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OF GREAT BRITAIN

GEMMOLOGICAL ASSOCIATION
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THE JOURNAL OF GEMMOLOGY
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(A)MUSING ON PEARLS PEOPLE AND POETRY

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

lately Director of the Gem Testing Laboratory of the London Chamber of Commerce and Industry

Alexander Selkirk's soliloquy on his life on a desert island by W. Cowper—so well portrayed by Daniel Defoe's book *Robinson Crusoe*—contains the lines '...better dwell in the midst of alarms than reign in this horrible place'.

In retrospect, in retirement, I have dwelt upon such lines, fortunately in happier vein than poor Selkirk. My own choice might have been 'Far from the madding crowd' (of commuters?).

This well-known incomplete quotation from Gray's *Elegy* is one of many from that fine poem. Another quotation, 'Full many a gem of purest ray serene the dark unfathomed caves of ocean bear', is a most apt gemmological line. In their monumental work *The Book of the pearl*,* Kunz and Stevenson use these lines to emphasize the longevity of diamonds and rubies whereas pearls may 'be born to live and die unseen'; such is their fate. They state that 'probably only a small percentage of pearls produced gladden the sight of man'.

**The Book of the Pearl*, by George Frederick Kunz and Charles Hugh Stevenson: Macmillan & Co., London, 1908.

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Having dipped and delved into this superb book, first published in 1908, I felt pleased that I had not erred in my own independent choice of that phrase. The study of the structure and formation of pearl, and that of its cultured counterpart, inadvertently set in motion today's gemmological knowledge in our trade.

Having been without a telephone for a few months, I have had to resort to more letter writing than usual. My friends and colleagues, presently working and/or retired, may well have noticed some repetition of what I call 'news' and others term 'shop'.

One very pleasant letter from that renowned gemmologist, F. S. H. Tisdall, in an elegant hand despite his eighty plus years, dwelt upon some aspects of gemmology, chiefly colour and the use of the 10 × lens—we have much in common in our appreciation and approach to gem testing.

Another letter, from R. K. Mitchell, mused upon the Laboratory and its problems. Mitchell, a Tully Medallist of 1934, was a contemporary of Robert Webster, and has been a life long friend of us all in the Laboratory. I was interested a day or two later, to read in my copy of the *Journal** his article *Some fallacies of Gemmology,* and equally pleased to note his observations in it on dichroism in tourmaline. I have sometimes noted curved structure lines in synthetic rubies when viewed through a dichroscope. In such cases I was establishing random orientation of cutting as an additional check against the optical correct cutting of natural ruby—a useful point in cases where little can be deduced due to rubbed surface, no microscope, no x-ray phosphorescence, but the eye tells you by the *first impact of colour* that 'here is a doubtful stone'.

The dichroscope, like the 10× lens and what I term the 'Chelsea filter', can provide much useful information. As well as being simple, they are extremely manoeuvrable, unlike x-ray sets or zoom-lens binocular microscopes.

In the same *Journal* I read of the demise of one of the characteristics taught in my day—that of the Beilby layer—but what started me dwelling upon the madding crowds of gemmology was the article entitled *An unusual pleochroism in Zambian*

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*J.Gemm., XVII (7), July, 1981.—Ed.

Emeralds. In this article by Dr Karl Schmetzer and Prof. Dr H. Bank, they discuss colour causes and quote 'normal' emerald and its chromium content. Zambian emeralds, they say, have a *normal* chromium spectrum but superimposed on it is that of the aquamarine (iron) spectrum.

I like to see and read articles by such authorities mentioning chromium spectra as in normal emeralds. It is true that I am an advocate of 'chromium as a criterion for emeralds'. When working in a busy laboratory for tradespeople, it is useful to have a yardstick or level to measure by or start from. The 'quality' does not matter; that financial aspect can be safely left to the competent merchants who buy, sell and exist by their financial judgement.

Thus the scent of chromium sparked off my musing upon this madding crowd. In similar vein I read with relish in *Gems and Gemology* (Vol. XVI, No. 10*, pp.321-2, Summer 1980) an article by Bob Crowningshield of the New York Laboratory, on the difficult colour determination of a blue-green beryl. He ended his description as follows: 'With the *chromium* we felt it had to be considered emerald'. This is what I consider to be an unsolicited testimonial to the 'chromium as a criterion for emerald' cult from a source which does not normally subscribe to this particular requirement.

On the question of colour, the use of colour charts to decide ruby, pink sapphire, green beryls of fine colour (with the desire to give them the accolade of emerald), to me is a *bête noire.*

Being free or far from the madding crowd has its compensations in that one can, as a practical, experienced, trade gemmologist, give opinions which are not necessarily in line with protocol or requirements of a director of a laboratory. One feels free. In similar vein, being very recently a grandfather one can now enjoy the delights of parenthood, but if fractious behaviour occurs, one can readily relinquish the reins and avoid being left holding the baby!

So that, far from dwelling in the midst of alarms, I am happy in my retirement from the madding crowd, writing, if not pearls of wisdom, at least something of and around our mutual interest—gemmology.

[*Manuscript received 26th August, 1981.*]

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*The Summer 1980 issue, though in fact No. 10, bore 'Number 9' in the contents page (p.289).—Ed.

'TAPROBANITE' IS TAAFFEITE

By R. KEITH MITCHELL, F.G.A.

For some time a gem, hailed as a new mineral from Sri Lanka and named tentatively 'taprobanite' after an early name for that island* has caused some excitement among a select few of the world's leading gemmologists.

This material, known so far in two faceted gems only, was analysed by electron probe techniques, which, although very accurate and efficient even for microscopic fragments of a mineral, have the enormous advantage of leaving the test specimen completely unaltered and undiminished. These analyses proved that this 'new' mineral, which has been found only in red and orange colours, has a composition of $MgO + Al_2O_3 = 95\%$, leaving only 5% of BeO; and unit cell dimensions of $a \approx 5.7$Å and $c \approx 18.3$Å.

These results are fairly close to, but certainly not identical with, the analysis of the first known taaffeite carried out by Dr Max Hey in the early 1950s. Dr Hey was working by normal chemical means and with what was then considered to be a very small amount of material, a mere 0.03 carat, and on this he reached an approximate estimate of $MgO + Fe_2O_3 + Al_2O_3 = 89\%$ with BeO 11%. The cell measurements were $a = 5.72$Å and $c = 18.38$Å.

On the death of Count Taaffe in 1967, I was offered his entire stock of stones, most of which were small and of little interest, contained in 44 boxes each crammed with stone papers, totalling several thousand in all. Since the remainder of the type specimen of taaffeite was among these and could not be bought separately, I bought the lot with the principal idea of preventing this important stone from falling into commercial hands where it might be sold and lost to public view. In pursuance of my original idea I later arranged for the stone to be put on long term loan with the Institute of Geological Sciences on the understanding that it should be displayed in their public collection in the Geological Museum.

Dr K. Schmetzer, of Heidelberg University, has been concerned with the investigation of the taprobanites and he wished

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

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to compare these with the original taaffeite, using the modern and more accurate non-destructive electron probe tests. The I.G.S. sought my permission and it was arranged that the stone should be sent via Prof. Dr Hermann Bank, of Idar Oberstein, to Dr Schmetzer.

The latter gentleman has now confirmed beyond reasonable doubt that taaffeite and taprobanite have the same chemical composition and the same unit cell measurements and crystal symmetry.* So they are one mineral, and taprobanite, as a new mineral, does not exist.† This means that there is no reason whatsoever to alter the original name of taaffeite, given to it in honour of Count Taaffe who, in 1945 with little more than a low-powered dissecting microscope for equipment, found what he concluded, correctly, was a new mineral.

The type specimen is now back on display in the I.G.S. Museum. Readers may also see the second of the discovered taaffeites in the Mineral Gallery of the Natural History Museum, to whom it was presented by Mr B. W. Anderson. That museum has also acquired the first known crystal of taaffeite and a minute portion of this was used in Dr Schmetzer's investigation. The crystal is not on display at the time of writing.

[*Manuscript received 27th January, 1981; revised 11th January, 1982.*]

**Zur Mineralogie ternärer Oxide in System BeO-MgO-Al_2O_3.* Naturwissenschaften, 67, S471 (1981). Dr Schmetzer has asked me to add that this was a short preliminary paper only and that a further paper with much more data is in preparation.

† The Commission on New Minerals and Mineral Names of the International Mineral Association have agreed unanimously that taprobanite and taaffeite are accepted as belonging to the same species. The voting for the retention of the original name of 'taaffeite' was 15 to 1 in favour.

VISUAL IDENTIFICATION OF GILSON LAPIS

By R. KEITH MITCHELL, F.G.A.

C. A. Schiffmann has dealt in considerable detail with the scientific distinction of the Gilson lapis lazuli substitute from natural lapis.* He has not, in that paper, mentioned the fairly obvious visual differences between them.

The Gilson material is available in two main types, without pyrite inclusions and with pyrite inclusions.

The first of these is quite rare in nature and any lapis lazuli of fine colour and a very even small grain should be automatically suspect as being probably the man-made product. Acid tests would confirm this, but there are still visual tests which could be applied. These will be described below.

The other Gilson material, containing pyrite specks, is a more convincing imitation of the real stone. But, again, there are several quite easily identified visual differences when the material is closely examined under magnification.

As in the first type, the grain sizes of the substitute material are very regular, and there are no patches or veins of white or colourless calcite. Possibly the most obvious difference lies in the shapes of the pyrite fragments.

Gilson is known to have said that it is quite simple to synthesize pyrite but, with the natural mineral so plentiful, it is just not worth the expense. So he uses natural pyrite, crushed and sieved to size.

Now pyrite has only indistinct cleavage and its fracture is uneven rather than strongly conchoidal. This means that it breaks normally into quite simply shaped chunky pieces with rather smooth sides.

On the other hand, when formed in lapis lazuli, natural pyrite is found to be in exceedingly complex multiple penetration-twins of both the cube and the pyritohedron leading to immensely contorted masses despite their very small size. When cut through in polishing, these usually give outlines which are obviously far more convoluted than those of the pyrite fragments in the Gilson product. The latter are sometimes so smooth shaped that the mere act of polishing is

*J.Gemm., 1976, XV (4), 172-9.

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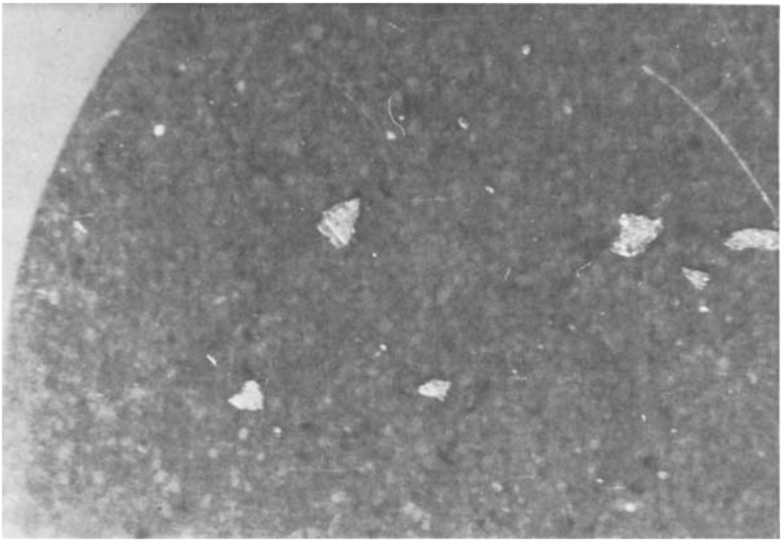

FIG. 1. Lapis lazuli substitute, showing the simple shapes of the crushed and sieved pyrite and the small regular grains of the blue matrix minerals.

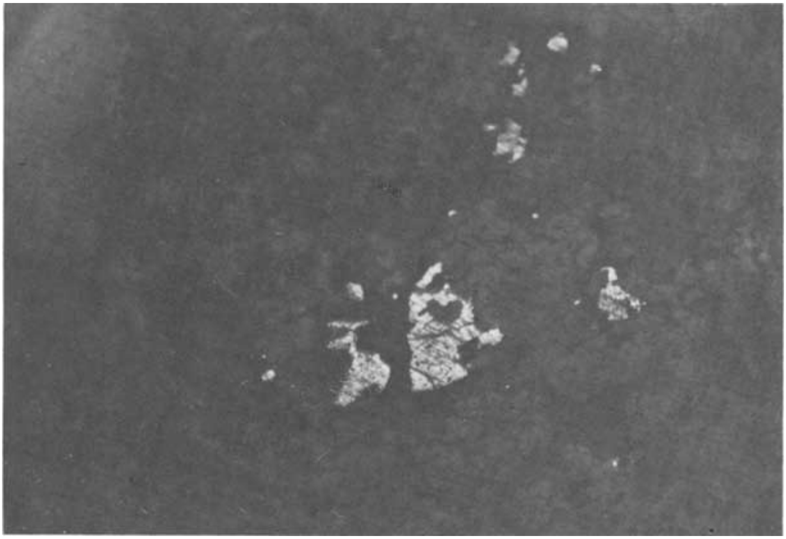

FIG. 2. A small group of pyrite in natural lapis showing the contorted outlines of these inclusions and also the large and variable grains of other minerals in the matrix.

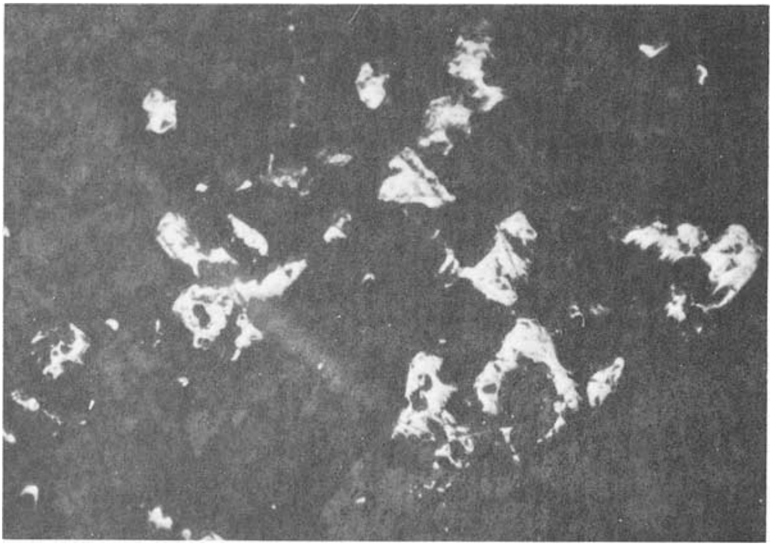

FIG. 3. Another group showing similar features to those in Figure 2. Note that in both there are pyrite inclusions which actually enclose 'lakes' of the blue matrix minerals.

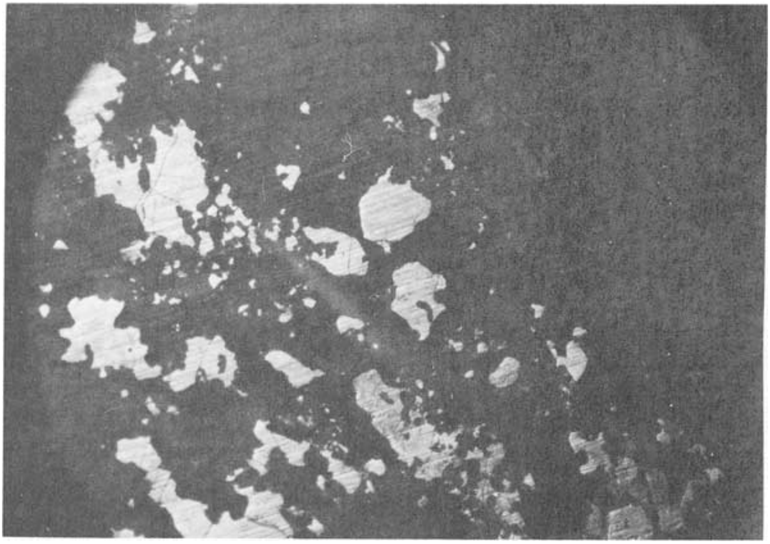

FIG. 4. A larger group of pyrite inclusions in natural lapis. Although the great majority of the specks are complex in outline, one or two can be seen which approach the simpler shapes found in the crushed material used by Gilson. On their own these could confuse, but not if the grain size of the matrix is taken into account.

sufficient to lift them out of the matrix, leaving an empty hole, possibly with a tiny fragment of the brassy mineral at its base. Figure 1 illustrates the type of pyrite inclusion to be expected in the Gilson material, although in this instance they are grouped a little more closely than is usual. In most specimens examined the distribution through the material has been very regular.

Figures 2, 3 and 4 are of pyrite inclusions in natural lapis lazuli and it will be seen that many of these are of quite fantastically contorted shapes, even, in some instances, entirely surrounding tiny 'lakes' of blue lapis in their brassy outlines. It will also be noticed that, although it is quite possible for isolated specks of pyrite to occur, in the majority of cases the mineral tends to occur in close groups or in veins. It is rarely regularly distributed through the rock in the way that it is in the Gilson substitute. Another quite noticeable feature in the natural material is the fact that the blue of the matrix is very often much deeper around the pyrite inclusions, and that the grain sizes of the blue minerals are often variable and can be comparatively large and irregular in shape. This may possibly be visible in Figures 2 and 3. Natural lapis may also show patches of white or colourless calcite, or these may occur in straight veins. Figure 4 shows polishing lines which would not be visible without magnification. The pyrite in almost all specimens examined tended to be slightly under-cut and the polish was far from perfect although the brassy mineral looked very bright. This is because the blue constituents are exceptionally soft and it is not advisable to continue polishing long enough to bring the harder pyrite to a fine polish. In the natural stones the pyrite crystals beneath the surface are still very complex in shape and are well keyed into the matrix. They scarcely ever lift out in polishing.

Another point became apparent when examining the different materials under a binocular microscope, and this applies to both the Gilson types of material. In all natural lapis it was found that areas occurred in which there was a shallow degree of transparency, probably to a depth of not more than a half millimetre, but quite obvious in the exaggerated 'depth' of stereoscopic vision given by such an instrument. The Gilson stones did not show this and were apparently quite opaque. I find that Anderson has noted this feature and the fact that the imitation does not show crystal outlines, in his ninth edition of *Gem Testing*.* However, I should

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*pp.144-5.—Ed.

point out that the pyrite in natural lapis is so complex in its twinned shapes that any simple crystalline outline is rarely to be identified. But the essentially greater diversity of shape is quite marked in the natural rock.

[*Manuscript received 1st April, 1981*]

ENSTATITE FROM MAIRIMBA HILL, KENYA

By Dr K. SCHMETZER and Dr H. KRUPP

Heidelberg, W.Germany

ABSTRACT

Enstatite of yellowish green colour from the region of the Mairimba Hill, Kenya, is described. The crystals have refractive indices of $n_x = 1.652$, $n_z = 1.662$, $\Delta = 0.010$ and a density of 3.23 g/cm^3 and owe their attractive colour to a content of 1.45% FeO and 0.22% Cr_2O_3.

