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THE GEMMOLOGICAL ASSOCIATION AND GEM TESTING LABORATORY OF GREAT BRITAIN

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Cover Picture

Two small secondary synthetic spinel 'satellites' grow from an octahedral face on the main crystal. Magnified 5x. (See 'Gemmological investigation of a synthetic spinel crystal from the Soviet Union' by J.I. Koivula, R.C. Kammerling and E. Fritsch, p.300). *Photomicrograph by John I. Koivula.*

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EXAMINATIONS IN GEMMOLOGY 1991

Refresher Courses

The courses outlined below aim particularly to help gemmology students who will be sitting their Diploma Examinations, but one course also caters for the Preliminary Examinations. The tutorials, which may extend over one, two or three days (as set out below), usually include mock practical examinations. Some courses provide tuition only, whereas others include meals and accommodation.

NATURAL HISTORY MUSEUM

(formerly Geological Museum), South Kensington, London.

6-7 April, 13-14 April, 20-21 April
Tutors: Various GA/GTL lecturers Details: 071-404 3334

GENESIS

Epsom, Surrey

9-10 May, 30-31 May, 6-7 June, 13-14 June
Tutors: Colin Winter, Hilary Taylor Details: 03727 42974 or 071-404 3334

HATTON GARDEN AREA

London

11 June (Preliminary), 12-13 June (Diploma)
Tutors: Michael O'Donoghue, Peter Read Details: R. Huddlestone, 071-404 5004

NELSON GEMMOLOGICAL INSTRUMENTS

Sundays around Easter (provisional)

Tutorials at various venues depending upon demand. Topics include four difficult Cs – crystallography, chemistry, colour and cut.
Tutor: Jamie Nelson Details: 071-435 2282 or 071-435 0331

WEST DEAN COLLEGE

near Chichester, West Sussex

7-9 June (also 2-5 November)
Tutor: Peter Read Details: Sue Overman, 0243 63301

UPTON HALL

Upton, Newark, Notts.

4-5 March, 6-8 March, 4-5 June, 6-7 June
(also 23-24 September, 25-27 September).
Course contents vary – please check.
Meals and accommodation included.
Tutors: Alan Hodgkinson, Pat Daly Details: Carol Moore, 071-387 6611

Examination Dates

The examination dates for 1991 are as follows:

GEM DIAMOND EXAMINATION:

Monday 3 June

EXAMINATIONS IN GEMMOLOGY:

Preliminary – Tuesday 25 June
Diploma Theory – Wednesday 26 June
Diploma Practical – Thursday 27 June
The final date for receiving examination entry forms is 31 March.

Colour as a guide to the composition of scapolite from Burma

A.G. Couper

Department of Mineralogy, British Museum (Natural History), London*

The Pain collection of gemstones (BM 1973, 246-375) from Mogok, Burma, bequeathed to the British Museum (Natural History) in 1973, is remarkable not only for the number of gem-quality mineral species found in such a relatively small area of Burma, but also for the extraordinary range of colour within some of the species or groups. Foremost amongst the latter is the scapolite group which has marialite ($Na_4Al_3Si_9O_{24}Cl$) and meionite ($Ca_4Al_6Si_6O_{24}CO_3$) as its sodium-rich and calcium-rich end-members respectively.

There has always been much confusion surrounding the nomenclature of the scapolite group and in an attempt to simplify the problem the Commission on New Minerals and New Mineral Names of the International Mineralogical Association has approved the following proposals (P. Bayliss, 1987):-

1. The name scapolite should be retained as a group name to encompass minerals in the marialite-meionite series;
2. The names of marialite ($Na_4Al_3Si_9O_{24}Cl$) and meionite ($Ca_4Al_6Si_6O_{24}CO_3$) should be given species status;
3. Dipyre and mizzonite should be regarded as varietal names;
4. Wernerite is synonymous with scapolite and should be discarded.

Intermediate members of the series are given by Strunz (1970) as dipyre ($Ma_8Me_2 - Ma_5Me_5$) and mizzonite ($Ma_5Me_5 - Ma_2Me_8$). Gemmologists, however, tend to use only the end-member names, marialite for scapolites with Na>Ca (in atom per cent) and meionite for those with Ca>Na (in atom per cent) (Dunn *et al.*, 1978).

