



The Journal of Gemmology



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Cover Picture

A series of necklaces fashioned from a variety of gem materials.
Identification will be provided in the January issue.
(See 'Bead buyers and parcel pickers filter set', page 212)

The merger

Many members will be aware that the Gemmological Association has merged with the Gem Testing Laboratory of Great Britain. This merger was recommended by the Council of the GA at a meeting on 25 June 1990 and was agreed by attending members and proxy voters at an Extraordinary General Meeting held on 4 September 1990. Other members may wonder about the reasons for this merger and therefore we set out below the background events leading up to this decision.

The Gemmological Association can trace its history back to 6 July 1908 when it was proposed at the Annual Conference of the National Association of Goldsmiths that teaching courses and examinations in gemmology be launched. The first Gemmology Diplomas were awarded by the NAG in 1913. In October 1931 the GA was formally inaugurated as a NAG branch. In 1938 the Association's title was changed to the Gemmological Association of Great Britain, and in April 1947 it was incorporated as an independent Company.

Throughout its history the GA has operated from the NAG premises with its administration being carried out by NAG staff. This arrangement has become increasingly difficult as both Associations have developed along different lines and last year the NAG intimated to our Association that the joint administration would come to an end on 31 December 1990. It was decided therefore that it would be most convenient for our Association, as well as its subsidiary Gemmological Instruments Ltd., to move to new premises at 27 Greville Street, London, on 30 June 1990.

When, last year, the separation from the NAG became a probability the Officers of the Association had to consider its future – the primary concern being the continuity of its operations. However, it was also necessary to explore ways by which the Association could expand and prosper in the future. It was considered that a close association with the Gem Testing Laboratory of Great Britain could be beneficial. The Gem Testing Laboratory is the world's oldest such laboratory, founded in 1925 with Basil Anderson as Director. It has become a world leader in commercial gem testing and diamond grading, as well as in gemmological research.

When considering the history of our Association and the difficulties encountered over several years with its relationship with the NAG we became extremely anxious that our Association should not re-create these problems by entering into some sort of partnership with another independent organization. It was felt, therefore, that we should investigate the possibility of a complete merger with the Laboratory. A series of meetings followed where the proposal was discussed at length. These culminated

in the signing of an agreement between the Laboratory and the GA on 6 August 1990. This agreement was ratified at the Extraordinary General Meeting on 4 September 1990.

Professional advice was given to the effect that the most efficient way to effect the merger would be for the GA to transfer its assets to the Laboratory. At the same time the Laboratory would change its name to 'The Gemmological Association and Gem Testing Laboratory of Great Britain' and admit the Association members to the relevant class of membership. GA and Laboratory members would all have one vote at all General Meetings of the merged company. The Laboratory has also altered its Memoranda of Association to include the Educational Aims of the Association and its Articles of Association to include provision for a Members' Council.

The actual day-to-day management of the new company is under the control of a Council of Management which consists initially of the Chief Executive (Ken Scarratt), the Director of Gemmology (Roger Harding), supported by six non-executive directors. These would all have to be elected (if they wished to stand) at the first Annual General Meeting of the merged company. At each Annual General Meeting thereafter a third would retire by rotation, but could stand for re-election.

The Members' Council is envisaged rather along the lines of a Board of Trustees. It cannot interfere in the day-to-day management of the Company, but will be empowered to enquire into all operations, and, if it considers it necessary, to take its recommendations directly to the Members by calling an Extraordinary General Meeting of the Company. The Members' Council has been appointed initially from the current Council of the Association and the Committee of the Laboratory. All will retire at the second Annual General Meeting of the merged company, but may stand for re-election. At each Annual General Meeting thereafter a third will retire by rotation, but may stand for re-election. The members of the Council of Management are not, of course, eligible to serve on the Members' Council.

We have also been advised that it would be prudent to keep the Gemmological Association of Great Britain in existence and the mechanisms to achieve this were included in the resolutions passed at the recent Extraordinary General Meeting.

To summarize, the Gemmological Association and the Gem Testing Laboratory have amalgamated to form a single organization with a common administration. The educational aims of the GA will be expanded and the Laboratory services will be widened.

Gemstone prospects in Central Nigeria

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Abstract

The localities and geological setting of recent gemstone mining activities in central Nigeria are briefly described. Aquamarine and topaz occur in areas generally related to the edges of Younger Granite bodies. Tourmalines are associated with pegmatites of the Older Granite bodies. Sapphires and zircons have been extracted from eluvial deposits on weathered alkali basalts. The gem-quality zircons range from red to colourless and chemical analyses are reported of stones covering this range.

Introduction

Around 1980 the first information about new gemstone discoveries in Central Nigeria reached the outside world and by the middle of the eighties Nigeria had become an important producer of aquamarine, topaz, tourmaline and sapphire. A few articles about Nigerian gemstones were published between 1982 and 1987 (see references), but these deal mainly with their microscopic and physical properties.

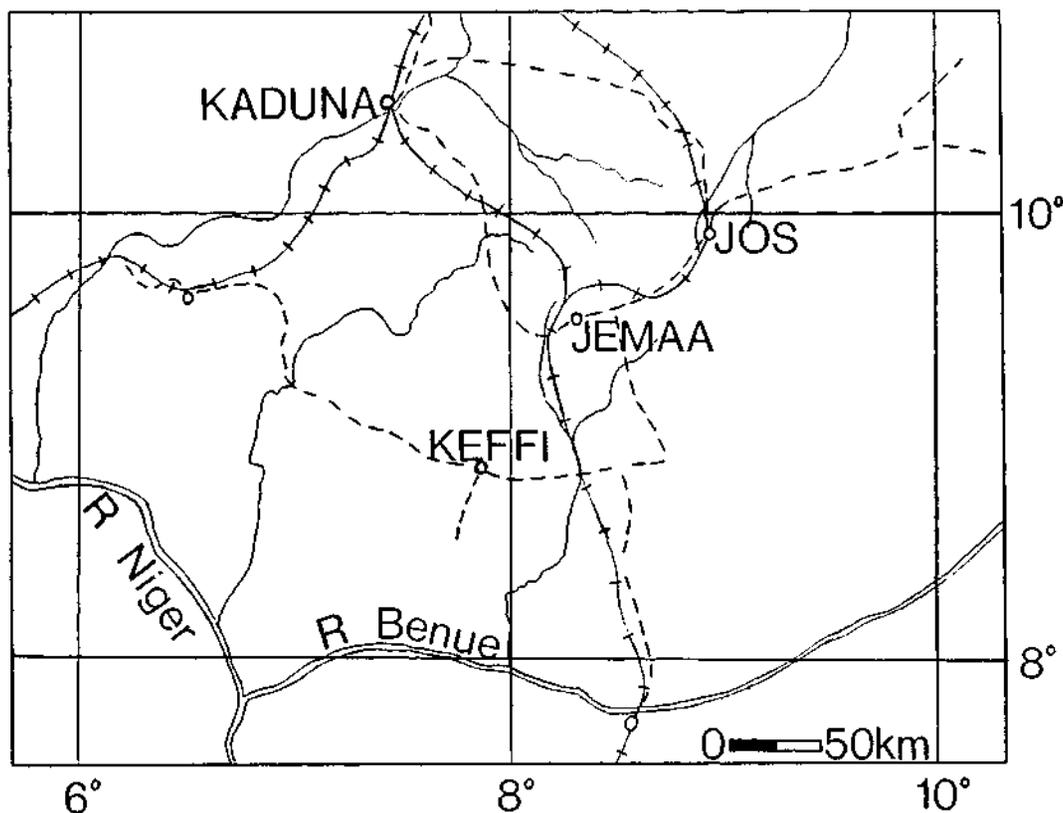


Fig. 1. Sketch map of part of Plateau and Kaduna States, Nigeria; location of places mentioned in the text.

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Most of these gemstones have been taken out of the country illegally and very little is known to date about production figures, or about the location and paragenesis of these gem deposits.

Recently one of us (J.K.) made a few short journeys to the central Nigerian Plateau- and Kaduna States (Figure 1), where all the newly discovered gemstone deposits occur.

Previous cassiterite mining

Since the turn of the century the central Nigerian district of Jos, in Plateau State, has been well known for the production of cassiterite (see Jacobson and Webb, 1946, and Geological Survey of Nigeria,

This kind of cover favoured a lateral dispersion of the mineralization of cassiterite in these plutons. The cooling and consolidation must have been rather rapid and the opportunity for the separation and concentration of the ore fluids greatly reduced. Hence, the almost total absence of payable lodes and pegmatitic formations.

Therefore, the richest concentration of cassiterite, both alluvial and primary, can always be correlated with recently 'unroofed' and superficially eroded intrusions of biotite-granite.

Although cassiterite is not a gemstone, the tin paragenesis is mentioned here because the aquamarine and topaz occurrences, described be-



Fig. 2. Pits dug in eluvial deposits of aquamarine, in 'unroofed' zone of Younger Granite pluton; Rafin Gabas Hills.

1988). It is interesting to note that the tin production from pegmatites, associated with some of the Older Granites, never amounted to more than 2% of total production. On the other hand, according to MacLeod, Turner and Wright (1971), cassiterite of economic interest can invariably be correlated here with Younger biotite-Granites and the richest tin mineralization is in those granites which have undergone a higher degree of late albitization. The cassiterite has occurred in a multitude of narrow greisen veins and quartz stringers in the roof zones of the biotite-granite intrusions, and has been retained within the parent rock beneath an impermeable cover of roof rocks.

low, probably have a similar origin.

Aquamarine of the 'Rafin Gabas Hills' District

Approximately 34 air km SSE of the town of Keffi, in the most western part of Plateau State, are the 'Rafin Gabas Hills', which form part of a mountainous Younger Granite complex of Upper-Cretaceous age (Figure 2). Gem-quality beryl in greenish and yellowish colours and aquamarines in blue to very deep blue shades have come from this district during the last eight years (Bank 1984a, 1986, Lind, Schmetzer & Bank 1986).

The occurrence of industrial beryl, together with tin and columbite, in the Younger Granites of North

Nigeria has been described by Taylor (1959) who reports that these primary deposits are located in quartz veins, stockworks and greisens, within or near the granite contacts.

In the 'Rafin Gabas Hills' district, the aquamarine crystals, white to pale blue topaz and smoky quartz crystals occur in narrow stringers and thin layers, which form a stockwork over an extensive area, mainly in the 'roof' zones of the granite hills. The granites consist mainly of quartz, albite and orthoclase with less than 5% mica (siderophyllite) and accessory minerals. The latter include serpentine, hematite, zircon, cassiterite, columbite, thorite and oxides containing thorium, uranium, lead and

During the middle of the eighties it was relatively easy to collect the eluvial, colluvial and alluvial aquamarine and topaz crystals on or near the surface, but the production has recently dropped dramatically, since this material is found only sporadically now.

Unless new areas of eluvial and alluvial deposits of aquamarine and topaz are discovered in this inhospitable mountainous region of Plateau State, Nigerian aquamarines might soon be a thing of the past. However, similar occurrences might well be discovered in other districts as the Younger Granite plutons are widespread throughout central Nigeria. Failing this, new gemstones will have to come from



Fig. 3. Prospectors follow narrow stockwork veins in Younger Granite with pegmatites in search of aquamarine and topaz.

rare-earth elements.

In other parts of Plateau State the aquamarine, topaz and smoky quartz crystals occur in fissures, joints and shear zones at the edges of granite bodies (Figure 3). Such channels enabled solutions to be transported through the granite to the outer zones of the plutons, where they cooled rapidly forming disseminated deposits of beryl/topaz and other rare minerals. We also observe syngenetic miarolitic and schlieren beryl occurrences here, which, according to Sinkankas, 1981, pp339,342, typically contain beautiful euhedral crystals, and this explains why so many well-formed aquamarines and topaz crystals have been found in the eluvial deposits.

hard rock mining, but the irregular pattern and distribution of aquamarine- and topaz-bearing veinlets in a hard granite, in many situations makes mining of these gemstones by blasting uneconomic.

Rarely, aquamarines of an outstanding deep blue colour are found (Bank, 1986), and recently an aquamarine nodule, in which a clear gemmy core is surrounded by a flawed margin, has been reported by Kampf and Francis (1989).

Tourmaline pegmatites SE of Keffi

The first article on the Nigerian tourmaline pegmatites appeared in 1984 (Bank, 1984c), but their location was at that time unknown to us. Now



Fig. 4. Tourmaline-bearing pegmatite SE of Keffi.

we know that these fine tourmalines have come from a granitic pegmatite belt, approximately 12 air km SE of Keffi and NW of Takwa Hill. The geological setting of these pegmatites is as follows: the major plate tectonic event of Pan African age took place 600 ± 150 million years ago and led to widespread re-activation of the internal region of Nigeria with the emplacement of large volumes of granites, called Older Granites. The Pan African belt evolved as a consequence of collision between the passive margin of the W. African Craton or stable shield area, and the active margin of a continent to the East. The Older Granites intruded both the Precambrian migmatite-gneiss complex and the schist belts and are themselves traversed by numerous pegmatites, many of which are albitized. These pegmatites are concentrated around the Older Granites and related to them.

The tourmaline bearing pegmatites SE of Keffi (Figure 4) consist mainly of orthoclase feldspar, partly albitized, relatively little quartz, biotite and muscovite. Lepidolite and albite, in the form of cleavelandite are commonly associated. The border zones, in contact with adjacent gneiss, are well defined with an abundance of small muscovite

'books'. A few beryl crystals occur in the border zones and although blue in colour, these crystals are always opaque and of no gem value.

One of us (J.K.) visited seven tourmaline-bearing pegmatites and according to the local miners, another thirteen pegmatites in this belt are known to contain tourmalines. The visited pegmatites vary in width from 3 to 5 m, dip very steeply and appear to have a length of 400 m or more. Workings have been erratic and shallow, never more than to a depth of 6 m, probably due to lack of capital and proper mining equipment. Lately, tourmaline production has virtually halted in this district. However, the little mining done so far, has certainly established the potential of gem quality tourmalines in many colours throughout this pegmatite belt. Over the years these pegmatites have yielded tourmalines of gem quality from finest green to bottle green, red tourmaline in many shades and various fancy colours in yellow, rose and even violet. In addition water-melon tourmalines and gem-quality tourmaline nodules have been found here.

Sapphires and zircons of the Jemaa District

In the southwestern corner of Kaduna State and approximately 50 air km SW of Jos is the village of Jemaa.

The first sapphires were discovered here in 1968 by a tin mining company, but the company ceased operations after a few months. Most of the sapphires found were too dark to market at that time and the commercial heat-treatment of sapphires was still unknown. Sapphires reported to be from this area appeared in 1974. Production seems to have increased considerably from 1984 onwards (Figure 5), although no statistics are available as practically all sapphires have been smuggled out of Nigeria by Senegalese and Mali traders (Figure 6).

Geologically the Jemaa sapphires are related to basalts and the occurrence appears to be identical to the sapphire deposits of New South Wales in Australia and those in Thailand and Kampuchea. The Newer Basalts in central Nigeria were erupted after the Plateau had achieved its present-day topography and certain lava flows in the Jemaa and Gimi river area can be followed over a distance of some 20 km. Some of the basalts are now largely decomposed.

The Jemaa alkali basalt is dark grey porphyritic and amygdaloidal. The amygdaloids are commonly filled with carbonate, largely siderite in composition with bands of manganoan siderite which has grown inward from the walls. The phenocrysts of olivine and feldspar are euhedral, subhedral, rounded or embayed. Irregularly-shaped pyroxene grains occur in the groundmass of the basalt and analyses indicate that it is a clinopyroxene of salite composi-

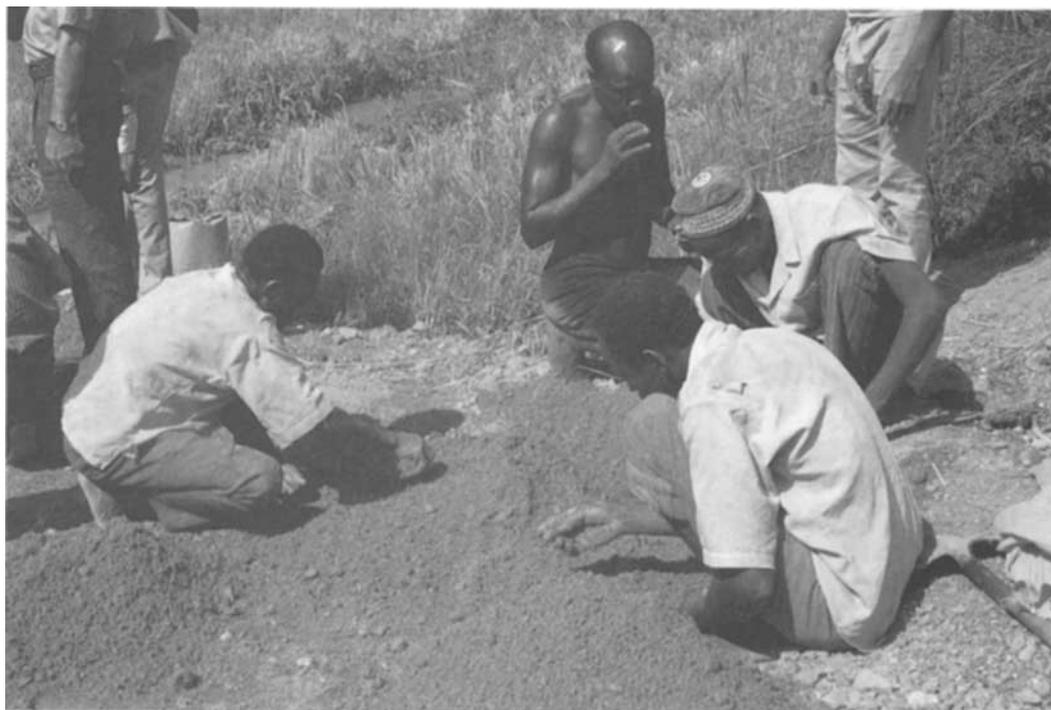


Fig. 5. Washed concentrate being sorted for sapphire and zircon, near Jemaa.



Fig. 6. Illegal sapphire diggings in decomposed alkali basalt flows near Jemaa.



Fig. 7. Zircon crystals from decomposed alkali basalts near Jemaa, showing range of colour and degree of rounding. The largest crystal in the picture is 19 mm long.

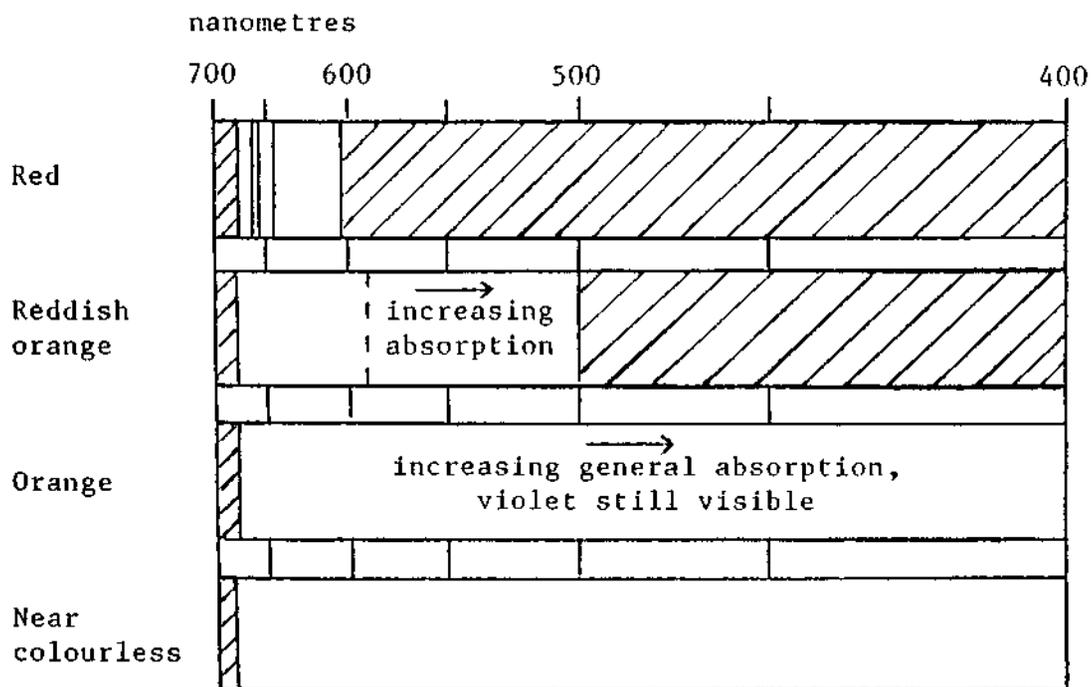


Fig. 8. Sketches of absorption spectra in four zircons showing a colour range from red to colourless.

tion. The chemical data determined for the olivines, pyroxenes and ilmenite are all consistent with those described in the literature for alkali basalts or their ultramafic nodules.

The sapphire and zircon xenocrysts embedded in the basalt flows have dull, slightly corroded surfaces and rounded edges. They were probably derived from a deep crustal rock that was invaded and shattered by upward-moving basaltic magma (Scarratt, Harding and Din, 1986).

The physical, spectroscopic and microscopic properties of the Nigerian sapphires are described by Kiefert and Schmetzer (1987), and Henn (1986) describes idiomorphic apatite crystals, rounded zircon crystals, 2-phase and other inclusions.

Most Nigerian sapphires have a distinct colour zoning and show a flat prismatic habit. Although most sapphires range in colours from dark blue to fine blue, green, yellow and bi-colour sapphires also occur here.

The average crystal diameter of these gemstones, recovered by very simple washing methods, is probably near 0.75 cm, but greater quantities of smaller crystals could be recovered with more sophisticated mining methods.

The same basalt lava flows also contain zircon crystals as slightly rounded euhedral prisms, some up to 2 cm in diameter. They range from transparent to opaque, in different colours from deep red to orange and almost colourless. A large percentage of the zircons is of gem quality (Figure 7).

Four samples showing the range in colour were selected for chemical analysis and to determine whether colour is related simply to composition. Sketches of their absorption spectra are given in Figure 8, and the analyses are given in Table 1.

The results indicate that red zircon (Table 1, col. 1) has a minor element content significantly different from those of the orange and near-colourless zircons. It contains more Ca, Nb, Sc, Th, U, Y and REE than the other stones, but less Mn and Ti. The analysis of the reddish orange zircon in column 2 is not significantly different from that of the orange stone in column 3 and the visible gradation in colour intensity is not paralleled by the values of the minor elements determined. The cause of the red or orange colours therefore remains unresolved.

The analyses indicate that the zircons contain a variety of minor and trace elements, and there may be a correlation between depth of colour and one or more of these elements. But assigning the colour variation to one particular element or group of elements would require analysis by electron spin resonance or nuclear magnetic resonance techniques.