During a visit to Kenya in the beginning of 1981, one of the authors (H. K.) received a number of crystal fragments with a yellowish-green colour. On cutting these fragments, transparent gemstones up to 2 ct in weight were obtained. The stones were tested by optical and x-ray methods and were determined as enstatites; the chemical and physical data for these stones are given later in this paper. According to our knowledge, enstatite crystals of gemstone quality were known to occur in East Africa, up to now, only from localities in Tanzania. No data for samples from Kenya are published or available.

Enstatite is the magnesium end member of the orthopyroxene solid solution series with the general formula of $(Mg, Fe)_2Si_2O_6$. From natural samples, a complete solid solution series between the end members enstatite, $Mg_2Si_2O_6$, and orthoferrosilite, $Fe_2Si_2O_6$, is known, but only crystals with iron-contents smaller than 16.32% FeO (enstatite and bronzite) are reported to occur of gemstone

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quality. Such crystals are described from localities in Tanzania, Sri Lanka, Burma, Arizona (U.S.A.), Brazil, Mexico, and India. The samples are green, yellowish-green or brown, and sometimes stones with asterism or chatoyancy are observed (Bank 1974, 1977; Dunn 1976, 1978).

Enstatites from Tanzania are brown or green. The samples probably originate from at least two or more different localities, which are not exactly known. The following physical data of crystals from these localities are published:

	green enstatite, Tanzania Bank (1974)	yellowish-brown enstatite, Tanzania Bank (1977)	brown enstatite, Tanzania Dunn (1976)
n_x	1.665	1.654	1.653
n_z	1.675	1.664	1.663
Δ	0.010	0.010	0.010
D[g/cm^3]	3.25	3.28	3.25

The optical data mentioned above show that the green enstatites are iron-rich while the brown and yellowish-brown stones are iron-poor members of the orthopyroxene solid solution series. By electron microprobe analyses of the second group samples, iron contents of 1.89 and 2.00% FeO were found (Dunn 1976).

The enstatite crystals investigated on this occasion were found in an alluvial deposit in the Mairimba Hill region, south of the Taita Hills, southern Kenya. Other gem minerals from this locality, which occur together with enstatite, are small fragments of actinolite. The actinolites are emerald green, due to a small chromium content and resemble the chromium-actinolite crystals from Merelani, Tanzania, described by Schmetzer and Krupp (1979). Unfortunately the actinolite fragments from Mairimba Hill are so small, that cut stones of this material are not available.

The enstatite fragments of the Mairimba Hill region are yellowish-green and show a weak pleochroism between a light green and an intensive yellowish-green. Optical data and density are: $n_x = 1.652$, $n_z = 1.662$, $\Delta = 0.010$, $D = 3.23$ g/cm^3. These values show only small differences compared with the data of the yellowish-brown enstatites from Tanzania and indicate a smaller iron content in the Kenyan enstatites.

A chemical analysis of enstatite from Kenya, done with the electron microprobe, is given in Table 1. The crystal contains only a

TABLE 1

Chemical data of enstatite from the region of the Mairimba Hill, Kenya.

Analysis by electron microprobe, in weight-%		cations calculated to O = 6	
SiO_2	55.57	Si	1.894
Al_2O_3	3.60	Al	0.145
Cr_2O_3	0.22	Cr	0.006
FeO	1.45	Fe	0.041
MgO	38.27	Mg	1.945
Σ	99.11	Σ	4.031

small iron content of 1.45% FeO, but also traces of chromium (0.22% Cr_2O_3). After normalization of the analysis to O = 6, a defined crystal chemical formula is

$$(Mg_{1\cdot95}Fe_{0\cdot04}Cr_{0\cdot01})_{\Sigma2\cdot00}\,(Si_{1\cdot89}Al_{0\cdot15})_{\Sigma2\cdot04}O_6.$$

The percentage of the iron-free end member enstatite is calculated to 98%. A comparison of the absorption spectra of some enstatite crystals from Kenya with the absorption spectra of enstatites from different localities, given by Runciman *et al.* (1973) and Rossman (1980), shows that the attractive colour of the stones is caused by the small contents of iron and chromium replacing magnesium in the enstatite lattice.

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[*Manuscript received 23rd September 1981.*]

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AN OCCURRENCE OF GEM QUALITY ELBAITE FROM GLENBUCHAT, ABERDEENSHIRE, SCOTLAND

By BRIAN JACKSON, F.G.A.

Department of Geology, Royal Scottish Museum, Edinburgh

Tourmaline is not uncommon in many of the schists, gneisses and granites of Scotland, but until the discovery of elbaite all tourmaline to date had been described as the black, non gem-quality, ferrous iron, species, schorl.

OCCURRENCE

The elbaite locality is approximately 0.8 km due north of Peatfold Farm, Glenbuchat, Aberdeenshire. Here mica schists and phyllites are overlain by foliated diorite, epidiorite and hornblende schists. Into these are intruded granite pegmatites and aplites, which are probably related to the large granite masses to the north and south. Although there are several granite pegmatites in the surrounding area, so far only one has produced gem-quality tourmaline. This pegmatite, although obscured for the most part by overburden, is clearly indicated by linearly distributed float material, running approximately ENE-WSW, with a tongue of float on the downslope side due to creep. Within the float there is a distinct lithological variation towards its centre. The rock changes from a normal coarse-grained granite pegmatite containing microcline, quartz, muscovite, and schorl tourmaline, with minor garnet and biotite, through graphic intergrowths of quartz-feldspar and quartz-muscovite, the latter containing minor amounts of blue-black schorl, into a lithium-rich pegmatite containing clevelandite, quartz, muscovite, lepidolite, elbaite and schorl. Accessory minerals include cassiterite, columbite-tantalite, zircon, galena, albite, arrojadeite and triplite. Apart from elbaite and lepidolite no other lithium minerals, such as spodumene and amblygonite/montebrasite, were found. Some minor chalcedony veining was also evident. This mineralogical and structural variation in the float indicates that the underlying pegmatite is complex and zoned. The distribution of the elbaite throughout the pegmatite is limited, but where found it is locally abundant,

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FIG. 1. Particoloured elbaite (14 × 2 mm). *(Crown Copyright Reserved)*

occurring as hexagonal prismatic crystals in a wide range of colours from pink and mauve to various shades of green, including blue-green. Some colourless (achroite) crystals also occur. Where the matrix consists mainly of muscovite and lepidolite, the elbaite is usually pink; sometimes with a thin exterior of green elbaite giving rise to the so-called watermelon structure. All colours, including the colour-zoned watermelon and particoloured crystals, are found where the matrix contains a significant amount of exceptionally fine-grained pale green muscovite coating euhedral to sub-hedral quartz and joint surfaces. The coloured elbaite crystals, although small, are practically all of gem quality. Their average size is in the order of 8 mm by 3 mm, but gem crystals up to several centimetres (max. 4 cm) have been found (Figure 1). Many of the larger pink elbaites have an unusual cavernous core partially filled with irregular rod-like structures aligned parallel to the prismatic faces (Figure 2). It is postulated that this structure is ultimately the result of channel leaching. Later generations of elbaite, not affected by such a mechanism, have long capillary-like growth tubes running

FIG. 2. SEM photograph of rod-like structures (×45). *(Crown Copyright Reserved)*

parallel to the prismatic faces, and these, in earlier generations, could possibly have acted as pathways for later leaching solutions. The channels could, however, be a function of exceptionally well developed growth striations formed during early crystallization or even skeletal growth. Often these channels and cavities are filled with muscovite, and rarely complete replacement of the pink core of watermelon tourmaline occurs. Other inclusions include shorter densely packed growth tubes, mica and twisted veils.

Many of the elbaite crystals show rupturing across the prism, sub-parallel to {0001}. Where the fracture pieces have moved apart, subsequent regeneration is evident. Some crystals also show healing of rupture scars by a later differently coloured elbaite.

PHYSICAL AND CHEMICAL PROPERTIES

Dark blue-black, blue-green, green and pink coloured varieties were analysed using an electron microprobe, and the resultant partial analyses are presented in Table 1 (boron, lithium and oxygen cannot be detected by the microprobe).

TABLE 1

Partial analyses of tourmalines from Glenbuchat

Colour	*SiO_2*	*Al_2O_3*	*FeO*-*	*MnO**					
			Na_2O			*CaO*	*Cr_2O_3*	*Total*	*Species*
very dark blue-black	34.83	35.51	12.73	0.92	1.35	—	—	85.33	schorl
very dark blue-black	35.51	35.40	13.42	0.91	2.04	—	—	87.28	schorl
blue-green	37.46	37.67	4.47	1.89	3.05	0.22	—	84.78	elbaite
blue-green	37.60	37.42	4.5	1.77	2.39	0.20	—	83.87	elbaite
green	37.13	37.77	4.58	1.66	2.50	0.18	—	83.82	elbaite
green	37.55	37.75	5.03	1.72	2.47	0.21	0.10	84.83	elbaite
pink	37.64	42.37	0.20	0.25	1.77	0.08	—	82.31	elbaite
pink	37.65	42.48	—	—	1.65	—	—	81.78	elbaite

*The iron and manganese content of Glenbuchat tourmaline has been calculated as divalent oxides but it may actually be in part or wholly trivalent.

These results are consistent with published data (Deer, Howie and Zussman 1963) for schorl and elbaite. The decrease in iron content is also consistent with changes in colour from blue-black through green (verdelite) to pink (rubellite).

The refractive index (RI), double refraction (DR) and specific gravity (SG) presented in Table 2 are also consistent with published data (Dunn 1975). These properties show the normal reduction in RI, DR and SG with reducing iron content. This is most noticeable

TABLE 2

Species	*Colour*	*Refractive Index*		*Double Refraction*	*Specific Gravity*
		ω	ε		
schorl	blue-black	1.660	1.630	−0.027	3.18
elbaite	blue-green	1.640	1.618	−0.022	2.988
elbaite	green	1.638	1.617	−0.021	3.039
elbaite	pale green	1.640	1.618	−0.022	2.980
elbaite	pale green	1.640	1.620	−0.020	3.047
elbaite	pink	1.630	1.611	−0.019	3.039
elbaite	pink	1.635	1.618	−0.017	3.022
elbaite	pink	1.633	1.615	−0.018	2.963

TABLE 3

Apparent Colour	*Pleochroic Colours*	
	ε	ω
dark blue-green	very pale green	blue-green
blue-green	colourless	blue-green
blue-green	pale blue-green	blue-green
blue-green	blue-green	blue-green
pale blue-green	colourless	pale blue-green
pink	colourless	pink
pink	pale pink	pink
pale pink	colourless	pale pink
purple pink	pale pink	dark pink

between schorl and elbaite with only minor variations in these physical properties between colour varieties. Table 3 gives the pleochroic colours.

CONCLUSION

The float material containing gem-quality tourmaline and indicating an underlying complex pegmatite represents a very interesting occurrence. The existing evidence indicates that the potential of the pegmatite as a gem producer is probably low, as only the very smallest of gemstones could be cut from the crystals discovered so far. Nevertheless further investigations in the area will be necessary to determine the actual nature, extent and gem-producing potential.

ACKNOWLEDGEMENT

I am most grateful to Mr Gordon Sutherland for allowing me to photograph his fine specimen of particoloured elbaite tourmaline.

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GROSSULAR GARNET FROM THE JEFFREY MINE, ASBESTOS, QUEBEC, CANADA

By WILLOW WIGHT, B.A., F.G.A., and J. D. GRICE, Ph.D.

National Museum of Natural Sciences, National Museums of Canada, Mineral Sciences Division,
Ottawa, Ontario, K1A OM8, Canada

The Jeffrey Mine is the second largest asbestos deposit in the world. Located about 160 km east of Montréal, the Jeffrey Mine has been producing since 1881. Now owned by the Canadian Johns-Manville Company, it supplies about 13% of the world production of chrysotile asbestos (some 600 000 tonnes a year) from an open pit which measures over 275 m deep and 1250 m across. Grice and Williams (1979) have given an overview of the geology and notable minerals (at least 66 mineral species are represented) of this locality.

Grossular garnet, associated with diopside, K-feldspar and quartz, is most commonly found on granitic rocks that intrude the Jeffrey Mine ore body. The grossular varies from colourless through shades of white, pink, orange and green (Figure 1). Since about 1950, the orange-coloured variety, hessonite, has been known to mineral collectors in North America and Europe with individual crystals ranging up to 3 cm in diameter. Some have been faceted into beautiful gems. The collection of the National Museum of Natural Sciences contains gems of 24 and 14 carats

FIG. 1. Grossular garnet from the Jeffrey Mine, Asbestos, Québec, Canada. Hessonite (NMNS #20206) 8.5 ct, 13 × 11 mm.

FIG. 2. Grossular, hessonite variety (NMNS #32028) Crystal diameter is 1.3 cm.

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which are particularly noteworthy. Smaller gems in the 1-5 carat range and small crystal groups mounted in jewellery have been commercially marketed in Canada with some success.

The green grossular, which has been incorrectly reported as uvarovite, is much less abundant than hessonite. Green grossular crystals also are smaller, commonly less than a centimetre across. The one faceted gem in the National Museum's collection weighs only 0.25 carat and has many inclusions.

A few crystal specimens of colourless to pale yellow grossular have been observed at the Jeffrey Mine over the years. Recently, six faceted colourless grossular gems were brought to the National Museum of Natural Sciences by Frank and Wendy Melanson, of Hawthorneden, Bannockburn, Ontario. To our knowledge, these are the first of their kind, and they have been described by Wight and Grice (1981).

A few crystal specimens of an attractive pale pink colour are known, but no suitable faceting material has been found.

Only two crystal forms have been observed on the Jeffrey Mine grossulars: the rhombic dodecahedron d{110}, which has 12 faces, and the trapezohedron n{211}, which has 24 faces. These forms may occur independently or may be combined in the same crystal. Crystals showing both forms exhibit bright, even,

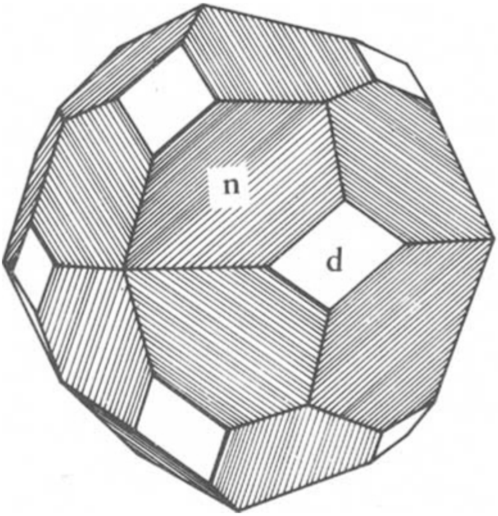

FIG. 3. Sketch of grossular crystal in Figure 2. Crystal forms are the trapezohedron n{211}, which is lined to represent striations, and the rhombic dodecahedron d{110}.

TABLE 1. Chemical Analyses of Grossular

Colour	COLOURLESS				PINK	HESSONITE		GREEN		
SPECIMEN	IDEAL	NMNS 43018	NMNS 40146 (rim)	TANZANIA*	NMNS 37489	NMNS 32755	SRI LANKA	NMNS 40146 (core)	KENYA	TANZANIA*
REFERENCE	Deer *et al.*, 1962		Grice & Williams, 1979	Muije *et al.*, 1979		Grice & Williams, 1979	Bauer, 1904	Grice & Williams, 1979	Gübelin & Weibel, 1975	Muije *et al.*, 1975
CaO	37.36	38.3	37.74	39.7	37.8	36.84	30.57	35.88	35.1	34.5
Al_2O_3	22.63	22.1	21.69	19.9	21.9	22.17	23.00	17.04	20.9	20.5
SiO_2	40.01	39.8	39.49	39.5	39.4	39.29	40.01	37.80	38.7	42.5
Na_2O		0.0	0.00		0.0			0.00	0.1	
MgO		0.0		0.1	0.0	0.00	0.33	0.03	0.5	0.3
TiO_2		0.0	0.06	0.4	0.2	0.05		1.20	0.25	0.3
V_2O_3		0.0		0.06	0.0				3.3	1.2
Cr_2O_3		0.2		0.0	0.2	0.01		6.97	0.19	0.12
MnO		0.1	0.31	0.2	0.5	0.57	0.59	0.77	0.75	0.5
FeO		0.4	0.47	0.1	0.5	1.85	3.31	0.94	0.05	0.1
Total	100.00	100.9	99.76	99.96	100.5	100.78	97.81	100.63	99.84	100.02
R.I.	1.734	1.734	1.734		1.736	1.738		1.742		
R.I. gems		1.733 (6 gems)		1.731 to 1.732		1.736 to 1.741 (7 gems)	1.753 NMNS 20213	1.738 NMNS 20619	1.739 to 1.744	

*faceted gems

dodecahedral faces while the trapezohedral faces are heavily striated (Figures 2, 3)—the result of oscillatory growth between the dodecahedral and trapezohedral forms. This oscillatory growth is also illustrated in the growth dislocation inclusions observed (Wight and Grice, 1981) in the faceted colourless grossulars.

Chemical analyses of the four different colours of grossular were performed on an electron microprobe, using an energy dispersive spectrometer for all samples except for specimens numbered 40146 and 32755 where a wavelength dispersive spectrometer was used. The results are given in Table 1, together with comparable analyses from the literature. When possible, the corresponding refractive index was determined by grain mounts in oil immersion. The refractive index of the faceted gems in the Museum's collection was measured in sodium light with a Rayner Dialdex refractometer. These values are included at the bottom of the table. All gems from the Jeffrey Mine, with the exception of the green grossular, showed anomalous double refraction and strain colour fringes when viewed between the crossed polars of a polariscope.

Chemically pure grossular, $Ca_3Al_2(SiO_4)_3$, is colourless and has a refractive index of 1.734 (Deer *et al.,* 1962). Its crystal structure is such that it readily accepts a number of cation substitutions, most frequently some elements from the first transition series of metals (titanium, vanadium, chromium, manganese and iron). With the substitution of these elements, colour is imparted to the mineral, and the colour intensity and refractive index increase proportionally with increasing amounts of these cations.

