	34.0	22.0
Colourless slivers	1065	47.7	30.0

D.A.B.

BALFOUR (I.). *The 'Wittelsbach' diamond.* Indiaqua, 32 (1982/II), 135-7, 7 figs, 1982.

A history of the 35.50 carat blue diamond known as the Wittelsbach, which is of Indian origin and has been thought to be from the same rough as that which yielded the 44.50 carat Hope diamond. This, however, is unlikely. It is now in private ownership. R.K.M.

BALFOUR (I.). *The 'Williamson Pink' diamond (Famous diamonds of the world, XIV).* Indiaqua, 33 (1982/III), 125-8, 10 figs, 1982.

An account of the finding of this rare stone, its ultimate presentation by Dr Williamson to the then Princess Elizabeth, and its cutting to a perfect 23.60 carat brilliant and mounting in a brooch in the form of a stylized jonquil. R.K.M.

BALL (R. A.). *Precious opal from New Zealand.* Aust. Gemmol., **15**, 1, 12-16, 12 figs (2 in colour), 1 map, 1983.

Investigates three specimens of jelly and milk opal from site on the Coromandel Peninsula, North Island. Electron micrographs confirm structure as that of opal from a volcanic locality. [Expression 'crystal opal' is used; this needs explaining since it is not recognized terminology.] R.K.M.

BANK (H.). *Durchsichtiger geschliffener goldgelber Mellit.* (Transparent cut gold-yellow mellite.) Z.Dt.Gemmol.Ges., **31**, 4, 281-2, bibl., 1982.

A cut golden yellow mellite is described with its properties. Unfortunately the stone is unsuitable for commercial use because of its softness (Mohs hardness = 2), which also made cutting very difficult. E.S.

BERKOWITZ (R.). *Lab Report on Spectroscopes.* Can. Gemmol., **1**, 4, 27-9, N.D. [1977].

A comparison of three hand-held prism spectroscopes—Beck, Zeiss Jena, and Carl Zeiss (W. Germany). All were good, specific reading with the Beck being slightly easier. Price and availability also recorded. J.R.H.C.

BERKOWITZ (R.). *Pleochroism and the Dichroscope.* Can. Gemmol., **1**, 2, 6-8, 1976.

The subject simply explained, with a cautionary tale of a lady who bought an andalusite ring while she was wearing polaroid sunglasses. J.R.H.C.

BOYD (F. R.). *Predicting the occurrence of diamondiferous kimberlites.* Indiaqua, 33 (1982/III), 31-4, 10 figs, 1982.

Suggests methods of predicting content of diamond by mineralogical examination of peridotite nodules in kimberlite. R.K.M.

BRACEWELL (H.). *Random ravings at the 'Range'.* Wahroongai News, 9-12, November, 1982.

Local advice and comment resulting from a trip to the remote Harts Range gem area. R.K.M.

BRACEWELL (H.). *From Mt Isa to 'the Centre'.* Wahroongai News, 13-14, November, 1982.

Continues the travelogue of the Bracewell 'Round Australia' rock-hunting and fossicking trip, covering the route from Mt Isa to Alice Springs via Mt Oxide (azurite) and Tennant Creek (gold, silver and copper). These are valuable accounts for anyone contemplating such a trip into the desert out-back of central Australia.
R.K.M.

BRACEWELL (H.), BROWN (G.). *Harts Range hessionite.* Aust. Gemmol., **15**, 1, 6-10, 6 figs, 1983.

Hessonite from Sri Lanka and from Ontario compared with a stone from an unidentified new source in the Harts Range, Northern Territory. Inclusions are markedly different from the 'sugary' Sri Lankan material. [There is no etymological justification for the incorrect spelling of hessonite adopted throughout this paper.]
R.K.M.

BROWN (G.). *Coloured diamonds.* Wahroongai News, 13-21, 10 diagrams, October, 1982.

A summation of known facts gathered from various written sources. Includes lists of natural and artificially induced colours together with diagnostic criteria.
R.K.M.

BROWN (G.). *Lapis Lazuli.* Wahroongai News, **17**, 1, 5-10, January 1983.

An exhaustive summary of facts regarding this ornamental blue gem rock. SG range is almost certainly too broad. Some typographical errors, e.g. lazulite where lazurite is obviously intended. [Lazulite is an entirely unrelated phosphate. Lazurite is the principal constituent of lapis lazuli.] R.K.M.

BURROW (D.). *Arkansas quartz crystal mining.* Lapidary J., **36**, 10, 1758-60, 7 figs, 1983.

Personal account of mining for quartz in the state of Arkansas during the present century. M.O'D.

BURTON (J.). *Gemfari with the Miltons.* Wahroongai News, 23-4, November, 1982.

A journey by mini-bus of a party of nine from Brisbane to Chinchilla (petrified wood), Cheepie (opal), Quilpie, Augathella and over the Drummond Ranges to Sapphire (corundum), on to Mt Hay (thunder eggs), Marlborough (chrysoprase), Windera (agates) and back via Gympie. R.K.M.

CASSEDANNE (J.-P.). *Les agates de type Umbu.* (Umbu agates.) Revue de Gemmologie, 73, 5-8, 10 figs, 1982.

Umbu is the name given to certain Brazilian agates from the Rio Jacui in Porto Alegre. The methods of recovering the agates are described; most of them are sent for staining. M.O'D.

DAVIES (G.). *Diamond in science.* Indiaqua, 32 (1982/II), 125-9, 10 figs (unnumbered), 1982.

An explanation in easily understood terms of some of the unique properties of diamond. R.K.M.

FIELD (D. S. M.). *An Introduction to Gemmological Microscopy.* Can. Gemmol., **1**, 3, 6-10, 6 figs, N.D. [1977]; **1**, 4, 11-13, 1 fig., N.D. [1977]; **2**, 2, 2-8, 9 figs, N.D. [1978].

An admirable introduction, intended to describe the fundamental principles of optics as applicable to the loupe and the microscope simply, accurately and with minimal mathematics. Though Part III ended with the words 'to be continued', no more was published. J.R.H.C.

FRANCIS (P.). *Gem olivine from Afghanistan.* Lapidary J., **36**, 9, 1596-7, 1982.

Olivine is said to come from the area of Galicha, Afghanistan (the name most recently spelt Galeh Cha). This account is not based on a personal visit to the area but on sources in the literature and on the occurrence of olivine beads on the Iranian market. M.O'D.

FRÈRE (A.). *Beobachtungen an Altschliff-Diamanten.* (Reports on old cut diamonds.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 18-31, 14 figs, 1982.

An extensive report on the numerous cuts used for diamond in the past. M.O'D.

FRYER (C.), ed., CROWNINGSHIELD (R.), HURWIT (K. N.), KANE (R. E.). *Gem Trade Lab Notes.* Gems & Gemology, **XVIII**, 4, 228-33, 21 figs (15 in colour), 1982.

A yellow-green 'chameleon' diamond which changed to orange yellow when heated; a diamond with a cross etched on its table; another with long 'fringes' of short needle-like inclusions; and a burnt diamond in which pavilion facet edges appeared dark, are all described and illustrated. Another yellow diamond had a very faint 5920Å absorption, which proved it to be a treated stone; its LWUV colour was strong yellow. A fine 6 ct Zambian emerald had an absorption line at 4270Å, which seems to occur in these and in Pakistani stones *and* in iron-rich Gilson synthetic emeralds. Zambian emeralds have very high RI (1.585-1.592) and are almost inert under UV light.

Parisite, which, although not itself a gem mineral, is associated with Muzo emeralds and has a very striking and distinctive absorption spectrum, is discussed at length but the spectrum illustrated has been confused with siderite and is incorrectly titled. A large blister pearl was x-rayed and found to have been plugged. A star quartz with heavy rutile silk was thought to be from Sri Lanka; a brilliant orange-yellow natural sapphire was proved to have been heat-treated; another yellow sapphire which had faded in daylight may also be a heat-treated stone, although such behaviour is usually considered to indicate yellowing by x-radiation cobalt. For some reason the sapphire (purple-blue) is accepted as natural while the spinel (blue) is doubted on the grounds that cobalt coloured blue stones cannot occur in nature [they are normally pink]. This report is largely conjecture.

Grey-purple star spinel with both six and four-rayed stars; a man-made lithium fluoride with an intricate isometric pattern of inclusions, are described and illustrated. Another man-made fragment of potassium chloride is also described although hardly a gem species. R.K.M.