While accumulating data to be used when cataloguing the twelve Pain collection scapolite gemstones (BM 1973, 364-375), it became apparent that when they were listed in order of either increasing refractive index, n_o, (1.544-1.588) or specific gravity (2.60-2.72), they were arranged also in colour groups with dark-blue specimens having the lowest values and grey and colourless specimens the highest. In between were groups of mauve, pink, yellow, greenish-yellow and beige stones in order of increasing refractive index and specific gravity. Scapolite with such a range of colour has not been found at any other locality.

As a general rule the density of scapolite increases with the meionite content, but it can be used only as a rough guide to composition. Prediction of the meionite percentage from optical parameters is still the best and quickest procedure, according to Ulbrich (1973), and the claim is made that estimation from the refractive index n_o regression line (Ulbrich 1973, Figure 2 and equations 5-6, Table 4) is accurate within ± 5 per cent meionite at the 95 per cent confidence interval.

The 0.044 difference between the highest and lowest values of n_o (the refractive index n_o should be used preferentially over the average refractive index n_m (Ulbrich 1973)) indicates a considerable variance in composition between the colourless and the dark blue scapolite from Burma. The fact that the composition of scapolite varies widely was noted by Dunn *et al.*, (1978) when describing gem scapolites from world-wide localities. Among the specimens used for that study were three from Burma and one of them, G 3674, is described as pink with 30 per cent meionite content and having a refractive index n_o = 1.558; a second specimen, R 11157, is light yellow and has 57 per cent meionite content; the third specimen, G 3783, is colourless with 72 per cent meionite content and a refractive index, n_o = 1.587, but elsewhere in that paper the same specimen is described as light yellow. This may be a printing error or, as has been found in this present study, some otherwise colourless or grey material appears to have a very faint yellow tinge.

In order to obtain refractive indices of as many Burmese scapolites as possible, five more stones in the BM(NH) collection were examined and three from a private (A.J.) collection. The records of fourteen stones in the former Institute of Geological Sciences gem collection provided additional data, although in the case of the cabochon-cut stones

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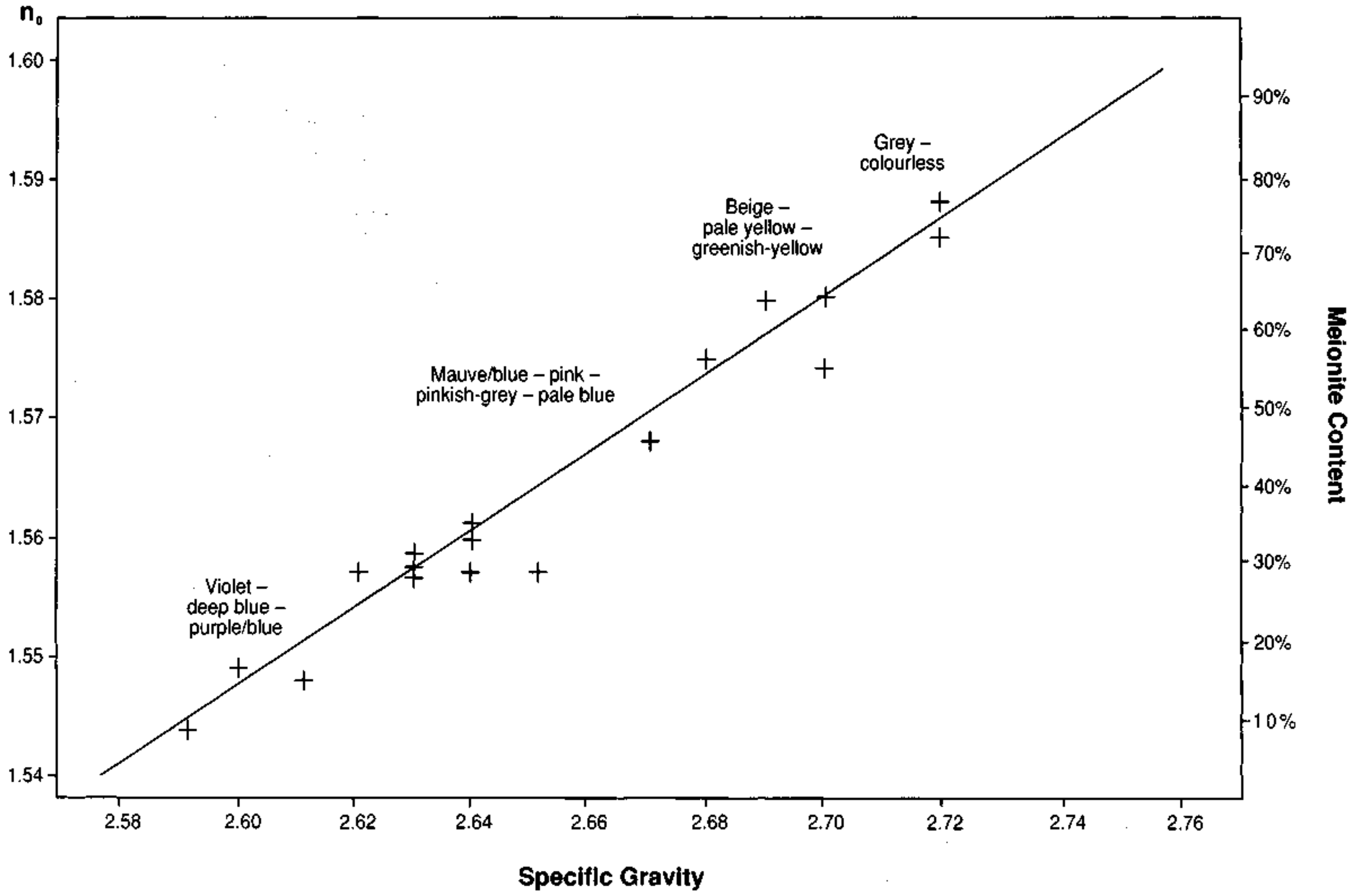