For the Jeffrey Mine grossular specimens the following observations and comparisons can be made. The colourless variety is almost pure end-member grossular with $\eta = 1.733$. This is similar to the colourless grossular from Tanzania (Muije *et al.,* 1979). A yellow tint in the Jeffrey grossular is probably caused by very minor amounts of iron. The pale pink variety contains approximately the same amount of iron as the colourless grossular (Table 1), but in addition there is a minor amount of manganese ($\sim$0.5 wt% MnO), which is likely responsible for the pink colour. With such a pale tint the refractive index does not change appreciably from that of pure grossular. The hessonite contains significant iron ($\sim$2 wt% FeO) and its refractive index has increased accordingly. The Jeffrey hessonite is orange as compared to the Sri Lanka hessonite, which is a darker cinnamon-brown colour because of its higher iron content. This results in an even higher refractive index. The green colour and increase in refractive index of the Jeffrey Mine grossular is attributed to chromium. The analysis given in Table 1 is for a dark-green example but Grice & Williams (1979) found that as little as 0.25 wt% Cr_2O_3 imparted a pale green colour. The Jeffrey Mine chromium-bearing grossular has the same hue as the vanadium-bearing grossular from Kenya and Tanzania (Gübelin & Weibel, 1975; Muije *et al.*, 1979). The effect of titanium is uncertain but it is present in the Jeffrey Mine grossular as well as those from Kenya and Tanzania. There is no apparent correlation between titanium content and colour intensity or hue.

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FLUORITE INCLUSIONS IN TOPAZ FROM NIGERIA

By S. HORNYTZKYJ, F.G.A.

While examining colourless water-worn pebbles of topaz from Nigeria (Figure 1) under the microscope, I observed small (41µm to 595µm) transparent light yellow and light green, and transparent colourless to milky, crystal inclusions in several topaz pebbles. What the inclusions seemed to have in common was the cubic crystal system to which they belonged: they were either cubes, octahedrons and rhombic dodecahedrons or their combinations (Figures 2 to 10). The decreasing order of their abundance in the examined topaz pebbles was: (1) different combinations of cube, octahedron and rhombic dodecahedron; (2) octahedron; (3) cube; (4) rhombic dodecahedron. The inclusions occurred singly or as clusters, and the different forms and their combinations were often

FIG. 1. Part of the examined topaz pebbles from Nigeria.

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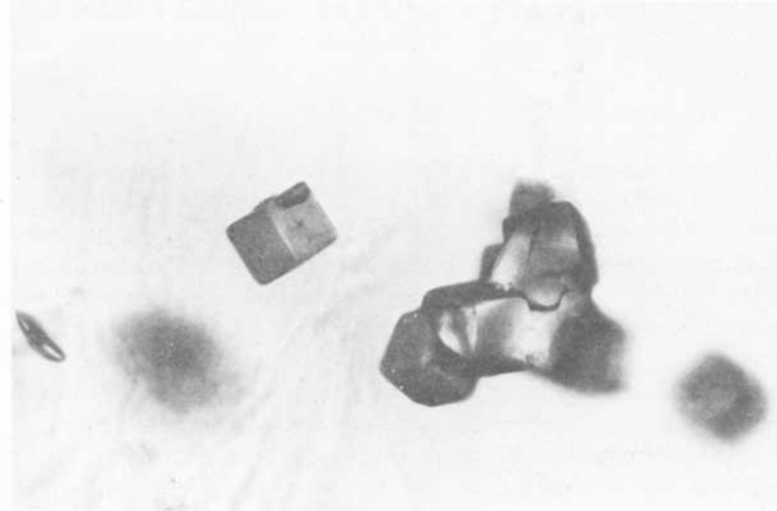

FIG. 2. Cubic fluorite inclusions in a topaz from Nigeria. (190 ×)

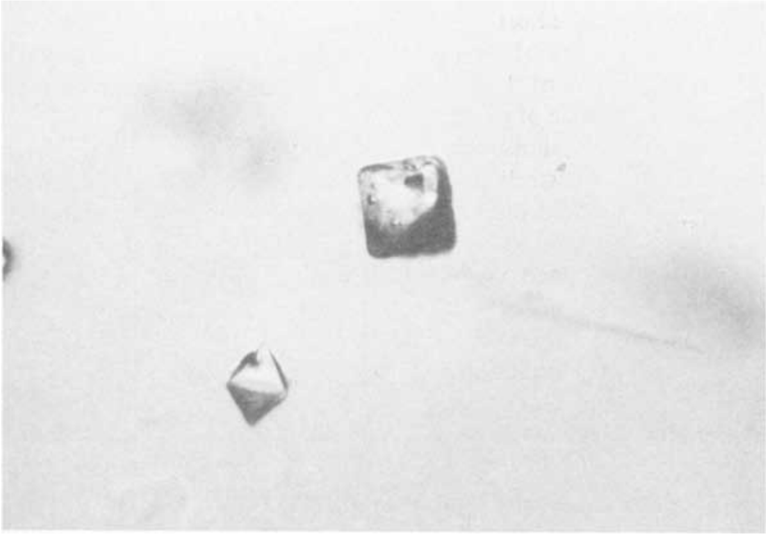

FIG. 3. Octahedral fluorite inclusions in a topaz from Nigeria. (140 ×)

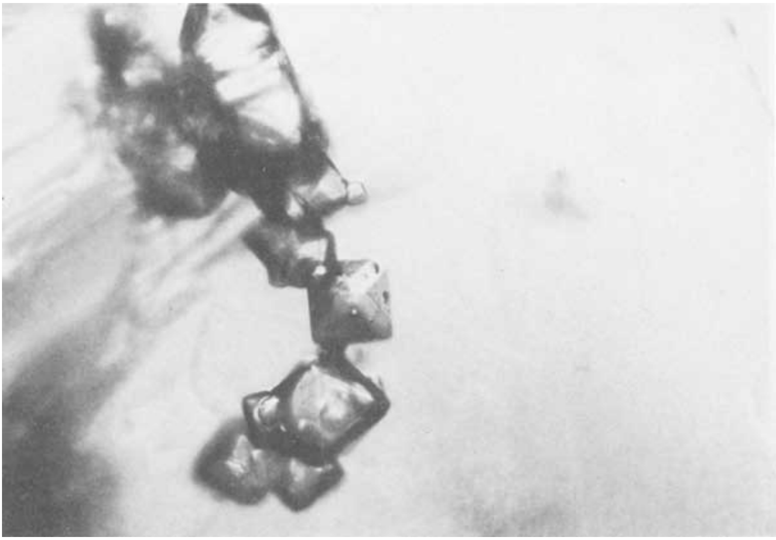

FIG. 4. Cluster of fluorite inclusions (a combination of octahedron and rhombic dodecahedron at the centre) in a topaz from Nigeria. (180 ×)

met together in one and the same host crystal. Generally they showed no particular orientation in respect to the host topaz, although they sometimes appeared to be embedded in some earlier crystal faces of the host. The inclusions often had a surface texture closely reminiscent of etch figures and growth hillocks (Figures 5 and 9), and some of them contained fluid inclusions consisting of liquid and a bubble of gas (Figure 10).

Of the inclusions, the cubic ones greatly resembled those described by Webster(1) as a characteristic feature in topaz from Nigeria, which according to him are probably fluorite crystals. As it was impossible to identify the inclusions merely on the basis of the before-mentioned observations, some of the topaz pebbles with numerous inclusions of the types already described were cloven in very thin plates, and from these a few whole crystals were hand-picked for more detailed study.

The crystals were isotropic between crossed polars. Microscopical examination in different liquids of known refractive indices gave a value 1.43, strongly indicative of fluorite. This conclusion was confirmed with a series of x-ray precession photographs, which proved these crystal inclusions to be fluorite crystals.

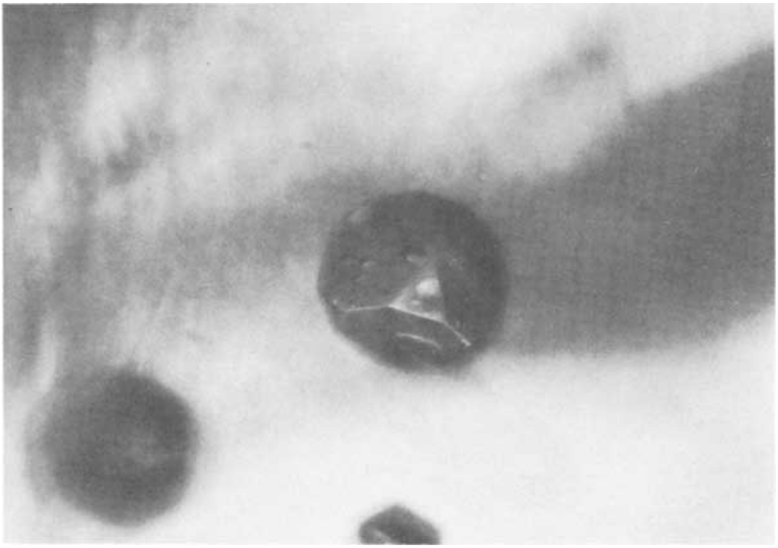

FIG. 5. Fluorite inclusion (a combination of cube and octahedron) with a surface texture resembling growth hillocks in a topaz from Nigeria. (110 ×)

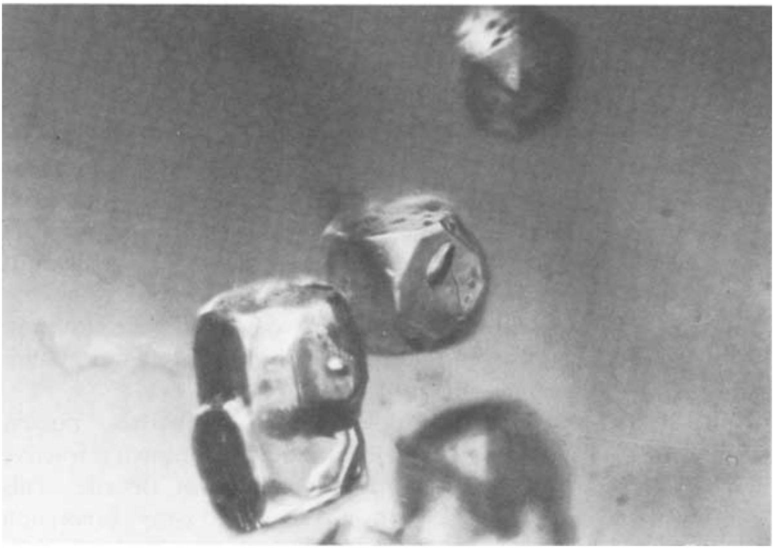

FIG. 6. Fluorite inclusions (a combination of cube, octahedron and rhombic dodecahedron at the centre) in a topaz from Nigeria. (160 ×)

FIG. 7. Fluorite inclusion (a combination of cube, octahedron and rhombic dodecahedron) in a topaz from Nigeria. (210×)

Colourless topaz is found as crystals and as rolled pebbles in the surroundings of the tin-workings of Rop in northern Nigeria,(1) the locality from which the examined topaz pebbles were derived. The crystals occur there in the altered biotite granites in greisen veins caused by the younger granitic intrusions of the plateau.(2, 3) The water-worn topaz pebbles are found in streams, and in alluvial gravel deposits originated with the biotite granites. Because fluorite is widespread as an accessory mineral in the greisen veins,(4) its occurrence in the topaz refers to common origin.

Well formed fluorite crystals were quite common as inclusions in the examined colourless topaz pebbles from Rop, Nigeria. Their presence in a topaz, either rough or cut, would thus seem to give a good indication of this particular locality. In addition, the two-phase inclusions found in the fluorite crystals could possibly be used in fluid inclusion thermometric study, in combination with the excellent fluid inclusions also occurring in the host topaz, to acquire valuable information about the geological conditions under which these two minerals crystallized.

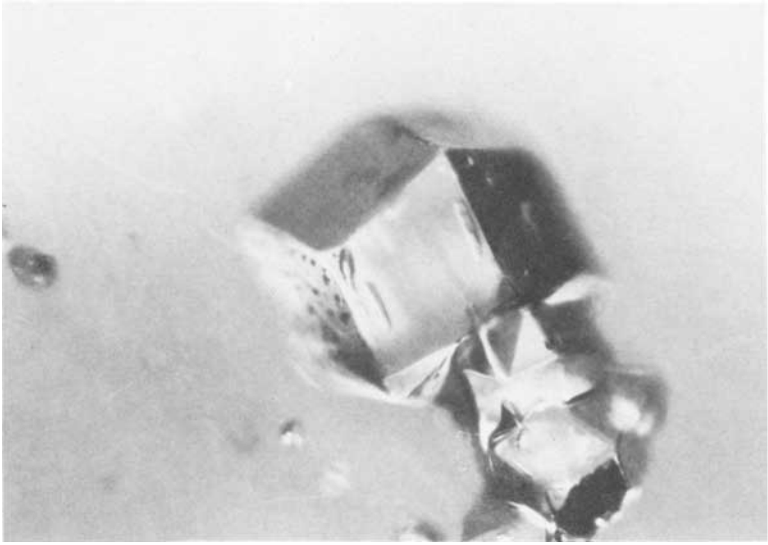

FIG. 8. Cluster of fluorite inclusions (a large rhombic dodecahedral crystal at the centre) in a topaz from Nigeria. (170 ×)

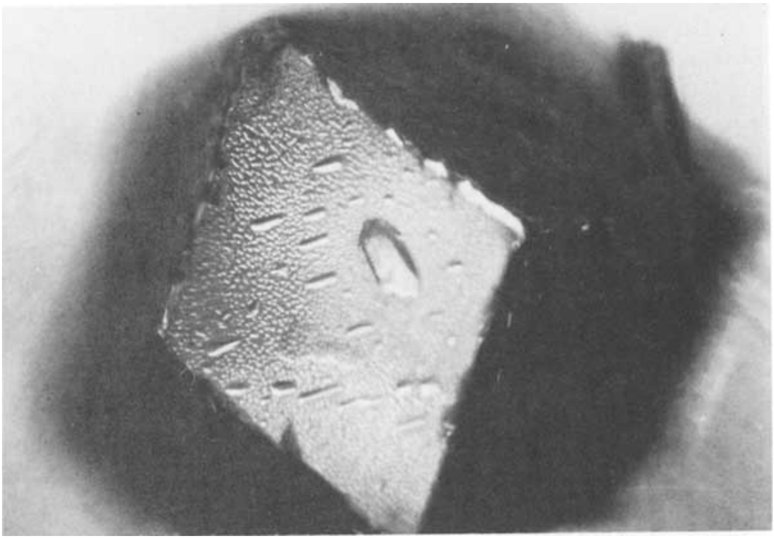

FIG. 9. Surface texture reminiscent of etch figures on the 110 face of a fluorite inclusion in a topaz from Nigeria. (165 ×)

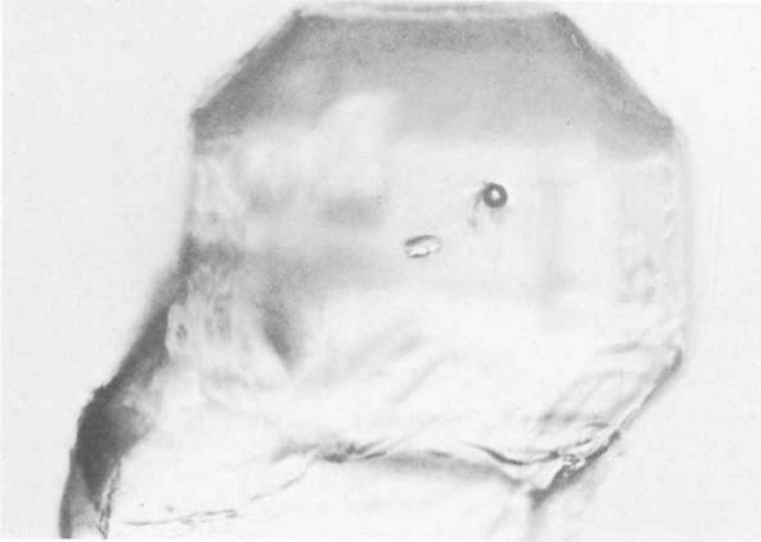

FIG. 10. One fluid inclusion and a smaller mineral inclusion in a fluorite crystal. The crystal itself is embedded in a topaz from Nigeria. (160 ×)

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A CONTRIBUTION TO THE SEPARABILITY OF NATURAL AND SYNTHETIC EMERALDS

By HENRY A. HÄNNI, Ph.D., F.G.A.

Minerlogical Institute, University of Basel, and Swiss Foundation for the Research of Gemstones, Zurich, Switzerland

There are various features to be used as a means of discriminating between natural and synthetic emeralds. In general, refractive indices and birefringence are lower in synthetic stones. Also the specific gravity is lower in synthetic stones in comparison with natural. But again there are exceptions, like Linde and Lechleitner hydrothermal synthetics (Webster, 1975). Another diagnostic feature is fluorescence. It cannot be used exclusively but has its diagnostic value only in connexion with other observations. A very important criterion is the internal aspect, i.e. the inclusions and growth marks. In many cases observation of these allows a rapid and secure diagnosis (Gübelin, 1969). But too often inclusions are lacking or undiagnostic, being difficult to interpret or never having been seen before. At the same time, the physical constants may be found to be in the overlapping region between natural and synthetic stones. In such troublesome cases the ingenious gemmologist has to look for new methods and sometimes is well advised to borrow techniques from neighbouring sciences. I have in mind, for instance, the method of x-ray topography (Schubnel and Zarka, 1971), which reveals characteristic growth defects in crystalline matter.

We know emeralds as a variety of beryl. Its green colour derives from a small admixture of Cr, but V and Fe may contribute to this colour too. Besides these visible impurities in originally colourless beryl there may be invisible impurities as well. These are elements which do not lead to absorptions in the visible part of the spectrum and thus do not cause colour. This contamination in the atomic dimension is best seen from chemical analyses of different beryls (Bakakin and Belov, 1962). In Table 1 chemical analyses of two emeralds (one synthetic, one natural) are presented in comparison with the theoretical concentrations calculated from the beryl formula. Gilson synthetic emerald is still very close to the ideal composition, containing a small proportion of Cr which

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replaces some Al in the crystal lattice. The natural emerald from Sandawana, however, is far away from the ideal beryl composition. It has considerable amounts of Na_2O and MgO and a certain content of FeO, MnO and, of course, Cr_2O_3.

TABLE 1

Theoretic and real compositions of beryl and emeralds in comparison

	$Be_3Al_2Si_6O_{18}$	Gilson synth. emerald	Sandawana, Zimbabwe
SiO_2	67.0	67.0	64.2
Al_2O_3	18.9	17.8	15.1
TiO_2	—	—	0.0
FeO	—	—	0.2
MgO	—	0.1	2.4
MnO	—	—	0.2
K_2O	—	—	0.0
Na_2O	—	0.1	2.4
Cr_2O_3	—	0.6	0.3
V_2O_3	—	—	0.0
BeO	14.1*	14.0*	13.9*
H_2O	—	—	2.0**
	'pure'	⟶	'impure'

* Stoichiometric content of BeO. Be is not detectable by microprobe.

** This value is put from experience and gives only the range of H_2O concentrations expected in natural emerald (Hänni, 1980).