Table 1. Analyses of zircons from Nigeria

Wt%	1	2	3	4
SiO ₂	33.2	32.4	31.8	32.1
ZrO ₂	65.3	65.6	65.3	66.5
HfO ₂	1.23	0.91	0.85	0.64
Al ₂ O ₃	0.02	0.08	0.09	0.01
Fe ₂ O ₃	0.12	0.83	0.37	0.08
CaO	0.30	0.01	0.01	0.01
Total	100.17	99.83	98.42	99.34
ppm				
As	<5	<5	<5	<5
Co	<35	<35	<35	<35
Cr	<35	<35	<35	<35
Cs	<1.5	<1	<1	<1
Cu	<25	<25	<25	<25
Mn	11	38	27	16
Nb	469	22	19	18
Ni	<10	<10	<10	<10
Rb	<40	<20	<20	<20
Sb	<1	0.4	0.4	<0.3
Sc	83	19.9	14.7	7.1
Ta	7.1	1.6	1.6	0.9
Th	448	71	55	40
Ti	148	240	374	134
U	436	62	56	38
V	<10	<10	<10	<10
Y	1035	404	270	219
REE				
La	<5	<5	<5	<5
Ce	<20	<15	<15	<15
Nd	<25	<20	<20	<20
Sm	1.84	0.64	0.83	0.98
Eu	1.34	0.52	0.70	0.75
Gd	<25	<25	<25	<25
Tb	5.7	1.31	2.58	2.14
Tm	39.6	15.5	17.3	12.5
Yb	360	119	130	95
Lu	63.8	16.0	19.1	13.5

Notes: determination of Si, Zr, Al, Fe, Ca, Co, Cr, Cu, Mn, Nb, Ni, Ti, V, Y, and Yb were made by ICP (inductively coupled plasma) emission spectrometry. Sample solutions were prepared by:

- fusion of ca 40mg with Na₂CO₃/Na₂O₂, in nickel crucibles, dissolution in HCl (200 ml) for SiO₂ and ZrO₂;
- fusion of ca 100mg with KHF₂, in platinum crucibles, dissolution in H₂SO₄ (50 ml) for all but SiO₂ and ZrO₂.

Determinations of Hf, As, Cs, Rb, Sb, Sc, Ta, Th, U and REE except Yb were made by INAA (induced neutron activation analysis)

- Red zircon, lab. no. 8698
- Orange zircon, lab. no. 8699
- Orange zircon, lab. no. 8700
- Near-colourless zircon, lab. no. 8701

Conclusion

Central Nigeria might well have more gemmological surprises in store for us. Indications of an emerald deposit have already been mentioned by Bank (1984b), and pegmatites with rare blue gem-quality gahnite in the Jemaa area have been reported by Jackson (1982). Furthermore, Nigeria has supplied large quantities of white topaz used for irradiation purposes during the last decade (see Schmetzer, 1987).

Acknowledgements

We would like to thank V.K. Din who carried out ICP analyses of the zircons, and Dr C.T. Williams who performed the INAA analysis for certain trace elements in these crystals.

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F.G.A

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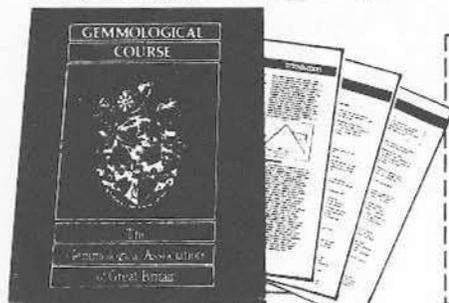
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Hematite inclusions in Eonyang amethyst from Korea

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Abstract

Eonyang amethyst is the highest gem grade material produced by Korea thus far. It often contains solid inclusions which occur as aciculae which may be terminated at one end by a small thin and elongate patch, dendrites, and angular plates. These inclusions, up to 3 mm in length and oriented nearly parallel to the developed growth lines, have been identified as hematite by reflected light microscopy, scanning electron microscopy and X-ray diffraction analysis.

Introduction

Korea's best gem-quality amethyst has been produced from geodes which have developed within the fine-grained mass of Eonyang granitic body. The granite is found near the town of Eonyang, located in the southern part of Korea peninsula. Annual production of approximately 10 kg of gem-quality material, produced from the Jeil Amethyst Mine, has been far below domestic demand necessitating the importation of large amounts of rough material, principally from Brazil. After the imported Brazilian amethyst is faceted, some is sold on the domestic market as 'Eonyang (or Korean) amethyst'. A resemblance between the

Eonyang and Brazilian amethysts sometimes makes distinguishing between the two difficult. In general, Eonyang amethyst displays a deep purple colour with a red tint, the red tint being absent in the Brazilian material. However, a more reliable indicator is the presence of solid and, occasionally, fluid inclusions, which are characteristics of the Eonyang amethyst. As such, these solid inclusions were analysed using transmitted and reflected light microscopy and scanning electron microscopy, which were supplemented by X-ray diffraction.

Investigation

The solid inclusions, which are frequently observed in Eonyang amethyst, may be acicular (Figure 1), dendritic (Figure 2) or angular (Figure 3). The aciculae are often terminated at one end with a small elongate patch (Figure 4). The inclusions attain a maximum size of 3 mm, and may be visible to the naked eye. In most cases they occur parallel to growth lines in the amethyst, which is often marked by distinct colour zonation.

For further examination, approximately 200 amethyst crystals were cut into thin slices and

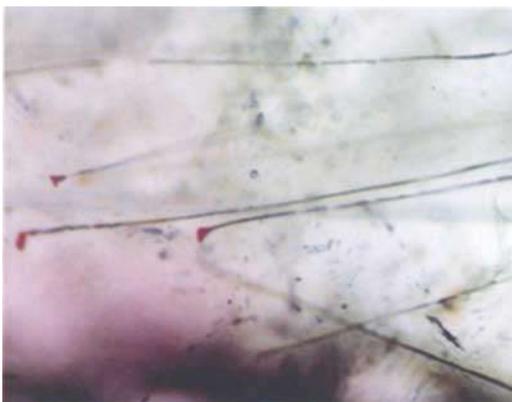


Fig. 1. Hematite aciculae oriented nearly parallel to the growth lines developed in Eonyang amethyst from Korea. Transmitted light. 100X.

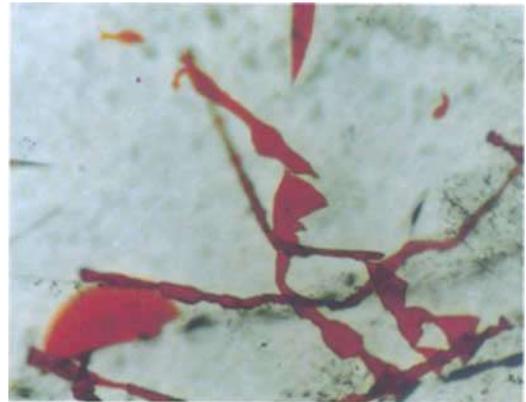


Fig. 2. Dendritic hematite crystals in Eonyang amethyst from Korea. Transmitted light. 100X.



Fig. 3. Anhedral fragment of hematite in Eonyang amethyst from Korea. Growth planes intersecting at 120° are seen. Transmitted light. 200X.

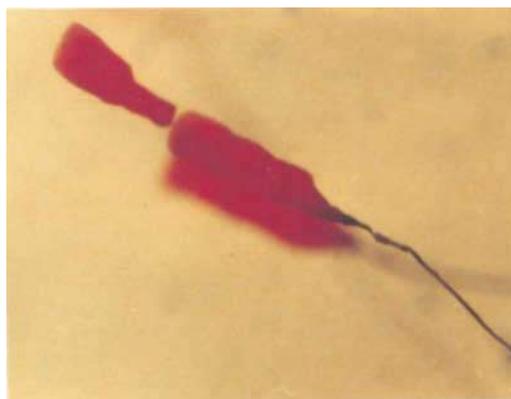


Fig. 4. Opaque hematite acicula attached to translucent (red) hematite patch in Eonyang amethyst from Korea. Transmitted light. 400X.

doubly polished. Under a polarizing microscope, the acicular crystals were observed to be opaque for the most part, while crystals of differing habits were translucent, showing various shades of red. In reflected light, the inclusions exposed at the polished surface are greyish-white with a bluish tint, and show a distinct pleochroism and a strong anisotropism. Vickers micro-indentation hardness tests give $VHN_{100} = 974-1039$, in good agreement with the value of 1038 reported by Craig and Vaughan (1981) for hematite.

Qualitative energy-dispersive X-ray analysis (Figure 5) carried out with the aid of a scanning

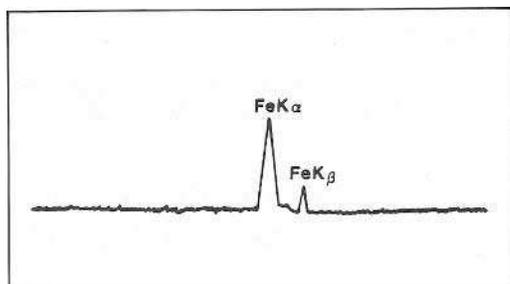


Fig. 5. Energy-dispersive spectrum of hematite inclusion in Eonyang amethyst from Korea.

Table 1. X-ray powder diffraction data of Eonyang amethyst containing hematite inclusion.

h	k	l	$d_o(\text{Å})$	1	I/I_o	$d_o(\text{Å})$	2	I/I_o
1	0	0	4.26		35	4.26		33
0	1	2	3.66*		2(30)			
1	0	1	3.342		100	3.341		100
1	0	4	2.690*		10(100)	2.686*		8(100)
1	1	0	2.519*		7(70)	2.511*		5(70)
1	1	0	2.459		17	2.460		15
1	0	2	2.282		17	2.280		15
1	1	1	2.238		5	2.237		5
2	0	0	2.125		10	2.128		10
2	0	1	1.980		6	1.976		6
0	2	4	1.838*		4(40)	1.839*		1(40)
1	1	2	1.816		15	1.816		15
1	1	6	1.689*		11(45)	1.690*		1(45)
2	0	2	1.672		10	1.672		10
2	1	1	1.541		15	1.543		13
1	1	3	1.453		4	1.455		4
2	1	2	1.384		8	1.381		8
2	0	3	1.375		5	1.376		15
1	0	4	1.282		10	1.288		3
3	0	2	1.253		2	1.256		2
2	2	0	1.226		4	1.228		4
2	1	4	1.198		4	1.199		3
1	1	4	1.183		4	1.183		3

1, Amethyst with red hematite patches. 2, Amethyst with opaque hematite aciculae. * represents X-ray line belonging to hematite and numbers in parentheses indicate intensities of hematite (JCPDS Card No. 33-664). $CuK\alpha$ radiation, 114.6 mm Gandolfi camera used.

electron microscope, reveals that Fe is the major element of the inclusions. X-ray diffraction analyses were also attempted on the opaque and translucent reddish crystals. Amethyst fragments, relatively rich in inclusions, were selected, and immersed in an HF solution for many hours to dissolve the enveloping amethyst. The undissolved material was then ground in an agate mortar. X-ray powder diffraction patterns of the undissolved amethyst and solid inclusion mixtures were obtained using a 114.6 mm Gandolfi camera with Ni-filtered $\text{CuK}\alpha$ radiation and 2 hour exposures. The X-ray powder data for the opaque and translucent inclusions (Table 1), after removal of reflections belonging to amethyst, agree well with X-ray data reported for hematite (JCPDS card No. 33-664). All the analytical data obtained in this study confirm the identity of the solid inclusions as hematite.

Acknowledgements

I thank Prof. G. Y. Chao of Carleton University, Ottawa, for the X-ray diffraction analyses, and Mr Y. K. Koh, president of Jeil Amethyst Mine of Korea for access to the mine and the donation of amethyst samples. Thanks are also extended to Ms H. S. Shin for her assistance in the laboratory. Financial support was given by the Korea Science and Engineering Foundation.

Reference

Craig, J. R., Vaughan, D. J., 1981. *Ore microscopy and ore petrology*. John Wiley & Sons, 406pp.

[Manuscript received 20 November 1989.]

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Gemmological visual aids

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Abstract

Three visual aids are described suitable for use in the classroom situation.

Introduction

While the main armoury of a teacher is black-board and chalk, three-dimensional models can often enlighten a physical concept, or help in interpreting special configurations particularly as in the science of crystallography.

Description

Visual Aid (1) [Axes of Symmetry, Figures 1 and 2]

Pop rivets were inserted into a 10cm edge white pine softwood cube at the face centre, the centre edge and the corners of the cube. The cube was supported on a mild steel stand having a lower fixed jaw and an adjustable upper jaw. The jaws consisted of $\frac{1}{8}$ inch diameter mild steel round stock and pointed at the ends to allow the cube free rotation within the pop rivets. Three colours were used to paint the cube so that each pair of parallel faces were

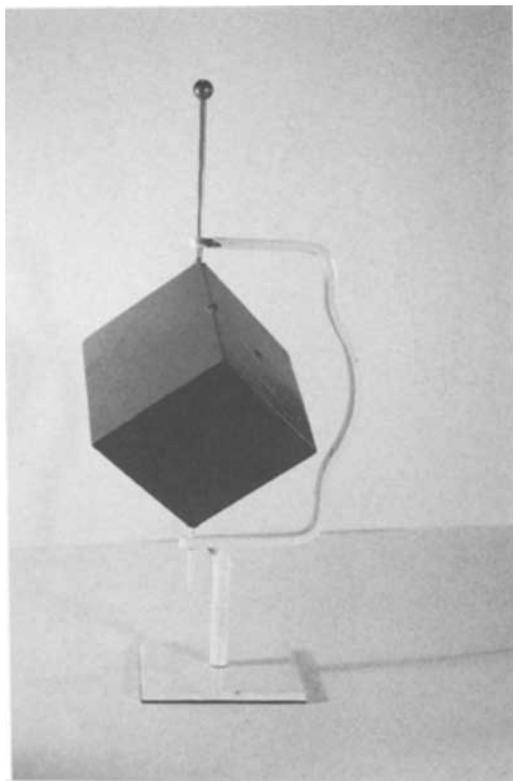


Fig. 1. Model of cube – triad axis.

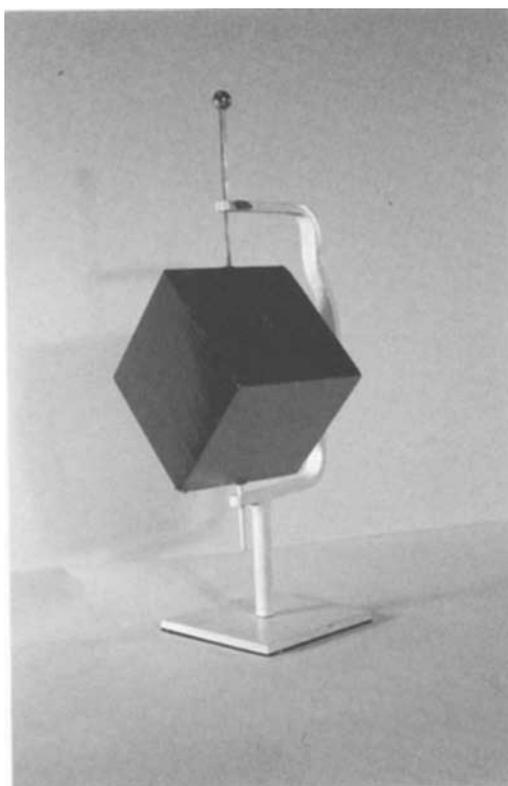


Fig. 2. Model of cube – diad axis.

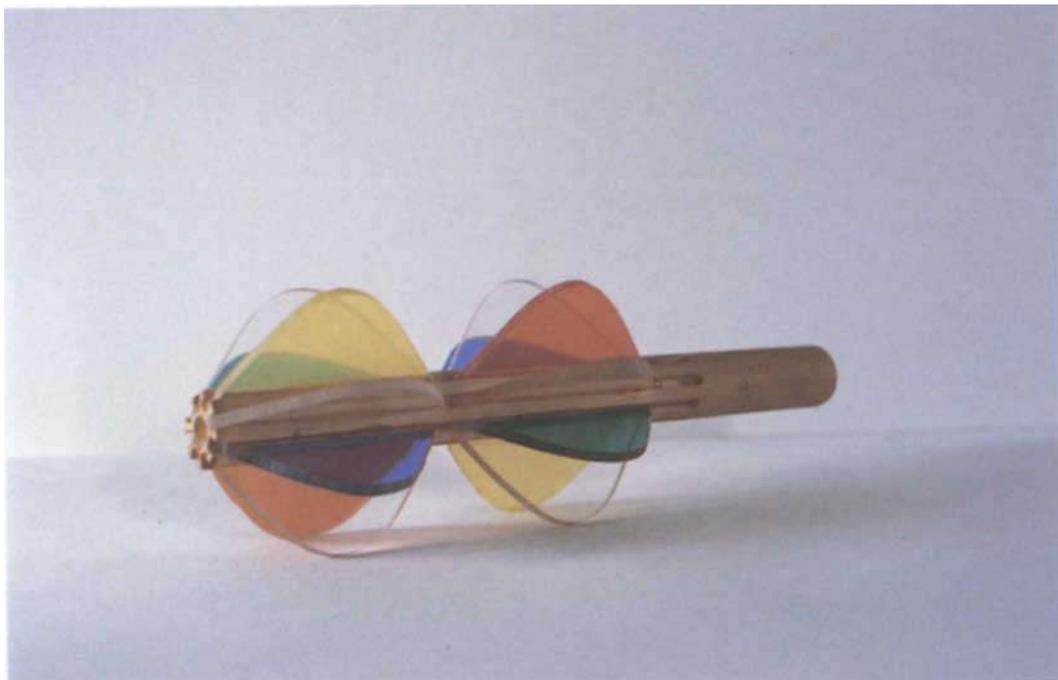


Fig. 5. Model showing the nature of ordinary light – fixed wavelength.

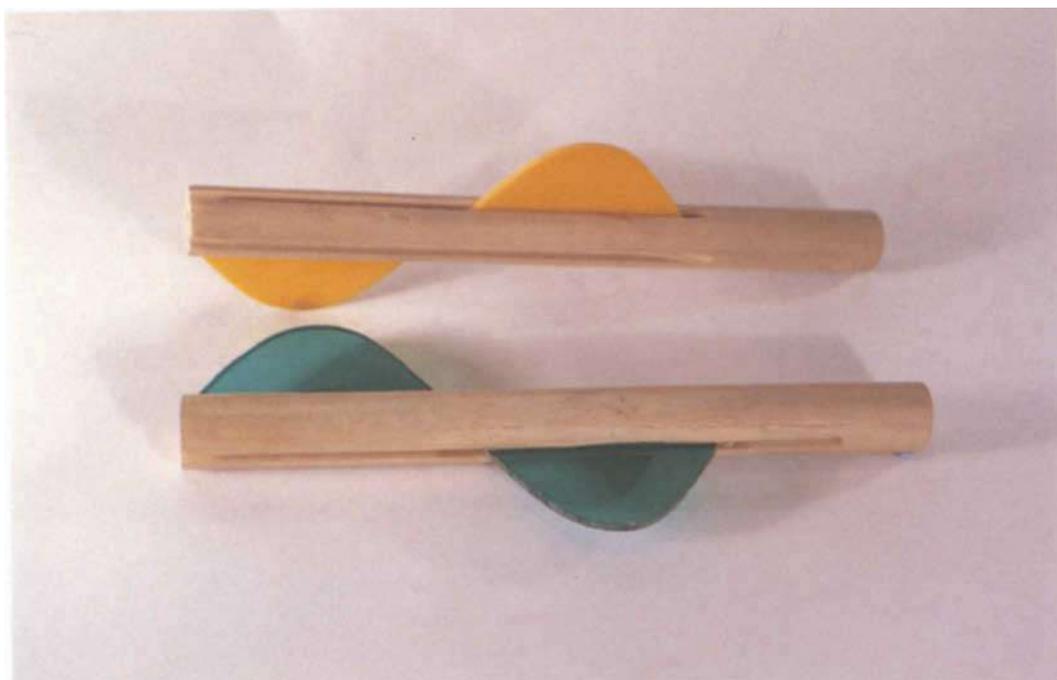


Fig. 6. Model showing the nature of plane polarized light rays.

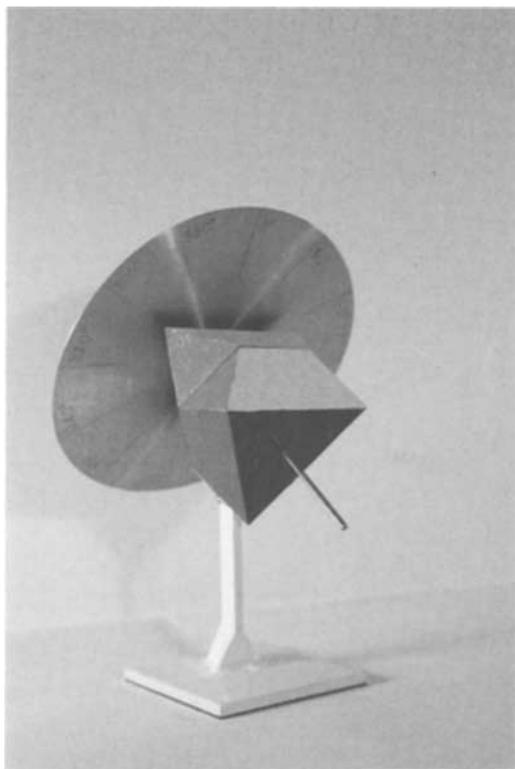


Fig. 3. Model of macle 180° rotation – symmetrical twin.

of the same colour. The model may serve either for demonstrations or by allowing students to explore, they can readily discover that the cube has 13 axes of symmetry – 3 tetrad, 4 triad and 6 diad. The stand can be employed for other crystal systems.

Visual Aid (2) [Spinel Twin or Macle, Figures 3 and 4]

If a regular octahedron was made and then cut along the twin plane, the two resultant parts would not be identical due to the kerf of material removed by cutting along a sloping face.

Hence two identical halves were made separately by milling the required shape from a block of nylon and fitting the two halves together to produce an octahedron of 10cm edge. The twin axis consisted of 1/8 inch diameter mild steel round stock inserted through the centroid of two opposite parallel faces with the twin axis at right angles to each of the faces. The lower half of the octahedron was fixed by machine screws to the stand's pillar while the upper half was free to rotate. To measure the angle of clockwise rotation of the upper half, an 8 inch diameter brass protractor plate provided with a collar and thumb screw locked the collar on to the twin axis. The octahedron was finally painted with 4

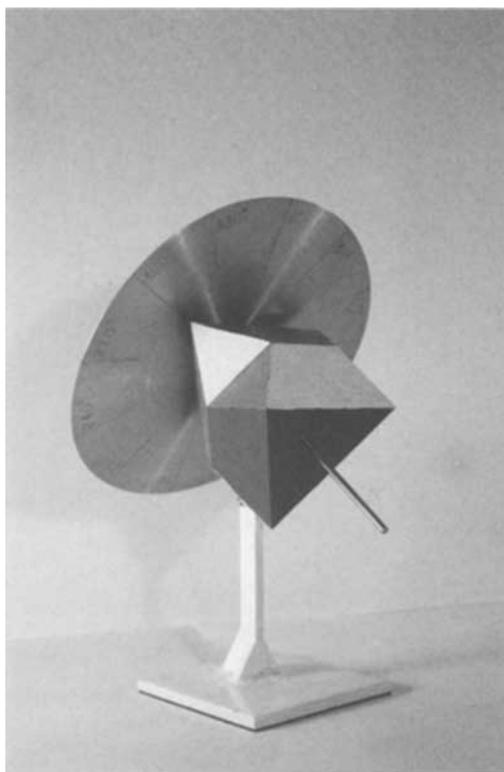


Fig. 4. Model of macle showing 300° rotation.

colours, each single colour corresponding to a pair of parallel faces. Congruency of the two halves is found by rotating the upper half of the octahedron about the twin triad axis through an angle of 60°, 180° or 300°. However it is only for a 180° rotation that each half is a mirror image about the twin plane i.e a 180° rotation is equivalent to reflection across the twin plane resulting in a symmetrical twin.

Visual Aid (3) [Light, Plane Polarized Light, Figures 5 and 6]

Light wave vibrations at right angles to the direction of propagation of a single light ray of constant wavelength has been represented by a 1 inch diameter wooden dowel rod, slotted along its length so as to accommodate several 1/8 inch-thick perspex sheets. The perspex is shaped as a sinusoidal wave and arranged radially around the rod. Polarized light is represented in a similar manner by a single sinusoidal wave.