Fig. 1. Gem scapolite from Burma. Refractive index, n_o, and meionite content plotted against specific gravity. Colour of stones has been added.

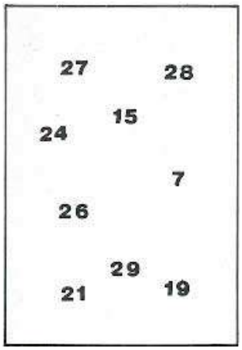

Fig. 2. A series of chatoyant scapolites from Burma. The key numbers relate to Table 1. *Photo Alan Jobbins.*

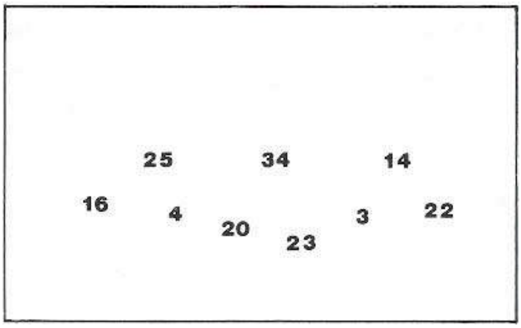

Fig. 3. A series of faceted scapolites from Burma. The key numbers relate to Table 1. *Photo Alan Jobbins.*

both refractive indices could not readily be determined. The refractive indices of the large cabochon-cut stones in the BM(NH) collection were obtained by scraping a very small amount of powder from around the girdle and measuring in sodium light using mixtures of paraffin oil and α-monobromonaphthalene as immersion media, the values of which were checked on a Bellingham and Stanley refractometer. Faceted stones were measured on a Rayner refractometer in sodium light and, in the case of the small cabochon-cut stones, a 'rough' measurement was obtained on a Rayner refractometer using the 'distant vision' or 'spot' method described by Lester Benson (1948). The specific gravities of the seventeen BM(NH) stones and the three from the private (A.J.) collection were obtained by weighing them in ethylene dibromide and correcting for temperature.

The thirty-four scapolite stones from Burma used in this study are listed (Table I) in order of increasing specific gravity, together with their colour and refractive indices if known. As it has been shown by Ulbrich (1973) that a close estimation of meionite percentage in scapolite can be made from the refractive index n_o, these two values (per cent meionite and n_o) have been related using the regression line calculated by Ulbrich (1973) Figure 2, and plotted against specific gravity (Figure 1). A scale showing the colours of the stones has been introduced to show the apparent relationship with

TABLE 1: Colours and optical data of some gem scapolites from Burma listed in order of specific gravity.