It would therefore appear that this difference in purity could be a basic diagnostic feature in distinguishing between natural and synthetic emerald. To test this, 45 cut stones of different origins and manufacturers were examined. They were analysed chemically by electron microprobe (see Appendix, p.144); on every sample four point analyses were carried out. The purpose of this investigation was to check whether the result found would be characteristic and to a certain extent safe. Obviously 45 stones cannot represent the whole range of emerald compositions found today. Nevertheless the diagrams (Fig. 1) give persuasive evidence of useful and characteristic differences between natural and synthetic emeralds, capable of being used as a means of discrimination.

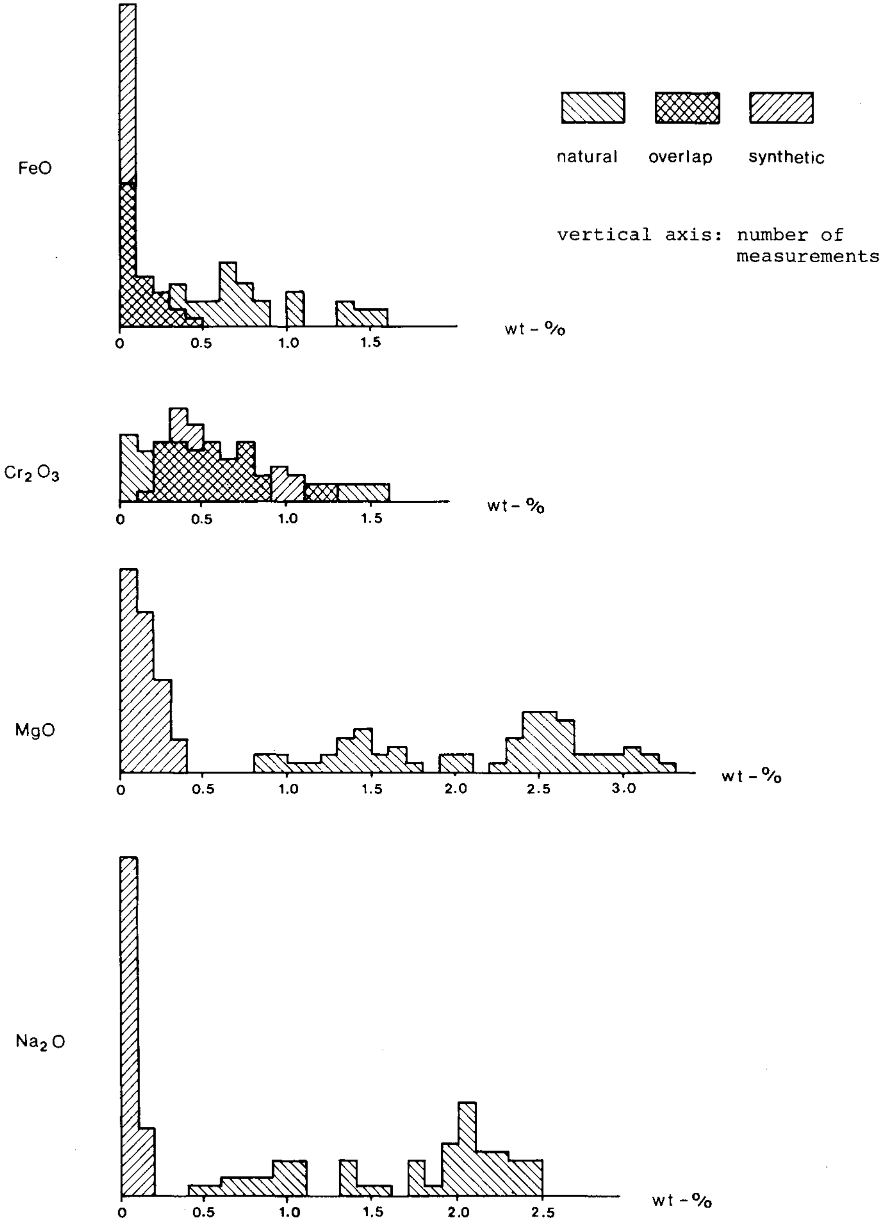


FIG. 1. Comparitive graphs of minor element concentrations in natural and synthetic emeralds.

(Vertical axis: number of measurements. Horizontal axis: weight %.)

NATURAL EMERALDS

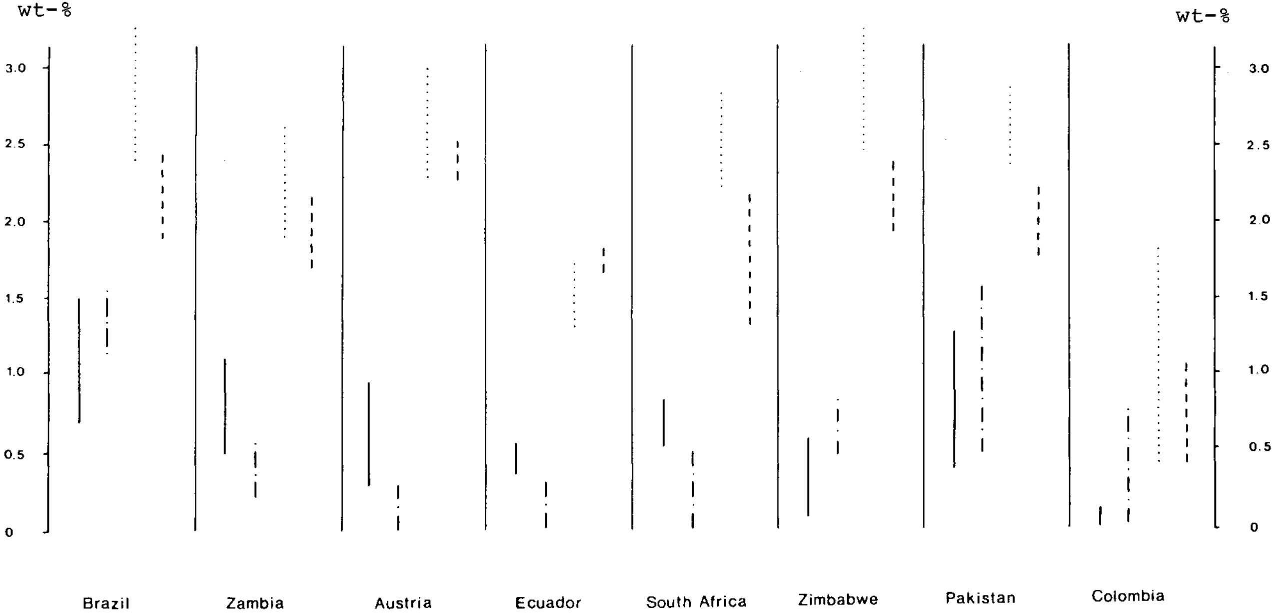
The concentrations of Cr_2O_3, FeO, MgO and Na_2O were plotted against the number of measurements (Figure 1). Also, the variations of contents show typical patterns for the different localities (Figure 2). Other main elements were not very rewarding in respect of separability. Minor elements and traces showed slight differences in emeralds from different localities or were below the detection limit of the microprobe. The concentrations of MgO and Na_2O may satisfactorily be used to distinguish between natural and synthetic emerald. The lowest MgO concentration found was 0.8 wt%, but most of the stones contained between 1.5 and 3.0% MgO, typically being around 2.0%. Cr_2O_3 and FeO concentrations of natural and synthetic emeralds overlap and thus have no diagnostic value. A surprising result came from a stone labelled 'emerald, Conquista, Brazil'. It contained no chromium, but 0.7% V_2O_3 and 0.9% FeO (Taylor, 1977).

SYNTHETIC EMERALDS

The contents of MgO and Na_2O are distinctly lower, leaving a broad gap between synthetic and natural stones. The MgO concentrations are frequently 0.1% going up to 0.4% in some Lechleitner products. Also the Na_2O concentrations are clearly set off from the lowest natural emeralds. Most of the synthetic emeralds do not contain measurable amounts of Na_2O, while natural emeralds showed at least 0.4%. The highest value found was 0.2% Na_2O in a Lechleitner Sandwich.

Two more observations are worth mentioning: Linde hydrothermal synthetic emerald always had 0.3-0.4% Cl. And Lechleitner synthetic emerald coated beryls showed surprisingly high Cr_2O_3 concentrations (6.5-7.5%) and according to Bank (private communication) up to 13.2%. The netlike fissures in this overgrowth, well known from microscopic examinations, are best explained by the differences in lattice dimensions caused by the larger Cr^{+3} ions on Al sites.

FIG. 2. Variations of minor element concentrations in emeralds of different origins.



DISCUSSION

Microprobe analysis as a chemical technique has been introduced in gemmology for some years (Gübelin, 1969; Dunn, 1977). Its application in this field becomes more and more popular with the increasing number of instruments installed. Thus chemical information is much more easily available. The most important condition in identification of gemstones is to work non-destructively. This premise and the need to obtain chemical data are entirely fulfilled by microprobe technique.

Analysing a cut emerald in this way yields important information, as shown above. If concentrations of Na_2O and $MgO > 1.0\%$ are detected, it seems that such material can be considered as natural emerald. Only Colombian emeralds tend to be purer and occasionally only slightly exceed this lower limit. New synthetic products as well as many more natural emeralds need to be analysed to obtain a more complete account of the 'invisible impurities'. Other parameters, like H_2O content and trace element concentrations, are potential features for a separation as well. But their determination is either not non-destructive or the method is not yet a routine procedure.

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For the APPENDIX, see next page.

[*Manuscript received 11th June, revised 19th August 1981.*]

APPENDIX: Microprobe partial analyses of natural and synthetic emeralds (see p.139 above).

Natural Emeralds

	Brazil		Zambia		Ecuador		South Africa		Zimbabwe		Pakistan		Colombia		Trapiche		Austria		
SiO_2	64.7	63.6	63.7	63.9	65.6	65.9	64.9	65.4	63.7	63.2	64.2	63.7	66.4	66.6	65.2	64.6	63.0	63.4	SiO_2
Al_2O_3	16.1	13.4	14.2	14.9	16.9	16.4	14.8	16.6	14.3	14.1	14.8	13.7	16.9	17.7	16.3	16.3	14.3	14.5	Al_2O_3
TiO_2	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	TiO_2
FeO	.6	.8	.7	1.1	.7	.8	.8	.7	.4	.6	.4	1.3	.0	.0	.0	.0	.7	.5	FeO
MgO	1.8	3.0	2.4	2.1	1.4	1.7	2.6	1.6	3.1	2.6	2.7	2.4	1.4	1.0	1.0	1.2	2.4	2.6	MgO
MnO	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	MnO
Cr_2O_3	.4	.0	.4	.3	.2	.2	.2	.2	.5	.6	.8	1.4	.2	.3	.2	.2	.1	.2	Cr_2O_3
V_2O_3	.0	.9	.0	.0	.1	.0	.1	.0	.0	.0	.1	.0	.3	.4	.8	.6	.0	.0	V_2O_3
Na_2O	1.6	2.3	2.0	1.7	1.4	1.5	2.1	1.3	2.3	2.1	2.1	1.9	1.0	0.6	.8	.8	2.0	2.0	Na_2O

Synthetic Emeralds

	Lechleitner Emerita Sandwich				Linde		Chatham		Japan Crescent vert		Gilson			Zerfass	Lennix		
SiO_2	64.7	64.6	65.2	65.9	66.1	66.2	66.8	68.0	67.1	66.8	67.6	66.3	66.9	66.7	66.4	66.0	SiO_2
Al_2O_3	13.9	18.0	18.2	17.7	18.6	18.8	19.5	19.1	19.8	19.9	19.3	19.3	19.4	19.4	18.1	18.7	Al_2O_3
TiO_2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	TiO_2
FeO	.0	.0	.2	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	FeO
MgO	.3	.0	.2	.1	.0	.2	.2	.2	.3	.3	.0	.4	.0	.2	.0	.0	MgO
MnO	.1	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.2	.0	.0	.0	.0	MnO
Cr_2O_3	7.0	.6	.5	.5	.8	.5	.4	.8	1.0	.9	.3	.6	.8	1.0	1.4	1.9	Cr_2O_3
V_2O_3	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0	.0	.1	.0	.1	.0	.0	V_2O_3
Na_2O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	Na_2O
Cl	.0	.0	.0	.0	.3	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	Cl

for analytical details see Hänni (1980)

DISTINCTION OF NATURAL AND SYNTHETIC RUBIES BY ULTRAVIOLET SPECTROPHOTOMETRY

By G. BOSSHART, M.Sc., G.G.
Swiss Foundation for the Research of Gemstones, Zurich, Switzerland.

ABSTRACT

For the purpose of securing the identification of natural and synthetic rubies (the inclusions of the latter are becoming increasingly scarce and unspecific), a procedure has been set up which evaluates their differential transmission behaviour in the ultraviolet region (Figures 1 and 2). This is the refined version of former investigations by short-wave immersion contact photography. The method is diagnostic, with the Burma rubies at the front of the natural ruby populations and certain Chatham, Kashan and Knischka stones at the respective front opposed to the natural populations areas (Figures 3 and 4).

An absorption band at 266 nm, presumably due to Ti^{3+}, and weak Fe^{3+} bands affect the position, width and depth of the UV absorption minimum. Elevated titanium contents are the cause of the abnormal dichroism so far observed only in Kashan synthetic rubies. Vanadium and manganese are present in minor amounts and appear only in some fluorescence excitation spectra if at all (Figure 5).

CONTENTS

(1) INTRODUCTION

Rubies as well as sapphires and emeralds belong to the most coveted class of coloured gemstones. It is due to this fact that commercial crystal growth still concentrates in a large measure on these three varieties. As a consequence of the increasing

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improvement of these growth techniques, e.g. by influencing the inclusion patterns of the synthetic stones, new or refined identification methods become indispensable.

The examination of the ultraviolet (UV) transparency aimed at distinguishing between natural and synthetic rubies does not really represent a new means of diagnosis. The method applied hereto however was empiric and barely semi-quantitative. It was a matter of photographically recording the differential transmission behaviour of rubies exposed to short-wave UV irradiation (immersion contact photography). These pictures are difficult to interpret, at least for natural low-iron rubies and iron-bearing synthetic samples. The following investigation presents the refinement of the method in terms of measurement data which can be assessed from the UV-VIS absorption spectra of the rubies and which allow a diagnosis.

(2) TEST SPECIMENS

Ninety-four rubies from Burma, Sri Lanka, Kenya, Tanzania and Thailand, a few rubies from Hunza (Pakistan), Cambodia, Brazil and Australia and forty-six synthetic rubies were analysed. The synthetic stones were from productions by the Verneuil, Chatham, Kashan and Knischka procedures (Knischka & Gübelin, 1980) and of older as well as of latest date. Apart from ruby-red samples, purple, brownish-red and pink to pink-orange varieties were tested also, provided that they showed a minimum chromium content. At the conclusion of the investigation, approximately 250 absorption spectra could be disposed of. They may be considered trustworthy, since the inclusion patterns confirmed the gemstone dealers' indications of origin.

(3) ABSORPTION MEASUREMENTS AND RESULTS

A detailed description of the measuring procedure follows to enable other analysts to verify the results on their own photometer.

a. *Measuring Instrument and Recording Conditions*

All spectra were run on a Pye Unicam SP8-100 UV-VIS spectrophotometer. This is a so-called double-beam, ratio-recording instrument containing a grating monochromator, coated optical parts, automatic lamp and filter changes, end-on photomultiplier (detector), wavelength programmer unit,

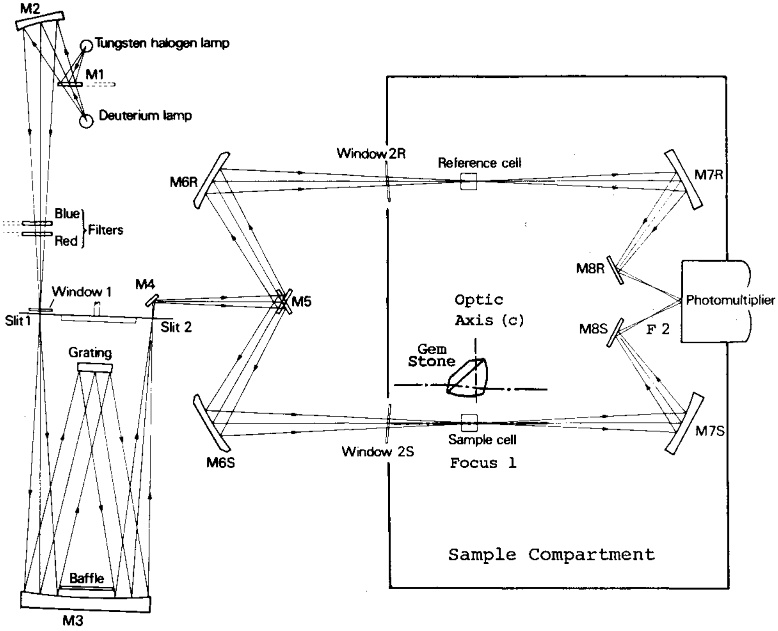

FIG. 1. Optical light-path in a Pye Unicam SP8-100 UV-VIS Spectrophotometer, from lamp-house (top left) via grating monchromator (bottom left), beam chopper (rotating mirrors M5) and sample compartment to the detector (photomultiplier). The gemstone is positioned in the first focus of the sample beam, with the optic axis ideally parallel or perpendicular to one of the directions of transmissibility. For gemstone spectra the reference beam is free (no cell).

automatic gain control and built-in recorder. The instrument scans from 900 to 190 nm. The detector is less sensitive at both ends of the spectral range (Figure 1).

For comparable survey diagrams, the following instrumental conditions were found to be optimal: spectral bandwidth 0.5 nm, wavelength range 800 (or 700) to 200 nm, scan speed 1 nm/sec, recorder advance rate 20 sec/cm, scale of registration 20 nm/cm and recording width 2 A (sensitivity, in absorption units).

In the sample compartment of the instrument, the reference and sample beam, symmetrical to each other, are focused at two points. Most rubies could be analysed in the first focus of the sample beam. This resulted in undisturbed, reproducible and specific spectra. Small rubies had to be measured in the second focal plane immediately in front of the detector. A difference in the character of the absorption curves which would have to be attributed to a fluorescence influence, however, was not noted, and stray-light effects made their appearance only above 650 nm.

Without applying expensive polarizer equipment, it was intended to position the sample in the beam in an orientated manner and to record absorption spectra which would be as separated as possible for the vibrations of the ordinary (o) and extraordinary ray (e). Sometimes size, shape, proportions and orientation of the cuts impeded the registration of oriented spectra. Due to the almost random orientation of the optic axis *(c)* relative to the mostly oval stone shapes and due to the transmissibility being essentially limited to two directions, it was not always possible to run parallel and perpendicularly to the *c*-axis. It is noteworthy that the proportion of the o- and e-vibration can easily be estimated from the registered spectra (e.g. absorption $475>476$ nm for o and $476>475$ nm for e). Unpolarized light travelling perpendicular to *c* shows a mixture of the o- and e-component. In the ray parallel to the *c*-axis, the e-vibration cannot possibly occur but only the pure o-component. Therefore it is remarkable that e was, none the less, frequently encountered in the spectra.

b. *Transmission and Absorption*

The notions transmission, absorption, concentration, colour hue, colour saturation and colour purity may briefly be set into relation to each other.