Unlike the previous two visual aids which may be regarded as 'real models', the latter represents a simplified conceptual model.

[Manuscript received 7 June 1990.]

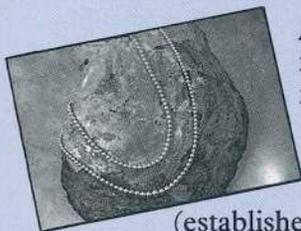
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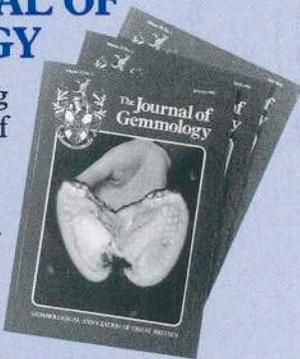
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Bead buyers and parcel pickers filter set

R. Keith Mitchell, FGA

Orpington, England

Hanneman Gemological Instruments of California have compiled a set of four colour filters under this rather quaint name. The stated principle behind these as a set is that a necklace or parcel of stones of one kind will all appear to be identical when viewed through one of these four filters. It is not made clear whether this applies to all the filters, or that this effect is to be expected with at least one out of the four. It is said to hold true regardless of the type of light used and of the sight of the observer, etc. Any stone which appears different should be examined more carefully to ascertain the reason for that difference. It is suggested that the use of the filters serves to eliminate variations in perceived colour between individual observers. Dr Jamie Nelson has passed one of these sets to me for an independent assessment.

By and large this use can be substantiated to some extent with two of the filters, but I feel that the proviso should be made that the necklace or parcel in question should be all one colour in the first place. For example my wife has a tourmaline necklace which has yellow, pink, green, blue and purple-red beads, and this appears similarly mixed through each of the four Hanneman filters despite being quite definitely all tourmaline. A box of mixed colours of zircon failed in the same way. One expected this, but the instructions accompanying the set should be specific on this point. There is always the occasional person who is dim-witted enough to accept the printed word without question, and I have seen more than one gemmological error arise from crass stupidity. Testing matched parcels I found that the effect seen could vary rather drastically with depth of actual stone colour.

Two of the filters have registered names, the *Aqua-Filter* and the *Ruby Filter*, although such a straight descriptive term as the latter can hardly claim legal protection with much hope of preventing others from using it. This is rather like trying to register the name 'Shoe-Polish' or 'Strawberry Jam'. These two filters are said to be particularly useful under strong incandescent light to 'characterise'

[identify?] blue and red stones respectively.

The Aqua-Filter

This is very similar to our *Chelsea Filter* and appears to be identical with an American one offered in Australia as the *Discrimagem Filter*. Both pass rather wider bands of green and deep red wavelengths than the *Chelsea*, plus a narrow region in the orange. The Hanneman filter is a pinkish-grey colour as against the more sombre greenish-grey of the *Chelsea*. Hanneman describes the filtered colour of aquamarine through this one as 'green', but in my eyes it is rather more blue, but the point is that the filter strengthens the natural blue-green of aquamarine just as the *Chelsea filter* does. A number of aquamarine coloured pastes and doublets gave a filtered colour almost identical with several of the aquamarines tested. Light blue spinel is claimed to be 'pinkish', but this refers to the synthetic material coloured by cobalt, and the instructions should make this clear. Again the *Chelsea Filter* gives the same result. It may be noted here that the extremely fine and rare 'cobalt' blue natural spinel gives a superb wine-red through either filter. Normal natural dark blue spinels gave a nondescript dark grey through the filters.

The effect with light blue topaz is described as 'blue-grey' but I think this could possibly be confused with the filtered colour of paler aquamarines. Pale blue and medium blue sapphires give a rather nondescript grey through either filter. Tanzanite loses its violet-blue and acquires a pinkish cast. Blue zircon gives a filtered blue-green which differs from that of aquamarine. I was unable to see the flashes of red which are mentioned in the instructions.

All of these effects are seen almost identically through the *Chelsea Filter*. In view of this similarity I tried the Hanneman version to authenticate emerald, although this use is not claimed in the instructions. It works for emeralds of good colour but gives a distinct green when poorish stones of

South African origin are examined. Poor coloured stones from the ancient Austrian mines at Habachtal gave a similar filtered green. This is because of the wider band transmission of green wavelengths. The Chelsea filter does not do this and is therefore the safer one for emeralds although, as pointed out below, it still needs to be used with care.

The Ruby Filter

This appears to be a standard tri-colour green, and has the rather startling effect of making rubies appear 'bright blue'. I would quarrel with the description 'bright' and would describe the effect seen when Burma rubies are viewed, as a sapphire-like blue with a hint of violet, while Thai rubies give a deeper violet blue. Light red spinels appear grey, but good ruby-red ones give a violet-blue which could just possibly be mistaken for the Thai ruby reaction. Almandite (almandine) is also said to appear grey through the filter; some do, but violet-red ones give a decided violet-grey, while brownish-reds appear brown.

A pyrope (RI 1.76), which is ash-grey in daylight and a fine raspberry-red in incandescent light, gave a decided blue. A fine large violet-red pyrope (RI 1.742) was blue enough through this filter to match the filtered blue of some Burma rubies. Three other violet-red garnets gave similar blue filtered colours and two of these were proved to be almandine-pyropes by their absorption spectra. The one exception, to my delight, was found to be a Thai ruby of 0.74 carats. [Careless re-parcelling of a stone at some earlier date?] That exception does prove the value of this particular filter, although I did take the precaution of checking it by spectroscope and refractometer, tests which are far more reliable than any filter.

No claim is made for this filter in respect of alexandrites, but I feel that it should be mentioned that a good quality natural stone was found to give practically the same filtered blue as the synthetic corundum 'alexandrine' imitation.

My best Siberian alexandrite gave a better blue than that of a Burma ruby seen through this filter. In premises lit entirely by incandescent bulbs it is just possible that such a stone could be assessed as ruby if nothing but the filter is used to test it.

The remaining two filters are not claimed specifically for any task beyond the general one mentioned earlier.

The Deep Green Filter

This one has been achieved by combining a blue filter, with absorption resembling that of cobalt in glass, with a yellow one which passes all wavelengths from green to deep red. The result is interesting since it will sort out Burma rubies (a

brilliant glowing red through the filter, which unfortunately is shared identically by synthetic rubies, by the best of the red spinels and by some red pastes and doublets), from Thai rubies which are a darker and much less emphatic red through the filter. It is fair to note that Hanneman says that these filters will not separate synthetic stones from their natural counterparts. But it is evident that a mixture of the stones I have listed could be passed as being of one species.

Tentative tests with this filter on light blue aquamarines, blue topaz and blue and green tourmalines revealed that they gave almost identical versions of the filtered colour seen in aquamarines under the Aqua-Filter, although this varied a little with the depth of colour of each stone. The conclusion has to be that this particular filter is too 'open', i.e. passes too much of the visual spectrum to be really safe, so that once again a parcel containing an assortment of these three species could appear to be of a single species when viewed through it. It does seem that the stated purpose of the set is not achieved in this one.

The Blue Filter

The fourth filter has a three band absorption resembling a slightly closed-up version of that of cobalt in glass, although its colour is rather violet. Again it is very 'open', with a range covering almost all the visible spectrum apart from those absorption bands. I have tried this one on a considerable number of different coloured stones but have not found a convincing use for it beyond the very general fact that a necklace or parcel matched in colour [not necessarily of one species] may still look matched through the filter. The instructions claim that this one will distinguish between different yellow or orange stones. There is a great variety of yellow and orange stones among the gem species and I was able to try it on similarly coloured yellow and golden zircons, beryls, tourmalines, sphenes, sphalerites, hessonites, spessartines, yellow sapphires, both synthetic and natural, scheelite, fluorite, apatite, citrines and topaz, and for the most part was not able to distinguish one from the other with any certainty. Indeed in many cases stones of similar colour gave practically the same filtered colour regardless of the species. Many of them could be identified on sight more easily in ordinary light without the filter.

The general conclusion is that these filters, as most of their kind, provide some empirical tests which need to be used with considerable care. In my opinion they do not give identification which can be implicitly relied upon in every instance and in some cases do not separate stones which are different species but the same or nearly the same colour. After

all, even our own much loved Chelsea Filter needs to be used intelligently, and I can cite one case where the gemmologist owner of a provincial jeweller's shop valued a bracelet of small semi-opaque blue-green beads as emerald, simply because they looked pink through the Chelsea Filter. The bracelet was in

fact stained green chalcedony, which should have been instantly obvious once it was looked at without using the filter.

[Manuscript received 30 July 1990.]

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Water in beryl – a contribution to the separability of natural and synthetic emeralds by infrared spectroscopy

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Abstract

Infrared absorption spectra of natural and synthetic emeralds in the range of water and hydroxyl stretching modes (3500 to 3800 cm^{-1}) are subdivided into five basic groups. Groups 0 and I represent flux-grown synthetic emeralds and synthetic emeralds which were hydrothermally grown from alkali-free media, respectively. Group II represents low alkali-bearing natural emeralds, e.g. from Colombia or Nigeria, as well as low alkali-bearing hydrothermally-grown synthetic emeralds, e.g. samples grown commercially in Russia. Groups III and IV represent medium to high alkali-containing natural emeralds. With the exception of group II, in which an overlap of spectroscopic properties between natural and synthetic samples is observed, all natural and synthetic emeralds belonging to groups 0, I, III, and IV are unequivocally recognizable as natural or synthetic by infrared spectroscopy in the 3500 to 3800 cm^{-1} range. Advantages and disadvantages of different techniques of infrared spectroscopy for the examination of emeralds are briefly discussed.

Introduction

Infrared spectroscopy has been applied to problems concerning the distinction of natural and synthetic emeralds since about 1967 (Wood & Nassau, 1967; Flanigen *et al.*, 1967). In general, this method is based on the presence or absence of one or two types of water molecules in the specimen in question. In flux-grown synthetic emeralds, no water absorption bands are observable by infrared spectroscopy, and in hydrothermally-grown synthetic emeralds water molecules which are not bound to alkali ions (type-I water molecules) are present. In natural emeralds, type-I water molecules as well as water molecules which are bound to alkalis (type-II water molecules) are found (Wood & Nassau, 1967, 1968; Flanigen *et al.*, 1967; Flanigen, 1971; Flanigen & Mumbach, 1971; Nassau, 1976). According to most recent structural refinements of natural and synthetic beryls and emeralds (Gibbs *et al.*, 1968; Morosin, 1972; Hawthorne & Černý, 1977; Brown & Mills, 1986) alkali ions and water molecules of both types are located in channel sites of the beryl structure (Figure 1).

The assignments of water absorption bands in the infrared were originally based on spectroscopic investigations of natural beryls and emeralds from different sources as well as on the spectra of synthetic flux-grown and hydrothermally-grown alkali-free synthetic beryls and emeralds, which were recorded by various authors using thin polished plates or finely powdered material (KBr pressed disk technique). Fundamental vibrations of water molecules were observed between 3500 and 3800 cm^{-1} (assigned to stretching modes of water molecules) and between 1500 and 1700 cm^{-1} (assigned to deformation modes of water molecules). A large number of absorption bands were found in the near infrared (from 4000 to 10000 cm^{-1}) which were assumed to be due to combination and overtone frequencies of the fundamental vibrations of both types of water molecules (cf. Nassau, 1980; Nassau & Nassau, 1980).

However, the criteria mentioned above became partly invalid since descriptions of spectroscopic properties of alkali-bearing, i.e. lithium- and/or sodium-containing synthetic beryls and emeralds were published, which were found to reveal absorption bands of both types of water molecules (Klyakhin *et al.*, 1981; Shatsky *et al.*, 1981; Kodaira *et al.*, 1982; Lebedev *et al.*, 1986). Additional problems arise from the possibility of incorporation of type-I and type-II water molecules in flux-grown synthetic beryl by hydrothermal treatment as described by Kodaira *et al.* (1984) and from absorption bands which are assigned to hydroxyl groups in beryl (e.g. Nikol'skaya & Samoilovich, 1979).

With the exception of flux-grown synthetic emeralds, practical problems for the examination of faceted emerald specimens of unknown origin arise from low transparencies in the range of fundamental water absorption bands (cf. Leung *et al.*, 1986; Stockton, 1987) and from high polarization dependencies of H_2O bands in the infrared (cf. Wickersheim & Buchanan, 1959; Wood & Nassau, 1967, 1968). For these reasons, in the papers of Leung *et al.* (1986) and Stockton (1987) additional

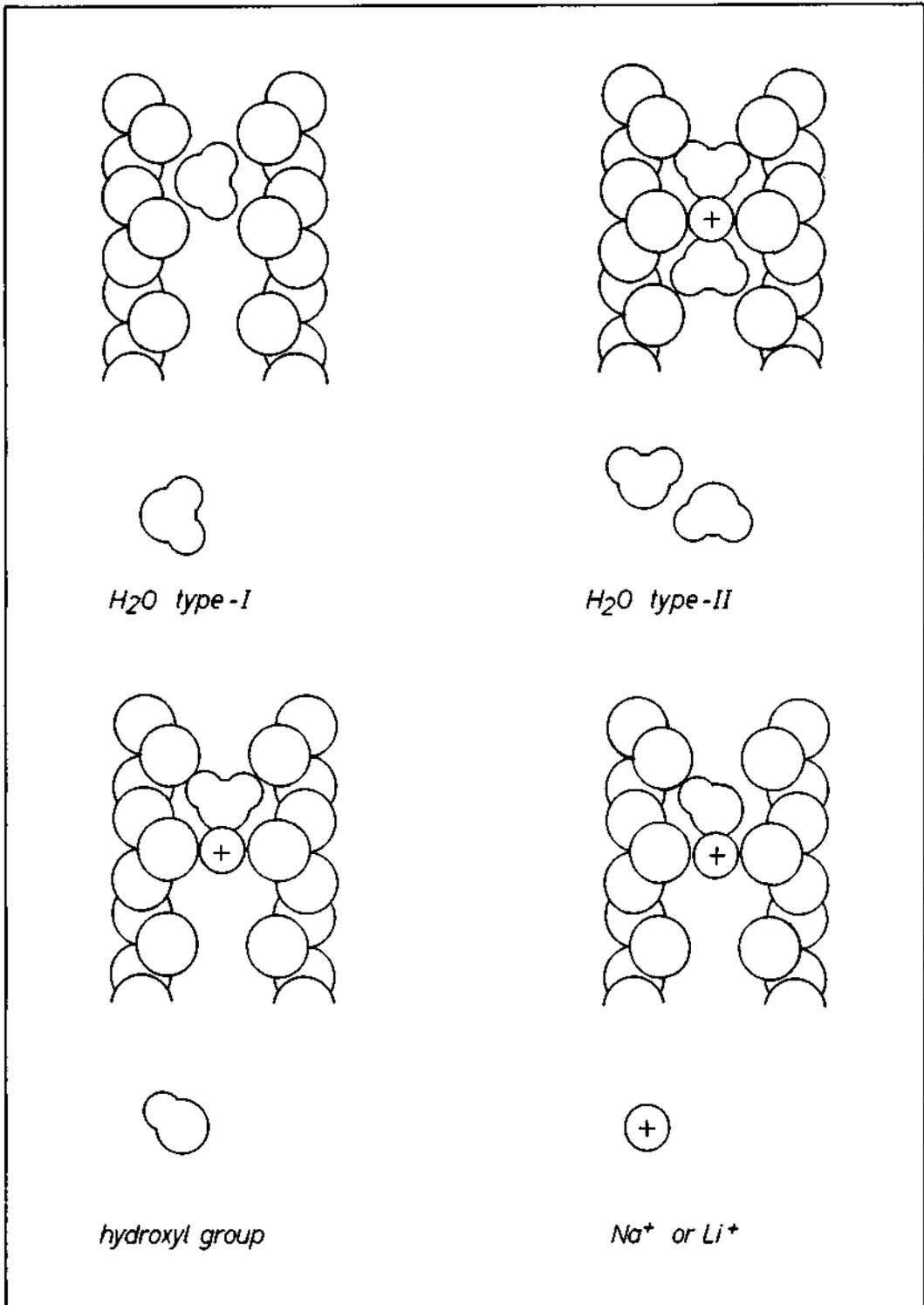


Fig. 1. Schematic drawing showing water molecules, hydroxyl groups and alkali ions as possible constituents in beryl. The *c*-axis is vertical in the diagram.

criteria for the distinction of natural and synthetic emeralds were worked out for different spectral areas, e.g. for the 2600 to 3000 cm^{-1} range measuring transmission spectra of faceted samples by use of a conventional double-beam infrared spectrophotometer (Leung *et al.*, 1986) as well as by the application of a Fourier transform infrared unit (Stockton, 1987). However, these criteria were found to be invalid for part of the specimens investigated, e.g. for Russian hydrothermally-grown synthetic emeralds, the spectra of which were identical to those of natural emeralds (Stockton, 1987).

The aim of the present paper is to elucidate spectroscopic properties of natural and synthetic emeralds in the range of fundamental stretching modes of water molecules and hydroxyl groups (from 3500 to 3800 cm^{-1}) in order to clarify the applicability of infrared spectroscopy for the distinction of natural and synthetic samples. In addition, the results presented can be applied to the assignment of overtone and combination frequencies in the near infrared in further studies.

Experimental details

Infrared spectra were recorded for 75 samples of natural emeralds, for 13 samples of synthetic hydrothermally-grown emeralds as well as for 15 samples of flux-grown synthetic emeralds in the range of H_2O stretching modes (from 3500 to 3800 cm^{-1}) using a Perkin-Elmer model 180 infrared double-beam grating spectrophotometer. Comparing literature data dealing with chemical properties of natural and synthetic emeralds as well as microprobe analyses performed by one of the present authors (cf. Schmetzer, 1989), the research material was selected in order to cover a wide range of chemical variability from synthetic flux-grown and hydrothermally-grown alkali-free emeralds to synthetic low alkali-bearing hydrothermally-grown emeralds from different producers, as well as low, medium and high alkali-bearing natural emeralds from different sources. All samples investigated were crystals or faceted stones of gemstone quality, and, in general, zones without major mineral inclusions were microscopically selected for spectroscopic examination. From all samples available for the present study, 2 mg of powder were scraped from faceted or rough emerald crystals using a diamond point, and KBr disks were pressed from 2 mg of emerald powder and 200 mg KBr.

Results

According to spectral features in the range of H_2O and OH stretching modes (from 3500 to 3800 cm^{-1}), infrared spectra of natural and synthetic

emeralds are subdivided into five basic groups (Table 1, Figure 2):

Group 0: In the spectra of flux-grown synthetic emeralds no absorption bands of water were observed.

Group I: The spectra of synthetic alkali-free emeralds yield only one strong absorption band with maximum at about 3694 cm^{-1} (designated band A).

Group II: In the spectra of low alkali-bearing natural and synthetic emeralds in addition to band A, a second absorption band at 3592 cm^{-1} (designated band B) was present. In different samples, variable intensity ratios of band A versus band B were observed, and beginning at a ratio of about 2:1 between bands A and B, a third absorption with maximum at 3655 cm^{-1} (designated band C) occurs as a weak shoulder of band A. However, in all spectra of group II, band A exceeds band B in intensity.

Group III: In this group, the intensity of band B exceeds that of band A. In different samples of this particular group, all of them natural emeralds with distinct sodium-contents, an increase of band C at about 3655 cm^{-1} is found to be parallel to a decrease of band A in intensity. In other words, the spectra of all samples of this group yield three absorption maxima (bands A, B and C) with significantly variable intensity ratios.

Group IV: In some natural samples with high sodium content, only absorption bands B and C were present, but no distinct absorption at 3694 cm^{-1} (band A) was observed.

In all four types of spectra of water-bearing natural and synthetic emeralds, no intensity correlation was found to be present between bands B and C. However, with increasing type C absorption bands, decreasing intensities of band A were found to be correlated (Figures 2, 3). In general, in all samples investigated by infrared spectroscopy and electron microprobe, a distinct trend of increasing sodium contents from about 0.03 to 2.5 wt.% Na_2O parallel to increasing intensities of B and C absorption bands and decreasing intensities of the A absorption maximum were measured (cf. Table 1, Schmetzer, 1989). The chemical variability within emeralds from one distinct source are reflected by infrared spectroscopy, i.e., samples originating from one mine or locality were found to reveal distinctly varying intensity ratios of infrared absorption bands A, B, and C (Figure 4).

Discussion

Though the method applied is partly destructive for an emerald sample of unknown origin, the KBr technique was preferred to the measurement of thin polished plates, which have to be cut from faceted or rough emerald crystals. On the one hand, the

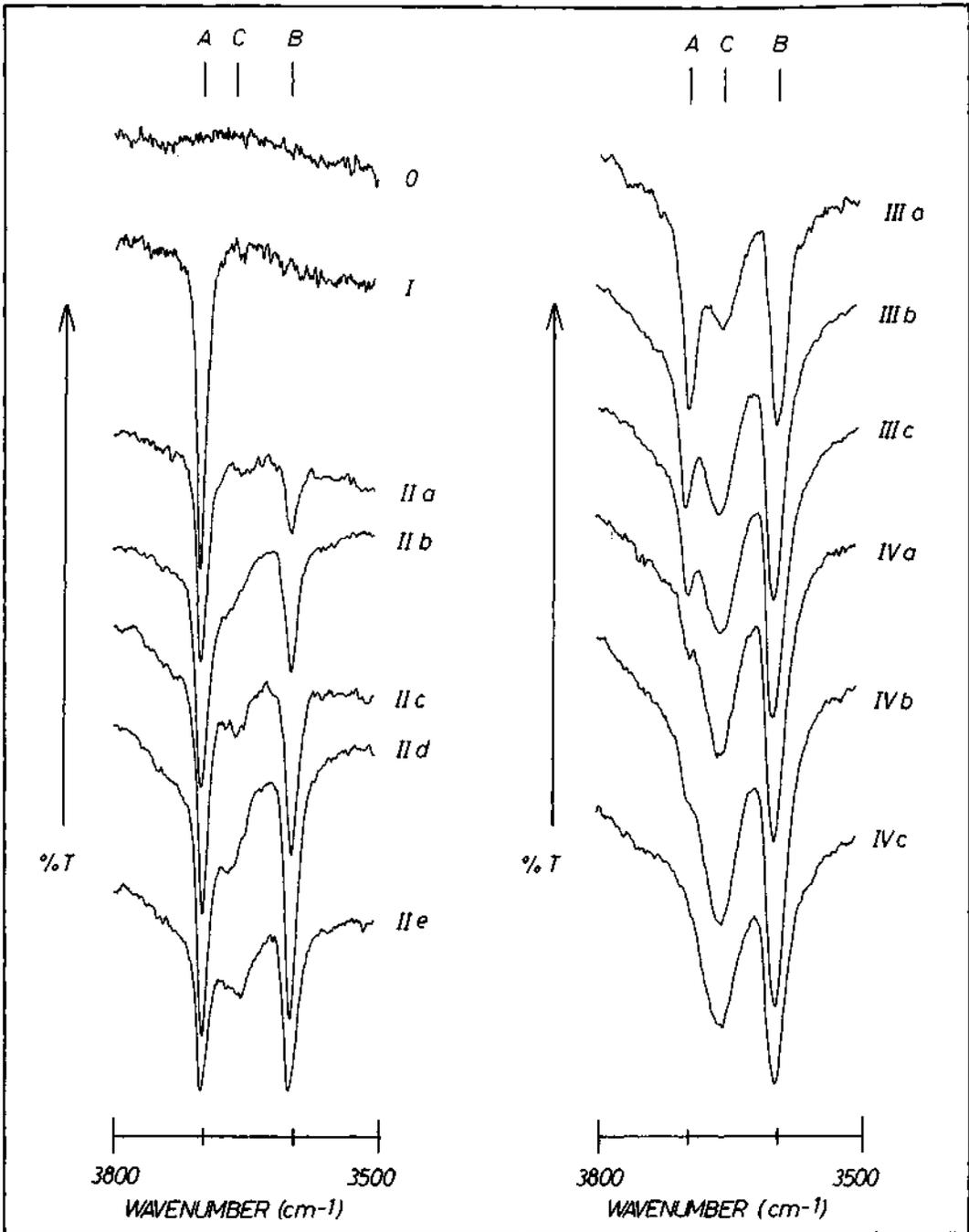


Fig. 2. Infrared spectra of natural and synthetic emeralds in the range of water and hydroxyl stretching modes: 0 water-free flux-grown Chatham synthetic emerald; I hydrothermally-grown Biron synthetic emerald; IIa natural emerald, Jos, Nigeria; IIb hydrothermally-grown Russian synthetic emerald; IIc natural emerald, Colombia; IId hydrothermally-grown Lechleitner synthetic emerald; IIe natural emerald, Chivor, Colombia; IIIa natural emerald, Itabira, Brazil; IIIb natural emerald, Socotó, Brazil; IIIc natural emerald, Zambia; IVa natural emerald, Sta. Terezinha, Brazil; IVb natural vanadium-bearing beryl, Salininha, Brazil; IVc natural emerald, Machingwe, Zimbabwe. Absorption bands are represented by the symbols A = 3694 cm^{-1} , B = 3592 cm^{-1} , and C = 3655 cm^{-1} .