					S.G.	n_o	n_e
1.	MI 35774	Faceted	Violet	Burma (?)	2.59	1.544	1.538
2.	BM.1973,374	Cabochon	Deep-blue	Mogok	2.60	1.55*	
3.	MI 35519	Faceted	Purple-blue	Burma	2.60	1.549	1.539
4.	BM.1973,370	Faceted	Deep-blue	Mogok	2.61	1.548	1.538
5.	BM.1973,375	Cabochon	Deep-blue	Mogok	2.61	1.55*	
6.	BM.1966,296	Cabochon	Pink	Mogok	2.62	1.557	1.543
7.	MI 28939	Cabochon	Pink	Mogok	2.63	—	—
8.	BM.1973,367	Cabochon	Pink	Mogok	2.63	1.55*	
9.	BM.1933,97	Cabochon	Pinkish-grey	Mogok	2.63	1.558	1.543
10.	BM.1912,684	Cabochon	Pink	Mogok	2.63	1.557	1.546
11.	AJ.O.1792	Cabochon	Pale-pink	Mogok	2.63	1.56*	
12.	AJ.O.2952	Cabochon	Mauvish-blue	Mogok	2.63	1.56*	
13.	BM.1966,295	Cabochon	Pink	Mogok	2.63	1.557	1.545
14.	BM.1973,368	Faceted	Pink	Mogok	2.63	1.559	1.543
15.	MI 35518	Cabochon	Pink	Burma	2.63	—	—
16.	MI 35522	Faceted	Pale-pink	Burma	2.63	1.557	1.542
17.	BM.1973,366	Cabochon	Pinkish-grey	Mogok	2.64	1.56*	
18.	BM.1912,683	Cabochon	Pink	Mogok	2.64	1.560	1.546
19.	MI 28940	Cabochon	Pink	Mogok	2.64	—	—
20.	MI 30205	Faceted	Pink	Mogok	2.64	1.557	1.540
21.	MI 30211	Cabochon	Blue	Mogok	2.64	—	—
22.	MI 35521	Faceted	Pink	Burma	2.64	1.561	1.544
23.	MI 35520	Faceted	Pale-blue	Burma	2.65	1.557	1.541
24.	MI 35524	Cabochon	Pale greyish-green	Burma	2.67	—	—
25.	BM.1973,369	Faceted	Pink	Mogok	2.67	1.568	1.545
26.	MI 28938	Cabochon	White	Mogok	2.68	—	—
27.	MI 30206	Cabochon	Pale-buff	Mogok	2.68	—	—
28.	BM.1973,372	Cabochon	Pale-yellow	Mogok	2.68	1.575	—
29.	BM.1973,373	Cabochon	Greenish-yellow	Mogok	2.69	1.580	—
30.	BM.1973,365	Cabochon	Beige	Mogok	2.70	1.574	1.552
31.	BM.1973,364	Faceted	Colourless	Mogok	2.70	1.580	1.550
32.	BM.1973,371	Cabochon	Grey	Mogok	2.72	1.588	—
33.	AJ.1.6908	Rough	Colourless	Mogok	2.72	1.588	1.557
34.	MI 31629	Faceted	Colourless	Burma	2.72	1.585	1.554

*Obtained by 'distant vision' method.

'MI' numbers refer to specimens in the collection of the Institute of Geological Sciences (IGS).

composition. Optical values obtained by the 'distant vision' method have not been used in the preparation of this graph.

It is interesting to note that the colours, refractive indices and composition of the three Burma scapolites used by Dunn *et al.* (1978) and referred to above, fit comfortably on to the graph (Figure 1). The wide range of composition of Burmese material shown by Dunn *et al.* (1978) to be from 30 per cent meionite for the pink stone, to 72 per cent meionite for the colourless stone, now appears from this study to be even greater, with the meionite content estimated to be 10-17 per cent for the group of violet, deep-blue and purplish-blue stones and 72-76 per cent for the group of grey and colourless stones. It must be noted, however, that there is some doubt about the locality of IGS 35774, the violet stone with the lowest estimated meionite content at 10 per cent, but it is thought most likely to come from Burma. The largest group consists mainly of pink stones with a few pale-blue or mauve amongst them and their estimated meionite content ranges from 30 to 35 per cent. Apart from a lone pink stone at about 45 per cent meionite there is a large gap from about 35 to 55 per cent meionite when blue disappears as a background colour and yellow appears to be the main influence in the body colour of the stones. From about 55 to 65 per cent meionite the stones are beige, pale-yellow, greenish-yellow and an almost colourless stone with a very faint yellow tinge. The next group on Figure 1 is at 72 to 76 per cent meionite and consists of a grey stone, with a very faint hint of yellow, and a colourless stone.