Transmission T (correctly: transmittance) of a matter is defined as the proportion of transmitted to incident light intensity I ($T = I_t/I_0$). It is inversely and logarithmically connected with the absorption A (correctly: absorbance) by

$$A = \log 1/T = -\log T.$$

Range of T:	100%	30%	10%	1%	0.1% ($=10^{-3}$)	.....	0%
Range of A:	0	0.5	1	2	3	.....	∞

It can be deduced from the comparison of T and A that transmission produces less specific spectra than absorption for values of T below about 30%.

In addition the absorption is *linearly* related to the concentration C of the absorbing elements and to the light path length L (Lambert-Beer law $A = kCL$, where k is the wavelength-dependent absorption coefficient).

The transmission of many coloured gemstones distinctly is inferior to 30%. Their elevated absorption levels are responsible for this state but also the high light losses on the outside and inside of the irregular gemstone bodies. A direct determination of the chromophore contents from the absorption maxima and stone sizes consequently is not possible (or at best approximately by a colourless cut corundum in the reference beam and by external chemical calibration).

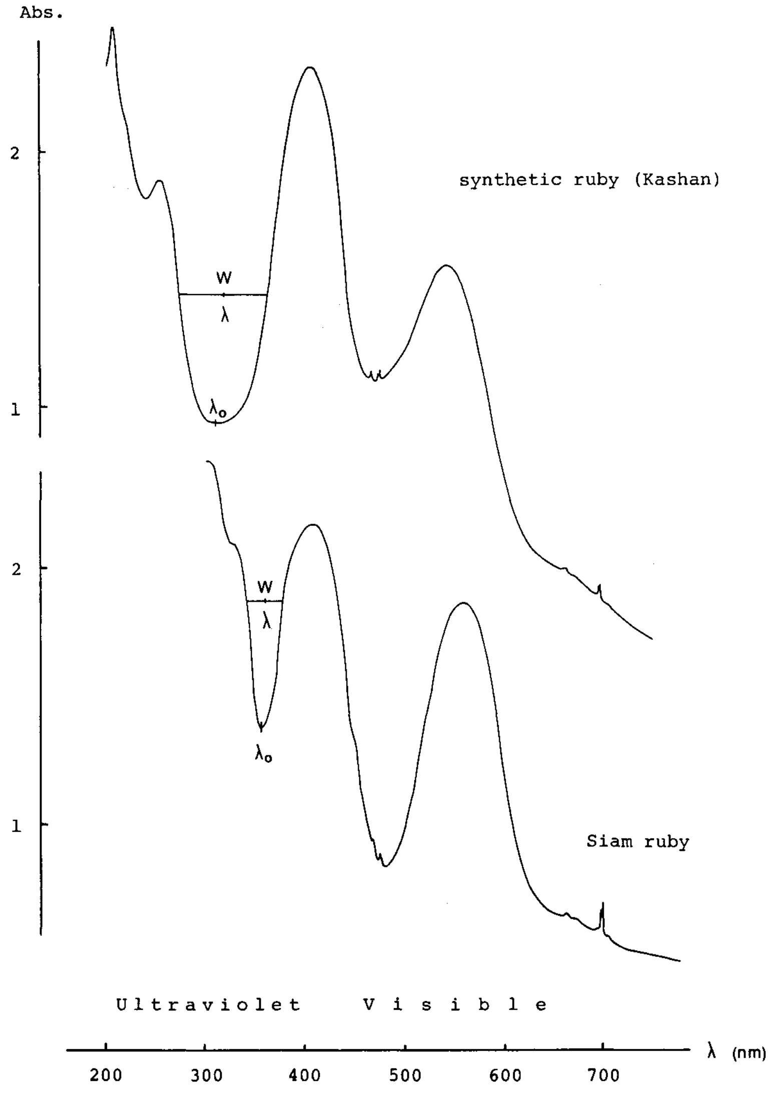

FIG. 2. Oriented absorption spectra of a natural ruby from Thailand (2.267 ct, vibrational component o>e) and of a synthetic ruby by Kashan (2.898 ct, vibrational component e>o) with characteristic differences in position, width and depth of the ultraviolet absorption minima. Evaluation by means of the position λ of the absolute minimum and by the profile parameters λ and W. Chromium bands near 550 and 405 nm (see section (3)c.—Ruby Spectra) and chromium lines e.g. near 693, 476 (doublets) and 469 nm. Absorption figures are approximate.

The hue of a gemstone colour corresponds to the sum of the wavelengths transmitted in the visible part of the spectrum (Figure 2, in rubies: red, stronger than blue). It is complementary to the absorbed colours.

The saturation of a gemstone colour depends on the depth of the transmitting visible areas (absorption minima) lying between the absorption bands.

The colour purity is a function of the strength and steepness of the absorption bands.

Each of the above-mentioned optical properties depends on the chromophore concentrations of the solids. In addition the absorption and colour saturation depend on the size of the sample.

The absorption maxima differ from the minima in that the maxima mostly are disturbed, in variable strength, by reflection and diffusion effects (polish, inclusions of the gemstone bodies). Experience shows that the position and shape of the minima, on the other hand, are influenced almost exclusively by the chemical composition of the specimens and can therefore be used as criteria for identification work.

c. *Ruby Spectra*

Prior to the evaluation of the ruby spectra, the influence on the UV absorption minima of the trace elements concerned is sketched below.

Pure colourless corundums absorb neither in the UV nor in the visible. They possess an absorption edge below 200 nm. Any deviations from this spectrum have to be ascribed to the presence of chromophores (Schmetzer & Bank (1981); only exception: lattice defects in irradiated light yellow corundums). In ruby crystals, some Al^{3+} of the corundum is replaced by Cr^{3+}. In the crystal field of a ruby, the three unpaired electrons of the Cr-3d-orbit may be lifted from the ground state to excited, unstable energy levels by absorbing defined energy quanta. They relax again under emission of light (fluorescence) and release of heat (Nassau, 1980). In rubies, two spin-allowed electron transitions correspond to these energy quanta. They are linked to two specific wavelengths which are characteristic for the positions of the strong chromium absorption maxima and for the resulting ruby-red colour:

polarization $\perp c$ (o-vibration): abs. maxima at 556 and 410 nm
polarization $\parallel c$ (e-vibration): abs. maxima at 542 and 397 nm

Values between these four maxima (such as 550 and 405 nm), produced by a mixture of the o- and e-spectrum, were identified in all recorded spectra. The pure chromium spectrum of some synthetic rubies reveals that an additional weak absorption band due to Cr occurs in the UV (after Schneyer (1971) at 254 or 250 nm respectively) and that the general absorption starts near 210 nm as can be seen from the Kashan spectrum of Figure 2.

Any absorption bands in addition to those already mentioned must be caused by other chemical elements. Most likely are the *transition elements* iron, titanium, vanadium and manganese. Schmetzer (1978) indicated the following band centre positions for these ruby impurities:

Fe^{3+} 697, 452-440, 392-386, 376-371 and 345 or 308 nm
Ti^{3+} wide band with maxima at 542 and 493 nm (e>o)
V^{3+} 574 and 395 (o) and 571 and 401 nm (e).

Apart from the *iron* band at 697 nm, all given maxima were found in iron-leading rubies, however feebly developed. The series of weak absorption lines sitting on a band between 345 and 326 nm and the band at 314 nm (not 308 nm) are helpful as they indicate iron traces in otherwise pure, Cr-rich rubies, as e.g. in Burma, Chatham and Knischka samples. Rubies from Thailand, typically richer in iron, sometimes exhibit the band at 450 nm (Figure 2).

A relatively narrow band near 266 nm is more conspicuous than the wide and weak *titanium* band in the visible. Both bands occur simultaneously. Obviously the band at 266 nm considerably influences the position, width and depth of the UV absorption minimum. This band is the most pronounced in pale, pink Kashan synthetics which uniformly show raised Ti levels. Therefore it is assumed that the band is associated with the trivalent, substitutional titanium ion. Furthermore it is conceivable that this chromophore is applied as a lightener of synthetic rubies (Verneuil synthetic rubies with comparatively high chromium and iron contents show garnet colour). To judge from indications by Recker (1973), this lightening process indeed appears to take place with additions of Ti_2O_3 (pink coloration) and not with TiO_2.

Vanadium maxima in corundums are but slightly shifted against the Cr peaks, so that V must be present at least in equally high concentration as Cr to appear in the spectrum. Schmetzer (1978) showed for such rubies (from Longido, Tanzania) that their red colour is only slightly altered. In view of the peculiar colour of synthetic alexandrite-like corundums and of one rare colour-changing Ceylonese corundum, all displaying undisturbed V-spectra, this is remarkable. In the present spectra the vanadium maxima near 572 nm were hinted at best in corundums from Sri Lanka, Kenya and Tanzania.

According to Recker (1973) synthetic corundums doped with MnF_2 are red-coloured. If then *manganese* contents do not necessarily alter ruby colours, absorption lines and bands can still be expected in the examined spectral range. However, the manganese traces found and mentioned in the section on Chemical Data did not show up in the diagrams.

It follows that all phenomena encountered in the ruby spectra are explained by iron and titanium contents, besides chromium.

d. *Evaluation of the Spectra*

For the numerical representation of the absorption minima, several parameters were chosen. In the course of the evaluation they were reduced to three. They are the wavelength of the absolute absorption minimum in the UV (λ_o) and the centre position and width of a profile situated at 0.5 absorption units above the minimum (λ and W in Figure 2). This profile is optimal in several aspects. It is free of the slightly shifted λ values found in the lowest parts of the minima (due to iron interferences). Then the profile is on a level which can be measured out in the spectrum of almost any ruby. It also is suited to characterize the whole absorption minimum and should be reproducible on any other photometer. Profiles on higher levels have comparable properties. However, they are measurable only in particularly UV-transparent rubies and synthetic stones.

The most significant parameter which was bracketed out is the value of the absorption minimum in the UV relative to the one in the blue region, on the basis of the absorption in the red at 640 nm (A_{UV}-A_{640}/A_{Bl}-A_{640}). This figure is more time-consuming to determine and not always unambiguous. For many cases, nevertheless, it can be considered in the evaluation as a fourth independent parameter.

Most absorption minima displayed fairly vertical axes ($\lambda \approx \lambda_o$), the slight inclinations of which were not sufficiently discriminative.

e. *Distribution of the Populations*

As could be expected, the o- and e-spectra of rubies, both of which are diagnostic, do not produce completely identical λ_o and λ/W values. The separation of the natural ruby areas from those of the synthetic rubies is clearly recognizable in Figure 3. This is even

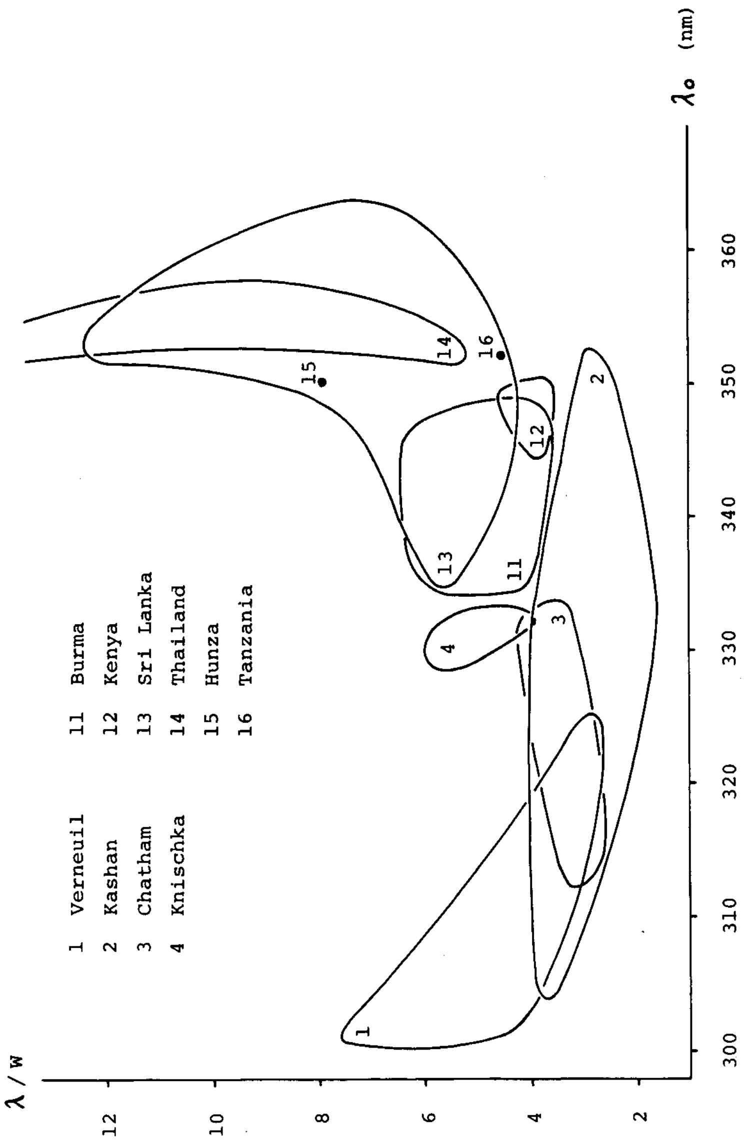

FIG. 3. Diagnostic population distribution of natural rubies (top right) and of synthetic rubies (left and bottom), determined from the UV absorption minima (vibrational component o>e). In general natural rubies show a narrower minimum than synthetic rubies, located at higher wavelengths (larger λ/W ratio and λ_0).

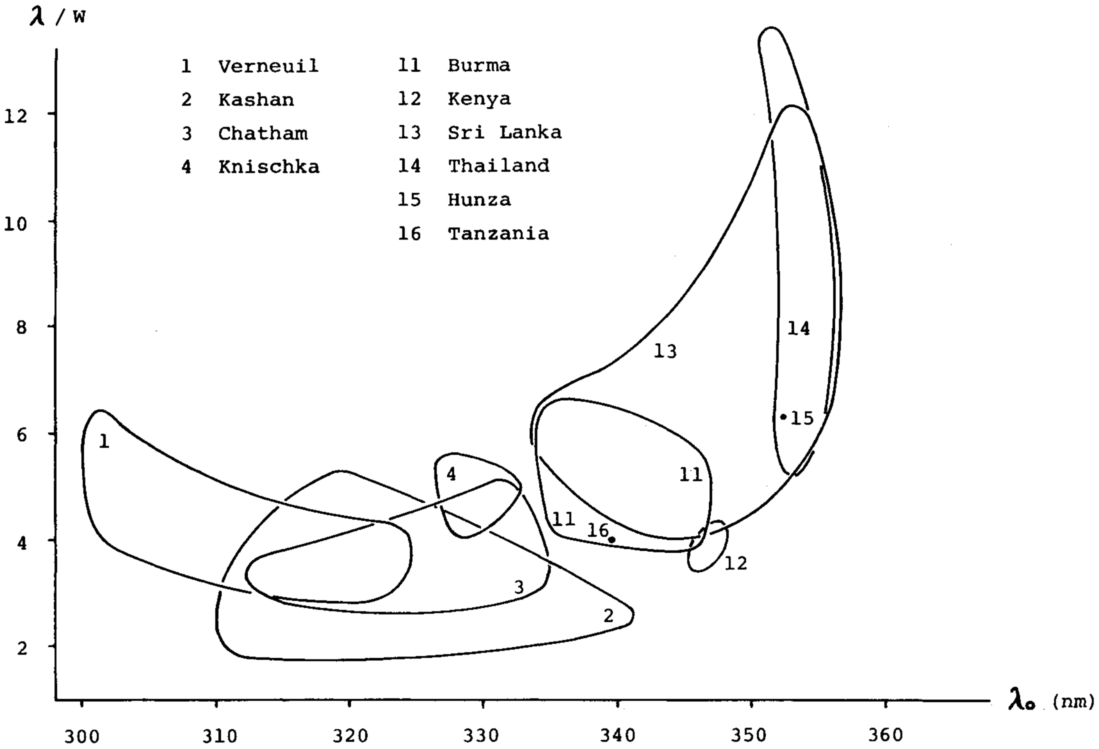

FIG. 4. Diagnostic population distribution of natural rubies (top right) and of synthetic rubies (left and bottom), determined from the UV absorption minima (vibrational component e>o).

more evident in Figure 4. Overlapping of these population areas has not been observed, although, in a restricted measure, intersections are theoretically conceivable in the adjacent regions of genuine and synthetic rubies.

The sizes of the areas have a multiple significance. Small fields originate from dense populations with chromophore compositions of apparently narrow limits (Burma, Thailand) or from populations with relatively few data (Kenya, Knischka). Wide areas indicate considerable variability of the trace contents (Sri Lanka, Kashan). The extreme range of the Thailand population is equivalent to a strong Fe+Cr coloration, that of the Verneuil population to a pure Cr colour.

The location of the populations also has a meaning. Natural rubies show a narrower minimum than synthetic rubies, located at higher wavelengths (larger λ/W ratio and λ_o).

f. *Additional Criteria for Identification*

In special cases the need for further criteria may arise. These are:

1. The relation of the UV to the blue absorption minimum: (A_{UV}-A_{640}/A_{Bl}-A_{640}). Variation of the values between 1 and 6 for natural rubies (Burma 0.5 to 2.2). Variation between 0 and 2 for the o-spectra and between −0.3 and +1.2 for the e-spectra of synthetic rubies (one means equal absorption of UV and blue, zero means equal absorption of UV and red).
2. Profiles at other levels, e.g. 0.1 A or 1 A above the minimum.
3. A maximum at 266 nm or, if hidden in the general absorption, a side minimum near 246 (o) and 242 nm (e) in Kashan synthetics and other titaniferous rubies.
4. With caution: the wavelength of beginning general absorption in the UV lying between 260 and 345 nm in natural and between 205 and 270 nm in synthetic rubies (exception: Knischka stones 260 to 290 nm).
5. Abnormal dichroism in Kashan synthetics with absorption $o \approx e$ (instead of $o > e$) and $e =$ intense brownish-orange (instead of pale pink-orange) due to an asymmetric transmission in the green-blue part of the e-spectrum.
6. Absorption lines at 706, *701* and 698 nm (according to Schneyer (1971) due to pairs and larger aggregates of Cr^{3+}) in certain natural and synthetic rubies. Singular wide band near 703 nm only in synthetic rubies by Kashan.