FUMEY (P.). *Orapa.* Revue de Gemmologie, 73, 9-11, 9 figs, 1982.

An account of the Orapa diamond pipe in Botswana. M.O'D.

GEISLER (R. A.). *The Ruby Deposits of Fiskenaesset, Greenland.* Can. Gemmol., **1**, 2, 4, 1 map, 1976.

Ruby deposits have been found at Fiskenaesset, SW. coast of Greenland, in a huge layered igneous intrusive complex, first observed by the Geological Survey of Greenland, associated with sapphirine, pargasite, gedrite, cordierite, kornerupine, phlogopite, enstatite, spinel, zircon and pyrope garnet. The rubies range to 3 inches across, varying from light pink to dark red, some with a slight violet cast. J.R.H.C.

GESCHWENDT (F.). *Ein Jadesammler und sein Katalog.* (A jade collection and its catalogue.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 84-7, 4 figs, 1982.

The jade collection of Heber R. Bishop and its catalogue are described. M.O'D.

GONTHIER (E.). *Les outils en jade de Nouvelle-Guinée. Part 1.* (Jade artefacts from New Guinea.) Revue de Gemmologie, 73, 12-14, 5 figs (3 in colour), 1982.

The term jade is loosely given to more than one mineral worked in New Guinea. Serpentines and quartzites are used for the manufacture of ceremonial and other objects. M.O'D.

GOODGER (W. D.). *Ruby with Kornerupine and Associated Minerals from Greenland.* Can. Gemmol., **1**, 2, 2-3, 1976.

Rock from Fiskenaesset, Greenland, contains ruby, kornerupine, pargasite, sapphirine, gedrite, cordierite, phlogopite, and spinel. It did not contain rubies of sufficient size/quality for economic cutting. Potential for gems in Greenland appears high. Tugtupite also mentioned. J.R.H.C.

GOODGER (W. D.). *Tsavorite.* Can. Gemmol., **1**, 1, 9-10, 2 figs, 1976.

A description of tsavorite [now properly called tsavolite] with two photomicrographs of inclusions. J.R.H.C.

GRAY (R.). *The Geology of the Fiskenaesset area.* Can. Gemmol., **1**, 2, 5, 1976.

The area in SW. Greenland is underlain by Precambrian gneisses with remnants of anorthosite and ultramafic rocks. Interbanded anorthosite, amphibolite, peridotite and norite occur as horizons up to 2 km wide, conforming with the gneisses' banding: intensely folded, reconstituted by granulite facies metamorphism, and affected by later retrograde metamorphism. Some doubly-metamorphosed anorthosite-norite rocks contain sapphirine, and related rocks contain hornblend, pyroxene, corundum, cordierite, spinel. Ruby occurs as subhedral to fractured euhedral crystals pseudomorphing sapphirine laths. J.R.H.C.

GÜBELIN (E.), SCHMETZER (K.). *Gemstones with alexandrite effect.* Gems & Gemology. **XVIII**, 4, 197-203, 5 figs (3 in colour), 1982.

Colour-change gems include chrysoberyl (alexandrite), garnets, sapphire, and, more rarely, spinel, kyanite, fluorite and monazite. [A well-written paper, but some colour illustrations seem inaccurate, possibly because unnecessary blue backgrounds have been used.] R.K.M.

GÜBELIN (E.), SCHMETZER (K.). *Eine neue Edelstein-Varietät aus Tansania: Gelbe, grüne und rötlich-braune Apatit-Katzenaugen.* (A new variety of gemstone from Tanzania: yellow, green and reddish-brown apatite cat's-eyes.) Z.Dt.Gemmol.Ges., **31**, 4, 261-3, 4 figs in colour, 1982.

A new occurrence of apatite cat's-eyes from the Umba Valley, Tanzania. A small percentage of the stones was clear and transparent, but most had fine, fibre-like inclusions. These were cut en cabochon and showed a very good, clearly defined chatoyancy caused by small needles of goethite. E.S.

GÜBELIN (E.), WEIBEL (M.), WÜTHRICH (A.). *Elucidating the optical theory of asterism.* J.Gemm.Soc. Japan, **9**, 1, 18-21, 4 figs, 1982.

Chatoyancy is explained in terms of physical and geometrical optics. M.O'D.

GURNEY (J.). *Diamond riches in the rollers.* Wahroongai News, May, 15-16, 1982. 'Abstracted from Indiaqua No 26 (1980).'

Discusses the contentions on the various trip concessions along the west coasts of South Africa and of Namibia. Shore concessionaires have rights to mine only to 100 feet below low-water mark. Low-water mark is a variable line open to many interpretations so the demarcation is nebulous. [The writer does not make it clear whether the 100 feet are in actual depth of water or 100 feet *beyond* the low-water line.]

Sea concessions allow vacuum dredging beyond this strip and are held by different companies. It is said that sea recovery by one company has produced 23 000 carats in six months. A figure of R500 per carat is put on this production. [An optimistic estimate?]

Origins of these diamonds are speculated upon. R.K.M.

HÄNNI (H. A.), STERN (W. B.). *Über die gemmologische Bedeutung des Gallium-Nachweises in Korunden.* (About the gemmological importance of the gallium inclusion in corundums.) Z.Dt.Gemmol.Ges., **31**, 4, 255-60, 1 graph, 1 table, 1982.

Twenty-four natural and eight synthetic corundums of different origins were investigated by energy-dispersive x-ray fluorescent analysis. All natural stones showed the presence of measurable Ga concentrations, while Ga was not detected in the synthetic stones. The use of this diagnostic feature is discussed in the light of general trace element investigations in gemstones. E.S.

HARRIS (J.). *Diamonds from Orapa or Brazil?* Indiaqua, 32 (1982/II), 35-8, 14 figs, 1982.

Describes classification of bulk parcels from individual mines by crystal form and colour. Shows that each mine has certain fairly constant percentages of each form/colour and suggests that the title question could ultimately be answered by such analyses. R.K.M.

HEALEY (D.), YU (R. M.). *Quality grading of corundum.* Lapidary J., **36**, 7, 1190-6, 3 figs, 1982.

An original and useful account of the methods used for grading ruby and sapphire at the Thai gem centre, Bangkok. Criteria in operation are discussed.

M.O'D.

HEALEY (D.), YU (R. M.). *Quality grading of jadeite.* Lapidary J., **36**, 10, 1670-4, 4 figs (1 in colour), 1983.

Various colours of jadeite are referred to the Munsell colour system with a view to establishing a system of grading. Both colour and clarity are assessed. M.O'D.

KANDA (H.), SETAKA (N.), OHSAWA (T.), FUKUNAGA (O.). *Growth condition for the dodecahedral form of synthetic diamonds.* Journal of Crystal Growth, **60**, 441-4, 1982.

A dodecahedral habit was observed in a synthetic diamond grown in molten nickel at high temperature and pressures when a small amount of water was added to the reaction cell. The (110) surface showed striations parallel to the <110> direction with some elongated ridges also present. M.O'D.

KAO (J. R.). *Taiwan's jade and lapidary transitions.* Lapidary J., **36,** 7, 1172-82, 11 figs, 1982.

A useful account with maps and analysis of nephrites, this piece describes the ornamental minerals to be found in Taiwan. M.O'D.

KATO (M.). (Main facet cutting angle.) J.Gemm.Soc.Japan, **9,** 1, 3-17, 21 figs, 1982. (In Japanese.)

Geometrical optics are employed to re-examine the optimum cutting angles between main facets of gemstones. M.O'D.

KELLER (P. C.). *The Chanthaburi — Trat gemfield, Thailand.* Gems & Gemology, **XVIII,** 4, 186-96, 14 figs in colour, 1982.

The geology, history and mining methods used to obtain ruby and sapphire in the Chantaburi and Trat region of SE. Thailand. Distinctions between these and corundum from Burma are given. Heat treatment to improve colour is discussed at some length and clues given for its detection. R.K.M.

KODAIRA (K.), IWASE (I.), TSUNASHIMA (A.), MATSUSHITA (T.). *High pressure hydrothermal synthesis of beryl crystals.* J. Crystal Growth, **60,** 172-4, 3 figs, 1982.