This study has shown that by using the refractive index, n_o, to estimate the meionite content of eight of the Pain scapolites, and then using colour and specific gravity as guides in the case of the remaining four, it is possible to classify the dark-blue scapolite as marialite, the pink as marialite (variety dipyre) and the pale-yellow, greenish-yellow, beige, grey and colourless stones as meionite (variety mizzonite).

Acknowledgements:

The author is indebted to Alan Jobbins for the loan of three stones from his private collection.

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'Machingwe': A new emerald deposit in Zimbabwe

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Abstract

Geological and gemmological details of a promising new emerald deposit in the Mweza Range Greenstone Belt of southern Zimbabwe are discussed and compared with data from Sandawana and other nearby emerald deposits.

Introduction

In May 1987 the first author was fortunate enough to have the opportunity to pay a short visit to a newly discovered emerald occurrence in Zimbabwe, named 'Machingwe deposit', thanks to the kind permission granted by the owner, Mr C.C. Chigumba, and with the assistance of the Mineral Marketing Corporation of Zimbabwe. This Corporation is a state controlled department based in Harare. It channels, on a non-profit basis, all gemstone and mineral sales from producers to world markets. The Corporation also acts as an advisory body to the small operator.

Geotectonic setting

With the exception of Palaeozoic mountain belts along the northwestern and southern margins, the African continental crust developed during the Precambrian. The major structural units of central and southern Africa can be subdivided into two cratonic blocks that were stabilized since middle Proterozoic times (about 1100 Ma) and are separated from each other by the so-called Pan-African Mobile Belts (Damara, Zambezi and Mozambique Mobile Belts – about 550 Ma in age). Within the cratons several older Archaean cratons occur, with ages of 2500 Ma and older, of which the Rhodesian Craton (Figure 1) is of special importance in the present study.

The Rhodesian Craton stabilized at about 2550 Ma; it is surrounded by the Zambezi and Mozambique Mobile Belts in the north and east respectively, and the Early Proterozoic Limpopo Mobile Belt (about 1850 Ma) in the south. The cratonic basement consists of older gneisses, a variety of schist belts, better known as Greenstone Belts, and younger (gneissic) granites and pegmatites.

The Greenstone Belts are elongated or irregular shaped bodies of steeply dipping, (partly) tightly folded, generally schistose rocks. Their length may reach a few hundred kilometres.

Geology of the Zimbabwean Greenstone Belts

Stratigraphically the Zimbabwean greenstone formations can be subdivided into three divisions, respectively the Sebakwian, Bulawayan (2700-2600 Ma) and Shamvaian Supergroups. They are composed of ultramafic, mafic to felsic intrusive and volcanic rocks, such as peridotites, basalts (pillow lavas), andesites and rhyolites, with intercalations of sedimentary rocks (conglomerates, pelite, banded iron formation, limestones, etc.).

The older Sebakwian and to a lesser extent the Bulawayan are mainly volcanic deposits with intercalations of meta-sedimentary rocks, while the younger Shamvaian Supergroup is largely represented by metamorphic clastic deposits. These volcano-sedimentary deposits seem to have covered large areas of the Archaean crust.

The Zimbabwean and other greenstone formations in the world have been intensively investigated (see Windley, 1977). With respect to the stratigraphy, volcanic geochemistry and structural appearance they are remarkably similar. Furthermore they are always surrounded by older gneisses and younger, partly intrusive, granitoid plutons, and nearby high-grade metamorphic terrains.

The Zimbabwean Archaean basement rocks underwent a low-grade regional metamorphism. The (ultra)mafic rocks recrystallized into upper-greenschist facies to lower amphibolite facies 'greenstones'. Current rock-types of the Greenstone Belts are serpentinites, talc schists, chlorite schists, tremolite-chlorite schists, hornblende schists, phyllites and quartz-mica schists.