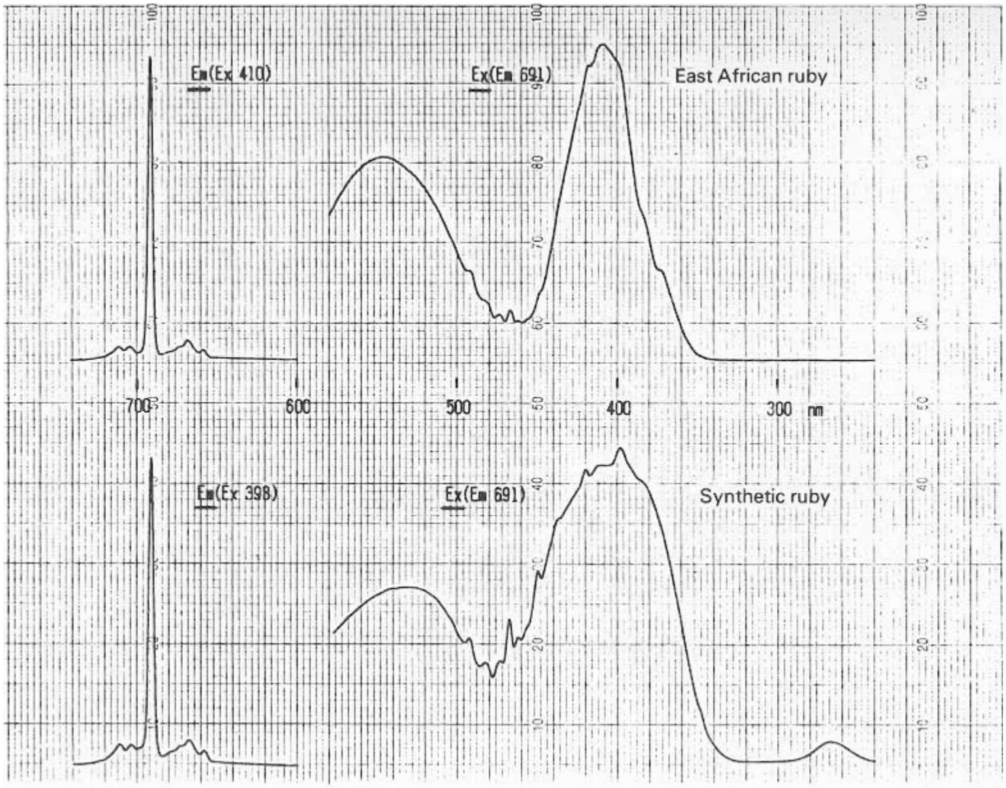

FIG. 5. Fluorescence spectra of an East African and a synthetic ruby (top/bottom) with identical chromium emission (left) but differential excitation bands (right). Graph by B. Suhner.

(4) FLUORESCENCE-SPECTROMETRIC RESULTS

Emission (Em) and excitation (Ex) spectra may be applied to trace element analysis (Schwarz, 1977). B. Suhner, of Herisau (Switzerland), recorded the spectra of some sixty rubies of various localities and productions on a Perkin-Elmer Fluorescence Spectrophotometer 650-10S. He intended to determine whether natural and synthetic rubies could be distinguished by this method. With his friendly permission the results will be summarized here and correlated with the absorption data.

The following can be stated:

1. The Em-spectra show a main line at about 692 nm for all rubies. It is accompanied by at least two weaker satellite lines on each side (Figure 5, left side). At room temperature it is a single line and not a doublet as in the absorption spectrum. Em-spectra are not suited for the intended separation.

2. The Ex-spectra qualitatively are comparable with the chromium absorption diagrams, with the exception of item 4.

3. Ex-spectra exhibit clearly distinguishable peak widths for most natural and synthetic rubies (Figure 5, right side). However, many Burma and some Sri Lanka rubies display the same band near 268 nm as synthetic stones do, but the band is absent in the bulk of natural rubies. It must be identical with the absorption band at 266 nm.

4. The Cr bands at 410 (o) and 397 nm (e) are suppressed in the Ex-spectra of certain Knischka synthetics. They are dominated by a number of lines between 420 and 500 nm, of which those at 468, 450 and 492 nm are the most important. These lines can hardly appertain to the fluorescence-quencher element iron. Eventually they are caused by the vanadium or manganese traces. In very reduced form these lines are detectable in both spectra of Figure 5.

It may be concluded that an identification is possible only for relatively extreme colouring ion compositions. In this respect the synthetic rubies are too similar to many Burma, Kenya and some Sri Lanka rubies. Low-temperature spectra might yield more specific information.

(5) CHEMICAL DATA

Chemical data are available not only rapidly but non-destructively by analysis on the microprobe and, as a recent asset, by energy-dispersive x-ray fluorescence (EDS-XRF). The significance of the latter is demonstrated by Hänni (1982) for the discrimination of natural and synthetic emeralds. Also Stern & Hänni (1982) described shortly that XRF analysis enables the recognition of flux fusion products, under favourable circumstances.

Several minor components and trace elements were examined qualitatively on an EDS-XRF spectrometer (model Tracor Northern 1710, AgL radiation), specifically for one ruby from each of four different localities and four different growing techniques. The findings are summarized in Table 1 and confirm the presumptions based on the absorption and excitation spectra. Comparisons in the columns (vertical) are admissible but not in the lines (horizontal). Apart from Cr, Fe, Ti and V, minor amounts of manganese were detected in several of the eight rubies. More extensive studies by XRF are under way.

TABLE 1	Relative Trace Element Contents in Rubies			
	Cr	Fe	Ti	V
Thailand	***	***	*	**
Sri Lanka	**	***	***	*
Kenya	**	**	**	*
Burma	**	**	**	**
Chatham	***	*	*	*
Kashan	*	**	***	*
Knischka	***	**	**	*
Verneuil	**	*	*	*
Trace Content	major ***	medium **	minor*	

(6) SUMMARY

A procedure was developed allowing the evaluation of the UV transmission of natural and synthetic single-crystal rubies, with the following main results:

(a) Rubies from Thailand and many from Sri Lanka differ chemically so much from synthetic rubies that they cannot be confused in terms of colour and transmission behaviour. In contrast, the similar trace element composition of Burma and Kenya rubies and of the lighter Chatham, Kashan, Verneuil and Knischka synthetic rubies causes their red colorations to be comparable or even confusible. Their excitation spectra therefore are ambiguous also. The absorption minima in the UV, however, allowed a safe identification of 150 natural and synthetic rubies. Moreover it may be expected that extensive microprobe or XRF studies will produce new criteria of separation, as is shown by Hänni (1982) for genuine and synthetic emeralds.

(b) To judge from the colour and absorption diagrams of a few rubies from Hunza (Pakistan), Brazil, Cambodia and Australia, they lie, chemically speaking, between the extremes of rubies from Burma and Thailand. Tanzania rubies with their high vanadium content are in the front region of the population areas of natural rubies but exhibit much less transparency in the UV than in the blue region. This is typical of most natural rubies.

(c) It is an advantage that heat-treated rubies display the same absorption properties as naturally coloured rubies from the same locality.

(d) The method naturally is limited by synthetically overgrown genuine rubies (e.g. Knischka products). They present spectra with intermediate values for λ_o and λ/W, dictated by the colour saturation and light-path length in the proportion of genuine nucleus size to thickness of synthetic overgrowth.

(e) An absorption band at 266 nm presumably is associated with Ti^{3+} traces. It accompanies the bands in the visible spectrum of titaniferous rubies (Kashan synthetics). Additional chemical data are required for trustworthy designation as a titanium band.

(f) Until now an abnormal dichroism was noted only in Kashan synthetic rubies. It is caused by raised Ti levels and is connected with an asymmetric transmission of the green-blue.

(7) ACKNOWLEDGEMENTS

Sincere thanks are extended to Dr W. Heinzelmann, University of Zurich, for numerous suggestions regarding photometer application and valuable hints for spectrum evaluation. Without the support with specimens of mostly known origin by gemstone dealers and jewellers from Zurich, the present investigation would have remained fragmentary. Special thanks go to Dr W. B. Stern for supplying the XRF data, to Dr H. A. Hänni for technical discussions and material assistance, and to Mr U. Näf for drawing Figures 2 to 4 (all of the University of Basle). The spontaneous conveyance of fluorescence data by Mr B. Suhner, Dip. Eng., of Herisau (Switzerland), merits particular recognition.

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[*Manuscript received 1st October 1981; revised 4th January 1982.*]

GEMMOLOGICAL ABSTRACTS

BAKER (D. M.). *Revolution in diamond cutting: laser sawing of diamond crystals.* Gems & Gemology, **XVII**, 3, 150-2, 3 figs in colour, 1981.

A computerized method of using an infrared laser beam to 'saw' diamonds in directions which cannot be sawn (or cleaved) normally. Cutting is by a neodymium doped YAG laser giving a beam that is focused down to a spot 25 microns in diameter, and is carried out by multiple traverses of the diamond crystal back and forth across the fixed beam which thus burns off a minute amount each time. Wastage (5%-7%) is slightly higher than with conventional sawing, but method allows otherwise impossible cuts to be made. Resultant surfaces are rather striated.

R.K.M.

BASTOS (F. M.). *Emeralds from Itabira, Minas Gerais, Brazil.* Lapidary J., **35**, 9, 1842-8, 12 figs, 1981.

Emerald has been found at Itabira, north-east of Belo Horizonte Minas Gerais, Brazil. Emerald is said to occur in a schist with biotite within a pegmatite. Quality of the best stones is said to equal that of Chivor and Muzo material. Three-phase inclusions, mica flakes with profuse tremolite needles are reported. RI is 1.580-1.589; SG 2.71 to 2.74. M.O'D.

BROWN (G.). *The emerald.* Wahroongai News, 7-12, September 1981.

A reasonably thorough account of emerald as a gem mineral, which mentions the dichotomy which exists in the definition of emerald (with Cr^{3+}), while emerald-coloured beryl is known which owes its colour to V^{3+}. R.K.M.

BROWN (G.). *Cathaystone—an effective cat's-eye chrysoberyl imitation.* Wahroongai News, 13-14, September 1981.

This is the cat's-eye made from material resembling that used in fibre optics. Made in several colours it is said to be an excellent imitation of chrysoberyl cat's-eye, too good perhaps in some of them. R.K.M.

BROWN (G.). *Opal.* Wahroongai News, 10-14, October 1981.

A summary of opal which goes into its history in some detail and lists varieties which will be new to many readers. Sedimentary opal occurrences in Australia are described and illustrated by rough sketches. R.K.M.

BROWN (G.). *Synthetic emeralds.* Wahroongai News 15-19, October 1981.

Follows on from the paper published in the September issue on natural emerald. First paragraph suggests that large single crystals of emerald have been grown for almost 100 years. [Size is comparative, but abstracter does not think the 1 mm crystals of Hautfeuille and Perrey can be regarded as 'large'.] Otherwise this account is fair enough and effectively summarizes the facts as they are known.

R.K.M.

BUTLER (J. N.). *The quartz minerals of Redcliffe Peninsula.* Wahroongai News, 10-12, November 1981.

A summary of the chalcedonies and altered quartz and chalcedonies from a Tertiary basalt zone north of Brisbane. These are to be found on the beaches along the peninsula and are generally weathered to a greater or lesser extent. Weathering is of two types, chert and a more chalky form. In extreme cases these can replace almost all of a given nodule. R.K.M.

CASSEDANNE (J.-P.). *Note sur la brazilianite et ses gisements brésiliens.* (Note on brazilianite and its Brazilian locations.) Revue de Gemmologie, **68**, 14-17, 6 figs (3 in colour), 1981.

Brazilianite is found in pegmatites in several locations in Minas Gerais, Brazil. These are shown on a map in the text, together with illustrations of typical crystals. Constants are given and there are 19 references. M.O'D.

CASSEDANNE (J.-P.). *Le quartz à rutile de Ibitiara.* (Rutilated quartz from Ibitiara.) Revue de Gemmologie, 69, 7-11, 9 figs (2 in colour), 1981.

Rutilated quartz is found at Ibitiara, 400 km west-north-west of Salvador in the State of Bahia, Brazil. Details of the geology and associated minerals are given, with a map of the area. M.O'D.

CLOCCHIATTI (R.), MASSAIRE (D.), JEHANNO (C.). *Origine hydrothermale des olivines gemmes de l'ile de Zabargad (St Johns), Mer Rouge, par l'étude de leur inclusions.* (The hydrothermal origin of gem olivines from Zabargad (St John's) Island, Red Sea, by the study of their inclusions.) Bulletin de Minèralogie, **104**, 354-60, 4 figs, 1981.

The fluid inclusions in these peridots are rich in the volatile elements (CO_2, N_2, Cl, S, H_2O) with low partial pressure of CO_2. These olivines were crystallized by a hydrothermal process which affected the parent peridotite of the island. R.A.H.

COTTRANT (J.-F.), CALAS (G.). *Étude de la coloration de quelques diamants du Muséum national d'histoire naturelle.* (Study of the coloration of some diamonds in the National Museum of Natural History.) Revue de Gemmologie, **67**, 2-5, 7 figs, 1981.

Diamonds from Brazil and South Africa were studied with an automatic spectrometer working in the visible, ultraviolet and the near infrared. Examination of the absorption spectra allowed the origin of the coloration to be deduced and also the effect of aluminium and other impurities. M.O'D.

DÉLÉ-DUBOIS (M.-L.), MERLIN (J.-C.). *Étude par spectroscopie Raman de la pigmentation du squelette calcaire du corail.* (Raman spectroscopical study of the coloration of the calcareous skeleton of coral.) Revue de Gemmologie, **68**, 10-13, 5 figs (2 in colour), 1981.

Raman spectra for different colours of coral are given. This method will distinguish true coral from imitation products. M.O'D.

DESHPANDA (M. L.), NENE (S. G.), RAJARMAN (S.). *Diamonds in India.* Wahroongai News, 13-17, November 1981. 'Abstracted from Indiaqua No. 26 (1980).'

Each author contributes one part of this paper.

1. *Indian kimberlites.* Of some 5000 world-wide known kimberlite pipes only 10% are diamondiferous and only one fifth of these is commercially viable. Kimberlites were found in 1925 in the ancient alluvial diamond areas of Andhra Pradesh and Madhya Pradesh. Only two out of six known pipes are diamond bearing and in these the output is low (2 to 4.5 carats per 100 tons of ore).

2. *Diamond exploration.* These Indian pipes are far older than those of Africa etc., and have therefore eroded much more, and it is accepted that yield decreases with depth. It is suggested that secondary (alluvial) deposits, as yet unexploited, will be more viable than possible pipes; these include hard and soft conglomerates, sources unusual in other diamond areas. Geophysical surveys are locating probable further pipes and more are hoped for; methods include remote sensing by satellite. It is suggested that the Krishna delta and its off-shore sands may be a further source of alluvial diamonds, as in South Africa.

3. *Examinations of old workings.* Sandstone/conglomerate outcrops, alluvial workings on slopes near the river, alluvial workings covered by further alluvium have been extensively worked in ancient times in the Krishna Valley. Mostly open-cast mines removed up to 8 metres of overburden to reach a metre of diamond bearing gravel. Old workings found by aerial survey; some formerly rich sources are remote from the known kimberlite pipes. Golconda mines so named because stones were marketed near there, although nearest mining area was 150 km distant. Mining ceased in late 18th century for a variety of economic and political reasons. Ancient miners removed only soft conglomerates (easily crushable), about a 15 cm layer and probably rich in diamonds. Mining of conglomerate lenses was seen by Tavernier in 1665; grit layers, 30 or 40 cm thick, were excavated horizontally to a depth of 20 metres, using crow-bars, long-handled spades and 'small sized children . . . to crawl into these narrow drives and push out the loosened gravel'. Some diamonds still found occasionally by villagers after heavy rains. R.K.M.

DILLON (S.), ed. *Gem news.* Gems & Gemology, **XVII**, 2, 117-18, 1981.

Reports Argentine Capillitas rhodochrosite mine to reopen. Australian gem-cutting centre mooted for Perth. Diamonds found at Kimberly, Western Australia, include an 11 carat crystal and fancy pinks. Aga Khan mine, W. Australia, is being explored and emerald and scheelite stockpiled. 30 square miles of Central Queensland are being mined by up to 40 companies, producing mainly yellow sapphires of small size. San Carlos Apache Reserve, near Phoenix, Arizona, now claimed to be the most important source of gem peridot; comprehensive report promised. About 10% of Zaire diamonds (mostly industrial) are being sold outside the De Beers marketing organization. R.K.M.

DILLON (S.), ed. *Gem news.* Gems & Gemology, **XVII**, 3, 180-2, 1981.

Diamond production in Angola, Australia, Botswana, Lesotho, U.S.A. and U.S.S.R. is reported. Predicted 20-25 million carats from 5 million tons of ore in Ashton Joint Venture (Argyle, W. Australia) seems extremely optimistic. Jwaneng Mine, Botswana, should increase production to 10 million carats by 1985.

Murfreesboro, Arkansas, Crater of Diamonds reports find of 8.83 carat diamond, second largest from that mine. U.S.S.R. have started to sink new deep mine in Yakut area. Prof. E. Gübelin reports that Pakistan is producing emeralds of good colour, ruby and spinel, topaz (natural pink), aquamarine, chrome diopside, kunzite, pyrope, chrome tourmaline, quartz and ornamental chalcedonic quartzes for additional interest, although not all are commercially viable. R.K.M.

DILLON (S.). *GIA's golden anniversary.* Lapidary J., **35**, 7, 1402-12, 14 figs (7 in colour), 1981.

The whole range of work of the Gemological Institute of America is discussed and notes on leading personalities are given. Some of the stone collection is illustrated. M.O'D.

DUNN (P. J.), BENTLEY (R. E.), WILSON (W. E.). *Mineral fakes.* Mineral. Record, **12**, 4, 197-219, 47 figs (8 in colour) 1981.

The history of faking mineral specimens is extensively reviewed. Among practices which the gemmologist may encounter are the development of copper bloom in chalcedony (by exposure to laser light); various methods of affixing diamond crystals to matrix; emerald or beryl crystals attached to an inappropriate matrix; plastic imitations of tourmaline on matrix; the grinding of faces onto a crystal and the various ways of dyeing specimens. Methods of detection are also discussed. M.O'D.

DUYK (F.). *Sur l'emploi du microscope en gemmologie.* (On the use of the microscope in gemmology.) Revue de Gemmologie, **67**, 8-12, 17 figs, 1981.

Adaptation of a microscope for the better study of inclusions is described. M.O'D.

DUYK (F.). *Un appareil bien simple—1.* (A very simple tool.) Revue de Gemmologie, 69, 16-17, 7 figs, 1981.

The device in question is intended to make easier the observation of interference figures. M.O'D.

FRYER (C.), ed., CROWNINGSHIELD (R.), HURWIT (K. N.), KANE (R. E.). *Gem Trade Lab Notes.* Gems & Gemology, **XVII**, 2, 101-6, 14 figs (13 in colour), 2 tables, 1981.