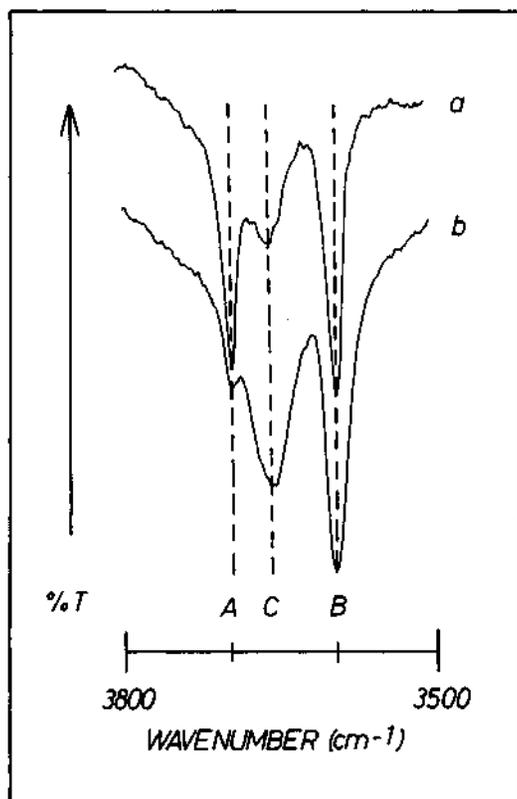


Fig. 3. Infrared spectra of natural emerald, Colombia (sample a) and natural emerald, Tauá, Brazil (sample b), indicating the high variability of absorption bands, which are represented by the symbols A $\hat{=}$ 3694 cm^{-1} , B $\hat{=}$ 3592 cm^{-1} , and C $\hat{=}$ 3655 cm^{-1} .

method applied avoids polarization dependencies of infrared absorption bands and, on the other hand, using modern microbeam techniques, the method is performable with less than 0.5 mg of emerald powder. Thus, the KBr technique can be applied not only to fundamental research problems, i.e. to a classification of infrared spectra of natural and synthetic emeralds, but is also useful for practical identification of faceted emerald samples of unknown origin. In other words, this method can be applied to the identification of emerald specimens (with permission of the owner), if other non-destructive methods, e.g. microscopy or absorption spectroscopy in the visible and ultraviolet range (cf. Schmetzer, 1988, 1990) do not yield criteria for an unequivocal determination of the sample.

According to the great variability of intensity ratios of absorption bands A, B, and C, which are correlated with chemical data, especially with sodium contents of the samples, the three absorption bands in the range of water and/or hydroxyl

stretching modes (from 3500 to 3800 cm^{-1}) are assigned to three different types of water molecules and/or hydroxyl groups. A detailed discussion of this assignment and a model of water and/or hydroxyl types in natural and synthetic beryl and emerald is given by Schmetzer (1989). In summary, band A at 3694 cm^{-1} is assigned to type-I water molecules which are not bound to adjacent alkali ions. Bands B and C at 3592 and 3655 cm^{-1} , respectively, are caused by type-II water molecules and/or hydroxyl groups, which are bound to alkali ions. Most probably, band B is due to water molecules which are bound to alkalis (lithium and/or sodium) in the sequence $\text{H}_2\text{O}-\text{Na}-\text{OH}_2$ (type-IIa water molecules), and band C is assigned to water molecules or hydroxyl groups which are bound to alkalis in the sequence $\text{H}_2\text{O}-\text{Na}-\square$ (type-IIb water molecules) or $\text{HO}-\text{Na}-\square$ (hydroxyl groups) [Figure 1], with \square representing vacancies in channel sites of the beryl structure. However, bond strength calculations favour the presence of water molecules and the absence of hydroxyl groups adjacent to alkali ions in channel sites of the beryl structure.

For practical application of infrared spectroscopy to the determination of emerald samples of unknown origin, according to the present state of the authors' experience including also literature data, all emeralds with spectra belonging to groups 0, I, III and IV are identifiable unequivocally as spectra of synthetic or natural emeralds (cf. Table 1). Spectra belonging to groups 0 and I are assigned to non-water-bearing flux-grown synthetic emeralds and to type-I water-containing synthetic emeralds which were grown hydrothermally from alkali-free media, respectively. Spectra of groups III and IV are caused by medium to high alkali-bearing natural emeralds with distinct amounts of alkali-bonded type-IIa and type-IIb water molecules and lower amounts of non-alkali-bonded type-I water molecules. At present, spectra of samples belonging to groups III and IV were not measured for synthetic emeralds of commercially available types nor for synthetic beryls or emeralds grown for research purposes.

Spectra belonging to group II are possibly due to low alkali-bearing natural emeralds, e.g. samples from Nigeria or Colombia, or can be caused by synthetic emeralds which are grown hydrothermally from alkali-bearing media, e.g. Lechleitner fully synthetic emeralds or samples of the commercial type of Russian hydrothermally-grown synthetic emeralds (cf. Schmetzer, 1988). Both groups of samples contain distinct amounts of non-alkali-bonded type-I water molecules as well as alkali-bonded type-IIa water and lower amounts of alkali-bonded type-IIb water molecules.

Table 1. Classification of natural and synthetic emeralds according to spectroscopic features in the infrared from 3500 to 3800 cm^{-1} .

Group	Absorption bands and intensity ratios: $A \hat{=} 3694 \text{ cm}^{-1}$; $B \hat{=} 3592 \text{ cm}^{-1}$; and $C \hat{=} 3655 \text{ cm}^{-1}$	Chemical properties	Examples
0	no distinct absorption bands	flux-grown synthetic emeralds	Chatham, Gilson, Lennix, Russian flux-grown synthetic emeralds
I	A	synthetic emeralds grown hydrothermally from alkali-free media	Linde, Biron, Pool, Swarovski hydrothermally-grown synthetic emeralds
II	$A > B \gg C$	low alkali-bearing natural and synthetic hydrothermally-grown emeralds, sodium contents ranging from approx. 0.03-0.5 wt. % Na_2O	Emmaville, New South Wales, Australia. Jos, Nigeria. Eidsvold, Norway. Sandawana, Zimbabwe. Colombia, different localities. Russian hydrothermally-grown synthetic emerald. Orissa, India. Lechleitner hydrothermally-grown synthetic emerald*.
III	$B > A > C$	medium alkali-bearing natural emeralds, sodium contents ranging from approx. 0.5-1.0 wt. % Na_2O	Ural Mountains, USSR. Colombia, different localities. Itabira, Minas Gerais, Brazil. Lake Manyara, Tanzania. Carnaiba, Bahia, Brazil.
	$B > A \approx C$		Socotó, Bahia, Brazil. Filabusi, Zimbabwe.
	$B > C > A$	high alkali-bearing natural emeralds, sodium contents ranging from approx. 1.0-2.0 wt. % Na_2O	Lake Manyara, Tanzania. Maria Mine, Morrua, Mozambique. Zambia, different localities. Cobra Mine, Gravelotte, South Africa. Tauá, Ceará, Brazil.
IV	$B > C \gg A$	high alkali-bearing natural emeralds, sodium contents ranging from approx. 1.5-2.5 wt. % Na_2O	Habachtal, Austria. Sta. Terezinha, Goiás, Brazil. Ankadilalana, Madagascar. Sandawana, Zimbabwe. Salininha, Bahia, Brazil. Ajmer, India. Machingwe, Zimbabwe.

*fully synthetic emerald without natural seed (cf. Eppler, 1968).

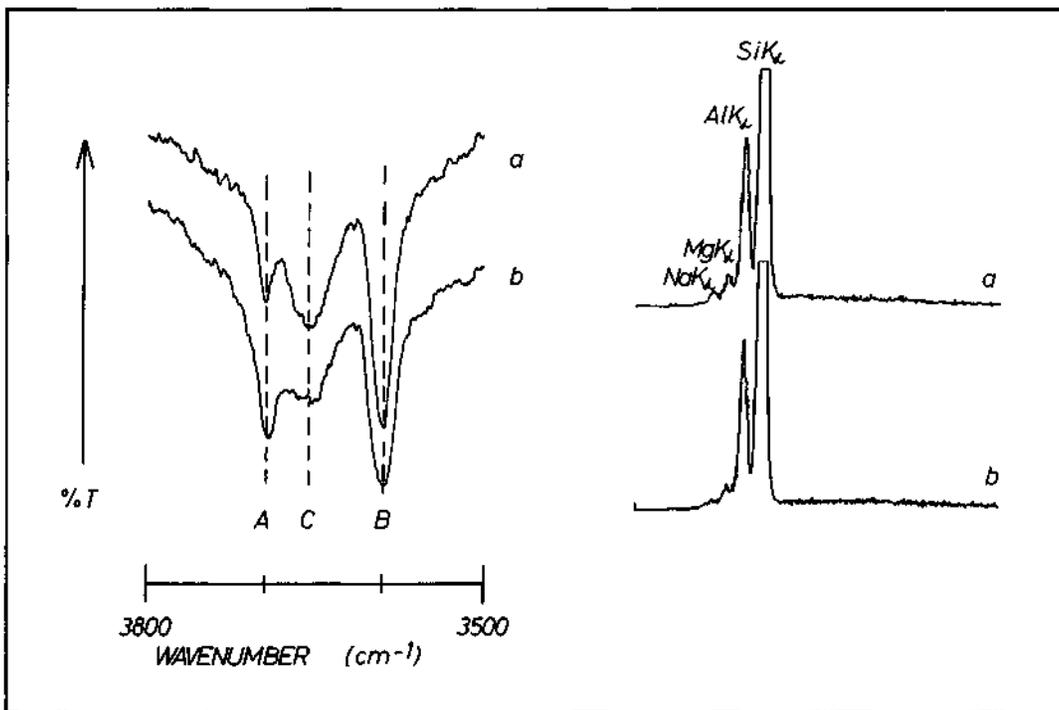


Fig. 4. Infrared spectra (left) and energy dispersive X-ray spectra (right) of two natural emeralds (samples a and b), both from Lake Manyara, Tanzania, indicating the variability of absorption bands, which are represented by the symbols A $\hat{=}$ 3694 cm^{-1} , B $\hat{=}$ 3592 cm^{-1} , and C $\hat{=}$ 3655 cm^{-1} ; with decreasing amounts of Na_2O from sample a to sample b decreasing intensities of band C and increasing intensities of band A are correlated.

According to these results, most natural and synthetic emerald samples can be distinguished by infrared spectroscopy in the range of H_2O or OH stretching modes (3500 to 3800 cm^{-1}) using the KBr pressed pellet technique. Due to the fact, that an overlap of spectroscopic properties is observed for low alkali-bearing natural and synthetic samples in the range of fundamental vibrations, similar overlaps are expected for the range of overtone and combination frequencies in the near infrared (from 4000 to 10000 cm^{-1}). In addition, each examiner has to be aware of the high polarization dependencies of emerald water absorption bands in all spectral areas.

For these reasons, in order to work out unequivocally criteria for a determination of faceted emerald samples of unknown origin, non-destructive examinations of single-crystals in the infrared have to be carried out with polarized light on optically orientated stones. These preconditions, however, may cause extreme difficulties and, in some cases, may favour the KBr technique, using less than 0.5 mg of emerald powder which may be scraped carefully by a diamond point from the girdle of a faceted stone. In addition, using the KBr pressed pellet technique, a careful examiner is able to record

spectra for powdered material scraped from distinct parts of a faceted gemstone, which are selected before by microscopic examination. Thus, this method is useful to distinguish between flux- or hydrothermally-grown synthetic emerald and natural seed material.

An example is given here for Swarovski synthetic emerald. According to Stockton (1987), infrared spectroscopy of this non-commercial synthetic emerald using the Fourier transform technique yields spectroscopic features which are typical for natural emerald or, at least, not conclusive. The investigation of some powder of Swarovski synthetic emerald consisting partly of hydrothermally-grown synthetic material and partly of natural seed material using the KBr disk technique yields an infrared spectrum which is typical for group II spectra and does not allow to determine the sample as synthetic emerald (Figure 5). However, after careful preparation of powder consisting of hydrothermally-grown material only (without residues of the natural seed), an infrared spectrum of group I typical for synthetic emerald was obtained (Figure 5).

Thus, for both techniques advantages and disadvantages are known to exist, and each examiner

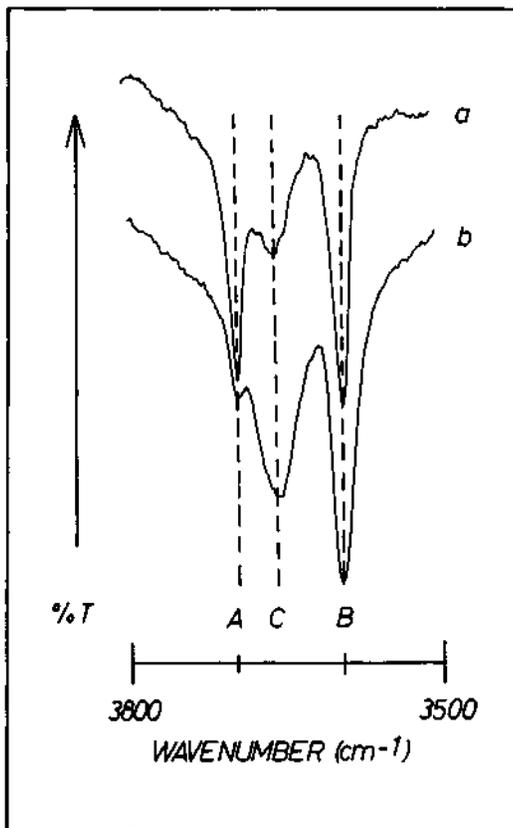


Fig. 5. Infrared spectra of Swarovski synthetic emerald excluding seed material (sample a) and including seed material (sample b) indicating the variability of absorption bands, which are represented by the symbols A \approx 3694 cm^{-1} , B \approx 3592 cm^{-1} , and C \approx 3655 cm^{-1} in samples with or without admixtures of natural seed materials.

has to be aware of the overlaps in each method. Using some emerald powder in connection with KBr pressed pellet techniques, the observed overlap in group II spectra is due to identical or almost identical amounts of alkalis as well as to identical ratios of type-I, type-IIa and type-IIb water molecules, respectively. At present, this overlap is only important for Lechleitner synthetic emeralds as well as for Russian hydrothermally-grown synthetic emeralds, which can be identified by absorption spectroscopy in the visible as well as by microscopic and chemical investigations (cf. Schmetzer, 1988, 1990). In other words, emerald samples of unknown origin, the infrared spectra of which were found to belong to group II, have to be examined by other methods in order to work out unequivocal criteria for the presence or absence of Russian hydrothermally-grown synthetic emeralds or Lechleitner hydrothermally-grown fully synthetic stones.

The reasons for overlaps in the infrared spectra of faceted single-crystals as described by Leung *et al.* (1986) and Stockton (1987) are unknown at present, and further research has to be carried out in order to clarify these specific properties of infrared spectra of natural and synthetic emeralds.

Acknowledgements

The authors are grateful to the following persons who kindly supplied natural and synthetic emerald samples for the present study: Dr R. Diehl of Freiburg, FRG; Mr I. Z. Eliezri of Ramat Gan, Israel; Dr H. A. Hänni of Basel, Switzerland; Dr R. Haupt of Innsbruck, Austria; Dr H. Holländer of Pforzheim, FRG; Mr R. E. Kane of Santa Monica, USA; Dr J. Kanis of Cascais, Portugal; Mr E. Petsch of Idar Oberstein, FRG; Dr D. Schwarz of Ouro Preto, Brazil; Mrs G. Webb of Sydney, Australia; Prof. Dr P. C. Zwaan of Leiden, Netherlands. Spectroscopic investigations were performed with permission of Prof. Dr H. H. Eysel at the Anorganisch-Chemisches Institut der Universität Heidelberg, FRG.

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CONGRATULATIONS TO THE FINNISH GEMMOLOGICAL SOCIETY ON THE OCCASION OF THEIR 25TH ANNIVERSARY

It is a pleasure to salute the achievement of our gemmological friends in Finland in promoting the scientific study and dissemination of information concerning gemstones.

Challenges to our skills in identifying gem and decorative materials are constantly arising in a fast-changing world and it is reassuring to know that there are in existence stable organizations of integrity to whom professionals and ordinary members of the public can turn for help and guidance.

To reinforce this aspect of professional service the Gemmological Association and Gem Testing Laboratory of Great Britain have, this year, merged to form one organization. This new grouping will continue to offer education courses, examinations, gem testing and grading, and to sell books and instruments world-wide, and will expand in those areas of gemmological challenge.

With our best wishes
from

**The Gemmological Association and Gem Testing
Laboratory of Great Britain**

27 Greville Street London EC1N 8SU
Telephone: 071-404 3334 Fax: 071-404 8843

Gemmological teaching in Hong Kong and China

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Since 1982, the writer has designed and manufactured a variety of instruments and apparatus related to the teaching and practice of gemmology. Most of these items have been sold outside the UK through sales agencies in Adelaide, Chicago, Colombo, Dusseldorf and Hong Kong.

His Hong Kong agent, Mrs Ou Yang was a member of the Executive Committee of the Gemmological Association of Hong Kong (GAHK) and a teacher at the Department of Geography and Geology, Hong Kong University. She had recom-

mended to both bodies that the writer be invited to give three evening lectures and to organize two daytime weekend practical courses on appropriate gemmological subjects. The most suitable time was mid-May 1988. A formal invitation was received which could not possibly be refused.

It was then suggested that Mr Alan Jobbins be asked to deliver two additional evening lectures. The first would be on 'Corundum deposits around the World' on which subject he has an unrivalled on-the-spot experience. The second would consist of a talk with questions describing the FGA teaching syllabus, the form of the examinations and the offering of guidance on the best ways for preparing and sitting the examinations. Happily for the times proposed, Mr Jobbins's other gemmological commitments allowed him to join us later in Hong Kong.

The writer and his wife Doris were met at the airport by Mrs Ou Yang and her gemmologist colleague Mrs Christine Wong. We were taken, together with our numerous boxes of teaching equipment, to the University's Robert Black College. This is a special guest house financed by the University to provide accommodation for foreign lecturers and their wives. It stands behind the University campus on a steep tropical wooded hillside. It consists of a group of separate suites of rooms grouped around cool ornamental courtyards designed in the Chinese fashion. (See Figure 1.)

The lodgings provided were luxurious by any standard and the central restaurant catered to any national taste. The balconies of the suites gave a panoramic view of the spectacular city and its enormous harbour. Figure 2 shows the blue roofs of the guest house, the University buildings on the left and part of the harbour as a backdrop.

Our friends lost no time in putting the writer to work. His first lecture was given on the day following our arrival. The evening lectures were held in the rooms of the Hong Kong Diamond Bourse. The courses, limited to 14 students, took place from 2.00pm to 6.30pm in the laboratory of



Fig. 1. The cool courtyards of Robert Black College, University of Hong Kong.



Fig. 2. The roofs of Robert Black College with Hong Kong University buildings (left) and Hong Kong harbour as a backdrop.

the University's Department of Geography and Geology.

Much use was made in the courses of the instruments and visual aids developed by the writer to demonstrate the actual physical principles involved in gemstone testing instruments. Some of this apparatus will be described later.¹

The 8-day schedule (which started on Friday 13 May) was hectic as can be seen from the table below.

Schedule of lectures and courses

13 May	Lecture. 'The four optical attributes of a diamond' JBN
14 May	Course. 'Gemstone characterisation and grading' JBN
15 May	Course. 'Diagnostic gemstone inclusions' JBN
17 May	Lecture. 'The characterisation of pearls using X-rays' JBN
19 May	Lecture. 'Practical methods for determining gemstone body colour using the CIE Tristimulus Colour System' JBN
20 May	Lecture. 'Corundum deposits around the world' EAJ
21 May	Course. Repeat of course of 14 May. JBN
22 May	Course. Repeat of course of 15 May. JBN
22 May	Lecture. 'The FGA Examination' EAJ

Needless to say, there was some time for sight-seeing. The city itself, the harbour and best of all, the restaurants were superb. Mrs Christine Wong took us on a conducted tour in her Range Rover to the New Territories beyond Kowloon on the Chinese mainland.

The GAHK was founded in 1979 when it had a start-up membership of over 300. Its Annual General Meeting was held on 21 May at the Royal Garden Hotel. Here the President, Mr Louis Lo, presented Mr Jobbins and the writer with engraved commemorative plaques. The occasion was also marked by the presentation of many leave-taking gifts to Mrs Anne Paul. Mrs Paul is one of the Founder Members of the Association and has served on its Executive Committee since its inception. She has devoted much time and effort to furthering the cause of gemmology in Hong Kong. Following the AGM, a farewell banquet in her honour was enjoyed by over eighty members. She has now returned to New York.

The routine teaching of gemmology is carried out mainly by individual qualified gemmologists who conduct classes and tutorials in their own homes or business premises. The basic pieces of testing equipment, i.e. refractometers, loupes and OPL spectrometers, are usually the personal property of each student. Almost all instructors possess the more costly items such as GIA microscopes, wavelength-scale spectrometers, specific gravity



Fig. 3. Students engaged on course work in a laboratory at Hong Kong University. Mrs Ou Yang and the writer are seen centre rear.

sets, UV fluorescence units, colour camera accessories for photographing inclusions and other visual aids. The Association has also managed to acquire, both by purchase and donation, a considerable amount of similar apparatus. It is thus able to loan out this material whenever required for all the larger teaching sessions or lectures, as it did for the present series.

Curiously enough, the Association has no permanent premises of its own. However, its good relations with the Department of Geography and Geology of the University allow it to make use of its splendid laboratory and lecture room at weekends and evenings. Mrs Ou Yang, who serves part-time on the Department's teaching staff, acts as the coordinator for such arrangements. In Figure 3 Mrs Ou Yang and the writer are seen (centre rear) in the University laboratory where students are engaged on course work. It was she who had suggested earlier to her geological friends in the University of Wuhan, China, that our lectures might also be of interest to them. As one who had earned her second degree from the terrestrial discovery of the green mineral ureyite (cosmochlore), the chromium analogue of jadeite, in certain Burmese jade-like gemstones,² she was well-known in these circles. She had often visited Wuhan to deliver talks on her various gemmological researches.