Specific higher-temperature exceptions occur near the contacts with the younger granites and the large number of pegmatitic off-shoots. In these environments, especially at the contacts with the ultramafic schists, pegmatoid impregnations under

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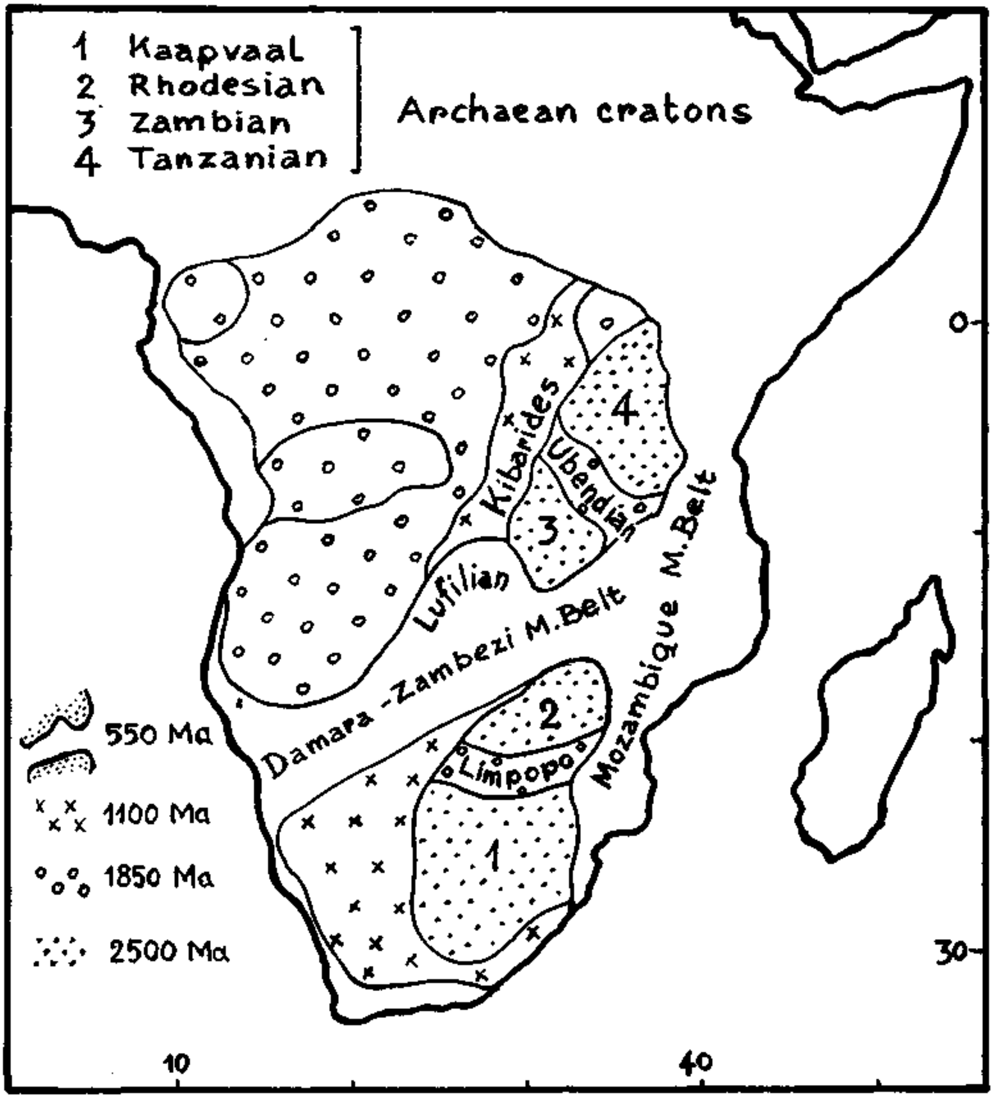

Fig. 1. Distribution of the Precambrian geotectonic units in central and southern Africa.

high pressure (pneumatolitic) were responsible for restricted but intense contact-metasomatic reactions altering the ultramafic rocks into biotite and biotite-phlogopite schists. A similar lithology has been reported from other emerald-producing areas (Martin, 1962; Sliwa & Nguluwe, 1984; Schwarz & Eidt, 1989).

The formation of phlogopite took place according to the mineral reactions (1) alkali feldspar + serpentine = phlogopite + talc + water, and (2) alkali feldspar + talc = phlogopite + quartz, while the appearance of biotite instead of, or, in addition to phlogopite depended on the original iron content of the ultrabasic rock (Schwarz & Eidt, 1989).

The mafic and ultramafic rocks of greenstone belts are well known suppliers of mineral ores containing the economically important elements like chromium, cobalt, nickel, copper, zinc, silver, gold, manganese and iron. In earlier days greenstone belts were called 'gold belts'.