Beryl crystals were synthesized hydrothermally under a pressure of 10 kbar. Size of the crystals increased with rising temperature and reached 0.3 mm in length maximum. Shapes were hexagonal plates from pure water and hexagonal prisms from a solution of 0.1N NaOH. Infrared spectra were found as for the natural crystals. M.O'D.

KOIVULA (J. I.). *Tourmaline as an inclusion in Zambian emeralds.* Gems & Gemology, **XVIII,** 4, 225-7, 2 figs in colour, 1982.

Needles of dark dravite tourmaline identified for the first time in emeralds from an African source. R.K.M.

LIVSTRAND (W.). *Chantaburi, Thailand's sapphire centre.* Lapidary J., **36,** 7, 1224-30, 12 figs, 1982.

An account of sapphire mining, dealing and grading in Thailand. M.O'D.

MADDERN (D. T.). *Irradiation controversy on rubellite.* Wahroongai News, **17,** 1, 17-18, January 1983.

Discusses controversy which has arisen in America on whether fine Brazilian rubellite tourmaline from Ouro Preto has had its colour enhanced by irradiation. From evidence quoted it seems that this is unlikely in the case of recent finds of exceptionally good reds. Some other reds may respond to such treatment. It is suggested that irradiation might even reduce the colour to some extent. The view is expressed that the blue tourmaline (indicolite) is also free from the taint of this treatment by irradiation. [Nothing is said about heat treatment.] R.K.M.

MANSON (D. V.), STOCKTON (C. M.). *Gem quality grossular garnets.* Gems & Gemology, **XVIII,** 4, 204-13, 12 figs (mostly graphs), 1982.

A careful study of this sub-species which is now known to occur in colours varying from colourless through reddish-brown, orange, golden, yellow, light and dark green. An attempt is made to define tsavorite [tsavolite] more carefully.

R.K.M.

MATHUR (S. M.). *The diamond deposits of India.* Indiaqua, 33 (1982/III), 21-9, 31 figs, 1982.

A summary of the known and historic diamond areas in the subcontinent which identifies various kimberlites and diatremes [volcanic pipes in general] in Panna and Andhra Pradesh, reaching the conclusion that India's pre-eminent position as a diamond producer is lost for ever, but putting forward several valid suggestions for exploitation of likely river and coastal alluvial areas, which might prove to be profitable. R.K.M.

MILEY (F.). *Facts about diamonds.* Lapidary J., **36,** 9, 1534-44, 1982.

General overview of diamond, its recovery, cutting and pricing. M.O'D.

MOOR (W. F.), OBERHOLZER (W. F.), GÜBELIN (E.). *Taprobanite, a new mineral of the taaffeite group.* Schweiz.Mineral.Petrogr.Mitt., **61,** 13-21, 1981.

A mineral with hexagonal symmetry and belonging to space group $P6_3mc$ was claimed to be a new mineral from tests made on a cut gemstone. [Later study proved the mineral to have identical x-ray pattern and density, with optical properties, to those of taaffeite. The name taprobanite is deemed unnecessary.] M.O'D.

O'DONOGHUE (M.). *The dealer looks at gemstones—7.* Gems, **14,** 5, 15, 1982.

Discusses danburite from a Madagascar location (stones of a topaz colour); dark blue topaz and what to look for in the cutting of a stone.

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

O'DONOGHUE (M.). *Man-made gemstones.* Gems, **14,** 5, 16, 1982.

Discusses work in progress at the Royal Radar Establishment and an early book on crystal growth. (Author's abstract.) M.O'D.

PAGE (B). *The Diamond Rush.* Telegraph Sunday Magazine, 334, 18-24, 10 photos in colour, 1 map, 6th March 1983.

A well illustrated journalistic report by Bruce Page on the discovery in 1979 of diamonds in the Kimberley Ranges in the north of Western Australia and subsequent development by the Ashton Joint Venture, down to February 1982 when agreement was announced (subject to review in 5 years) between the Joint Venture and De Beers Central Selling Organisation that C.S.O. would take most of the gem diamonds and 75% of the 'near gems' and industrials, leaving the rest for direct marketing. [According to the Annual Report of the Rio Tinto-Zinc Corporation PLC for 1982, the mining and marketing proposals were approved by the Western Australian Government and commercial production commenced in January 1983: the diamond export sales agreement with C.S.O. completed on behalf of CRA Ltd and Ashton Mining Ltd (together holding 95% of the joint venture) provides for CRA and Ashton Mining to retain 25% of their share of lower value gems and industrial diamonds for open market sales independent of C.S.O. from mid-1984.]

J.R.H.C.

PEARSON (G.). *Seismic gem prospecting.* Aust. Gemmol., **15**, 1, 17-18, 1983.

Describes simple seismic prospecting and suggests that it could be useful in locating gemmiferous placer deposits. R.K.M.

PIENAAR (H. S.). *Gem quality friedelite from the Kalahari manganese field near Kuruman, South Africa.* Gems & Gemology, **XVIII**, 4, 221-4, 4 figs (2 in colour), 1982.

A rare cryptocrystalline chloro-manganese silicate, which has been found at one place in that area in rose-red to carmine, opaque to semi-opaque, material suitable for cabochon gems. R.K.M.

REYMER (H.). *Lab Reports.* Can. Gemmol., **1**, 1, 12-13, 1976.

Records colour-improved jade cabochons (revealed by spectroscope), Verneuil-type synthetic rubies with curved lines parallel to girdle, synthetic flux-grown rubies, distinction of green tourmaline from low zircon, plastic imitation conch pearl given away by 'molding mark on "back"'. J.R.H.C.

REYMER (H.). *Laboratory Reports.* Can. Gemmol., **1**, 2, 23, 1976; **1**, 3, 29, N.D. [1977].

(1) The importance of three-phase inclusions in Colombian emeralds as against two-phase inclusions in those from Brazil, Russian-grown synthetic citrine in the rough, and a 2 ct natural ruby apparently without flaws, showing what at 100× appeared to be a cloud of round bubbles but at 280× were clearly negative crystals, are mentioned. A 'spot' RI reading of 1.54 showed that what looked like a poor emerald or jadeite cabochon was a moss agate. A small green stone pronounced as chrysoberyl by a student after test was shown to be sapphire when the RI was read correctly—showing the danger of guessing and then making the tests fit. (2) An Australian sapphire doublet was given away by a fluorescent pavilion and a non-fluorescent table. J.R.H.C.

RISLING (M.). *The Diagnostic Value of Inclusions.* Can. Gemmol., **1**, 3, 2-5, 4 photomicrographs, N.D. [1977].

The first of a series, this contains Part 1, which, after a brief Introduction, covers the classification into Protogenetic, Syngenetic and Epigenetic, following Dr Gübelin. J.R.H.C.

RISLING (M.). *The Diagnostic Inclusions of Ruby and Sapphire.* Can. Gemmol., **1**, 4, 2-7, 5 photomicrographs, N.D. [1977].

Part 2 of the series on the *Diagnostic Value of Inclusions.* [Parts 3 and 4 were abstracted in J.Gemm., 1978, **XVI**, 2, 135 and 7, 481, respectively.] J.R.H.C.

RITCHIE (C.). *Making ivory jewellery—1.* Gems, **14**, 5, 32-6, 6 figs, 1982.

The various types of ivory are listed and the first stages in fashioning explained. M.O'D.

ROBINSON (R.). *Anakie gemfields—sapphire mining.* Wahroongai News, 17-21, 6 figs, November, 1982.

Mining and mining methods in this extensive field, which yields something less tnan 10% of its total corundum output as gem quality. Dark blues, parti-colours, greens and, rarely, yellows are found, also bronze stars. Red and brown zircons also are found in quantity. R.K.M.

ROTHSTEIN (J.). *Hydrophane.* Lapidary J., **36,** 9, 1490-514, 1982.

A description, with a good deal of historical material, of the hydrophane variety of opal. Special reference is made to occurrences in the United States. M.O'D.

ROTHSTEIN (J.). *The gem feldspars.* Lapidary J., **36,** 10, 1718-23, 1983.

Somewhat breathless account of the varieties of feldspar with possible ornamental application. A list of variental names (including commercial ones) is appended. M.O'D.

SCHMETZER (K.), BOSSHART (G.), HÄNNI (H. A.). *Naturfarbene und behandelte gelbe und orange-braune Sapphire.* (Natural and treated yellow and orange-brown sapphires.) Z.Dt.Gemmol.Ges., **31,** 4, 265-79, 4 figs in colour, 8 graphs, 2 tables, bibl., 1982.