To our great surprise they were most enthusiastic

about this offer and seemed anxious to embrace anything gemmological. It appears that while China had trained over 100,000 geologists since 1976, the end of the horrendous ten-year long Cultural Revolution of Mao Zedong, there were now only 3 qualified gemmologists in the entire People's Republic of over 1.2 billion people! The virtual destruction of the Geology Faculty of Beijing (Peking) University by the young anti-intellectual Red Guards had resulted in the 1976 decision to transfer the main teaching centre for geology to a new home in Wuhan. This is a large sprawling city on the Yangste River, some 1000 kilometres upstream from Shanghai on the East China Sea. It is actually a twin city connected by a huge road-rail bridge; this is doubly remarkable for its clever and elegant construction and for its being the first bridge upstream from the coast (see Figure 4).

However, they explained that our offer posed a problem. China's recent explosive economic expansion had swallowed up most of the government's available hard currency, leaving no funds for any leap into gemmological teaching by paid foreign instructors. They proposed to Mrs Ou Yang a solution to this obstacle which delighted us the moment we heard of it. It was this. All that was required of us was to bear the cost of transporting ourselves and our personal and teaching baggage the short, 'hard-currency' distance to Guanzhou

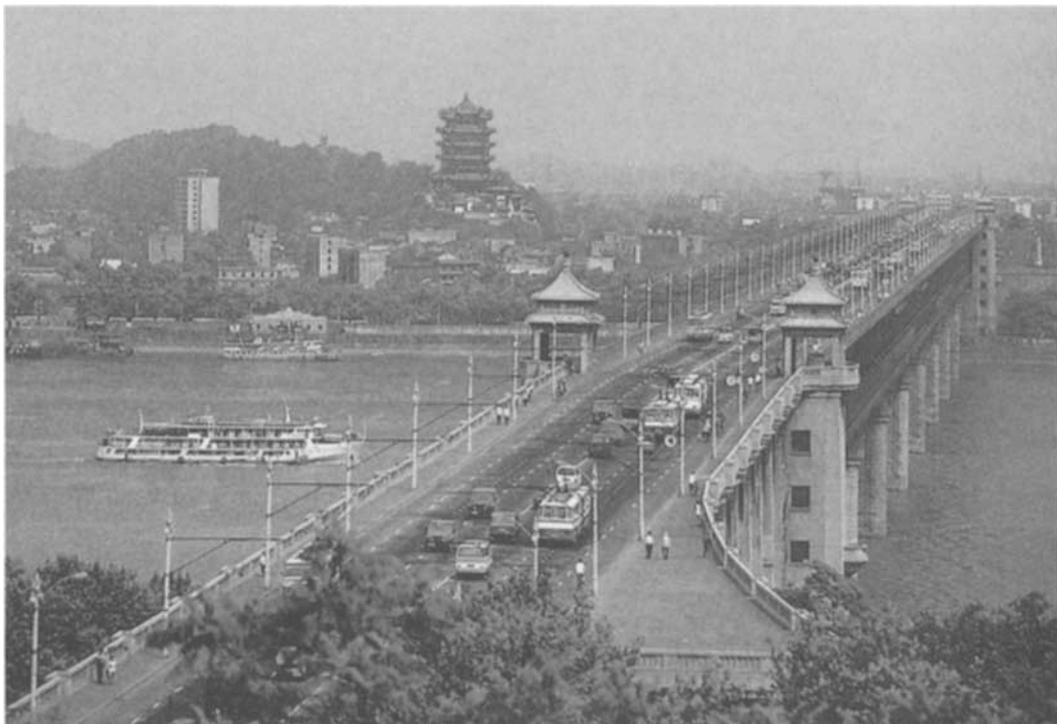


Fig. 4. The Changjiang Bridge across the Yangste at Wuhan.



Fig. 5. Alexand Zhang, our guide, in the gardens of the Shaanxi Museum at Xi'an.



Fig. 6. General view of the University of Geosciences campus, Wuhan.



Fig. 7. The Library, University of Geosciences, Wuhan.

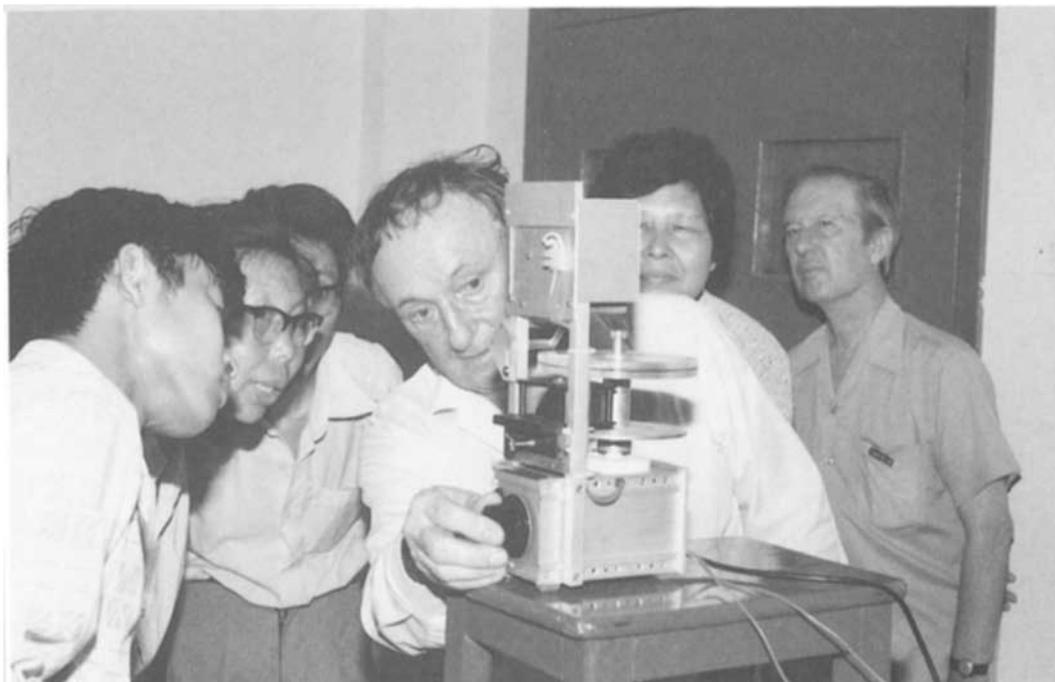


Fig. 8. Dr Nelson demonstrating to students at the University of Geosciences, Wuhan.

(Canton) from Hong Kong and back. Once inside China, the Faculty of Geology could easily meet our entire travelling and accommodation expenses in their own currency. As recompense for our teaching labours, it would also provide us with a week-long sight-seeing tour of China, together with an English-speaking guide to smooth our travels. We doubted whether we ever had a better offer in our lives!

Just as we have our own endearing names for foreigners, so have the Chinese. We soon discovered that Anglo-Saxons are known as the 'long-nosed pink faces'. The three of us were thus easily identified by our guide at Guanzhou railway station. He was a personable and handsome young man, Alexand Zhang of the Foreign Affairs Office. He at once ran into the first of many travellers' trip-wires. He discovered that our reserved airline seats to Wuhan had been re-allocated to some ex-Chinese nationals from Taiwan, now a much-beloved tourist dollar source. Failing to obtain places of any kind on the alternative long railway journey, he flew into a well-staged fury and eventually won us train tickets and sleeper reservations. Our subsequent adventures proved he had the right stuff for coping with the wilder aspects of free-lance travel in China. Maximizing one's comfort there is a full-time occupation and he was good at it. We quickly named him 'Alexander the Great' (see Figure 5).

Arriving at Wuhan, we were quickly installed in the University's residential block for visiting scientists. While spartan in comparison with our HK quarters, it was spacious and spotless. The food was plentiful, but of the 'fuel' rather than of the gourmet kind of the Robert Black College.

We were welcomed by Professor Chen Zhonghui,* Vice-President of the China University of Geosciences (Wuhan) who showed us around the campus buildings. Occupying an area of about 0.6 by 1.0 kilometres beside a picturesque lake and at the foot of a wooded hill, it is located on the outskirts of the city. It is primarily a geological university of science and engineering with supporting liberal arts and business administration departments and is one of the nation's key universities. It has nearly 5000 full-time undergraduate students and about 1000 professional teachers. About 400 students are now specializing for their masters and doctorate geological degrees at the Graduate School. A view of the campus is shown in Figure 6. The magnificent library of which they are particularly proud is shown in Figure 7; it houses 620,000 books and periodicals in Chinese and foreign languages.

The lecture hall held about 150 students and was

*In China, as in Spain, the first written name of a person of either sex is that of the father. The last is the given or mother's name.



Fig. 9. Professor Yen Weixuan, helped by students, translating English specimen labels into Chinese.

full even at repeat sessions of the same lecture. These were the same five as delivered in Hong Kong. Mr Jobbins added a sixth, describing the discovery of the sources of New Zealand jade. Very few spoke English, so that all lectures were translated into Mandarin by another Foreign Affairs Office interpreter, Mrs Hua Xin. She had spent two years in Heidelberg, Germany, on a study of meteorites. Her grasp of technical detail and speed of translation was superb.

The person who master-minded the timetable of lectures and courses was Professor Yen Weixuan, the wife of Professor Chen. When we innocently stated our willingness to work all the hours necessary, she took us precisely at our word and was in continuous hot pursuit to fill all her time slots – up to midnight on several occasions!

When first shown the small bare room which was to be our courses classroom, we despaired of making any use of it. However, in a twinkling, power supplies, projectors, blackboards and benches for 15 students were installed. A new, large, tailor-made blackout curtain was made and fitted without fuss.

The courses given in Hong Kong were unsuitable

for beginners in gemmology so that generalized introductory talks and equipment demonstrations were given instead (see Figure 8). The writer had brought with him his collection of some 500 cut stones and euhedral crystals and these were supplemented by Alan Jobbins's collection. With these and the use of the conventional instruments brought from the UK, the students were able to examine and sometimes measure their properties. The only equipment which the Mineralogy and Petrology Department were able to provide were lots of classical petrological microscopes; these were only of limited use.

The English names on the stones' polythene bags had, of course, no meaning in the practical sessions. Undaunted, during a session lasting well beyond midnight, Professor Yen, accompanied by some eight students and armed with a large, battered English/Chinese geological dictionary and with a little guidance from the writer, translated the whole 500-odd names and other details (see Figure 9). The writer, conscious of this impressive collective labour, has preserved these little slips of Chinese writing in his collection, all of which returned home safely. The instruments still remain in Wuhan however!

To cope with the large number of students, many of whom were professional geologists from other parts of China, several repeat sessions were held both during the day and in the evenings. It was a truly exhausting time for Mr Jobbins and myself, but the sheer enthusiasm of the students to learn something about this new, almost naughty, subject was enough to recharge our flagging batteries.

Why 'naughty', one might ask? It must be remembered that China is a poor, industrially under-developed nation. While her cities are large (Chungking, 'the furnace of China', about another 1000 kilometres upstream from Wuhan, has a population of 14 million), 95% of her people are peasant-farmers living far from cities. There never has been, unlike India, a long tradition favouring personal adornment with jewellery or decorative clothing, except among the Mandarin ruling classes. The Marxist-Leninist dynasty, still very much in power since 1949, does not favour such western 'bourgeois liberal' habits. Indeed, the Revolutionary Red Guards forcibly removed and destroyed any such articles from those bold enough to wear them. The 1979 reformist economic policy of Deng Xiaoping did relax these strictures somewhat, but the recent crackdown in Tiananmen Square has moved this small reform into a swift reverse. There is now, unfortunately, a new kind of Great Wall of China which has been erected to seal off the pro-democracy movements in the European Marxist countries.

The reason for the sudden Chinese interest in gemmology arises purely for its potential for obtaining the hard currencies of Japan and the western countries to pay for its economic plans. China possesses great mineral wealth and doubtless untapped and as yet undiscovered gemstone mineral deposits which a gem-hungry world now needs.³

Unfortunately, in the past, many valuable gemstone crystals were inadvertently destroyed by miners ignorant of their worth. The Geological Museum in Beijing now houses some of the finest surviving specimens in the country, including the largest diamond found recently in the Changma district – a clear 119-carat octahedron.

Between lectures and classes, we found time to discuss with Professor Chen and his wife the possibility of future links with the GA of GB. They were clearly eager to start such liaisons. As a friendly gift from the GA, Mr Jobbins presented them with the manuals for the Preliminary and Diploma Correspondence Courses. This gesture delighted them and after studying the manuals carefully over the next few days, they made several interesting proposals.

The first was that they be allowed to translate them into Chinese, with the intention of using them as the basis for starting up their own gemmology

teaching in Wuhan. The translations would be used only in the People's Republic of China itself. As recompense, the GA would have the sole rights to offer them to other Chinese-speaking teaching centres throughout the rest of the world, including Taiwan.

Secondly, they would like to invite Mr Jobbins and the writer to teach a more intensive 10-day course in Wuhan in May 1989. They proposed that a group of 15 students would be selected to begin preparations for taking the GA Preliminary Examination. The May 1989 visit would be in the nature of a coaching exercise with a mock examination test for sitting the July 1989 examination (see later Postscript).

Finally, they requested that we advise them as to the most suitable instruments with which to equip their proposed new gemmology teaching laboratory and to tender officially for this apparatus. There followed much detailed discussion, with Doris Nelson using all her acquired business skills as a negotiator on behalf of the GA. Shortly afterwards, the President of the China University of Geosciences (Wuhan), Professor Zhao Peng-da, arrived from Beijing. His visit was presumably, among other matters, to consult with Professor Chen about these negotiations. Following this, a kind of celebra-



Fig. 10. Academic group prior to departure from Xi'an: left to right, Dr J. Nelson, Prof Yen Weixuan, Dr Hua Xin, Mrs Nelson, Mrs Jobbins, Prof. Chen Zhonghui and E.A. Jobbins.

tory banquet was held, at which he attended.

On the evening prior to our departure for our first sightseeing excursion, a final agreement was reached on all the points discussed, subject to ratification by our own Executive Committee and Council.

By this time, Mr Jobbins' wife, Mary, had flown from Hong Kong to Wuhan to join us on our trip to far-distant Xi'an (see Figure 10). This is the celebrated city on the Silk Road, of the clay warrior army found in the mausoleum of China's first Emperor, Qin Shi Huang more than 2000 years ago.

Postscript

The invitation for May 1989 was taken up by Alan Jobbins and Ken Scarratt, who were worked equally hard. By this time both the GA Preliminary and Diploma courses were translated into Chinese and were available to students in duplicated form. In June 1990 twelve students from China sat the Diploma examination; ten passed, one with distinction – a highly creditable performance.

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[Manuscript received 3 February 1990.]

Detection of synthetic emeralds by thermal conductance

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In reporting on three thermal conductance meters (the Gemtek Gemmologist,¹ the Alpha-test² and the Gem-trak³), all of which were designed to identify coloured gemstones as well as diamond simulants, I now find that I had failed to emphasize one interesting additional capability of this type of instrument.

Recently, while using an Alpha-test unit (see Figure 1) to check a Gilson synthetic emerald, I confirmed that the thermal conductance of the synthetic stone was at least twice that of a natural emerald.

To explore this phenomenon more thoroughly I then made a series of tests using the Alpha-test instrument to check the thermal conductance of a range of natural and synthetic emeralds. Five

separate measurements were made on each sample, and these were then averaged for each stone (see Table 1). From the results it became clear that the flux-melt synthetic emeralds showed a consistently greater thermal conductance than did the natural emeralds (with the Alpha-test, the lower the reading, the greater is the measured thermal conductance). With the hydrothermally produced samples, the resulting Alpha-test readings tended to be closer to the lower limit of the natural stones, but could still provide a reasonable discrimination (no similar thermal discrimination could be discovered during earlier tests on natural and synthetic corundums).

Of the two coated-type Lechleitner emeralds that were tested, the one with a good surface lustre gave a reading close to that of natural emerald, while the

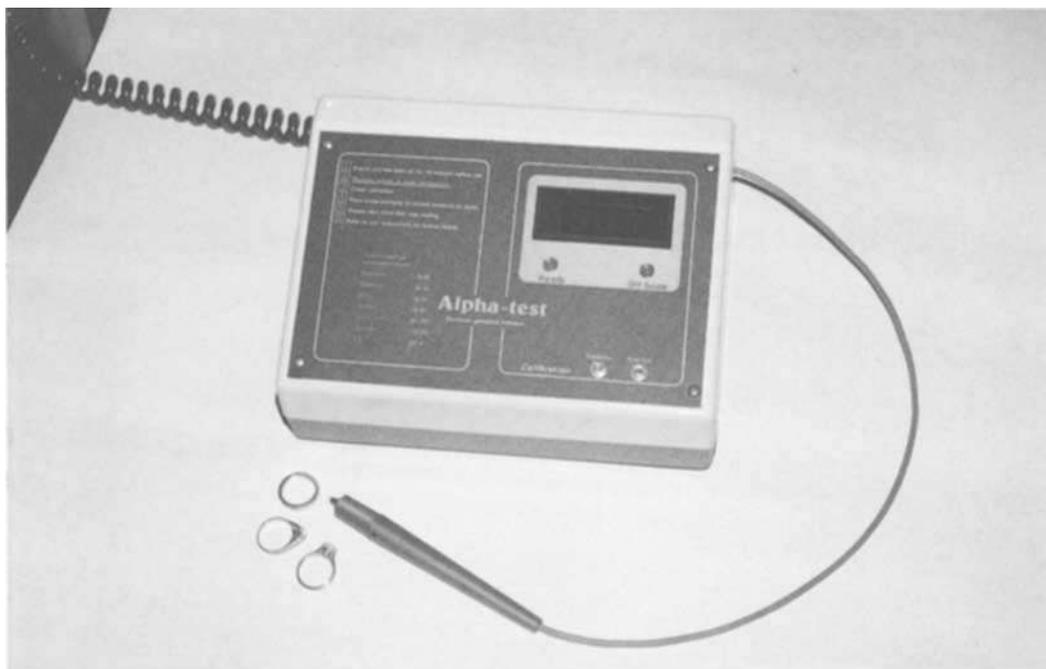


Fig. 1. The Alpha-test thermal conductance tester uses two pre-set probe tip temperature sensing levels to operate a counter/timer which indicates on a digital display the rate of heat absorption by the specimen.

Table 1. Alpha-test readings (low readings indicate high thermal conductance)

Synthetic emeralds	Average reading	Natural emeralds	Average reading
Gilson crystal (flux-melt)	71	Indian (Ajmer)	216
Gilson – block (flux-melt)	77	Indian (unknown)	221
Crescent Vert (flux-melt)	92	South African (Cobra mine)	233
Lennix 2,000 (flux-melt)	83	South African (Cobra mine)	177
Lennix 2,000 (flux-melt)	89	Colombian (Muzo)	230
Lechleitner coated (hydrothermal)	*	Colombian (unknown)	157
Lechleitner coated (hydrothermal)	153	Brazilian (unknown)	211
Lechleitner solid (hydrothermal)	80	Pakistan (dark green – Swat)	221
Biron (hydrothermal)	132	Pakistan (light green – Swat)	185
		USSR (Ural mountains)**	150

Note: All stones within size range 0.25 to 3 carats, except where shown.

*Off-scale reading (very low thermal conductance)

**159.8 carats

one with the poorer lustre consistently produced an off-scale reading (indicating a very low thermal conductance).

Finally, I would like to acknowledge the help of Mr Roy Huddleston who provided all the test samples, recorded the results and subsequently demonstrated the Alpha-test's ability to detect synthetic emeralds at my talk to the Association in the Flett theatre, London on 2 May 1990.

Note: The Alpha-test is the only thermal conductance model of this type still commercially available. Stockists are H.S. Walsh, 232 Beckenham Road, Kent BR3 4TS.

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[Manuscript received 5 July 1990.]

Gemmological Abstracts

ARJALAGUER, I., VILARDELL, D., 1989. Abacos del peso aproximado y de proporciones correctas de los diamantes con talla brillante tipo Tolokowsky. (Calculations of approximate weight and correct proportions of Tolokowsky-type brilliant-cut diamonds.) *Gemologia*, 31, 83/84, 7-21, 27 figs, pull-out tables.

Charts and diagrams are used to illustrate methods of weight calculation for Tolokowsky-type brilliants. Estimation of ideal proportions can also be carried out with the same methods. M.O'D.

BALFOUR, I., 1990. Famous diamonds. The Taylor-Burton diamond. *Industrial Diamond Review*, 1/90, 50, 536, 32/3, 2 figs in colour.

In the first of a series of articles written for IDR, the author recounts the purchase of some of the gems that Richard Burton gave to Elizabeth Taylor. The best known among these was the 69.42 ct pear-shaped diamond, later to be called the 'Taylor-Burton' diamond.

The diamond had been cut from a 240.80 ct stone recovered from the Premier mine in 1966 and purchased by Harry Winston. After a six month study of the stone, Harry Winston's cleaver parted the diamond (under the glare of television lights) into two pieces weighing 78 and 162 carats. The 69.42 D-flawless gem cut from the larger of these pieces was first sold in 1967 to Mrs Harriet Annenberg-Ames of the USA. Then in 1969 it was auctioned and purchased by Robert Kenmore, Chairman of the Kenmore Corporation (owners of Cartier Inc.), who paid the record price of \$1.05m and named it the 'Cartier'. Subsequently Richard Burton, who was outbid at the auction, purchased the stone for an undisclosed sum from Cartier and the stone was renamed the 'Taylor-Burton'.

After Miss Taylor's divorce from Richard Burton the diamond was sold in 1979 for nearly five million dollars to a New York jeweller (part of the proceedings being intended for the building of a hospital in Botswana). By the end of that year the stone had been sold once again and was last reported to be in Saudi Arabia. P.G.R.

BANERJEE, A., 1990. Erkennungsmöglichkeiten von künstlich gefärbtem Lapislazuli. (Practical

recognition of artificially coloured lapis lazuli.) *Kurzmitteilungen aus dem Institut für Edelsteinforschung der Johannes Gutenberg-Universität Mainz*, 5, (1/2), 4-5, 1 fig.

Imitation and dyed lapis lazuli can be distinguished from the natural untreated product by UV-VIS spectra. M.O'D.

BROWN, G., 1989. Synthetic quartz update. *Wahroongai News*, 23, 11, 20-3. Facts on man-made quartz. R.K.M.

BROWN, G., 1989. Kuri Bay cultured pearls. *Wahroongai News*, 23, 11, 27-8.

A brief account of cultivation of large pearls on NW Australian coast. About 35% of them are marketable. *P. maxima*, silver-lipped oysters, are fished on Eighty Mile Beach and transported to culturing farms at Kuri, about 300 miles to the north east. R.K.M.

BROWN, G., 1989. Cowell jade update. *Wahroongai News*, 23, 11, 31-2.

A new assessment of this important deposit in green and black varieties, said to be the largest known source of high quality nephrite. Dendritic weathered grey-blue variety is rare and valuable. R.K.M.

BUSHNELL, N., 1989. Diamonds - Australia's great treasure hunt. *Mazal U'Bracha*, 30, 62-73, 5 figs.

In an article first published in *Australian Business* the present production of the Australian diamond fields is reviewed. A list of the companies involved with details of their prospecting and mining areas is appended. M.O'D.

CAMPBELL, I.C.C., 1990. Doublets which simulate emerald. *South African Gemmologist*, 4, 1, 21-3, 3 figs in colour.