Chromium and nickel are mainly restricted to the ultramafic rocks, i.e. serpentinites and talc schists (Martin, 1962; Windley, 1977; Metson & Taylor, 1977). This fact, in combination with extensive intrusions of beryllium-bearing pegmatites, has in several places lead to the fortuitous crystallization of emeralds at, or adjacent to, the contacts of the pegmatitic impregnations with the greenstones.

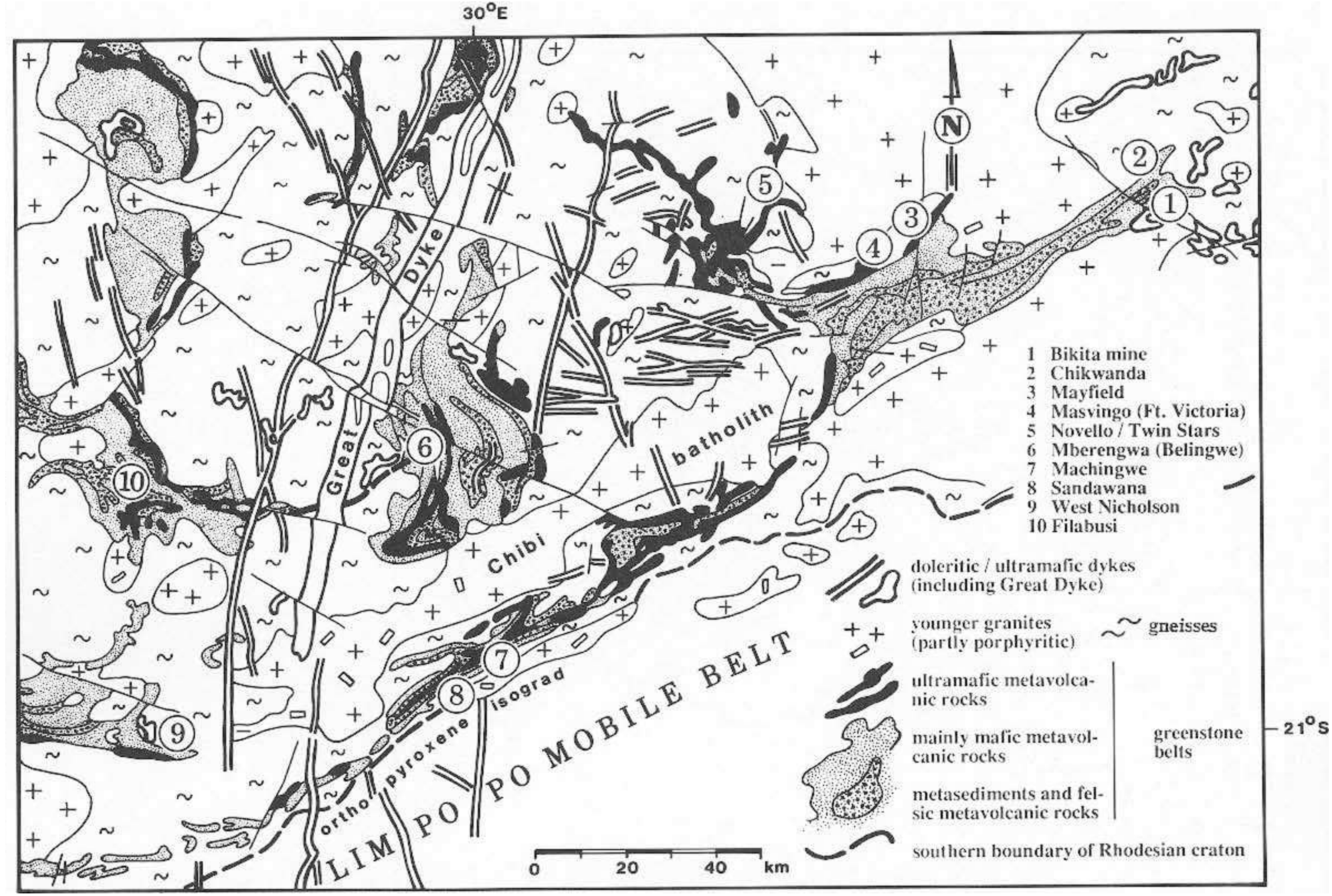

Fig. 2. Geological map of the southern part of the 'Rhodesian' craton adjacent to the Limpopo mobile belt (Derived from the Provisional Geological Map of Rhodesia, 1971, and the Provisional Map of the Granitic Rocks of the Rhodesian Craton, A.E. Phaup, 1971).