Natural yellow and orange-brown sapphires owe their colour to trace elements (Fe^{3+}, Ti^{3+}, Cr^{3+}). Similar colour is achieved in synthetic stones with Ni^{3+} and Cr^{3+} and by an additional annealing process. With colourless and pale yellow sapphires similar colour can be obtained by irradiation or annealing, both processes generating colours which cause a continuous increase of light absorption from orange to the blue end of the spectrum. For commercial use, annealed stones can be considered colour-stable. Absorption of irradiated or heated corundums differs little from natural light yellow sapphires from Sri Lanka, apart from stronger absorption in the violet region. Inclusions in annealed yellow sapphires have the same characteristics as those in heated corundums of other hues. E.S.

SHEARER (J.). *Excerpts from the disclosure on his find in the Bancroft area of Ontario of a source of gemstone named "Trilliumite".* Can. Gemmol., **1,** 1, 10-12, 1976.

Records the finding and marketing under the trade-name 'Trilliumite' of blue-green facetable apatite. J.R.H.C.

SINKANKAS (J.). *Artistry in rock crystal: the Van Pelt collection.* Gems & Gemology, **XVIII,** 4, 214-20, 4 figs (3 in colour), 1982.

Describes the hollow rock-crystal faceted egg and a pair of vases designed and cut by this brilliant husband-and-wife team. R.K.M.

SNOW (J.). *An unusual stone.* Wahroongai News, 3-4, November, 1982.

A transparent purplish rough fragment with corundum constants was found to have a biaxial interference figure. After some confusion with possible [?] chrysoberyl, it was confirmed as corundum in a negative biaxial form. [Dana Ford says 'Often abnormally biaxial'.] R.K.M.

SPRINGER (P. G.). *The agates of Nova Scotia.* Lapidary J., **36,** 8, 1330-8, 16 figs (15 in colour), 1982.

Agates are found in the North Mountain range of Nova Scotia and can also be picked up on the shores of the Bay of Fundy. M.O'D.

STREIGHT (S. G.). *Letter to the Editor; Beilby Layer.* Aust. Gemmol., **15**, 1, 20, 5 (unnumbered) figs in colour, 1983.

Accompanied by five 'gemscapes' by R. F. Brightman, praises his *Surface Topography of Gem Crystals* (abstracted on p. 433 above), but criticizes his reference to the Beilby Layer and recommends reading of P. J. Crowcroft, *Demise of the Beilby-Bowden Theory of Polishing* (J.Gemm., 1981, **XVII**, 7, 459-66) for better understanding of the polishing process. J.R.H.C.

THORSSON (H.), RISLING (M.). *The Reflectancespectrophotometric Method of Colour-grading Diamonds.* Can. Gemmol., **1**, 4, 8-10, N.D. [1977].

A comparison of the efficiency in colour-grading diamonds of numerous human subjects and the most advanced colorimeter on the one hand with that of the reflectancespectrophotometer on the other left no doubt of the great superiority of the reflectancespectrophotometer. J.R.H.C.

TOMBS (G. A.). *A new synthetic emerald.* Aust. Gemmol., **15**, 1, 24-6, 6 figs (4 in colour), 1983.

Describes a new synthetic emerald of unknown origin with RI 1.567-1.572, SG 2.67, transparent to short UV but no fluorescence. Spectroscope indicates low chromium content plus vanadium. Inclusions veil-like, some solid material, possible phenakite 'nails' with acute angled colour and growth zoning. It is suggested that this is due to a wedging process (a reversal of seeding?) [I have no idea what this means.] No natural type of emerald inclusion was seen. Stone remarkably clean but rather yellowish in colour. R.K.M.

VÁVRA (N.). *Bernstein und andere fossile Harze.* (Amber and other fossil resins.) Z.Dt.Gemmol.Ges., **31**, 4, 213-54, 12 figs (3 in colour), extensive bibl., 1982.

An extensive review of spectroscopic and chromatographic methods used for the identification of amber and other fossil resins. Chemical composition, formation of deposits, mining and use of these resins are discussed, and their varieties and differences in quality discussed. Fossil inclusions in amber and other resins are described and some examples are illustrated. Imitation, falsification and 'improved' products to be found on the market are mentioned and methods for identification discussed. A list of commercial products is included. E.S

WADDINGTON (F.). *The History of Jewellery and Gemmology: Part I—The Shadowy Beginnings of Jewellery.* Can. Gemmol., **1**, 1, 4-5, 1976.

From an ox-rib with stone-cuts carbon-dated at about 237 000 years old, via Cromagnon Man about 37 000 years ago and French cave-frescoes, Middle East goldsmithing of 5000 B.C., garnet and other cabochons of 4000 B.C., and a rock-crystal loupe (?) of 1600 B.C., to Babylonian cylinder seals of about 1500 B.C.

J.R.H.C.

WADDINGTON (F.). *The History of Jewellery and Gemmology: Part II—Jade.* Can. Gemmol., **1**, 2, 14-15, 1976.

Nephrite jade has been worked and revered for perhaps 4000 years. A Chinese prince and princess 2000 years ago were enclosed in jade coats to preserve them for eternity—the prince had over 2000 pieces of jade plates drilled and fastened together with gold wire. Most Chinese jade apparently came from Turkestan: recently great quantities from a nephrite mountain in British Columbia have been exported to China for carving. Jadeite mixed with another mineral (from Guatemala) was expertly carved in Central America by the Olmecs before the Christian era and later by the Mayas until the sixteenth century. In New Zealand the Maoris used nephrite 1000 years ago. But jadeite from Burma was almost unknown in China until the late eighteenth century. J.R.H.C.

WADDINGTON (F.). *The History of Jewellery and Gemmology: Part III—On Cutting and Engraving.* Can. Gemmol., **1**, 4, 16, N. D. [1977].

A brief account of the shaping of stones, from flint axe-heads in the Stone Age, agates rubbed on wood or leather with fine sand with more uniform shapes following the wheel about 3000 B.C., ancient engraving with a sapphire point in Egypt, Greece and Rome, faceting 1300 A.D. in India, to 'Tassie Gems' (glass reproductions of Greek and Roman intaglios) in the 1800s. J.R.H.C.

WAITZMAN (M. D.). *Grape's the color, sugilite's the stone.* Lapidary J., **36**, 8, 1334-8, 6 figs (5 in colour), 1982.

A brief account of the discovery and properties of manganoan sugilite. Absorption bands forming two pairs were located in the green-blue and blue areas of the spectrum. M.O'D.

WILD (K. E.). *Lapis-lazuli und Turkis.* (Lapis lazuli and turquoise.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 77-83, 1982.

Brief review of these two materials and their imitations. Testing notes given. M.O'D.

WUTHRICH (A.), WEIBEL (M.), GÜBELIN (E.). *Elucidating the optical theory of chatoyancy and asterism.* Aust. Gemmol., **15**, 1, 3-5, 4 figs, 1983.

An explanation of the optics of star-stones and cat's-eyes recognizing that the effects seen are in general virtual images. R.K.M.

ZEITNER (J. C.). *Anyway it's royal—the story of sugilite.* Lapidary J., **36**, 8, 1316-24, 8 figs, 1982.

Manganoan sugilite with gem potential was discovered at a manganese mine north-east of Hotazel in the Kalahari region of South Africa. Some material is translucent; hardness is quoted as 6½-7½, SG 2.74, RI 1.607-1.610. M.O'D.

ZEITNER (J. C.). *How to carve amber, jet, coral and more.* Lapidary J., **36**, 7, 1148-58, 11 figs, 1982.

A largely derivative article on simple fashioning of the materials described. M.O'D.

Bangkok gemmologist discovers very rare taaffeite specimen. Retail Jeweller, **22**, 541, 20, 10th March 1983.

A colourless water-worn mineral fragment identified as a 2.41 carat taaffeite was found in Bangkok in a parcel of rough bought in Thailand. RI 1.716-1.720 and SG 3.59 are quoted. Article cites an optimistic fifty known specimens. R.K.M.

BOOK REVIEWS

Anthony (J. W.), Williams (S. A.), Bideaux (R. A.). *Mineralogy of Arizona.* Revised reprinting. University of Arizona Press, Tucson, 1982. pp.263. Illus. in colour. Price on application.