A parcel of faceted emerald simulants was shown to consist of true emerald doublets in that both crown and pavilion were natural emerald glued together in the plane of the girdle. The stones ranged in size from less than 1 carat to over 8 carat and showed RI in a range feasible for emerald, 1.570-1.574 to 1.589-1.596. DR varied from 0.004-

0.007. The presence of natural inclusions could cause problems in stones in which the join is not visible. Some gas bubbles could be seen in the junction plane but this was not observed in all specimens examined. M.O'D.

CARLSSON, G., 1990. Radiamantier fran Australien. (Diamond from Australia.) *Gem Bulletinen*, 1/1990, 3pp.

The history and occurrence of diamond in Australia are described. M.O'D.

CASSEDANNE, J.P., LEDOUX, L.A., 1990. Une curieuse opale chatoyante. (A curious chatoyant opal.) *Revue de Gemmologie*, 102, 3-5, 5 figs in colour.

A piece of rough opal from an unspecified location in the Brazilian state of Bahia provided chatoyant stones with a fairly sharp whitish eye with a brownish-green background. The SG was measured at 2.15 and the RI at 1.46. No luminescence nor radioactivity was detected. Ferric iron was indicated by the presence of a strong absorption band at 490-400nm. M.O'D.

CLIFFORD, P., 1990. Gem fire. *Lapidary Journal*, 43, 12, 20-6, 3 figs in colour.

A gemstone collection has been inaugurated in the Cleveland Museum of History, Ohio, USA. Highlights are described. M.O'D.

COENRAADS, R.R., SUTHERLAND, F.L., KINNY, P.D., 1990. The origin of sapphires: U-Pb dating of zircon inclusions sheds new light. *Mineralogical Magazine*, 54, 113-22, 7 figs.

Uranium-lead isotope dating of two zircon inclusions in sapphires from the Central Province of New South Wales, Australia, show the ages to be 35.9 ± 1.9 and 33.7 ± 2.1 Ma. These and other data show that there is a genetic link between the growth of large corundum crystals and the processes involved in alkali basaltic magma generation. It has been found impossible to grow corundum from a corundum-bearing basaltic composition and the presence of U, Th, Zr, Nb and Ta in inclusion minerals show that corundum could not have crystallized from most basaltic compositions since these elements are incompatible with them. It is possible that crystallization took place with a high proportion of incompatible elements and volatiles in the melt. The crystallization products are carried to the surface by upward movement of later magmas. The economic concentration of sapphire is probably dependent upon the corundum carried by a particular basaltic province. M.O'D.

DERJAGUIN, B.V., FEDOSEEV, D.V., 1990. Low

pressure diamond growth. *Industrial Diamond Review*, 3/90, 50, 538, 155-9, 2 figs.

A review of diamond film science and technology by two leading Soviet specialists specially commissioned by IDR. Today it is almost universally accepted that low pressure diamond film growth was first achieved in the USSR, and the basic concepts further developed and 'commercialized' in Japan, followed by the USA and the rest of Europe.

As more than 1000 papers and patents have been published on the synthesis of diamond from a gas phase, the authors have restricted their review to the main fundamental results obtained in this field and have supplemented this with references to original works where necessary (although these text references, numbering fifty, appear to have been omitted from the published review).

The review deals first with the growth of synthetic diamond on diamond seed powders from the gas phase (methane, acetylene, and other hydrocarbons) in which the gas is heated up to the substrate temperature. The growth of diamond from methane is generally proportional to its pressure. When carbon is deposited from the gas phase, different carbon phases (mainly diamond, carbon and graphite) grow on the seed powder substrate. Graphite blocks the surface of seed crystals and diamond does not grow on the graphite surface at moderate supersaturations. The resulting synthetic diamond crystals, grown from methane up to a temperature of 1600°C possess a higher thermal stability (i.e. the ability to retain a high crushing strength after being heated to elevated temperatures) than the seed powder.

The second part of the review describes the various methods used to grow diamond crystals and thin films by chemical reactions. Thermal pulsing via a focused high-intensity light source (laser beam) is used to raise the temperature of the substrate from a mean of 1000 to around 2000°C. It was found that thin polycrystalline diamond films could be grown on a single seed crystal within the temperature range 1300 to 1600°C. Subsequently, prevention of the formation of graphite and the improvement of the diamond film was obtained by the use of a methane/hydrogen DC plasma, and this made it possible to grow thin polycrystalline diamond films on non-diamond substrates. Diamond films, grown at the rate of 0.1 to 10 μm per hour, had an electrical resistivity higher than 10^9ohm.cm , and a thermal conductivity of about 1,800 $\text{W/m}^\circ\text{C}$ (natural diamond ranges from around 1000 for Type I to 2600 for Type II). P.G.R.

DOMENECH, M.V., SOLANS, J., 1989. Estructura cristalina, composicion quimica y propiedades fisicas de las gemas. 1. Densidad. (Crystal struc-

ture, chemical composition and physical properties of gemstones. 1. Density.) *Gemologia*, 31, 83/84, 22-5.

The relationship between chemical composition and density is explained using gem materials as examples. M.O'D.

EVEN-ZOHAR, C., 1990. Namibia: walking on diamonds. *Mazal U'Bracha*, 33, 59-66, 11 figs.

Recent developments in diamond mining in Namibia are described with remarks on the new Elizabeth Bay mine. M.O'D.

FIELD, R., 1989. Colour in Scottish agates. *Journal of Mines and Minerals*, 7, 13-17, 15 figs (6 in colour).

The formation and colouring of agate is discussed with particular reference to Scottish material. Several important localities are described. M.O'D.

FRANK, F.C., LANG, A.R., EVANS, D.J.F., ROONEY, M.-L.T., SPEAR, P.M., WELBOURN, C.M., 1990. Orientation-dependent nitrogen incorporation on vicinals on synthetic diamond cube growth surfaces. *Journal of Crystal Growth*, 100, 354-76, 12 figs.

Several significant phenomena concerning the optical properties of diamond and the inhomogeneity of impurity distribution in synthetic diamond are described. Evidence is based on optical transmission at 430nm, Schlieren photography, birefringence, IR absorption microscopy, differential abrasion resistance patterns, cathodoluminescence topography and X-ray topography with synchrotron and conventional sources. Phenomena are detailed and correlated for one specimen with data from a second similar specimen. Material belonged to one cube growth sector designated (001) with the seed absent. The chief feature of interest was a Maltese Cross type of cathodoluminescence which showed on both surfaces parallel to (001). M.O'D.

FRITSCH, E., ROSSMAN, G.R., 1990. New technologies of the 1980s: their impact in gemology. *Gems and Gemology*, 26, 1, 64-75, 11 figs in colour.

These include computers and micro-processors; image furnaces concentrating light to make synthetics, still largely experimental; low pressure and low temperature diamond films; improved radiation to alter colour; new fillers for cracks in diamond and other gems; the electron probe for analysis; infrared, X-ray and Raman spectroscopy; cathodoluminescence; neutron magnetic resonance; electron-spin resonance and proton induced X-rays. [Most of these require apparatus outside the reach of the average gemmologist.] R.K.M.

FRYER, C.W., (ED.), CROWNSHIELD, R., HURWIT, K., KANE, R.E., HARGETT, D., 1990. Gem Trade Lab notes. *Gems and Gemology*, 26, 1, 94-8, 12 figs in colour.

Synthetic amethysts salted into a natural parcel are bad enough, but synthetic sapphire of the required purple was also found, fortunately detectable by routine tests.

A rare andalusite cat's-eye is described and illustrated. A flawless fancy yellow diamond shattered under stress of minor repair-cutting. Another diamond had an internal cleavage covered with trigons.

An apparently fine emerald had filled fractures showing 'flash effects' similar to those seen in diamonds, and it was confirmed that Zvi Yehuda is now treating emeralds. A pair of natural opals were seen with black tops and white opal bases, first thought to be doublets, but no join could be seen at the sharp demarcation.

A string of naturally grey cultured pearls were found to have an exceptionally thick layer of black conchiolin.

Rough from Africa was identified as quartz with a beautiful blue colour due to inclusions of fine lazulite. All items are nicely illustrated. R.K.M.

GARCÍA GIMÉNEZ, R., LEGUEY, S., 1990. Saphirs et rubis de Tanzanie. (Sapphires and rubies of Tanzania.) *Revue de Gemmologie*, 102, 6-8, 8 figs (5 in colour).

Ruby, blue sapphire and other colours of corundum from Tanzania, are described. Colours are referred to a chromaticity coordination chart and details of inclusions and absorption spectra are given. M.O'D.

GAUTHIER, J.-P., LASNIER, B., 1990. La perle noire obtenue par traitement à l'argent. (Black pearl obtained by silver treatment.) *Revue de Gemmologie*, 103, 3-6, 8 figs (2 in colour).

Treatment with silver can turn a pearl to a near-black. Details of the treatment and characterization are given. M.O'D.

GAUTRON, L., 1989. Alpine quartz. *Journal of Mines and Minerals*, 7, 29-39, 20 figs (2 in colour).

The crystal habit of Alpine quartz is discussed with notes on various geological environments. Some collecting anecdotes are included. M.O'D.

GILLBERG, L., 1990. Opaler i Australia. (Opal in Australia.) *Gem Bulletinen*, 1/1990, 2pp, 1 fig.

A short description of the occurrence of gem-quality opal in Australia. M.O'D.

GIULIANI, G., RODRIGUEZ, C.T., RUDEA, F., 1990.

Les gisements d'émeraude de la Cordillere Orientale de la Colombie: nouvelles données métallogéniques. (Deposits of emerald in the eastern Cordillera of Colombia: a new metallogenic data.) *Mineralium Deposita*, 25, 105-11, 4 figs.

In Colombia emeralds are found in Lower Cretaceous shales of the eastern Cordillera. The tectonic pattern of the deposits is related to deep reverse and large regional fault systems and emerald mineralization is controlled by hydrothermal solutions which permeate through fractures and along stratification planes. Emerald is found in calcite veins, pockets and brecciated zones associated with pyrite, quartz, parisite, codazzite and fluorite. The emerald-forming process is epigenetic hydrothermal in type. Alteration of arenite shale formations in the Cretaceous may have contributed to the formation of solutions and establishment of hydrothermal channels. Black shales could yield Cr, V, Fe, Al and Si for the emerald but the source of the beryllium is unclear and is further discussed. M.O'D.

GROMOV, A.V., GRANADCKIKOV, B.G., ANDREYENKO, E.D., 1990. (Typomorphic features of emeralds from various deposits.) *Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva*, 119, 2, 102-12, maps. (Russian with English abstract.)

Comparative studies of emeralds from various deposits of the USSR, Pakistan, Afghanistan and Colombia are reported, concentrating on diagnostic features of this gemstone in raw material, facet inlets and cabochons, and jewellery. Solid and fluid inclusions have been studied in parallel-sided polished plates from low-quality crystals and 'emerald aerugo' and in faceted stones; homogenization temperatures are reported. Spectroscopic studies in the range 400-750nm reveal the colour variations in emeralds from the different deposits. Density and refractive indices are tabulated; emeralds from Swat, Pakistan, have the highest values, with $D 2.78 \text{ g/cm}^3$, $n 1.588-1.591$, $w 1.596-1.600$. R.A.H.

GRUNDMANN, G., MORTEANI, G., 1990. Emerald mineralization during regional metamorphism: the Habachtal (Austria) and Leysdorp (Transvaal, South Africa) deposits. *Economic Geology*, 84, 1835-49, 16 figs.

The classic theory of emerald formation in schists attributes the formation to interaction between invading pegmatitic magma or vapour phases and pre-existing metasediments, metavolcanics and/or ultrabasic rocks. Detailed studies of the emerald deposits in the Habachtal and at Leysdorp show that the emerald formation was not due to a single-stage contact metamorphism at the border

zone of magmatic intrusive bodies. In these two deposits the emeralds are found in metasomatic (blackwall) zones associated with ultramafic bodies formed by syn-to post-tectonic reactions during low-grade regional metamorphism. These reactions occur at the contact of pre-existing beryl- and phenakite-bearing pegmatites and albitite pegmatoids with biotite-talc and actinolite schists at Leysdorp or at the contact of beryllium-rich garnet-mica schists and biotite-plagioclase-gneisses with serpentinites and talc-schists in the Habachtal.

M.O'D.

HENN, U., BANK, H., 1990. On the colour and pleochroism of Cu-bearing green and blue tourmalines from Paraiba, Brazil. *Neues Jahrbuch für Mineralogie, Monatshefte*, 6, 280-8, 6 figs.

A recent find of tourmaline in the state of Paraiba, Brazil, has produced material coloured bright blue and green. The colour is ascribed to trivalent Mn and/or divalent Cu. In the blue specimens two strong absorption bands show maxima at 700 and 520nm, the first band caused by divalent copper and the second by trivalent Mn. Both are in distorted octahedral coordination and cause different absorptions in ordinary and extraordinary ray directions. In the green stones only the divalent copper absorption band is recorded at 700nm.

M.O'D.

HÖBELT, K.H., 1990. Opale von Yowah, Queensland, Australien. (Opal from Yowah, Queensland, Australia.) *Lapis*, 15, 5, 37-9, 8 figs (7 in colour).

Precious opal in the form of nuts or nobbies is found at Yowah, Queensland, Australia. Examples of gem quality are illustrated and briefly described.

M.O'D.

JARRY, A., 1990. Excursion à Madagascar. (Excursion to Madagascar.) *Revue de Gemmologie*, 103, 11-12, 8 figs (5 in colour).

Ruby, spessartine, danburite, tsavorite, kornerupine, apatite and spodumene are among the gem-quality minerals described.

M.O'D.

KAMMERLING, R.C., KOIVULA, J.I., 1990. An interesting imitation of jadeite. *South African Gemmologist*, 4, 2, 20-3, 2 figs in colour.

Dyed green quartzite as an oval cabochon weighing 11.54 ct was offered as jadeite. RI was 1.540-1.549, DR 0.009, uniaxial positive and aggregate reaction between crossed polars. The stone was unevenly coloured medium dark to yellowish green. SG was estimated as 2.66 and the stone showed a diffuse absorption band from 688-662nm. M.O'D.

KAMMERLING, R.C., KOIVULA, J.I., KANE, R.E., 1990. Gemstone enhancement and its detection in the 1980s. *Gems and Gemology*, 26, 1, 32-49, 18 figs in colour.

This beautifully illustrated paper summarizes developments in the decade, covering the many effects of heat treatment; irradiation; dyeing; oiling; fracture-filling, with special reference to glass-filled holes in rubies and sapphires, and to the latest 'Yehuda-filled' cracks in diamonds and emeralds.

Where possible, ways of detection are given, but it is recognized that some treatments leave no trace other than the colour itself which may be unexpected in a natural stone. Altogether an important and extremely valuable paper. R.K.M.

KLEYENSTÜBER, A., 1990. Observations on a pyrope-almandine garnet. *South African Gemmologist*, 4, 2, 14-19, 4 figs (2 in colour).

A transparent orange-brown cabochon weighing 7.55 ct was found to be pyrope-almandine garnet on the basis of gemmological testing and energy-dispersive X-ray analysis. The stone had $n=1.749$, SG 3.756 and absorption between 600 and 400nm. Wavy round channels becoming flat before breaking through the polished surface were observed with the microscope. These are hollow structures perhaps containing crystal inclusions. M.O'D.

KOIVULA, J.I., KAMMERLING, R.C., 1990. A gemmological review of Colombian emeralds. *South African Gemmologist*, 4, 1, 5-15, 6 figs in colour.

Properties of ten Colombian emeralds are given with coloured photomicrographs depicting characteristic inclusions. M.O'D.

KOIVULA, J.I., KAMMERLING, R.C., 1990. Gem news. *Gems and Gemology*, 26, 1, 100-9, 19 figs in colour.

First a report of things seen at the Tucson '90 Mineral Fair; new and convincing cabochon 'emerald' triplets were from Kammerling of Idar-Oberstein; deeper diffusion in treated blue sapphires was claimed by Gem Source representative, immersion microscopy detected the treatment; a six-armed star ekanite was seen [the first ekanite found was also asteriated, but with four arms only]; cat's-eye iolite was also seen (last two not illustrated); three different mother-of-pearl cameos are shown; quartzite dyed green to simulate jade was also seen.

Montana sapphires were available in a range of colours, and light blues from Colombian and Brazilian sources. An unusual greyish-violet spinel cat's-eye, and a rare red taaffeite with a uraninite inclusion, are illustrated; the new 'fluorescent' bluish-green and emerald green tourmalines from

Paraiba were confirmed by Gerhard Becker of Idar-Oberstein as heat-treated, with a table showing changes obtained at 50° intervals from 350°C to 550°C; heat removes red of trivalent manganese and leaves other colourants, such as divalent copper; Tanzanian zircon was seen for the first time.

Diamonds

New 'flash' colours have been seen in glass-filled diamonds, pinkish-purple changing to yellowish-green against a bright background. Cloudy circular white patterns were on surfaces of some treated stones. 34 stones were graded before and after filling, 21 were down in colour and 18 improved in apparent clarity, only nine of which showed both changes, four showed no changes and 12 lost on colour without increasing clarity. In Australia Argyle diamonds are installing a computerized clarity analysis machine which assesses from three directions fifty times faster than human sorters. Kimberlite pipes have been found in Saskatchewan, Canada, one with micro-diamond, other pipes were sought; a computerized Israeli/Japanese diamond-cutting plant is opening in Israel. Ghana government is inviting private mining to increase dwindling production; Australians have developed new air-survey for diamond, using light beams, resultant spectra giving immediate image quality.

Coloured Stones

Amethyst sceptre crystals found at Salem, Connecticut; a 2250 ct 'emerald' beryl found in Finland; a major discovery of orthoclase from Itrongahy, Madagascar, is reported by E. Julius Petsch jun., who also supplied sample colours of spinel from the Umba region of Tanzania. Star quartz (not illustrated) reported from Plumas County, California; sunstone from Idaho is illustrated; a 20.37 ct liddicoatite tourmaline from Minas Gerais is thought to be the largest; unusual spectral iridescence in a metamict green zircon from Sri Lanka was due to laminated structure.

Synthetics and Imitations

Another large 'crystal', purporting to be emerald, was a five-sided glass prism with shrunken surfaces, unconvincing colour, moulded or partially melted edges, internal bubbles and adhered clay and mica. Other examples are known to originate in Africa. A new type of synthetic ruby, believed to be from USSR, had an aggregate grained texture with some homogeneous areas. R.K.M.

KOIVULA, J.I., KAMMERLING, R.C., FRITSCH, E., 1990. Gemmological description of a glass imitation emerald from Zambia. *South African Gemmologist*, 4, 2, 7-13, 8 figs in colour.

A yellowish green supposed emerald crystal with RI 1.53 (mean) and estimated SG 2.50 and inert to UV turned out to be glass. Numerous gas bubbles could be seen. A 'matrix' proved to be partly a clay-like substance and partly mica, coating the five-sided habit which must have been the result of fashioning. The specimen weighed 82.85 ct.

M.O'D.

LAHL, B., 1990. Achat und Jaspis zwischen St Egidien und Hohenstein-Ernstthal in Sachsen. (Agate and jasper between St Egidien and Hohenstein-Ernstthal in Saxony.) *Lapis*, 15, 7/8, 61-6, 15 figs in colour.

Fine specimens of agate and jasper are found between St Egidien and Hohenstein-Ernstthal, Saxony [East] Germany. Many have been cut and polished for ornamental use.

M.O'D.

LARSSON, T., 1990. Den Förbisedda Adelstenen. *Gem Bulletin*, 1/1990, 3pp.

A description of the growth, characterization and history of natural and synthetic spinel.

M.O'D.

MISIOROWSKI, E.B., 1990. Jewelry of the 1980s: a retrospective. *Gems and Gemology*, 26, 1, 76-93, 22 figs in colour.

A nicely illustrated resumé which endeavours to cover the vast spread of design tendencies in the decade, some of which were highly innovative. It is pleasing to find some British examples here, but one or two examples, e.g. the Windsor flamingo brooch, were not of that decade, although they were auctioned then.

R.K.M.

NASSAU, K., 1990. Gemology – the current decade. *Lapidary Journal*, 43, 11, 74-9, 4 figs in colour.

The various types of treatment undergone by some gem species are reviewed.

M.O'D.

NASSAU, K., 1990. Synthetic gem materials in the 1980s. *Gems and Gemology*, 26, 1, 50-63, 13 figs in colour.

Dr Nassau is a leading expert in his subject and has summarized the synthetic situation in the 1980s most efficiently.

He points out that a slowing of research in other fields, usually a source of 'spin-off' synthetic gems, led to a dearth of new man-made gems, a tendency which he thinks will continue, giving gemmology breathing space in which to perfect detection methods.

He suggests that major manufacturers of synthetic diamond may aim at the gem market, but considers the threat not to be imminent. The possible uses of single layer diamond films up to 2 μm thick is discussed [a μm is 1000th of a

millimetre, not 100th]. Thicker films are technically difficult and need not yet be feared.

R.K.M.

O'DONOGHUE, M., 1986. Kamienie szlachetne i ozdobne wysp brytyjskich. (Gem and ornamental minerals of Britain.) *Mineralogia Polonica*, 17, 1, 111-14.

Occurrences and quality of gem minerals found in the British Isles are reviewed. Particular reference is made to fluorite and to agate.

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

PETROV, I., 1990. Role of natural radiation in tourmaline coloration: discussion. *American Mineralogist*, 75, 237-9.

The paper reviews the various theories of tourmaline coloration so far proposed. The optical absorption band at 515nm and the colour-producing processes in elbaite are composed of several different phenomena. These are metastable O^{1-} centres, $\text{Mn}^{4+} \rightarrow \text{Mn}^{3+}$ electron centres and electronic transitions of transition metal ions, Mn^{3+} for example.

M.O'D.

PLASZYŃSKA, M., 1988. Measurement of transmission of Chelsea filter. *Mineralogia Polonica*, 19, 1, 113-15, maps.

The transmission spectrum of the Chelsea filter (produced by Gemmological Instruments Ltd, London) has been measured in the visible range (333=800nm). It is zero at 333=361.4 and 607.7=684.5nm and increases strongly for $\lambda 684.5\text{nm}$; there is a minor maximum at 578.7nm.

R.A.H.

READ, P.G., 1989. Identification methods, old and new. *Canadian Jeweller*, November 1989, 49, 1 fig.

The article contrasts the use of the Chelsea emerald filter (in the identification of emerald simulants and synthetic spinel simulants of aquamarine, sapphire and tourmaline) with the possible use of scattered Raman radiation in the identification of diamond.

(Author's abstract) P.G.R.

READ, P.G., 1990. Identifying synthetic amethysts and filled diamonds. *Canadian Jeweller*, March 1990, 27.

Test methods for distinguishing between twinned natural quartz and untwinned synthetic quartz (including the use of the conoscope) are reviewed, with the warning that they may no longer be valid as the synthetic untwinned material was developed specifically for the electronics industry and is not necessarily a feature of synthetic quartz. Identifica-

tion methods for detecting glass-filled rubies and diamonds are also described.

(Author's abstract) P.G.R.

ROBERT, D., 1990. Ces nouvelles tailles, vous connaissez? (Do you know these new cuts?) *Revue de Gemmologie*, 103, 7-9, 8 figs (2 in colour).

Several new cuts, suggested mainly for diamond, are described and illustrated. M.O'D.

RODRIGUES, P., BANERJEE, A., 1990. Anwendung der Infrarotspektroskopie in der Edelsteinkunde: Untersuchungen des Infrarot-Pleochroismus von Dipyr (Na-reichem Skapolith). (The application of infrared spectroscopy in gem testing: investigation of the infrared pleochroism in dipyre (Na-rich scapolite).) *Kurzmitteilungen aus dem Institut für Edelsteinforschung der Johannes Gutenberg-Universität Mainz*, 5, (1/2), 1-4, 4 figs.