These combine reports from the three GIA Labs which have in past years been published individually. Mossy patches on a green diamond, normally indicative of radium salt treatment, gave no radioactivity; some other form of treatment suspected. A good green olivine (peridot) inclusion is illustrated in another diamond. Linde-like synthetic emeralds, lacking phenakite nuclei, possibly new; a natural emerald crystal in a faked matrix; and a plastic jadeite substitute used in making a snuff-bottle, are shown. Dyed and waxed lapis lazuli, and a natural opal which improved markedly when wet, also reported. Large cultured blister pearls with M.O.P. centres, distinct from Mabe pearls, and a fire-damaged natural pearl necklace were identified. A ruby with a large thin film inclusion gave startling interference colours under vertical illumination. Banded purple sugilite was compared with sogdianite and leucophoenicite, but was proved to be correctly identified. A multi-coloured polished mineral slab comprised pink corundum, green tourmaline and blue kyanite. R.K.M.

FRYER (C.), ed. CROWNINGSHIELD (R.), HURWIT (K. N.), KANE (R. E.) *Gem Trade Lab Notes.* Gems & Gemology, **XVII**, 3, 161-6, 20 figs (18 in colour), 1981.

A triangular cut diamond with three (cylindrically) concave facets framing the table; a thin slice of emerald carved on both sides in bas relief; three interesting and beautiful ivories and a nephrite based clock (ruby-inlaid with enamel-framed smoky quartz 'see-through' dial) reminiscent of the style of Fabergé; are described and illustrated. A black opal with a resin filled cavity in its back; mabe pearls set back to back in a metal band to look like a solid pearl; synthetic, flux-grown Chatham rubies containing typical unmelted flux, some looking rather like 'fingerprint' inclusions, whispy veils, hexagonal platinum flakes (not to be confused with sub-metallic haematite plates in natural Sri Lankan and African rubies), angular, near colourless, crystals, twinning and growth lines of various types, have also been examined and identified. The latter show very strong red fluorescence under longwave UV. Shortwave UV and x-rays gave weak to moderate reds. A parti-coloured purple sapphire with an orange centre exhibited contrasting weak and strong orange fluorescence in long-wave UV light. A cat's-eye sillimanite, resembling apatite, showed absorption at 4400Å, spot RI gave 1.66 and a rotated polaroid suggested birefringence was between 0.015 and 0.020. Stone checked by powder x-ray diffraction. R.K.M.

GATES (C.), GATES (S.). *How to buy CZ facet rough.* Lapidary J., **35**, 8, 1588-98, 6 figs, 1981.

Some useful hints on the properties and behaviour of cubic zirconia crystals are given, with particular reference to faceting. M.O'D.

GILL (S.). *Gemstone gleanings in the Kingdom of Nepal.* Gemmological Review, **3**, 12, 6-11, 12 figs, 1981.

A list of the gem materials found in Nepal is arranged by locality. M.O'D.

GONTHIER (E.), SCHUBNEL (H.-J.). *Les derniers lapidaires du néolithique de la vallée de la Baliem.* (The last neolithic lapidaries of the Baliem valley.) Revue de Gemmologie, 69, 12-15, 10 figs (3 in colour), 1981.

Neolithic artefacts from the Baliem valley in New Guinea are discussed. Some actinolite and serpentinized peridotite have been employed as tools. M.O'D.

GOOD (A.). *Chemically-induced colour in sapphire.* Gems, **13**, 5, 32, 1 fig, 1981.

Pale blue and heavily included sapphire from Sri Lanka can be altered in certain circumstances to much clearer and better-coloured material by appropriate heat treatment. The stones in which this process has been carried out are known as Geuda stones. M.O'D.

GÜBELIN (E.), MOOR (R.), OBERHOLZER (W. F.). *La taprobanite, une nouvelle pierre précieuse du Sri Lanka.* (Taprobanite, a new gemstone from Sri Lanka.) Revue de Gemmologie, **67**, 6-9, 2 figs, 1981.

A cut stone of 1.02ct and of a red corresponding to DIN 6164, annexe 8, location between 8:4:2 and 8:5:2, had SG 3.607 and refractive index 1.717-1.721 with a birefringence of 0.004 (all these are mean figures). Hardness is over 8 on Mohs's scale and the stone belongs to the hexagonal crystal system. It was first believed to be a red form of taaffeite but the chemical composition was later found to be $BeMg_3Al_8O_{16}$. Chromium provides an emission line at 685.2nm and some reddish luminescence. Space group is $P6_3mc$. The first stone examined is now kept as the type specimen at the Institute of Crystallography and Petrography, Ecole Polytechnique Federale, Zürich. M.O'D.

HEALEY (D.). *Sun, sapphires and serendipity.* J.Gemm.Assoc. Hong Kong, 2, 8-17, 1981.

An interesting and full account of a visit to Sri Lanka made by some members of the Gemmological Association of Hong Kong. A visit to a gem pit is described. M.O'D.

HOFER (S. C.), MANSON (D. V.). *Cryogenics, an aid to gemstone testing.* Gems & Gemology, **XVII**, 3, 143-9, 5 figs, 1981.

The G.I.A. have recently adopted techniques introduced by Dr Collins, of King's College, London, which have been available to the London Gem Laboratory, using liquid nitrogen, since 1976. Their apparatus is the best available and includes a Zeiss PMQ_3 spectrophotometer and a custom designed cryogenic system using liquid helium to lower stone temperatures to around 50 K (about −223 °C). Ingenious use of thermocouples monitors temperatures. Cool-down periods seem rather long but the temperatures reached are exceptionally low. R.K.M.

HURLBUT (C. S., Jr.). *A cubic zirconia refractometer.* Gems & Gemology, **XVII**, 2, 93-5, 1 fig, 1981.

With the advent of this hard, highly-refracting, isotropic material its use as a refractometer prism was predictable and it has now been used in an adapted American Duplex II instrument. The main limitations for the important region between 1.81 and 2.06, its upper reading, are imposed by the available contact liquids, either West's solution, which is explosively combustible, or selenium compounds which are unpleasantly poisonous. R.K.M.

KANE (R. E.). *Hornbill ivory.* Gems & Gemology, **XVII**, 2, 96-7, 3 figs (in colour), 1981.

Describes this rare yellow 'ivory' made from the solid casque of the helmeted hornbill. (A protected species, so it is hoped the 'ivory' will remain very rare.) Not a true ivory, the casque is modified feathers rather than teeth. R.K.M.

KELLER (P. C.). *Emeralds of Colombia.* Gems & Gemology, **XVII**, 2, 80-92, 12 figs (10 in colour), 1981.

A short account of the Muzo and Chivor mines, their history, geology and production. Several large and important crystals and cut stones are illustrated [some, strangely, against emerald green backgrounds]. The 'Spanish Inquisition' necklace is one of these, said to be 300 years old [despite the presence of baguette diamonds and, apparently, a platinum mount. The main stones may well be the age claimed]. R.K.M.

KENNICUTT (W.). *The ruby mines of Franklin.* Lapidary Journal, **35**, 3, 744-6, 1981.

Corundum is found in stream beds in the Franklin area of North Carolina. Many are recovered by panning. M.O'D.

KOIVULA (J. I.). *Photographing inclusions.* Gems & Gemology, **XVII**, 3, 132-42, 20 figs (14 in colour), 1981.

A very interesting paper on photomicrography which emphasizes the need for vibration-free equipment, clean gems and apparatus, and careful preparation—also the many problems of lighting which must be overcome if first class pictures are to be obtained. Mr Koivula seems to be working under conditions where time and cost are not limiting factors and his results, some of which illustrate the paper, are a tribute to his expertise and patience, and a delight to the eye. He advocates working dry not with immersed stones. R.K.M.

KOMOTAUER (S. K.). *Quarz, SiO_2.* (Quartz, SiO_2.) Mineralien Magazin, **6**, 1, 5-19, 19 figs in colour, 1982.

A useful overview of quartz with particular reference to its crystal form and with helpful illustrations of twinning depicted in colour. Further information is promised for a later paper. M.O'D.

KVAPIL (Ji.), KVAPIL (Jo.), MANEK (B.), PERNER (B.). *Czochralski growth of YAG:Ce in a reducing protective atmosphere.* J. Crystal Growth, **52**, 542-5, 4 figs, 1981.

Ce^{3+} ions destroy colour centres in YAG crystals grown in a reducing protective atmosphere. M.O'D.

LEITHNER (H.). *Russische Topase und Berylle.* (Russian topaz and beryl.) Lapis, **6**, 9, 9-14, 15 figs (9 in colour), 1981.

Most topaz and beryl found in the U.S.S.R. come from the area of Sverdlovsk, which is discussed. M.O'D.

LEVINGSTON (K. R.). *Gem diggings—Chudleigh Park.* Wahroongai News, 16-23, 2 maps, November 1981. (Reprinted from Queensland Government Mining Journal, **80**, 35-8.)

A small region between Hughenden and Mount Garnet in North Queensland which produces peridot and some poor quality spinel; sapphire formerly, but this is now rare. Basalt cone is known unofficially as Mount Batchelor [a nice tribute to H. H. Batchelor who discovered it and at one time contributed most fascinating short accounts of his 'gemming' trips to the *Gemmologist*]. Open to the public the prospect area is gemmiferous to about 40 cm and is mined by shovelling, screening and sorting. Main part of paper is concerned with geology and mineralogy of the region and with its topography. R.K.M.

MAGGART (H.). *Sapphires of Montana.* Lapidary J., **35**, 7, 1444-52, 18 figs, 1981.

The Rock Creek area of Montana and its sapphire deposits are described. M.O'D.

MEYER (H. O. A.), GÜBELIN (E.). *Ruby in diamond.* Gems & Gemology, **XVII**, 3, 153-6, 1 fig. in colour, 1981.

An occurrence of a ruby crystal inclusion in diamond has been authenticated. Ruby is assigned to the eclogitic group of possible inclusions. Some interesting conclusions are drawn. R.K.M.

MUNASINGHE (T.), DISSANAYAKE (C. B.). *The origin of gemstones of Sri Lanka.* Economic Geol., **76**, 1216-25, 1981.

The sequence involved the emplacement of basic and ultrabasic igneous rocks into metamorphosed argillaceous rocks. Then followed the intrusion of beryllium-enriched pegmatitic fluids. Finally, chemical weathering and alluvial-gravity transportation localized the gem concentrations. R.A.H.

NASSAU (K.). *Heat treating ruby and sapphire: technical aspects.* Gems & Gemology, **XVII**, 3, 121-31, 10 figs in colour, 1981.

The practice of heat treating sapphires has been rumoured, reported and debated for many years. Dr Nassau has put the matter on a factual basis which outlines nine different processes which are apparently in use: 1, to develop asterism; 2, to remove silk or asterism; 3, improve blue colour; 4, lighten blue colour (can result in a greenish stone); 5, diminish banding and strain in Verneuil synthetics; 6, introduce fingerprint inclusions in synthetics; 7, add asterism by diffusion; 8, add blue by diffusion; 9, add other colours by diffusion. Most treatments seem to involve temperatures approaching that of actual fusion of corundum and leave blister damaged surfaces which need repolishing where cut stones have been treated. Most processes are detectable in some stones but not necessarily easily so. [Following Mr Robert Crowningshield's important lecture on this subject during the Gemmological Association's Jubilee celebrations, this is a very valuable paper. Mr Crowningshield's lecture was substantially reproduced in the paper entitled *'The heat and diffusion treatment of natural and synthetic sapphires'*, by Crowningshield (R.) and Nassau (K.),—J.Gemm., 1981, XVII (8), 528-41—which covers much the same ground as the Nassau paper but does so from a rather more practical point of view, since it emphasizes detection methods where these are available; also there is some attempt to discuss the ethics which arise from artificial treatments of this kind. Not all the processes are yet known in full detail.] R.K.M.

O'DONOGHUE (M.). *The dealer looks at gemstones.* Gems, **13**, 5, 26-8, 1 fig. (in colour), 1981.

This forms the first part of a series describing the criteria employed by gemstone dealers when selecting rough and cut material for sale.

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

PAYNE (T.). *The andradites of San Benito County, California.* Gems & Gemology, **XVII**, 3, 157-60, 5 figs (4 in colour), 3 tables, 1981.

A new source, not precisely identified, of gem andradite, one of the rarer gem garnets. It occurs as small yellowish-green to orange-brown and emerald green crystals, in situ and in alluvial deposits derived therefrom. Some of the orange brown (topazolite) stones exhibit chatoyancy. Pale yellow-green, dubbed 'Greenfire' for no very rational reason, is the commonest colour, emerald green (demantoid) is rare. RI 'greenfire' 1.851 approx, and 1.888 for demantoids; brownish stones fall between these values. Greenfire appears to display iron absorption centred at 4450Å. Demantoid exhibits 3 bands in red orange. Drawings do not convey spectra very convincingly. R.K.M.

POUGH (F. H.). *Treatments, betterments and chicaneries in gemmology.* Lapidary J., **35**, 9, 1804-41, 1981.

The substance of a talk given at the International Gemmological Congress in Kyoto, 1981, this gives a useful overview of present trends in alteration of colour while adding little fresh material. M.O'D.

READ (P.). *Gem stone carving and jewellery of China.* Gems, **13**, 5, 16-19, 8 figs (2 in colour), 1981.

The writer describes the state of the jewellery industry in the People's Republic of China. A number of divisions of the National Arts and Crafts Corporation deal with various aspects of jewellery and gemstone fashioning. M.O'D.

READ (P. G.). *Gemstones of Sri Lanka.* Gem World, **8**, 4, 18-20, 1981.

Recent developments in mining and selling gemstones in Sri Lanka are mentioned. Japan takes much of the alexandrite and cymophane production. M.O'D.

ROSSMAN (G. R.). *Color in gems: the new technologies.* Gems & Gemology, **XVII**, 2, 60-71, 24 figs (17 in colour), 1981.

An excellent account of the causes of colour and colour change in a wide range of popular gems. Well illustrated and clearly explained with some information on the detection of artificially altered colour. R.K.M.

SCHMETZER (K.), BANK (H.), STÄHLE (V.). *The chromium content of Lechleitner synthetic emerald overgrowth.* Gems & Gemology, **XVII**, 2, 98-100, 2 figs in colour, 2 tables, 1981.

Emerald overgrowth of selected Lechleitner stones giving sharp RI readings, examined for chromium content by electron microprobe. Another sample gave broad shadow edges and varied in its Cr^{3+} content from 7.64% to 13.20% across the table facet. Others varied from 0% to 10.01%, the first having no emerald deposit on its table (removed in repolishing?). Most had very high Cr^{3+} ratios in the surface overgrowth by comparison with normal synthetics and natural emerald, rather as one would expect. R.K.M.

STOCKTON (C. M.), MANSON (D. V.). *Scanning electron microscopy in gemology.* Gems & Gemology, **XVII**, 2, 72-9, 12 figs, 1981.

Explains in reasonably simple language working and capabilities of the scanning electron microscope-energy dispersive system (SEM-EDS), including very high magnification and great depth of field, and its limitations (e.g., examines surfaces only and does not penetrate interiors as would a light microscope). Secondary electrons, back-scatter electrons and x-rays generated by the stream of electrons each yield different types of information, the last duplicating the normal function of the expensive electron microprobe in analysis. Uses in identifying microscopic inclusions surfacing on a stone, and mixtures of minerals, such as maw-sit-sit, are illustrated. Other projects are in hand. R.K.M.

SUNAGAWA (I.). *Natural and synthetic gem materials, a comparison.* Bulletin de Minèralogie, **104**, 128-32, 3 figs, 1981.

Differences detectable between natural and synthetic crystalline materials include external morphology, surface microtopography of crystal faces, growth bands, sector structures, inclusions, dislocation, planar defects, micro-twinning, stacking faults, etc. Some of these differences are demonstrated using high-resolution TEM lattice images of natural and synthetic emerald, x-ray topography, and surface microtopography of natural and synthetic diamonds and emeralds.

R.A.H.

UBAL (K.). *Die Mine der Weissen Königin.* (The White Queen mine.) Mineralien Magazin, **5**, 12, 540-1, 1 fig. in colour, 1981.

A brief history of the White Queen tourmaline mine in the Pala district of southern California is given. M.O'D.

WEIBEL (M.), WESSICKEN (R.), WOENSDREGT (C. F.), WUTHRICH (A.). *Sternsaphir und sternquartz.* (Star sapphire and star quartz.) Schweiz. Mineralog. Petrograph. Mitteilungen, **60**, 133-6, 2 figs, 1 photo, 1980.

The basic phenomena involved in chatoyancy and asterism is the scattering of light by extremely thin rods or cylinders, The star effect is described as seen in the white star quartz from Ratnapura, Sri Lanka, and the black star sapphire from Bang-kha-cha, Thailand. R.A.H.

WOENSDREGT (C. F.), WEIBEL (M.), WESSICKEN (R.). *Star quartz asterism caused by sillimanite.* Schweiz. Mineralog. Petrograph. Mitteilungen, **60**, 129-32, 5 figs, 1980.

The asterism of star quartz from Ratnapura district, Sri Lanka, is caused by acicular inclusions of sillimanite (identified by electron diffraction pattern). The sillimanite needles are preferentially oriented with their *c*-axes parallel to [100] of the host quartz. R.A.H.

ZHURAVLYOV (V.). *Mirny, the town of diamond miners.* Gem World, **8**, 4, 36-7, 1981.

A brief account of mining for diamond in Siberia. M.O'D.

Gemology from art to science. Jeweller's Circular-Keystone, Sept., part 2, 15-251, illus. in black-and-white and in colour, 1981.

Based on a celebration of the 50th anniversary of the Gemmological Institute of America, this piece reviews developments in gemmology ranging from the advances in instrumentation to the discoveries of new gem materials. The work of pioneer and present-day figures in G.I.A. is discussed. M.O'D.

BOOK REVIEWS

KALOKERINOS (A.). *Opal, Edelstein der tausend Farben.* (Opal, gemstone of a thousand colours.) Kosmos, Stuttgart, 1981. pp.139. Illus. in colour. DM 48.

This is a German version of a book first published in 1971 but with some additional colour plates and a short section on synthetic opal by Rudolf Mertens, who has also supplied some of the illustrations. The book covers opal from all known locations with particular emphasis on Australia. Quality of illustration is very high and since the publishers have named this as part of a series ('Kosmos Edelstein-Monographie') it is to be hoped that others in the series are equally well conceived and executed. M.O'D.

ST MAUR (S.), STREEP (N.). *The jewellery book.* Magnum Books, Methuen, London, 1981, pp.198, illus. in black-and-white (line drawings). £1.95

Described as the first really practical book about jewellery, it is scarcely that. Most of the writing appears to be from the somewhat garrulous pen of Ms St Maur, Mr Streep having been brought in 'to provide the technical back-up'. Thus it is written for the lay public largely by a lay-person, and, rather inevitably, it contains some silly errors.