About 40 new minerals have been added in a chapter at the back of the original text which is still superb value as a mineralogical guide in general as well as being an official state mineralogy. Very fine pictures make the book worth obtaining.

M.O'D.

Deer (W. A.), Howie (R. A.), Zussman (J.). *Rock-forming minerals.* 2nd edn. vol.1A. (Orthosilicates). Longman, London, 1982. pp.919. £50.

This second edition of what is the major work on the rock-forming minerals contains information on the gem species garnet, topaz, olivine, staurolite, kyanite, zircon, sphene, andalusite and vesuvianite. Volume 1B will cover the disilicates and ring silicates. Though the conception and layout remain the same as in the first edition, the amount of work done in the twenty years since that edition appeared has meant that what could be comfortably accommodated in one volume now needs two. In each entry the structure is discussed first, followed by the chemistry, optical and physical properties, distinguishing features and paragenesis. Then follows an exhaustive bibliography. To the serious mineralogist the complete work is a necessity, and even the gemmologist will find a great deal of information lucidly set out and easily located. Though the price is high, the cost of compiling bibliographies and collating a vast amount of data from many sources is also considerable, so that for these days the price is not unreasonable. M.O'D.

MacKenzie (W. S.), Donaldson (C. H.), Guilford (C.). *Atlas of igneous rocks and their textures.* Longman, Harlow, 1982. pp.148. Illus. in colour. £9.95.

It is rare today to see so well-produced a book at such a competitive price. This one, divided into two parts, first dealing with igneous rock textures, shown by the presentation of thin section material in both plane-polarized and cross-polarized light, and with a second section in which the varieties of igneous rocks are treated in the same way, succeeds in being both beautiful and informative. It is a salutary discipline to observe the appearance of rock types in thin section and to try to identify both the crystals and the rock. The authors unashamedly admit that they have included some pictures on the grounds of their attractiveness irrespective of their didactic purpose. To me all pictures in the book serve both functions. M.O'D.

Mumme (I. A.). *The emerald.* Mumme Publications, Port Hacking, N.S.W., Australia, 1982. pp.135. Illus. in black-and white and in colour. Price on application.

After a short introduction the book continues with reports of the major emerald deposits of the world, and within this section there is a good deal on the geology and mode of occurrence of the material. Much mining activity is shown in photographs and there are details of production where available, together with appropriate references scattered in the text. Details of the physical and optical features of emerald are given next and there is a section on emerald synthesis. Quite a lot of information is given on the emerald deposits of Australia and the stones shown in colour appear to be of good colour. There is a general bibliography but no index. This book is a very useful addition to the somewhat scattered emerald literature and, in the Australian deposits at least, nicely complements Sinkankas's *Emerald and other beryls.* One or two factual slips (the SG of synthetic spinel is 3.64, not 3.60) do not detract from overall worth. M.O'D.

SCHLEE (P.). *Bernstein-Raritäten.* (Amber rarities.) Staatliche Museum für Naturkunde, Stuttgart, 1980. pp. 88. Illus. in colour. Price on application.

This book is quite magnificent and the quality of the coloured pictures such that it is hard to put down. The illustrations are almost all of inclusions in amber, though towards the end of the book there are some artefacts represented. The text, which to some extent takes second place to the pictures, deals with all aspects of amber and discusses features which help to give a locality for a particular specimen. There is a short but useful bibliography. M.O'D.

SCHÜTT (E.). *Umgang mit edlen Steinen.* (Getting acquainted with gemstones.) Rühle-Diebener Verlag, Stuttgart, 1982. pp.271. Illus. in colour. DM87.60.

Gemstones are described in alphabetical order and there are no text diagrams, index or bibliography. Constants are not provided but the colour plates, of good quality, show broken or imperfect pieces or stones with prominent inclusions. This is an interesting and quite worthwhile feature. M.O'D.

STRÜBEL (G.), ZIMMER (S. H.). *Lexikon der Mineralogie.* (Dictionary of Mineralogy). Enke Verlag, Stuttgart, 1982. pp. 363. DM 24.80.

A pocket-sized dictionary which includes both mineralogical terms and names of minerals, this is an up-to-date account of mineralogy at the beginning of the 1980s. The authors have taken pains to include virtually all minerals officially named, and there are some useful text drawings and a bibliography, chiefly of works in German. M.O'D.

WORNER (H.), SEGNIT (R.). *Minerals of Broken Hill.* Australian Mining Co., Box 384D, Melbourne, 1982. Available in U.K. from Lythe Minerals, 2 Wellsic Lane, Rothley, Leics., LE7 7QB. pp.259. Illus. in colour. £31.50 post paid.

Mining of the orebody at Broken Hill in New South Wales began one hundred years ago. This superbly illustrated book describes the minerals found there, gives a history of mining development and outlines the way in which the mineralogy came about. The bulk of the book is occupied by a section in which the minerals are listed and described alphabetically; descriptions are confined to the appearance of the crystals and their place in the mine, together with their associations. There is no attempt to give details of constants since there are plenty of sources of information of this kind. There is a very comprehensive list of references keyed to mineral name and a more general though scholarly bibliography. This will probably be the last monograph of this size and scale to deal with one locality. It is in no sense a popular book, but for students of mineralization it is unmatched. M.O'D.

ASSOCIATION NOTICES

GIFTS TO THE ASSOCIATION

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

Mr Glyn A. Henwood, F.G.A., Basingstoke, for a copy of *'The Gemmologist' Chart: Gems of the World,* compiled by R. Dick-Larkam.

Mr Geoff Neary, F.G.A., Huddersfield, for a framed sheet, published in 1809 and in excellent condition, of drawings of outline crystals showing different growth patterns.

Mr S.H. Ramshad, London, for crystallized chrysocolla and pink opal from the mine of Nishapur, Khorasan, Iran.

OBITUARY

Dr Haruo Akizuki, D.Sc., F.G.A. (D.1981), Ichikawa, Japan, died on 24th November, 1982. Dr Akizuki was a former Professor of Mineralogy at the University of Nairobi, Kenya, and a member of and adviser to the Gemmological Association of Japan.

Mr Czeslaw Krakowiak, F.G.A. (D.1978), Gdańsk, Poland, died on 18th November, 1981.

Mr Arthur Stuart Murray, F.G.A. (D.1948), Leeds, died on 26th March, 1983.

NEWS OF FELLOWS

Mr Peter G. Read, C.Eng., F.G.A., has been appointed Editor of a new quarterly publication called *Gem Instrument Digest,* which will report on and discuss new gemmological test instruments, identification techniques and grading equipment.

Mr P. G. Read, C.Eng., F.G.A., and Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., are Directors of Precious Stone Training Service Ltd and have given several two-day courses on diamond and on corundum during 1983. Mr Eric Bruton, F.G.A., has also spoken at some of these courses.

MEMBERS' MEETINGS

London

On 12th April, 1983, at the Central Electricity Generating Board Theatre, Sudbury House, 15 Newgate Street, London E.C.1., a talk was given by Mr Julius Petsch on new gemstone discoveries in Africa and Brazil, and, allied to this, he gave details of the latest emerald, ruby, aquamarine and amethyst mines in those two countries.

Midlands Branch

On 25th March, 1983, at the Society of Friends, Dr Johnson's House, Birmingham, Mr David Kent, F.G.A., gave a talk entitled 'Gemmology in a practical sense'. Members were able to view Mr Kent's comprehensive collection of gemstones.

On 28th April, 1983, at the Society of Friends, Mr C. R. Cavey, B.Sc., F.G.A., gave a talk on 'Gem sources and varieties'.

On 12th May, 1983, at the Society of Friends, the Annual General Meeting was held, at which Mr Douglas Morgan, F.G.A., and Mrs Janet Leek were re-elected Chairman and Secretary respectively. The A.G.M. was followed by a discussion on gemmological topics.

North-West Branch

On 21st April, 1983, at Church House, Hanover Street, Liverpool 1, Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., gave a talk entitled 'Some rare gemstones'.

On 19th May, 1983, at Church House, Mr C. R. Burch, B.Sc., F.G.S., gave a talk entitled 'Some inclusions in quartz and other silica gems'.

On 16th June, 1983, at Church House, Mrs Val Duke spoke about some of her visits to the gem mines in Brazil.

South Yorkshire & District Branch

On 24th March, 1983, at the Sheffield City Polytechnic a practical evening was held. The emphasis was on crystallography and members brought a variety of specimens for identification.