Polarized IR spectra were obtained from thin crystal plates of dipyre in different radiation directions at room temperature. Distances between O and H atoms could be calculated by measuring the IR pleochroism of the OH-stretching frequencies from 3700 to 3200cm⁻¹. KBr spectra showed that the OH vibrations arise exclusively from hydroxyl rather than molecular water. Specimens were of gem quality. M.O'D.

SCHWARZ, D., 1990. Die brasilianischen Smaragde und ihre Vorkommen: Santa Terezinha de Goiás/Go. (The Brazilian emeralds and their occurrence: Santa Terezinha de Goiás/Go.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, 39, 1, 13-44, 23 figs (4 in colour), 6 tables, bibl.

New investigations of the emerald occurrences in Santa Terezinha de Goiás/Go show deposits are stratiform. The optical data (RI and birefringence) measured are the highest ever observed in emeralds (up to 1.593-1.602; 0.008-0.010). They have the highest mean concentration of all Brazilian emeralds for chromium and iron. Fluid inclusions in general are very small. Mineral inclusions can be spinel, carbonates, mica, talc, amphibole, pyrite, and to some extent rutile, hematite, chalcopyrite, pentlandite and ilmenite. E.S.

SERSEN, W.J., HOPKINS, C., 1989. Al comprar y al vender gemas-que luz es la mejor? (Which light is the better for testing and selling gemstones?) *Gemologia*, 31, 83/84, 26-50, 9 figs.

The effect of incident light on gem testing and display is examined. M.O'D.

SHIGLEY, J.A., DIRLAM, D.M., SCHMETZER, K., JOBBINS, E.A., 1990. Gem localities of the 1980s.

Gems and Gemology, 26, 1, 4-31, 28 figs, and world map.

A superbly illustrated summary of some old, and many new sources which came to light in the 1980s, most of which, if not all, were reported at the time in *Gems and Gemology*.

Perhaps the most important of these was the discovery and exploitation of diamonds in the north of Western Australia, which put that country to the forefront of diamond production by 1988.

This long and important paper ends with a detailed table of gem localities and nearly 200 references which emphasize the work that has gone into it. [Illustration of a Sri Lankan pink star sapphire on page 26 shows curved striae which look uncommonly like evidence of synthesis.] R.K.M.

SOBCZAK, N., SOBCZAK, T., 1985. Korale ozdobne. (Gem coral.) *Mineralogia Polonica*, 16, 2, 85-93.

A useful account of coral and its main imitations.

M.O'D.

SOBCZAK, T.S., SOBCZAK, N.R., 1987. Royal Lavulite - nowy kamien ozdobny. (Royal lavulite - a new gem material.) *Mineralogia Polonica*, 18, 1, 73-5.

A short account of the manganoan sugilite with the trade name Royal Lavulite. M.O'D.

SONNELLRATH, J., 1990. Brasilianische Andalusite und Zink-Staurolithe von Edelsteinqualität: Chemismus, Bildungsbedingungen, optische und kristallographische Eigenschaften. (Gem quality andalusite and zincian staurolite from Brazil: chemistry, formation conditions, optical and crystallographic characteristics.) *Kurzmitteilungen aus dem Institut für Edelsteinforschung der Johannes Gutenberg-Universität Mainz*, 5, (1/2), 5-6.

Gem quality andalusite and zincian staurolite have been found in several placer deposits in Brazil, notably from Paramirim das Crioulas, Bahia. Crystallographic and structural details are discussed together with notes on occurrence, chemistry and colour. M.O'D.

SZENICS, T., 1990. The rediscovery of axinite at Thornberry Mountain near Coarsegold, Madera County, California. *Mineralogical Record*, 21, 127-32, 5 figs in colour.

Some medium- to low-quality axinite crystals were recovered from an albite-actinolite matrix in a dike approximately 4 1/8 miles north-east by east of Coarsegold, California. Previous finds from this site, at first incorrectly described as a pegmatite, have included gem-quality material but there seems to be no more available. M.O'D.

THEMELIS, T., 1990. Oiling emerald. *Lapidary Journal*, 43, 12, 19, 2 figs in colour.

The practice of oiling emerald is described with notes on how to recognize it. M.O'D.

WALTER, D.R., 1989. Australian gems: malachite. *Wahroongai News*, 23, 11, 29-30.

Found mainly at Burra, north of Adelaide. Another source of green and black malachite is at Harches Creek, Northern Territory. Neither cuts to very large sizes. R.K.M.

WARD, F., 1990. Emeralds. *National Geographic Magazine*, July 1990, 38-69, 34 figs in colour.

An up-to-date and accurate overview of the mining and marketing of emerald throughout the world with notes on identification techniques. M.O'D.

WATT, J.C.Y., 1990. Neolithic jade carving in China. *Transactions of the Oriental Ceramic Society*, 53, 11-26, 22 figs.

During the past few years important Neolithic sites in the areas beyond the Yellow River basin have been investigated. In some of these sites bowenite is found as well as nephrite and it has been used for similar artefacts. The latest thoughts on the purpose of some of the obscurer objects are given. M.O'D.

WHITE, J.S., COOK, R.B., 1990. Amethyst occurrences of the eastern United States. *Mineralogical Record*, 21, 203-13, 19 figs (18 in colour).

Amethyst occurs in four distinct types of geological environment in the eastern United States. Most occurrences are restricted to crystalline units of the Piedmont and Blue Ridge physiographic provinces. Other amethyst deposits occur in Triassic traprock dikes and sills extending from northern Virginia to Nova Scotia. Especially fine gem quality material has been recovered from Upper Providence Township, Delaware County, Pennsylvania. M.O'D.

WILSON, W.E., 1990. What's new in minerals? *Mineralogical Record*, 21, 253-60, 17 figs in colour.

A report of notable exhibits at the 1990 Tucson Gem and Mineral Show includes well-formed chrysoberyl crystals from Pancas, Espirito Santo, Brazil; dark green apatite from the Jose Pinto mine, Governador Valadares, Minas Gerais, Brazil; gem quality realgar from Shimen, Hunan Province, China; rose quartz from the Pitorra mine, Minas Gerais, Brazil; sceptre elbaite from Barra de Salinas, also in Minas Gerais; clear yellow orthoclase crystals from Itrongay, Malagasy Republic and fine azurite groups from the Bou Beker mine near Touissit,

Morocco.

M.O'D.

WOODRUFF, R.E., FRITSCH, E., 1989. Blue pectolite from the Dominican Republic. *Gems and Gemology*, 25, 4, 216-25, 13 figs in colour.

Best known for amber and conch 'pearls', this Caribbean country is now producing an attractive massive blue pectolite, a sodium calcium silicate coloured here by copper. Finest material is a good turquoise blue, grading to bluish-green and green; fibrous, polycrystalline with RI 1.59 to 1.63, SG 2.62 to 2.83 for best blues, H 5 to 6 for the fibrous material. Fluoresces green, through yellow to blue, more intensely in UV. Dendritic acicular red hematite and other attractive graining due to the fibrous structure increases the appeal of the stones. Authors consider output could increase if geology of deposit were studied. R.K.M.

ZEITNER, J.C., 1990. Obsidian. *Lapidary Journal*, 43, 12, 43-50, 2 figs in colour.

The mode of occurrence of obsidian is described and some of the types are listed, with notes on fashioning. Locations in the United States are mentioned. M.O'D.

ZEITNER, J.C., 1990. Eternal sky. *Lapidary Journal*, 43, 11, 49-57, 3 figs (2 in colour).

The various turquoise deposits of North America are reviewed with notes on Indian artefacts and on contemporary production. M.O'D.

ANON. 1989. Geological Museum Newsletter 1989/2. Hot rocks from Hawaii. *Wahroongai News*, 23, 11, 7-8.

A brief account of lava flows in Hawaii, one type smooth and billowy called Pahoehoe; the other block and tumbled, called Aa. Lavas largely labradorite feldspar, but large grains of peridot can be found. R.K.M.

1990. World's largest opal to be sold at Christie's Geneva, 15 November. Press release, Christie's.

The world's largest opal, Jupiter-Five, and a smaller stone, Persephone, are due to be sold at Christie's Geneva on 15 November 1990. Jupiter-Five weighs 5.27 kilos [26,350 ct] and was found in 1989 at Coober Pedy, South Australia. Persephone weighs 765 ct and shows strong red and orange as well as other colours; this stone is polished and the colours appear strong in dim light. M.O'D.

Book reviews

ADAMSON, G.F.S., 1988. *At the end of the rainbow: gold in Scotland*. Albyn Press, Haddington. pp.94. Illus. in black-and-white. £6.95.

This interesting book lists many occurrences of gold in Scotland with chapters on gemstones and freshwater pearls in which these topics are briefly covered. Much of the information would be hard to find elsewhere; grid references would have been useful but perhaps security considerations prevented this.

M.O'D.

ANDERSON, B.W., 1990. *Gem Testing*. 10th edn. revised and updated by E.A. Jobbins. Butterworths, London. pp. x, 390. Illus. in black-and-white, with 70 coloured plates. £30.00.

It is ten years since the late and greatly missed Basil Anderson revised his *Gem Testing* for its 9th edition. Originally published as *Gemtesting for Jewellers* nearly 50 years ago, the book has developed and matured over the years to become one of the most readable and certainly the most authoritative of gemmological texts. Four reprints of that edition, the last in 1988, added no new information, although a glaring printers' error among the spectrum illustrations was corrected.

Such a valuable text should not be allowed to die, and a 10th edition was badly needed. Very sadly, Basil Anderson passed away in 1984 at the age of 81, and Mr E.A. Jobbins, formerly Curator of Minerals and Gemstones at what was then the Geological Museum, and a gemmologist of very considerable note, has now taken on the exacting task of updating and revision.

The major part of this new edition remains largely as written by Anderson, and new facts, of which there are many, have been inserted discretely without disrupting his eminently readable style. Official pronouncements from various international bodies in the last decade or so have decreed certain changes and we find the wavelength of light, which was formerly measured in Angstrom Units (Å), now quoted in nanometres (nm). Heavy liquids and those used for optical purposes have been given new names: the familiar, and one might almost say much loved, 'methylene iodide' now becomes 'di-iodomethane' which may make organic chemists happy, but tends to leave established gemmologists

puzzled; while 'mono-bromo-naphthalene' becomes '1-bromonaphthalene'. [The latter is no great change, but one is left wondering why the first liquid retains its Greek suffix instead of becoming '2-iodomethane'.] However these are changes imposed from outside and were necessary parts of the updating. Basil Anderson, too, would almost certainly have conformed, but I do not think he would have been happy at abandoning the Angstrom.

The greatest change in this new edition is the inclusion of two valuable new chapters: '7 The manufacture of synthetic and imitation stones' and '8 Gemstone enhancement'. Many of the excellent illustrations and facts for these are taken from the books *Man-made Gems* and *Gemstone enhancement* by Dr Kurt Nassau, a world authority on these matters, with his permission and that of his publishers. Figure 7.1, a diagram of the Verneuil furnace, has been taken from the 9th edition of the Anderson book and still has the oxygen and hydrogen input tubes labelled in reverse. (B.W.A. was aware of this, and that the same drawing was also incorrect in his book *Gemstones for Everyman*, but he apparently did not leave a note of the error with a possible tenth edition in mind.)

Chapter 9 'Detection of synthetic, imitation and composite stones', has been re-shuffled to accommodate new developments in a logical order.

The further sixteen chapters dealing with specific gems are again left largely as Anderson wrote them, but with many important new facts and developments incorporated skilfully to maintain the continuity. Only in one or two instances do facts seem slightly out of sequence and a check shows that they were so in the 9th edition.

The new book has 390 pages as against 434 in the 9th, but the page size of the 10th is 23 x 16cm (9th, 21 x 13cm), with 50 lines (9th, 42 lines) to the page, so the new edition is substantially the longer book. Many of the mono-chrome illustrations [I am tempted to call them 1-chrome] are from previous editions, occasionally turned around to present a fresh and perhaps better aspect, but there are many new ones, some of which are quite outstandingly good. But the truly great feature in this respect is the 70 superb colour plates covering 16 pages which, being unnumbered, are additional to the 390

pages of the text. Many of these are the exceptional work of the revising author, Alan Jobbins, who is also responsible for the Topaz crystal group used for the dust cover. Much care was taken to ensure that the reproduction of the colour plates is as it should be, and the general result is outstanding.

The book is clearly printed, in a good modern type-face which I found easy on rather ancient eyes. The few printers' errors are almost all a matter of a single missing or misplaced letter and do not alter meanings in the ones I found. But it is normal practice for printers to correct spelling errors when they spot them and this can occasionally lead to 'corrections' where the original typescript was right and the correction wrong. One such occurs on page 328 where a source of glass imitation cat's-eye is given as 'India (Cathay)'; this I am told should have been '(Cambay)'. Cathay is the old name for northern China.

Webster's unscientific recipe 'ten level teaspoonsful salt to a normal tumblerful of water' for brine to float amber, is quoted twice, and I was relieved to see that the second time was followed by a more exact version (50g salt in 250ml of water). Teaspoons vary with the maker. They are not standard size, a fact which I brought to Robert's notice many years ago, without effect.

Alan Jobbins has done an excellent job in bringing this valuable work up to date, despite illness which necessarily delayed its production. It should now serve as a reliable and indispensable textbook for students world-wide, as indeed earlier editions have done in the past. It is an essential and very valuable addition to any gemmologist's library.

R.K.M.

CALVERT, J., 1990. *The gold rocks of Great Britain and Ireland*. Goldpanners Association, Beaconsfield. £12.50.

Facsimile reprint of a book first published in 1853. M.O'D.

DOWNING, P.B., 1990. *Opal adventures*. Majestic Gems and Carvings, Tallahassee. pp.234. Illus. in black-and-white and in colour. £11.50.

This is an excellent account of opal and opal mining, set chiefly in Australia, with special emphasis on South Australia, but with notes on other world locations. The author has visited many mines and gives step-by-step notes on how opal is identified in the mine and recovered. Different fields are compared and there are notes on the way opal is valued in the rough and on cutting. The author's notes on Japanese involvement in opal buying are interesting and the book can be strongly recommended. The colour photographs are good and there is a useful glossary of opal mining terms. A

short bibliography concludes the book. M.O'D.

FEDERMAN, D., 1990. *Modern jeweler's consumer guide to gemstones*. Van Nostrand Reinhold, New York. pp.253. Illus. in colour. £14.00.

This is an update of a book first published in 1988 under the title of *The First 60*. Sixty species are described in this update too, each one having updated mining and marketing information as well as brief gemmological notes where they are generally and commercially informative. The coloured photographs by Tino Hammid are excellent for a relatively cheap book which can be recommended for the jeweller's counter as well as for the gemmologist and student. M.O'D.

Edited by KAZMI, A.H., SNEE, L.W., 1989. *Emeralds of Pakistan: geology, gemology and genesis*. Geological Survey of Pakistan and Van Nostrand Reinhold Co., New York. pp. xxi, 269. Illus. in black-and-white and in colour. £28.00.

This is a major multi-author work on a single gem mineral from a particular area and as such is a rarity in gemmological literature. However, this type of work is likely to become more common in future as academic departments with experienced staff become more involved with the study of gemstones. This development is long overdue and most welcome. The book is well-produced on the whole (though my copy has some pages repeated, none appear to be missing) and the standard of the colour pictures is high. This is especially true of the set of inclusion photographs by Dr E. J. Gübelin. For such a book the price is very reasonable.

The book opens with an overview of the geology and metallogenic provinces of Pakistan, describing in particular the collision between the Indo-Pakistan and Eurasian plates. This collision resulted in the upthrust of the world's highest mountains and the mineral deposits formed in geological environments unique to the various tectonic zones resulting from the original collision and subsequent movements. The book then turns to the geological setting of the emerald deposits and then to the deposits themselves. The major mines in the Mingora area are fully described, the chapter treating each individual quarry in detail with maps and plans. The other deposits are then described; these include Gujar Killi, Khaltaro, Charbagh, Makhad, Barang and Nawe Dand. The deposit of emerald-like vanadium beryl at Gandao is also described.

The next chapter covers the gemmological characteristics of the emeralds and here the set of 36 coloured pictures of inclusions by Dr Gübelin show how the Pakistan emerald can in general be recognized by the presence of combined curved secondary fluid inclusions, jagged three-phase primary

inclusions and either euhedral dolomite crystals with chromite and/or fuchsite: this pattern is especially characteristic of the Mingora emerald. Stones from Charbagh show curved fluid inclusions with gersdorffite and/or magnesite and/or pentlandite. Khaltaro stones show primary and secondary fluid inclusions forming an endogenesis with albite, calcite and actinolite. These are general pictures only and it should be stressed that there is no overall diagnostic inclusion pattern for the emeralds.

The next chapter outlines regional chemical differences among emeralds and host rocks of Pakistan and Afghanistan with implications for the origin of emerald. This chapter gives considerable analytical detail of specimens and results from individual mines and sections of mines are compared. This section is followed by a survey of the mineral chemistry of emeralds and some associated minerals from Pakistan and Afghanistan. The survey used an electron microprobe. Next comes a reconnaissance study of the fluid inclusion geochemistry of the same deposits.

The rest of the book is devoted to the geology of worked emerald deposits in which many classic areas are given a similar treatment to that given to the Pakistan deposits earlier in the book. Each chapter in the book has its own bibliography and general references, selected by the US Geological Survey, come at the end. There are author and subject indexes to complete a major and superb work. The reviewer was delighted to renew acquaintance with areas where he spent many happy hours.

M.O'D.

LINTILHAC, J.-P., 1987. *Black pearls of Tahiti*. Royal Tahitian Pearl Book, Papeete, Tahiti. pp. 109. Illus. in black-and-white and in colour. Price on application.

The text is a translation from the French and describes the pearls of Polynesia. The oyster concerned is said to be *Pinctada margaritifera* and its variant *cumingi* also produces pearls. Despite the title most of the Polynesian pearls do not originate from Tahiti and few are truly black; the main pearl-producing areas are some of the outer islands of French Polynesia, especially those in the Tuamotu Archipelago and the Gambier Islands. Pearl colour varies from white to steel grey, bronze, blue, green, purple and pink; some examples are copper and gold or black. Shapes may be round, button-shaped, blister or keshi.

The book, whose style and presentation clearly aims at a wide readership, opens with a brief description of French Polynesia and continues with a history of pearl oyster fishing in Polynesia. The pearls from this area were unknown to Europeans until the visits of explorers in the seventeenth and

eighteenth centuries. Details of the original methods of diving show how dangerous a practice this was and many lives must have been lost. This account is followed by a description of modern methods of pearl recovery. The next section of the book describes the oyster itself, *Pinctada margaritifera Cumingi*, which is the most characteristic pearl-producing mollusc in the region. The old theory of pearl growth initiated by a solid intruder is discounted but no new theory is advanced. Methods of pearl farming are described and pearl classification outlined. The photographs which decorate almost every page add to the attraction of this useful guide. The pictures of molluscs are especially clear.

M.O'D.

PIENAAR, H.S., GLENISTER, D.A., 1987. *The Stellenbosch gem index: a numerical approach to gemstone identification*. De Beers Laboratory, University of Stellenbosch, South Africa. pp. ii, 39. US \$4.00 plus postage.

A value to be called the SGI value is calculated from the specific gravity and refractive index of a wide variety of gem minerals and is proposed as a useful single figure for identification in the range 1-6000, not all SGI values applying to known individual species. The book provides a list of gem minerals in numerical order of the values followed by an alphabetical listing. Separate tables for materials with a refractive index higher than 1.81 and for glass and plastics are also given. The idea is interesting and the tables useful though many minerals occur over a wide range of SGI figures; elbaite for example turns up in sixteen groups covering the numerical range 115-136. The concept would need wide acceptance to be really useful but the relative positions of species in the tables are interesting in themselves. Silicon carbide would fill one of the gaps, according to my calculations.

M.O'D.

Proceedings of the Gemmological Association and Gem Testing Laboratory of Great Britain and Notices

OBITUARIES

Mr W.A. Burslem, FGA (D.1964), West Derby, Liverpool, died on 16 July 1990.

Mr A.M.N. Thurlow, FGA (D.1934), Sevenoaks, died in May 1990.

Mrs Christine Wong, FGA (D.1984), Hong Kong, died on 30 April 1990.

MEMBERS' MEETINGS

London

On 25 September 1990 at the Flett Theatre, Geological Museum, Exhibition Road, London SW7, **Dr George Harlow** gave a lecture entitled '100 years of gems at the American Museum of Natural History'.

Midlands Branch

On 21 September 1990 at the Society of Friends, Dr Johnson House, Colmore Circus, Birmingham, **Mr Spencer Mather** gave a talk on the cutting of gemstones and lapidary work using machinery, much of which was home-made.

North West Branch

On 19 September 1990 at Church House, Hanover Street, Liverpool, **Mr John Bugg, FGA**, gave a talk entitled 'The law and gemmology'.

NEWS OF FELLOWS

Mr Alan Hodgkinson and **Dr Jamie Nelson** were invited to attend the Annual Spring Meeting of the German Gemmological Society (Deutschen Gemmologischen Gesellschaft) held in May 1990 at Idar-Oberstein, West Germany, and to speak on topics of their choice.

On 26 May a gathering of members of the Society was held in the Ausbildungszentrum (teaching centre and laboratories of the DGG). Six working groups gave lecture/demonstrations. Mr Hodgkinson demonstrated his 'Visual optics' technique of gemstone identification without instruments and Dr Nelson gave a talk/demonstration on 'The four optical attributes of a diamond'.

On 27 May a meeting was held in the Diamond and Gemstone Bourse (Börsensaal) at which Dr Nelson gave a lecture 'On the colour assessment of gemstones', illustrated with slides and demonstrations.

On 28 May in the Ausbildungszentrum events included a series of interlocking 'hands-on' demonstrations by Mr Hodgkinson and Dr Nelson of a variety of apparatus relating to research, teaching and student applications.

On 4 June 1990 **Mr Michael O'Donoghue** spoke on 'Gemstones' to Sotheby's 'Looking at Jewellery' course.

On 12-14 June 1990 **Mr Michael O'Donoghue**, with **Mr Peter Read** and **Mr Roy Huddleston**, conducted a three-day course in preparation for the Association's examination.

On 10 July 1990 **Mr Michael O'Donoghue** gave a talk entitled 'Synthetics' to the Essex Rock and Mineral Society.

On 24 July 1990 **Mr Michael O'Donoghue** gave a talk on his latest book, *Field guide to rocks and minerals*, on Radio Kent.

On 3 October 1990 **Alan Jobbins** gave the opening lecture on 'Jades' in the 'Gemmologia Europa III' series of lectures which are held biennially in Milan, Italy, under the auspices of CISGEM, the Milan Gem Testing Laboratory and the Milan Chamber of Commerce and Industry. Prominent gemmologists from France, Germany, The Netherlands and Portugal will present other lectures in the series.

ANNUAL GENERAL MEETING 1990

The 59th Annual General Meeting of the Association was held on 4 September 1990 at the Thames Restaurant, Earls Court Exhibition Centre, London SW5.

The Chairman, Mr David Callaghan, FGA, opened the meeting and welcomed members. Mr Callaghan reported that, as a result of the severance with the National Association of Goldsmiths (see

p.194), Mr Jonathan Brown and Mr Bill Pluckrose were no longer serving the Association. Mr Callaghan thanked them for the tremendous amount of work they have done which was very much appreciated. He also thanked Noel Deeks and Nigel Israel for their help and support during the year.

Mr Nigel Israel, Honorary Treasurer of the Association, presented the audited accounts for the year ended 31 December 1989. The adoption of the Report and Accounts was duly proposed, seconded by Mr David Larcher, and carried.