We are told that gems originated from rotten chips of wood, churned down into the depths of the earth, fossilized and crystallized; that .999 bullion gold contains colouring matter to make it golden; that citrine and topaz are not dissimilar in value; that cat's-eye and tiger's-eye are roughly the same value; that white sapphires are almost as precious as diamonds; that it takes 250 tonnes of mined rock to produce one carat of diamond; that opals absorb grease, which makes them less brittle, and so on. There are many other inaccuracies.

Ms St Maur's stated difficulty in finding interesting books and an expert on the subject is scarcely acceptable. There are plenty of each if she knows where to look.

It is regrettable that this book, written expressly for the general public, should not have been researched with greater care. Its slightly flippant and loose use of English makes for tedious reading. The gemmological content is negligible. R.K.M.

WISNIAK (J.). *Phase diagrams: a literature source book.* Elsevier, Amsterdam, 1981. 2 vols. Fl 655.00.

This work brings together references on phase diagrams published between 1900 and 1980. The arrangement is alphabetical by element—this part takes us well into the second volume, the remainder of which is devoted to the references which are quoted by number in the first section. There are 17,381 of them. Anyone working on crystal growth will find the work invaluable. M.O'D.

Colored gem digest. Ge-Odyssey Gem Publications, Garden Grove, California. Annual subscription $20.00.

The issue examined (Vol. 2, No. 3) contained articles dealing with the evaluation of cuts of faceted gems; on appraisals; on an auction at which gem rarities were sold at less than the commercial prices obtaining generally at the time; and on land appraisals and their link with gemstone investment. M.O'D.

ASSOCIATION

NOTICES

GIFTS TO THE ASSOCIATION

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

Mr S. H. Chung, Taiwan, for a nephrite cat's-eye weighing 2.17 ct.

Mr John L. Pyke, F.G.A., Birkenhead, for a collection of eight cut and polished gemstones (mixed varieties) suitable for students' use.

Mr Jiří Skalický, Brno, Czechoslovakia, for a collection of moldavites from South Bohemia together with copies of his articles on the Czech moldavites published in overseas journals.

Mr Peter van Blommestein, Kimberley, S.A., for a set of 12 colour transparencies showing the Kimberley Diamond Mine in its various stages of progress from 1871 to 1895, and a set of 14 slides of current methods in use there.

Mr Frank D. Walker, Dallas, U.S.A., for a copy of *Turquoise the gem of the centuries,* by Oscar T. Branson, Treasure Chest Publications Inc., Santa Fe, New Mexico, 1975.

NEWS OF FELLOWS

On 23rd November, 1981, Messrs E. Colman, G. M. Jones, J. S. Kelly and P. W. Spacey, FF.G.A., formed the nucleus of a 'get together' of members and friends from the South Wales and Border areas at the Angel Hotel, Abergavenny. Slides of gemstone inclusions were shown and the evening was adjudged a success by those present. It was agreed that regular meetings be held, albeit on an informal basis. Any member interested please contact Mr G. M. Jones on Abergavenny 3429.

'Gemstones' was the subject of the sixth annual 'Commodity Meeting' of the Institution of Mining and Metallurgy. This one-day meeting was held on 3rd December, 1981, at Goldsmiths' Hall, London, E.C.2. During the meeting Dr J. B. Nelson, F.G.A., demonstrated a visual colorimeter developed by him for the measurement of the body colour of all faceted stones, using the CIE Colour System. He also exhibited an optical ray-path device which shows the behaviour of a beam of white light as it enters and leaves each of three polished glass gemstone profiles (brilliant-cut, 'fish-eye' cut and 'lumpy' cut).

Dr Nelson also gave a talk on 'CIE colour measurement and its application to gemstones' to the Hampstead Scientific Society on 14th January, 1982, at Burgh

House, Hampstead. A model of CIE Colour Space was demonstrated, showing the point positions of 38 measured gemstone colours lying within it.

On 5th January, 1982, Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., spoke on 'Mineral inclusions' to the Mid-Herts Lapidary and Mineral Society.

OBITUARY

Mr Kenneth Arthur Banks, F.G.A. (D. 1956), Chorlton-cum-Hardy, died on 31st December, 1981.

Mr Geoffry Howard Parsons, F.G.A. (D. 1937), Westbury-on-Trym, died on 28th December, 1981.

Mr Robert Weston, F.G.A. (D. 1930 with Distinction), Birmingham, died on 19th October, 1981.

MEMBERS' MEETINGS

Midlands Branch

On 29th January, 1982, at the Society of Friends, Dr Johnson's House, Colmore Circus, Birmingham, Mr Peter Harrison, of the Treak Cliff Cavern, Castleton, Derbyshire, gave an illustrated talk on Blue John, the famous mineral mainly found in the Castleton area of the Peak District. The talk covered the properties of the mineral, difficulties experienced in working it, and the history of the industry at Castleton.

On Friday, 26th February, 1982, also at the Society of Friends, an illustrated talk was given by Mrs Edna Holloway, the Black Country peasant carver. Mrs Holloway carves ivory in the Japanese Netsuke style and has demonstrated her skill in a special programme on television.

North-West Branch

On Thursday, 25th February, 1982, at Church House, Hanover Street, Liverpool, Mr Nicholas Wainwright, F.G.A., gave a talk on gemstones in the retail business. Members were able to view specimens.

South Yorkshire and District Branch

On 21st January, 1982, at the Sheffield City Polytechnic, the Annual General Meeting of the Branch was held. Mr I. R. M. Lewis, F.G.A., and Miss J. I. Platts, F.G.A., were re-elected Chairman and Secretary respectively. The A.G.M. was followed by an informal talk and demonstration on the recognition of diamond and its simulants by Messrs I. R. M. Lewis and J. Reynolds, FF.G.A.

ANNUAL REUNION OF MEMBERS AND PRESENTATION OF AWARDS

The Annual Reunion of Members and the Presentation of Awards took place at Goldsmiths' Hall on 16th November, 1981.

The Chairman, Mr David Callaghan, F.G.A., who presided, said that it had been an important year. The Association was the senior of its kind in the world, having celebrated its 50th anniversary but having sprung from the National Association of Goldsmiths. It was for this reason that Mr Peter Hopper, F.G.A., the N.A.G. Chairman, was present to distribute the awards. There were some new awards this year. The Anderson/Bank Prize for the best non-trade candidate of the year in the Diploma Examination was being presented to a Hong Kong student by the Secretary, Mr Harry Wheeler, on his way to visiting Japan to take part in the Eighteenth International Gemmological Conference. There was also the Anderson Medal in the Preliminary Examination, commemorating the Association's Jubilee and Mr Anderson's 80th birthday: this had also been awarded to a candidate from Hong Kong.

Mr Callaghan then alluded to the two items on the table in front of him. One was a Jubilee present to the Association from Hong Kong, a marvellous fan given by their Gemmological Association; the other, a fine mounted crystal from the Norwegian Association.

Mr Hopper, after presenting the awards and recording his pleasure at the Association again being able to use the Goldsmiths' Hall, referred to the Jubilee exhibition which had also been held there and revealed that it had been visited by 3000 people apart from the members on the first day. It was a happy coincidence that he was Chairman of the N.A.G. at the same time as their anniversary. The Examinations had got a lot harder since he took them in 1958. He valued his F.G.A. above all other qualifications that he possessed, and urged all who possessed this qualification to use it to enhance the good name of the G.A. here and abroad.

Following the presentations, the Treasurer, Mr F. E. Lawson Clarke, F.G.A., recalled that his father had also been the Association Treasurer*.

The meeting ended with a vote of thanks to Mr Hopper by the Vice-Chairman, Mr Noel Deeks, F.G.A.

HONG KONG GEMMOLOGICAL ASSOCIATION AND PRESENTATION OF AWARDS

On 3rd November, 1981, Mr Alan Jobbins, F.G.A. and the Secretary, Mr Harry Wheeler, F.G.A., attended a specially organized reception and dinner given by the newly affiliated Gemmological Association of Hong Kong. Over 60 persons attended. This was an excellent opportunity to talk informally with their members, most of whom are F.G.A.s. After the dinner Mr Jobbins gave a talk on 'A Comparison between Volcanic and Breccia Agates of India' illustrated with slides, and Mr Wheeler spoke about the history of the G.A. of G.B. Then there followed a ceremony when the Secretary presented, on behalf of the Association, the Diplomas and Prizes that had been gained in the 1981 examinations by candidates in Hong Kong. In presenting the awards Mr Wheeler mentioned that it was an historic evening for the Hong Kong Association, because affiliation had only just been granted, it was the first time that an official of the G.A. of G.B. had presented awards outside the U.K., and the two new prizes, being awarded for the first time, the Anderson/Bank Prize and the Anderson Medal, had both been won by candidates from Hong Kong.

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*V. W. Clarke, Treasurer 1924-25 and 1932-42.—Ed.

Mr Cornelius (Con) Lenan, F.G.A.
Secretary Designate
(see p.176)

PRESENTATION OF AWARDS—TOKYO

On Saturday, 7th November, 1981, the G.A. of All Japan held a Presentation of Awards at the Imperial Hotel, Tokyo, at which Mr R. P. Martin, the Cultural Counsellor and British Council Representative in Japan, was present. The Chairman of the G.A. of All Japan, Mr Yamada Wadachi, introduced Mr Harry Wheeler, F.G.A., Secretary of the G.A. of G.B., who then presented Diplomas to those present who had qualified in our 1981 examinations. Following this, the Vice-Chairman of the G.A. of A.J., Mr Watanabe, thanked Mr Wheeler and then presented Certificates to those who had qualified in his own Association's examinations. Almost 100 persons were present. Afterwards a special evening reception (with buffet) was held, attended by about 150 persons. Mr Alan Jobbins, F.G.A., was also present.

COUNCIL MEETING

At a Meeting of the Council held on Tuesday, 2nd March, 1982, at Saint Dunstan's House, the business transacted included the appointment of Mr Cornelius (Con) Lenan, F.G.A., as Secretary Designate, to succeed as Secretary on Mr Wheeler's retirement in December 1982. A list of those elected to membership will be included in the July issue of the *Journal.*

SECRETARY DESIGNATE

Mr Cornelius (Con) Lenan, who as recorded above has been appointed to succeed as Secretary on Mr Wheeler's retirement, is a Fellow of the Gemmological Association (D. 1966), holds the N.A.G. Retail Jewellers' Diploma and is also a Member of the Institute of Marketing: he has also recently been appointed Executive Director-Designate of the National Association of Goldsmiths. His career commenced in the retail jewellery industry with Crouch the Goldsmiths in Cardiff. He continued his business career through service and manufacturing industries, gaining wide experience in the U.K. and on assignments in Europe, the U.S.A. and Australia. A Welshman, he is thirty-five and married with three children. His interests include oil painting, swimming, music and literature.

Mr Lenan has taken up his appointment and works closely with Mr Harry Wheeler, who continues as the Secretary until he retires in December 1982.

XVIIIth INTERNATIONAL GEMMOLOGICAL CONFERENCE

The XVIIIth International Gemmological Conference was held in Kashiko-jima and Kyoto in Japan from 8th to 13th November 1981. At the commencement of the proceedings all stood in silence as a tribute to the late James Payne, F.G.A. Invited delegates from the U.K. were Mr Alec Farn, F.G.A. (former Director of the London Gem Testing Laboratory), Mr E. Alan Jobbins, F.G.A. (Institute of Geological Sciences and a Senior Examiner of the Association) and Mr Harry Wheeler, F.G.A. (Secretary). Delegates from the following countries attended: Australia, Brazil, Canada, China, Denmark, France, Hong Kong, Italy, Japan, Korea, Netherlands, Singapore, South Africa, Spain, Sri Lanka, Switzerland, Taiwan, U.K., U.S.A., U.S.S.R., West Germany, and many interesting papers were submitted during the scientific sessions. The programme included a visit to Mikimoto Pearl Farm and Laboratories, where the harvesting of cultured pearls was seen and a visit to Pearl Island at Toba, where a special display of the Ama diving girls was organized (these diving girls are no longer used by Mikimoto, since the oysters are now reared artificially in their laboratories). Finally there was a visit to Lake Biwa to visit a freshwater cultured pearl company, followed by a boat trip to see the cultured pearl fisheries at close quarters.

The Conference finished with a 'Sayonara' party in Kyoto, when it was announced that the next Conference will be held in Sri Lanka in 1983. Professor Sunagawa and his Organizing Committee are to be complimented on the excellent organization and the arrangements made for a successful conference.

The various papers presented at the Conference are listed below:

Gemstone Resources of Australia, by E. R. Segnit, Australia.
Canadian Gemstones and Ornamental Mineral Occurrences, by W. F. Boyd and W. Wight, Canada.
Gem Minerals from Taiwan, by C. K. Huang, Taiwan.
Gem Occurrence in Sri Lanka with Special Emphasis on Elahera Gem Field, by E. Gamini and G. Zoysa, Sri Lanka.
Gemstones from the Tissamahara Area in Sri Lanka, by P. C. Zwaan, Netherlands.
Gemmy Minerals in Japan, by A. Chikayama, Japan.
Geochemical Aspects of the Central Australian Ruby Deposits, by D. H. McColl and R. G. Warren, Australia.
Sapphires of the Inverell District, New South Wales, by A. G. Tombs and J. H. Myers, Australia.
The Transvaal Emerald Deposits (South Africa), by Jan Kanis, South Africa.
Indian Agate Deposits, by E. A. Jobbins, England.
Geology and Mineralogy of Jadeite in Japan with Special Reference to Jadeite from the Kotaki-Omi Area, by Kazuya Chihara, Japan.
A Glimpse at the Gem Materials of China, by Liu Guobin, China.
The Kalahari Manganese Field near Kuruman, South Africa, by H. S. Pienaar, South Africa.
Recent Discoveries and Observations made in the Gem Trade Laboratory, by R. Crowningshield, U.S.A.
Gemmological News, by H. Bank, West Germany.
Some Gems from the Collection of the Fersman Mineralogical Museum, by V. S. Sobolev and L. V. Bulgak, U.S.S.R.
Pakistan Gem Deposits, by E. Gübelin, Switzerland.
External, Internal and Geochemical Aspects of Gem Garnets from Sri Lanka, by C. E. S. Arps and R. C. Litjens, Netherlands.
Tourmaline Chatoyancy, by Giorgio Graziani and Sergio Lucchesi, Italy, and Edward Gübelin, Switzerland.
The Last Neolithic Lapidary Men, by H. J. Schubnel, France.
New Possibilities of Corundum Identification Through Spectrophotometric Recording in Daily Gemmology, by C. A. Schiffmann, Switzerland.
Electron Spin Resonance in Gemmology, by L. V. Bershov, L. V. Bulgak, and A. V. Speranski, U.S.S.R.
Colorimetry in Gemmology, by Jean-Paul Poirot, France.

Diffraction-Grating (Spectrochromatic) Gemstones, by F. H. Pough, U.S.A.
New Views About Dichroism and Pleochroism, by Dina Level, France.
Application of Interference Contrast Microscopy to Identify Coated Diamonds, by Joji Sato and E. Sasaki, Japan.
Application to Gem Identification of Fluorescent X-Ray Analysis, by H. Ohguchi and E. Sasaki, Japan.
Gemology of Coloured Varieties of Synthetic Quartz, by V. S. Balitsky and A. A. Shaposhnikov, U.S.S.R.
The Origin of Diamonds and the Deep Gas Hypothesis, by J. M. Saul, France.
The Evolution of Diamond Grading Equipment, by R. T. Liddicoat, Jr, U.S.A.
The Pearl Challenge, by A. E. Farn, England.
Pearls, by Koji Wada, Japan.
The International Gemmological Conference—A Short Review, by Ove Dragsted, Denmark.
Garimpeiro Types of Gem Mining, by E. J. McGregor, Brazil.
Short History of the Gemmological Association of Great Britain, 1908-1981, by H. J. Wheeler, England.
Flashback, by Xaver Saller, West Germany.
Gemmology at a Crossroad, by Hans Reymer, Canada.
Gemmology and Physics, by L. Etienne-Amberg, Switzerland.

FELLOWS IN NEW SOUTH WALES

Mr John J. Douglas, F.G.A., of 31 Granada Avenue, Cardiff 2285, New South Wales, Australia, is interested in communicating with other Fellows of the Association in New South Wales. Anyone interested please communicate with him direct.

LETTER TO THE EDITOR

From Professor Dr E. Gübelin, C.G., F.G.A.

Dear Sir,

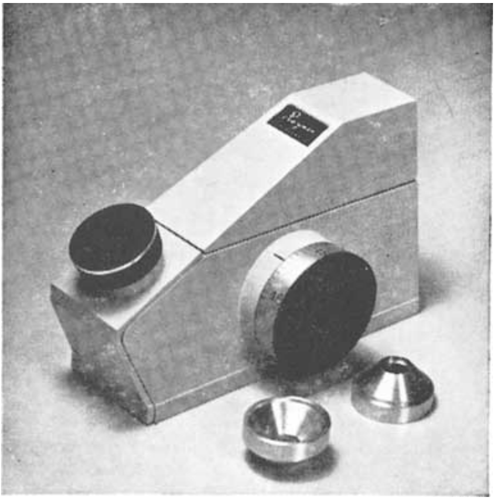
The voluminous Jubilee Issue of the *Journal of Gemmology* is such a fine publication—beautifully laid out with an impressive number of highly interesting and instructive contributions—that I feel urged to send you my enthusiastic congratulations for this outstanding publication, which will enjoy a prominent place in my gemmological library.

Having done some studies on inclusions in the new garnets from the Umba Valley in Tanzania, and also having vehemently opposed the ugly misnomer 'Malaya' garnet, I was particularly interested in reading the paper by Dr K. Schmetzer and Prof. H. Bank. With regard to the nomenclature of this new garnet, the authors emphasize that for the end members of the isomorphous series pyrope-almandine-spessartine garnet the designation 'pyralspite' is being used, wherefore no new fancy name is necessary. I certainly agree with this statement, and I am particularly satisfied that the problem is thus clarified, and the obscene misnomer 'Malaya' garnet (which actually means 'prostitute' garnet) is thus extinguished.

Strongly as I have always defended names officially acknowledged by mineralogy, in this case one should consider that the name of a gemstone which should attract the market must be a well-sounding, mellifluous and easily memorable name, which one certainly could not claim of the name 'pyralspite' even if it is scientifically justified. Therefore I wish to stick to my suggestion to endow this magnificent new garnet from the Umba Valley with the name *Umbalite* at least for commercial use. Names referring to the source or origin of gemstones have often been favoured by the trade as well as the public because it facilitates a closer relationship to the gem. See: benitoite, sinhalite, tanzanite, tsavolite, etc.

Yours etc.,
E. GÜBELIN

14th January, 1982.
Meggen, Lucerne, Switzerland.



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 any number of prints of individual articles may be supplied to authors provided application is made on or before approval of proofs. Current rates of payment for articles and terms for supply of prints may be obtained on application to the Secretary of the Association.

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.

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