On 10th May, 1983, at the Sheffield City Polytechnic Mr Peter G. Read, C.Eng., F.G.A., gave a talk entitled'New gem testing instruments'.

ANNUAL GENERAL MEETING

The 52nd Annual General Meeting of the Association was held on Wednesday, 4th May, 1983, at the Small Hall, Kensington Town Hall, Hornton Street, London, W.8.

Mr David Callaghan, the Chairman, presiding over the meeting, mentioned some of the items covered in the Annual Report. He referred to the Association's loss sustained by the death of Mr Norman Harper, Vice-President and former Chairman, and the retirement of his immediate predecessor as Chairman, Mr Douglas King, and also the retirements of Mr John Chisholm as Examiner after 27 years and Dr Judith Milledge as Examiner after 12 years, the former of whom, however, with the able assistance of Mrs Mary Burland, was continuing to edit the enlarged and improved *Journal.*

Mr Callaghan observed that once again the important special awards had gone overseas, this time to Canadians, after being won by students from Hong Kong the previous year, and went on to refer to the formation of an Education Committee under the chairmanship of Dr George Harrison Jones as an important move. He then paid tribute to Mr Lawson Clarke, who was retiring from the office of Honorary Treasurer which he had held continuously since 1951, an office that his father, the late Mr V. W. Clarke, had held before him in 1924-25 and 1932-42—a remarkable family record of service.

Mr Lawson Clarke, in moving the adoption of the Annual Report and Accounts, presented the Accounts for 1982: there was, however, an invisible asset, he said, which affected the figures appearing in the Balance Sheet, namely the high quality knowledge and support of the Officers, Council and Members. Looking back to his first year as Treasurer, Mr Lawson Clarke added that the current figures shed light on the value of this invisible investment: the Association's income had gone up by 120 times and its expenditure by a similar amount, whilst other figures had gone up by about 85 times. The motion for adoption having been duly seconded and put to the meeting was carried unanimously.

Sir Frank Claringbull, Mr David Callaghan and Mr Noel Deeks were then re-elected as President, Chairman and Vice-Chairman respectively; Mr Nigel B. Israel was elected Honorary Treasurer, and Mrs S. Hiscox, Messrs C. R. Cavey, A. C. Hilbourne, M. J. O'Donoghue, and P. G. Read were re-elected and Mr Brian Jackson was elected to the Council.

On the nomination of Council, the Chairman proposed the election of Mr Harry Wheeler as a Vice-President, and, on Mr Wheeler indicating his willingness to stand, he was duly elected a Vice-President of the Association by acclamation. In expressing his thanks, Mr Harry Wheeler, who was accompanied by his wife, Rene, said 'This is an honour beyond my wildest dreams.'

Messrs Hard Dowdy Watson Collin & Co. were re-appointed Auditors, and the proceedings then terminated.

THE NEW HONORARY TREASURER

Mr Nigel B. Israel, who, as recorded above, was elected at the Annual General Meeting to succeed Mr F. E. Lawson Clarke as Honorary Treasurer, is thirty-eight, a Fellow of the Gemmological Association (D.1978 with Distinction) and passed the Gem Diamond Examination in 1979. He was educated at University College School, Hampstead, where he obtained four Science A Levels. He spent ten years working for a firm of Chartered Accountants, involved in the preparation and auditing of accounts and with personal and company taxation. Since leaving accountancy he has dealt in fine jewellery and educational books, and after gaining his gemmological qualifications he has taught gemmology and associated subjects and is a regular member of the Post-Diploma Class.

COUNCIL MEETINGS

At the meeting of Council held on 23rd February, 1983, at Saint Dunstan's House, the business transacted included the following:

(1) following a report by Dr G. Harrison Jones, an Education Committee was formed with general responsibility to the Council for (a) the formation of educational policy (subject to the approval of the Council) and (b) all other educational matters including the review, creation, development, content, administration and promotion of all educational courses and activities and with power to co-opt persons thereto and/or to the Education Committee, and was constituted as follows, namely Dr G. Harrison Jones (Chairman), Drs A. J. Allnutt, R. R. Harding and J. B. Nelson, and Messrs P. J. E. Daly, A. E. Jobbins and D. Inkersole, with Mr Jonathan Brown as Secretary;

(2) the resignation from the Council of Mr Jonathan Brown, consequent upon his taking up full-time employment with the Association, was accepted;

(3) the following were elected to membership:

FELLOWSHIP

Anwar, Abdul A. M., Beruwala, Sri Lanka. 1982
Aoussat, Claude A., Vienna, Va, U.S.A. 1982
Arendtsz, Natalie A., Negombo, Sri Lanka. 1982
Baker, Judith, Ottawa, Ont., Canada. 1982
Balas, Aranka D., Budapest, Hungary. 1982
Bell, John A., Sevenoaks. 1982
Berthet, William L., Jacksonville, Fla, U.S.A. 1982
Bon, Maria H., Schoonhoven, Netherlands. 1982
Bouman, Henriëtta A. E., Bangkok, Thailand. 1982
Braunstein, Joan, Potomac, Md, U.S.A. 1982
Cassarino, Paul R., Rochester, N.Y., U.S.A. 1982
Chao, George Y., Ottawa, Ont., Canada. 1982
Chaturvedi, Vimal K., Jagdalpur, India. 1982
Cheung, Cliff P.-L., Toronto, Ont., Canada. 1982
Cowie, Gillian A., Liverpool. 1982
de Beer, Christiaan T. J., Durban, S.Africa. 1982
de Poli, Vesta, Genoa, Italy. 1982
de Regt, Marcus N., Goes, Netherlands. 1982
Dijkman-Vos, Christine S., Hong Kong. 1982
Esterhuizen, Karen F., Karoi, Zimbabwe. 1982
Fernando, Dudley L., Kew, Vic., Australia. 1982
Foster, Amanda L., Willowdale, Ont., Canada. 1982
Galsterer, Maureen G., Saginaw, Mich., U.S.A. 1982
Galt, Jessie J., Scarborough, Ont., Canada. 1982
Gea Lopez, Francisco J., Valencia, Spain. 1981
Geurts, Godefridus R. J. M., Heerlen, Netherlands. 1982
Glover, Brian M. G., Wallasey. 1982
Grishko, Alexander, Toronto, Ont., Canada. 1982
Gupta, Manoj B., Bombay, India. 1982
Harmer, Inge, The Gap, Qld, Australia. 1982
Hata, Kenichi, Kyoto-City, Japan. 1980
Hendriks, Fransiscus R. A., Amsterdam, Netherlands. 1982

Hinduja, Anuradha, Bombay, India. 1982
Hofer, Stephen C., Kensington, Conn., U.S.A. 1982
Hoogewerff, Regitse C., Diepenveen, Netherlands. 1982
Ickowicz, Steven, London. 1982
Jayaweera, Susil, Peradeniya, Sri Lanka. 1982
Jhaveri, Kalpana R., Bombay, India. 1982
Kauhanen, Pentti R., Helsinki, Finland. 1982
Kawai, Yoshito K., Utsunomiya-shi, Japan. 1982
Kesola, K. Juhani, Valkeakoski, Finland. 1982
Ketelaar, Arend C. R., Leidsendam, Netherlands. 1982
Kolamunne, Ahangangoda A. S., Kadawatte, Sri Lanka. 1982
Korhonen, Pentti K., Hämeenlinna, Finland. 1982
Kraan, Jan W., Amsterdam, Netherlands. 1982
Krishnamoorthy, K. L. N., Trivandrum, India. 1982
Kujanpää, Asko J., Helsinki, Finland. 1982
Kumaratilake, Wickramasinghe L. D. R. A., Kelaniya, Sri Lanka. 1982
Lam, Yat Hoong C., Singapore. 1982
McCall, Lois G., Wooster, Ohio, U.S.A. 1982
McQueen, B. Young, Jacksonville, Fla, U.S.A. 1982
Medniuk, Melanie A., Witham. 1982
Morishita, Kentaro, Tokyo, Japan. 1982
Morishita, Yuzuru, Hiroshima-Ken, Japan. 1982
Nicholas, Christopher E., Colombo, Sri Lanka. 1982
Nilam, Mohamed C. M., Weligama, Sri Lanka. 1982
Okada, Mari, Los Angeles, Ca, U.S.A. 1982
Piziura, Irene T., Nottingham. 1982
Ralls, Elizabeth L. W., Spokane, Wash., U.S.A. 1982
Ranabahu, Mallikage K.T.S., Ratnapura, Sri Lanka. 1982
Rubera, Anthony N., Dehiwela, Sri Lanka. 1982
St Amand, Mary J., Mill Valley, Ca, U.S.A. 1982
Schutt, Karl R., Manotick, Ont., Canada. 1982
Senanayake, Nimalka R., Homagama, Sri Lanka. 1982
Senanayake, S. A. M. A. S. P., Gampaha, Sri Lanka. 1982
Shah, Sanjay S., Bombay, India. 1982
Shenker, Ian L., Edgware. 1982
Staley, Nancy C., Potomac, Md, U.S.A. 1982
Toivainen, Heidi S., Östersundom, Finland. 1982
Uwais, M. Ifthikar., Kandy, Sri Lanka. 1982
van Velzen-Ritmeÿer, Elisabeth T. H., Rotterdam, Netherlands. 1982
van Zeijst, Raymond M. E., Nieuwegein, Netherlands. 1982
Vaughan, Susan E., Nottingham. 1982
Venemans, Anne C., Groenekan, Netherlands. 1982
Verjee, Nasim K., Nairobi, Kenya. 1982
Vuorinen, Jorma T., Hämeenlinna, Finland. 1982
Waghela, Mahesh R., Bombay, India. 1982
Walsh, Francine E., Dundas, Ont., Canada. 1982
Wols, René P., Rotterdam, Netherlands. 1982
Yamasaki, Kazutaka, Kochi City, Japan. 1982
Ypyä, Teuvo H., Kemi, Finland. 1982