Sir Frank Claringbull, Mr David J. Callaghan, Mr Noel W. Deeks and Mr Nigel B. Israel were re-elected President, Chairman, Vice-Chairman and Honorary Treasurer, respectively. Messrs A.E. Farn, A.J. French, Dr. G. Harrison-Jones, E.A. Jobbins, D.G. Kent, A.D. Morgan, P.G. Read, K. Scarratt and Mrs E. Stern, were re-elected to the Council.

Messrs Hazlems Fenton were appointed Auditors, and the proceedings then terminated.

EXTRAORDINARY GENERAL MEETING

At an Extraordinary General Meeting of the Association held on 4 September 1990 in the Thames Restaurant, Earls Court Exhibition Centre, London SW5, immediately following the Annual General Meeting, the following resolutions were proposed and passed:

1. THAT the Memorandum of Association be amended by the inclusion of the following at the end thereof:- 'THAT the Association shall transfer its assets and liabilities to The Gem Testing Laboratory of Great Britain substantially in accordance with an agreement in the form of that presented to the meeting with such amendments as may be agreed by the Officers.'
2. THAT the Articles of Association be amended by the inclusion of the following at the end thereof:- 'Notwithstanding any other provisions of these Articles the following shall, pursuant to the transfer of the assets of the Association to The Gem Testing Laboratory of Great Britain, have effect pending dissolution of the Association:-
 1. There shall be only three members of the Association who shall each have one vote and shall by their presence in person constitute a quorum at any meeting of the members. They shall not be required to pay any subscription. The first such three members shall be the individuals who are respectively, as at the date of this Resolution, the Chairman, the Vice Chairman and the Honorary Treasurer. All the present members other than the said three shall *ipso facto* on the passing of this Resolution cease to be members.

2. There shall be no officers of the Association but there shall be three members of the Council of Management who shall be the same persons as the three members and who shall by their presence in person constitute a quorum at any meeting of the Council of Management. All the present members of the Council of Management other than the said three shall *ipso facto* on the passing of this resolution cease to be members thereof.

3. Such members of the Council of Management shall continue to be such unless and until their resignation or death.

4. In the event of the:-

(a) resignation of one of the members the others shall have the right to and shall immediately appoint a replacement and no such resignation shall be effective unless his co-members shall have appointed a replacement.

(b) death of one of the members the others shall have the right to and shall immediately appoint a replacement. In the case of the remaining members not having made such an appointment within 28 days after the vacancy arising, the appointment may be made by the Gem Testing Laboratory of Great Britain.

5. No resignation of any sole remaining member shall be effective unless he shall have appointed replacements for his co-members and for himself.

6. In the case of the death of any sole remaining member without having made such appointment as is referred to above the appointments of the three new members shall be made by The Gem Testing Laboratory of Great Britain.

7. No appointment shall be effective unless the appointee shall have signified in writing his acceptance of the appointment.

8. No member of the Council of Management shall be a Chairman or have any second or casting vote.'

COUNCIL OF MANAGEMENT MEETING

At a meeting of the Council of Management held on 19 September 1990 at 27 Greville Street, London EC1N 8SU, the business transacted included the election to membership of the following:

Fellowship

Alejo, Deidre K., Kowloon, Hong Kong. D.1990
Anver, Mohamed F., Harpenden. D.1990
Barker, Damon A.N., Winchester. D.1990

Bing, Sara V., Exeter. D.1990
 Bowler, Simon R., Birmingham. D.1990
 Boyer, Alice M., Silver Spring, Md., USA. D.1990
 Charatan, Ivan L., London. D.1990
 Copestick, Bruce J., Harpenden. D.1990
 Davidson, Anthony, Newcastle upon Tyne. D.1990
 Downer, Martyn D., London. D.1990
 Garty, Annemarie, Dundee. D.1990
 Gibson, Bracken G., London. D.1990
 Hinds, Andrew F., Rickmansworth. D.1990
 Hollanders, David J., Maidenhead. D.1990
 Lynch, Kieran J., Coventry. D.1990
 Mallett, Gillian E., Cambridge. D.1990
 Mann, Alexandrina E., Nottingham. D.1990
 Parkhill, Melanie J., Wickhamford. D.1990
 Rackley, Trevor, Wantage. D.1990
 Ripley, Thomas, Stockton. D.1990
 Sanson, Steven N.J., London. D.1990
 Saywell, Neil, West Bridgford. D.1990
 Sergoulopoulos, Alexandros, Athens, Greece.
 D.1989
 Shafar/Pettigrew, Louise, Eaglesham. D.1990
 Smith, Karen, Dewsbury. D.1990
 Smookler, Sheryl, London. D.1990
 Spink, Michael C., London. D.1990
 Veecumsee, Dipal, Madras, India. D.1989
 Well (née Green), Sheila M., Glasgow. D.1990
 West, Kenneth J., Hove. D.1990

Transfers from Ordinary Membership to Fellowship

Baldock, Janine, London. D.1990
 Bubshait, Ahmed I., Manama, Bahrain. D.1990
 Clark, Susan W., London. D.1990
 Colomb, Nannette D., Epsom. D.1990
 Corne-Halstenbach, Michele, Geneva, Switzerland.
 D.1990
 Davies-Lloyd, Susan M., Tarporley. D.1990
 Edwards, Susan M., London. D.1990
 Fitzmaurice, Karl M., Dublin. D.1990
 Gademsetty, Subba R., Chigwell. D.1990
 Gunaratne, Ananda L., Kundasale, Sri Lanka.
 D.1990
 Hayakawa, Taketoshi, Kanagawa Pref., Japan.
 D.1990
 Henry, John M., Bolton. D.1990
 Inkpen, Michael S., Kingsbridge. D.1990
 Ishikawa, Noriko, Tokyo, Japan. D.1990
 Jhaveri, Devang, London. D.1990
 Jinbo, Kazuko, Tokyo, Japan. D.1990
 Komppa-Vigar, Leena M., Westoning. D.1990
 Lancaster, Wendy, New Malden. D.1990
 Lees, John A., Waterford, Va., U.S.A. D.1990
 Liyanage, Don C.S., Ashford Common. D.1990
 Matsumoto, Tamio, Tokyo, Japan. D.1990
 Nakane, Tomoko, Tokyo, Japan. D.1990
 Oldershaw, Caroline J.E., Penn. D.1990

Pyzowski, Carl C., Frackville, Pa, USA. D.1990
 Roberts, Anne M., Crawley. D.1990
 Shah, Anurag D., Nairobi, Kenya. D.1990
 Shibata, Hirofumi, Osaka, Japan. D.1990
 Sim, Evelyn, London. D.1990
 Skilton, Margaret, Auckland, New Zealand.
 D.1990
 Spencer, Stephen R., Drewsteignton. D.1990
 Terpilak, Thomas J., Bethesda, Md, USA
 Van Heesewijk, Jacqueline W., London. D.1990
 Wilson, Nean E., Longniddry. D.1990
 Wright, John C., Solihull. D.1990

Ordinary Membership

Balas, Sharon L., London.
 Bett, Dana I., London.
 Brown, Irwin H., Northwood.
 Burgess, Ian D., London.
 Chetwin-West, Sheridan L., Morecambe.
 Dale, Sharon J., Sutton.
 De Agustin, Luis, New York, NY, USA.
 Doyle, Robert, London.
 Duff, Alexandra S.F., Limerick.
 Duff, Wayne A., Harrow.
 Durkin, Lorraine J., London.
 Embleton, M.L., Basildon.
 Gemmell, James, Havant.
 Gonzalez Notario, Alfredo, Madrid, Spain.
 Graham, Josephine M., London.
 Gutmannsbauer, Winfried, Allschwil, Switzerland.
 Hering, Peter J., Cambridge.
 Jhaveri, Shree, Bombay, India.
 Jordan, Steven L., Boston.
 Kejriwal, Bindu, London.
 Lloyd, Brian R.D., Nairobi, Kenya.
 Martin, Melanie J., London.
 Miller, Carol B., Hong Kong.
 Neilson, Robert W.E., Strumpshaw.
 Nickless, Christine M., Birmingham.
 Olver, Paul A., Farnham.
 Packard, Gilian E., London.
 Patel, Chetan, Harrow.
 Pollard, Adrian N.F., Stockport.
 Sayed, Ahad, Brentford.
 Seaman, Teresa L., Hornchurch.
 Smith, Sarah J., London.
 Sollitt, Heidi, Thaxted.
 Stapley, Kerrie, Lancing.
 Steffensen, Torben A., Copenhagen, Denmark.
 Tubel, Wayne P., London.
 Tucker, Keith A., Ilkley.
 Vaughan, John W., London.
 Wasserman, Caron J., London.
 Webb, Lionel, Reading.
 Wilkins, Antony C.F., Folkestone.
 Zander, Marie C.M., Sao Paulo, Brazil.
 Zwaan, Johannes C., London.

EXHIBITIONS

History of the Cheapside Hoard

The famous Cheapside Hoard of Jewellery, discovered by a City workman in 1912, is being re-displayed in a new case in The Museum of London, London Wall, London EC2, from 18 September 1990. Fibre optic lighting adds an extra sparkle to the gemstones and delicate settings of these 16th and 17th century specimens.

The range of gems, settings and vessels in the hoard indicate that it was probably the stock in trade of a working goldsmith but contemporary portraits show that the jewels appear to date from the mid-16th to the mid-17th century. The enamelled chains and delicate hair pendants are typical of the 1560s although they were still worn in the early 17th century, whereas the enamelled fan holders or dress ornaments which can be seen in the late 16th century portraits, judging from prints by Wenceslaus Hollar, were fashionable in the 1640s. The wide variation in date and the presence of rock crystal tankards, salt, chalice and case suggest that this unknown goldsmith was also operating as a pawnbroker. The reliquary pendants and cameos with Christian subjects indicate that some of these pledged goods may have come from an ecclesiastical source.

The gems included garnets from India and Sri Lanka and turquoises from Nishapur, Persia and Sinai peninsula which were obtained through the Turkish market (hence the name). The emeralds were imported from Colombia after Christopher Columbus's voyage of discovery in 1492. Amethysts found in the Alpine regions, were believed to protect the wearer against harm in battle, and acted as an antidote against poison and drunkenness. Cameos and intaglios dating from Roman and Byzantine times were set in rings and pendants and indicate the contemporary interest in earlier gems.

Treasures and Trinkets

From January 1991 The Museum of London, London Wall, London EC2, will present an exhibition drawn from its collection of jewellery found in London from pre-Roman times to the 1930s. *Treasures and Trinkets* will include jewellery worn as symbolic of love, death, belief and social status.

The exhibition will have a strong educative purpose. The pieces will not simply be displayed for their glitter but to demonstrate the development of the jewellery trade in London, to explore the significance of symbols and association in jewellery and to cover changing fashions in jewellery and its relationship to dress from Roman to Victorian times. All these aspects will also be examined in the fully illustrated catalogue. There will be a full programme of lectures, demonstrations and workshops and a day conference organized in association

with the Society of Jewellery Historians.

1990 INTERGEM FAIR

The sixth INTERGEM Fair was held in Idar-Oberstein from 7-10 September 1990. It was opened by the German Minister for Economics. The central theme this year was 'Africa'; there was a special exhibition showing some beautiful specimens from that continent and there was also a series of lectures dealing with stones from Africa. Johnny Roux talked about 'Rough diamonds', and there were also talks entitled 'Tsavorite', 'Tourmalines in Namibia', 'Tanzanite' and 'East African corundums'.

Large quantities of mainly cut gemstones were on show, many cut in the modern idiom, some quite attractive. A number of beautifully carved animals and birds were exhibited.

THE BEAD SOCIETY

The Bead Society of Great Britain (formed in September 1989) is open to all those interested, either privately or professionally, in beads ancient and modern, of all shapes, sizes, materials and colours; their techniques of manufacture, and their application.

The Society currently holds meetings in London, including lectures/workshops and a 'bead bazaar'. In addition, a Newsletter is circulated to members five times a year.

Further details are obtainable from Carole Morris, Bead Society of Great Britain, 1 Casburn Lane, Burwell, Cambridgeshire, CB5 0ED.

THE JOURNAL OF GEMMOLOGY BACK NUMBERS

A member of the Association has for sale a complete set of *The Journal* from 1972 to 1989, as well as back issues of overseas journals. Enquiries to the Association, Box No. 1713.

CORRIGENDA

On the front inside cover of Vol. 22, No. 3, last line, for '071-404 3344' read '071-404 3334'

On p.163 above, first column, line 4, for 'authords' read 'authors'

On pp.174, 175 and 176 above, below graphs, for 'Wavelength' read 'Wave number'

On p.182 above, first column, line 25, for 'f1565' read 'f750'

On p.183 above, second column, line 18, for 'Wnedell Wilson' read 'Wendell Wilson'

On p.183 above, second column, line 30, for 'megrificent' read 'magnificent'

On p.185 above, first column, line 35, for 'Presidium Duotester' read 'Gem test instruments'

On p.146 and p.190 above, the price shown for the Gemdata - Update 2 should read £90.00 (plus postage and VAT).

Letter to the Editor

From Dr H.A. Hanni, FGA

Dear Sir,

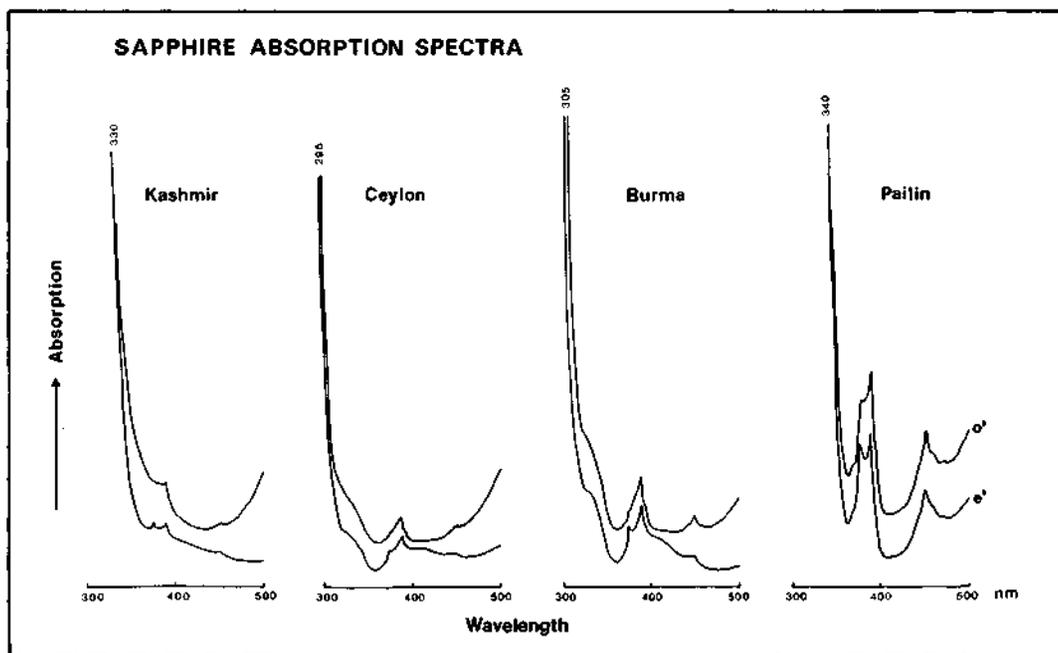
Some readers of my recent 'Contribution to the distinguishing characteristics of sapphire from Kashmir' (*Journal of Gemmology* 1990, 22, 67-75) would have welcomed an absorption spectrum in the publication of the described sapphires. I agree with this proposal and should like to give the following graphs of typical spectra of four different sapphire types. The comparison of them is meaningful concerning origin determination, since each of the four sources expresses its characteristic formation by a more or less typical absorption spectrum.

The graph shows spectra of sapphires from Kashmir, Sri Lanka, Burma and Pailin. The spectra are recorded with a spectrophotometer plus polaroid filters on oriented cut gemstones, thus an ordinary (o') and extraordinary (e') curve was

produced, showing more or less pure o and e vibration spectra.

From left to right they show increasing strength of Fe^{3+} presence, expressed by the peaks at 374, 388 and 450 nm. As well as the Fe^{3+} signal, the position of the cut-off (from 295 to 340 nm) is also of diagnostic value. In addition sapphires from Burma and Ceylon most frequently show a 'lump' at 328 nm, where the absorption is already approaching the cut-off edge.

Not every sapphire from a particular origin shows exactly the same characteristic path of the curve. There is some variation among them, e.g. the cut off may shift up or down some 10 nm. The depicted curves represent thus only mean values. An absorption spectrum from the characteristic part (between 500 and 290 nm) gives us further indications along with others (inclusions, chemistry etc) but cannot



be regarded as an isolated foolproof method.

The spectrum of 'Pailin sapphire' stands for a very large group of sapphire origins, those coming from alkali basalt deposits. It is therefore not typical for a geographic place, but for geological conditions under which basaltic sapphires were formed.

I hope to have satisfied those readers who were interested in additional and somewhat more technical information on sapphire spectra. Understanding this addition helps in that one is now able to differentiate between Kashmir and Pailin sapphires (two types which are often confused with each other). Even with a spectroscope the strength of the 450 nm line allows a safe differentiation.

Yours etc.,
H.A. Hanni

8 July 1990
SSEF Laboratory, Löwenstrasse 17, Zurich,
Switzerland.

ADVERTISING IN THE JOURNAL OF GEMMOLOGY

The Editors of the *Journal* invite advertisements from gemstone and mineral dealers, scientific instrument makers, publishers and others with interests in the gemmological, mineralogical, lapidary and jewellery fields.

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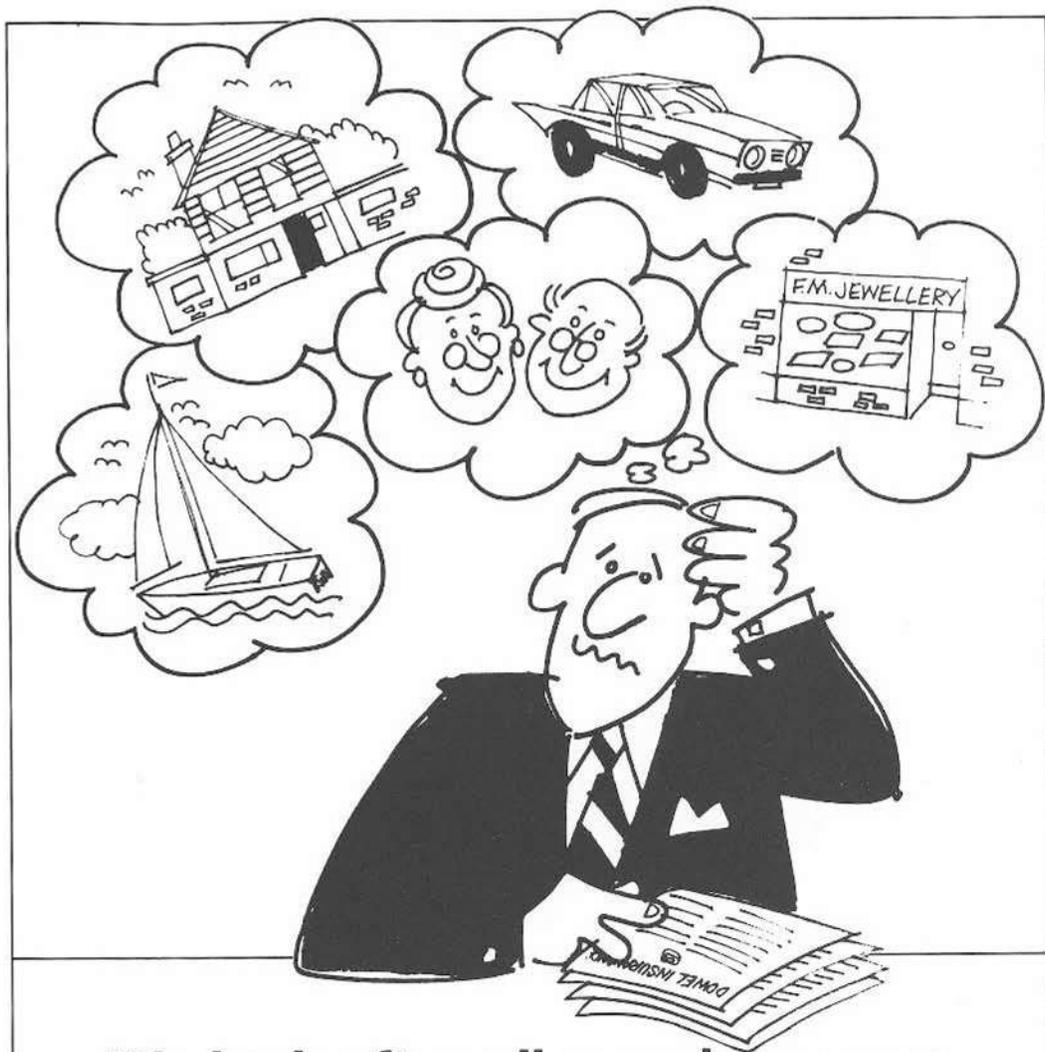
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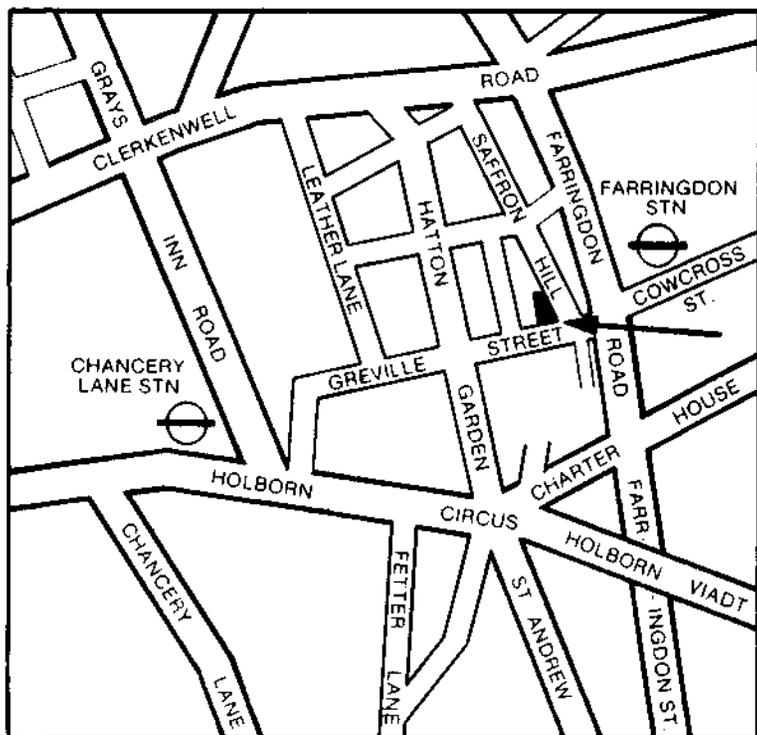
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Contents



Gemstone prospects in Central Nigeria	<i>J. Kanis and R.R. Harding</i>	195
Hematite inclusions in Eonyang amethyst from Korea	<i>Won-Sa Kim</i>	204
Gemmological visual aids	<i>J. Eadie</i>	207
Bead buyers and parcel pickers filter set	<i>R.K. Mitchell</i>	212
Water in beryl – a contribution to the separability of natural and synthetic emeralds by infrared spectroscopy	<i>K. Schmetzer and L. Kiefert</i>	215
Gemmological teaching in Hong Kong and China	<i>J.B. Nelson</i>	224
Detection of synthetic emeralds by thermal conductance	<i>P.G. Read</i>	233
Gemmological Abstracts		235
Book reviews		243
Proceedings of the Gemmological Association and Gem Testing Laboratory of Great Britain and Notices		246
Letter to the Editor		250

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