TRANSFER FROM ORDINARY MEMBERSHIP TO FELLOWSHIP

Cornioley, Jean-René, Fribourg, Switzerland. 1982

ORDINARY MEMBERSHIP

Abe, Nobuko, Tanashi City, Japan.
Alexander, Jean, Wantage.
Anderson, Iris K., Christchurch.
Apland, Ken A., Cottage Grove, Oreg., U.S.A.
Arita, Kouzi, Saga City, Japan.
Asagai, Toshiki, Sakai City, Japan.
Ashraf, Ashfaq A., Nairobi, Kenya.
Auberson, Viviane, Geneva, Switzerland.
Beveridge, Ronald R., Seacombe Heights, S.A., Australia.
Birkin, Paul M., Stoke-on-Trent.
Blackstock, George, Ewell.
Bottoms, Robert, Bicester.
Cox, Patrick P., Calgary, Alta, Canada.
Dathi, Kaniz, Harrow.
Davey, Frances V., Invercargill, N.Z.
Davis, H. Trevor, Liphook.
Dunn, Andrew C., Reading.
Duperray, Marie-Hélène, Gex, France.
Ellefsen, Sigmund M., Bergen, Norway.
Fletcher, Hazel J., Derby.
Gardener, Robert J., Stockport.
Gardener, Sheila, Yeovil.
Gibbs, Margaret E., Beaworthy.
Gibson, Dorothy, Chatham, N.J., U.S.A.
Glaholm, Janice A., Paris, France.
Gold, Ruth G., Anaheim, Ca, U.S.A.
Gordon, Ben, Houston, Tex., U.S.A.
Hatabu, Katuski, Kitakyushu City, Japan.
Hewitt, Paul R., Amersham.
Horovitz, Theodore, Geneva, Switzerland.
Hubrt, Ludek, Prague, Czechoslovakia.
Hui-Nam, Oh, Seoul, Korea.
Iyama, Isao, Kyoto-City, Japan.
Jaffery, Zulfiquar A., Machakos, Kenya.
Josephson, Jeffrey, Glasgow.
Kaye, Anthony M., Chester.
Kennedy, Muriel D., Toronto, Ont., Canada.
Khanna, Atul, Birmingham.
Kimishima, Yoko, Yokosuka City, Japan.
Kon, Mark J., Orwell, Ohio, U.S.A.
Koseki, Norio, Fukushima-Shi, Japan.
Kovithavongs, Panya, Edmonton, Alta, Canada.
Kwan, Ng Yue Yuk, Hong Kong.
Levy, Margot, Hong Kong.
Liggett, Sonia A., Cardiff.
Lippelt, Ulrich W., Karachi, Pakistan.
Long, Yvonne M., Dover.
Lopezzo, Lorraine V., London.
McMurrie, Alfred G., Liverpool.
Marczycha, Michael J., Leeds.
Matheson, Brian D., Adelaide, S.A., Australia.
May, Gerard, Belfast.
May, John K., Mt Pleasant, S.C., U.S.A.
Medcraft, Joseph, Perth, W.A., Australia.
Mitchell, Kenneth P., Crowborough.
Mitchell, William G., Fremont, Ca, U.S.A.
Moir, Evelyn A., Cove.
Murakami, Ryutaro, Osaka, Japan.
Naina Marikar, Mohamed R., Colombo, Sri Lanka.
Nakamura, Midori, Ichikawa City, Japan.

Nakamura, Yoshihiro, Wakayama City, Japan.
Narang, Ram C., Bombay, India.
Nawaz, Rab, Belfast.
Newton, Brian G., Saltash.
Ng, Fen Sin, Singapore.
Nishimoto, Hiroko, Takarazuka City, Japan.
Nist, Donald E., Los Angeles, Ca, U.S.A.
Nitta, Hisako, Tokyo, Japan.
Norberg, Arvid, Sollentuna, Sweden.
Ohta, Kumi, Tokyo, Japan.
Perks, Tessa G., London.
Platt, Eric, Colne.
Quam, Maurice D., St Paul, Minn., U.S.A.
Raniga, Dhiraj L., Richmond, B.C., Canada.
Reiner, Steven, Houston, Tex., U.S.A.
Rens, Gerald J., Johannesburg, S.Africa.
Richards, Sara, Rhosneigr.
Risbridger, Anne, Redhill.
Robinson, Stanley, Clayfield, Qld, Australia.
Ross, Gloria, Los Angeles, Ca, U.S.A.
Sakamoto, Masako, Ueda City, Japan.
Sato, Toshiko, Osaka, Japan.
Scoble, Bride P., Lytchett Matravers.
Sentell, Eric D., Aspen, Colo., U.S.A.
Shigeno, Katsuharu, Tokyo, Japan.
Shimada, Takanori, Tokyo, Japan.
Shum, Chan Hui, Kuala Lumpur, Malaysia.
Silk, David J., Uxbridge.
Singh, Jang B., Edgware.
Smallwood, Anthony G., Gray's Point, N.S.W., Australia.
Soanes, Stuart E., Oakville, Ont., Canada.
Sodel, Abdul H., Nairobi, Kenya.
Stroud, Louise M., Harrogate.
Suita, Shigeo, Kyoto City, Japan.
Surjaatmadja, F. K., Jakarta Timur, Indonesia.
Tagliamonte, Nino, Vicenza, Italy.
Tambuyser, Paul B., Schoorl, Netherlands.
Tamura, Hiroto, Ichikawa City, Japan.
Tazaki, Noriko, Tokyo, Japan.
Tazaki, Yasuko, Tokyo, Japan.
Teng, Albert C., London.
Terauchi, Toshihiro, Kyoto, Japan.
Terpilak, Thomas J., Silver Spring, Md, U.S.A.
Thilesen, Georg, Fredrikstad, Norway.
Thomis, Helen M., Halifax.
Todd, Sally E., London.
Toohey, Judith, Surbiton.
Uesugi, Tohru, Osaka, Japan.
Vander Brugge, Willy T., Ghent, Belgium.
Van Valkenburg, Eric, Tucson, Ariz., U.S.A.
Verhey, Elizabeth C., Vlaardingen, Netherlands.
Washio, Hiroaki, Funabashi City, Japan.
Wetten, Veronica, Hong Kong.
Williams, Kevin G., Cowbridge.
Woolley, Joseph G., Nelson, N.Z.
Yazu, Chiharu, Krume City, Japan.

At the meeting of Council held on 4th May, 1983, at the Small Hall, Kensington and Chelsea Town Hall, Hornton Street, London W.8., the business transacted included:

(1) the acceptance by Professor Dr Hermann Bank, F.G.A., of the Council's invitation to present the awards this year, which is the Fiftieth Anniversary of the foundation of the German Gemmological Association (Deutsche Gemmologische Gesellschaft) was reported, the Presentation of Awards being on 14th November at Goldsmith's Hall;

(2) it was decided to form an Advisory Committee to assist the Officers and Secretary in preparatory decisions before they come to Council;

(3) it was agreed that because of the relationship of the Association with the Gem Testing Laboratory of the London Chamber of Commerce and Industry, its Director for the time being should be invited to attend meetings of the Council;

(4) the Annual Subscriptions for 1984 were fixed as follows:
Fellows £15: Ordinary Members £18: Associate £18;

(5) it was agreed that—
from 1983 the Correspondence Course fees should be raised to:
Preliminary: U.K. £55.00 inc.15% V.A.T.
Europe $(U.S.)182.
Elsewhere overseas $(U.S.)231.
Diploma: U.K. £62.00 inc.15% V.A.T.
Europe $(U.S.)209
Elsewhere overseas $(U.S.)253.
and that from 1984 the Examination fees should be:
Preliminary: U.K. £22.00 inc.15% V.A.T.
Overseas $(U.S.)143.
Diploma: U.K. £30.00 inc.15% V.A.T.
Overseas $(U.S.)215.
Reduced Examination fees for Correspondence Course Members:
Preliminary: U.K. £20.00 inc.15% V.A.T.
Overseas $(U.S.)88.
Diploma: U.K. £26.00 inc.15% V.A.T.
Overseas $(U.S.)132.

(6) it was agreed that Mr Con Lenan be appointed a Director of Gemmological Instruments Ltd in the place of the late Mr Norman Harper;

(7) the following were elected to membership:

FELLOWSHIP

Arbeid, Martin J., London. 1967

ORDINARY MEMBERSHIP

Bartlett, Lynne, London.
Carlton, Adrian, Shevington.
Chan, Yau-Lap, Santa Monica, Ca, U.S.A.
Chui, Kit Nam R., London.
Cooper, Garth D., Colchester.
Ferrand, Shula, Asnières, France.
Fussell, Louise, London.
Haig, Elisabeth, London.
Hayward, Beryl D., London.
Hegge, Ola R., Fagernes, Norway.
Hill, Jean L. G., Kuala Lumpur, W. Malaysia.
Ho, Yuen-Yee, London.
Imai, Yoshiko, Tokyo, Japan.
Kuittinen, Raili T., Helsinki, Finland.
Kumarasuriar, Geetha K., Colombo, Sri Lanka.
Le, Christopher A., Hong Kong.
McCloskey, William P., London.
MacFadyen, Donald A., Scarborough, Ont., Canada.
McFarlane, Jack, Wetherby.
McLaren, Margaret E., Southwold.
Mazer, David A., Wilmington, Del., U.S.A.

Pohl, Werner, Bochum, W. Germany.
Popescu, Gabriela, Imola, Italy.
Quick, Fiona A., Harare, Zimbabwe.
Somers, William N., Dunsford.
Sorgen, Irving D., Fargo, N. Dak., U.S.A.
Stickley, Joan M., Kidderminster.
Subramaniam, Manoharan, Farnborough.
Tseglakoff, Mark, Zeehan, Tasmania.
Vargas, Robert L., Los Altos, Ca, U.S.A.
Visconti, Pio, Valenza, Italy.
Wiborg-Jenssen, Nellie, Tunbridge Wells.
Yap, Ching-Siew, London.

JOURNAL OF GEMMOLOGY—BACK NUMBERS WANTED

A Fellow is interested in purchasing a complete set from Volume I to Volume XIII inclusive. Anyone interested in selling these should write to Mr J.-M. Duroc-Danner, F.G.A., 7 Rue Michel Chauvet, 1208 Geneva, Switzerland.

LETTER TO THE EDITOR

From Mr Peter G. Read, C.Eng., M.I.E.E., M.I.E.R.E., F.G.A.

Dear Sir,

It is several years now since the nanometre replaced the Ångström unit as a unit of measurement for the wavelength of the visible, infrared and ultraviolet sections of the electromagnetic spectrum. Although there was some initial resentment to this change, the only numerical modification required was the moving of the decimal point one place to the left, and this change caused very little confusion when absorption spectra were quoted in nanometres or nm.

Communication difficulties do arise, however, when articles written by our physicist colleagues appear in the *Journal of Gemmology* containing less familiar wavelength terms such as wavenumber, electron volt, megahertz, micron, μ, and micrometre.

Of all these alternative units, at least the last three bear a numerical similarity to the nanometre in that one micron, μ or micrometre is equal to 1000 nm (use of the terms micron and μ is now 'generally deprecated' according to the French standards publication 'Le Système International d'Unités).

No such easy relationship exists with the other terms. In order to convert a wavenumber into nanometres, it is necessary to divide it into 10^7. To change an electron volt (eV) value into nanometres, it must first be multiplied by 8.006 and the result then divided into 10^4. Similarly, megahertz (MHz) must be divided into 300×10^9 to convert it to nanometres.

One solution to this problem would be to require authors to use the accepted and familiar gemmological wavelength unit of the nanometre when submitting articles to the *Journal.* I would go even further and also ask the *Journal's* abstracters to convert, where appropriate, any such wavelength references into the more recognizable nm. For the far infrared wavelengths this may result in the occasional rather cumbersome number, but this can easily be overcome. A wavenumber of 500 can, for example, be shown either as 20 000 nm, or more compactly as 2×10^4nm.

Yours faithfully,
PETER READ.

11th March, 1983.
Bournemouth, Dorset.

[*NOTE. In this connexion, readers' attention is called to (1) the note headed 'The Journal of Gemmology' (J.Gemm., 1976, XV(3), 164) and (2) 'The International System of Units and its Application to Gemmology', by Dr K. Nassau (J.Gemm., 1977, XV(5), 243-7).—Ed.*]

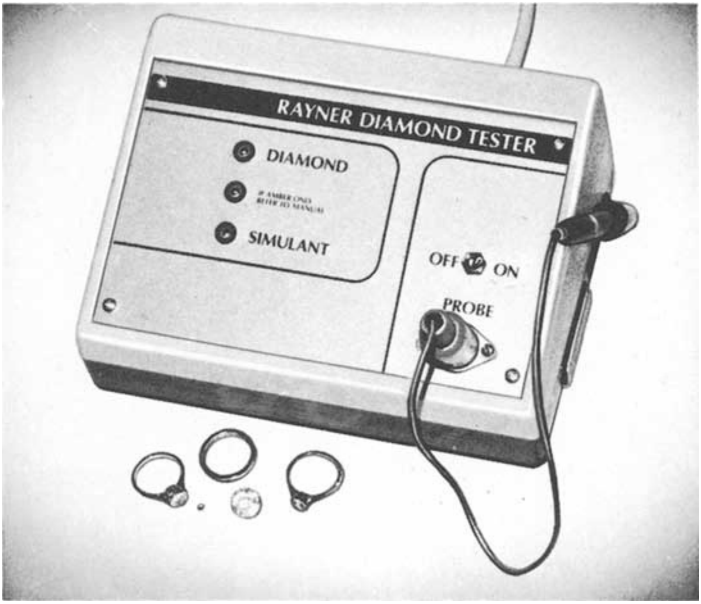
CORRIGENDA

On p.461 above, for 'Ickowicz, Stephen,' read 'Ickowicz, Steven,' and delete 'Ifthikar, Mohamad U. M., Kandy, Sri Lanka.'

On p.462 above, for 'Ranabahu, Millakage K. T. S.,' read 'Ranabahu, Mallikage K. T. S.,'

On p.463 above, insert 'Uwais, Mohamad I., Kandy, Sri Lanka.'

In J.Gemm., 1981, XVII (5), on p.358 delete 'Ifthikar, Ifthikar U.M., Kandy, Sri Lanka., and on p.361 insert 'Uwais, Mohamad I., Kandy, Sri Lanka.'


RAYNER DIAMOND TESTER
DIAMOND
SIMULANT
OFF
ON
PROBE

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 and the Gemmological Association of Hong Kong.

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 Editor is 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 Editor.

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 Editor—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. XVIII
No. 7
July, 1983

C O N T E N T S

Registered Office: Saint Dunstan's House, Carey Lane, London EC2V 8AB

milner Brentford, Middlesex

7.83/6972/4,500