Fig. 3. The hills of the Mweza Range Greenstone Belt covered by dense bush; a bulldozer has been operating near the No.3 shaft (1987).

The geological sketchmap of Figure 2 shows the southern part of the Rhodesian Craton in juxtaposition with the high-grade Limpopo Mobile Belt. Both units are separated by the 'pyroxene isograd', which is arbitrarily the northern boundary of the Limpopo Mobile Belt.

A striking feature on the map, southwest of Masvingo (previously Fort Victoria) and very close to the southern contact, is a narrow NE-SW trending 140 km long belt. This is the Mweza (Range) Greenstone Belt, consisting of volcano-sedimentary deposits belonging to the Bulawayan Supergroup, more or less adjacent to the elongated Chibi granite batholith.

The emerald occurrences

In May 1957 (Böhmke, 1982) the renowned Sandawana emerald deposit was discovered. Since then a number of other minor emerald occurrences have been discovered within the southern part of the Rhodesian Craton, such as the localities Novello, Twin Star, Chikwanda, Mayfield, Popoteke and Renders in the Masvingo Greenstone Belt and Mustard and others in the Filabusi Greenstone Belt (Anderson, 1976, 1978; Martin, 1963).

The most important emerald discovery to date, however, since the Sandawana emeralds on the Zeus claims, is a new occurrence approximately 12 km NE of the Sandawana mine, along the Mweza Range, which is named 'Machingwe' mine, after a nearby stream.

The presence of emerald in the Mweza Range Greenstone Belt is connected with the pegmatitic intrusions derived from the younger Chibi granite batholith. The metasomatic rocks at the contact of the pegmatoids and the (ultra)mafic rocks, i.e. the biotite and biotite-phlogopite schists, are the main host-rocks of the emeralds. But, as a result of contamination of the pegmatoid material, this gemstone is also present in the adjacent pegmatite.

The Machingwe Emerald mine

The car journey from Masvingo to the Mashingwe mine takes about 3½ hours. The first 135 km is a well-kept tarred road, passing various important asbestos mines exploited in the serpentinites of the Zvishavana (Shabani) district. Thereafter, the journey has to be continued over a 55 km very rough gravel road and only 4-wheel drive vehicles will be able to pass.

The vegetation of the Mweza Range greenstone hills is quite dense (Figure 3) and in sharp contrast to the surrounding almost barren granitic rocks with thorny bushes and little grass.

Amphibolite schists are the predominant rock-type on the Machingwe claims and various pegmatites, aplites, quartz-feldspar and feldspar veins and quartz stringers have intruded these amphibolites. Emerald is present in the schists as well as in the felsic rocks (Figure 4).

The first emeralds of the Machingwe stream area were found in December 1984 and the official name for the mine became 'Machingwe Syndicate No.2 Mine', but is better known under the name Machingwe mine.

At the time of the first author's visit to the mine the No.1 shaft was sunk on a 3m wide N-S striking, steeply dipping pegmatite (Figure 5) to a depth of 21m where the water table was struck. Just above this level is a 15m long adit.

Approximately 150m NW of the No.1 shaft is the No.2 or 'Mahonde' shaft with a depth of 15m. The near vertical pegmatite mined here is about 2m wide and is striking E-W. This well-developed pegmatite has a number of interesting apophyses which are emerald-bearing (Figure 6). A further 60m E of the No.2 shaft is the vertical No.3 shaft, where the same pegmatite is mined, which has widened here to 3½m and is dipping slightly south. The emerald production came mainly from the No.3 shaft. Also the first emeralds found in the area were discovered in the same place where later on the No.3 shaft was sunk.

Apart from producing ore from the three prospecting shafts, all mining has been carried out by open cast method. Two bulldozers were clearing the overburden and waste rock. Not only was the mining based on very simple methods at the time the mine was visited, but also the plant and the treatment of the emerald-bearing rock was very basic. A small screening trommel was the only mechanized equipment while all other work was done by hand.

The emerald potential of this occurrence, however, appears to be large and the fact that the nearby Sandawana mine, after more than thirty years, still produces emeralds of good quality, even at their deepest level of 150m, makes the Machingwe mine even more interesting as the geological conditions are likely to be similar.

In the past beryl was a very important strategic mineral, and Zimbabwe was the world's second

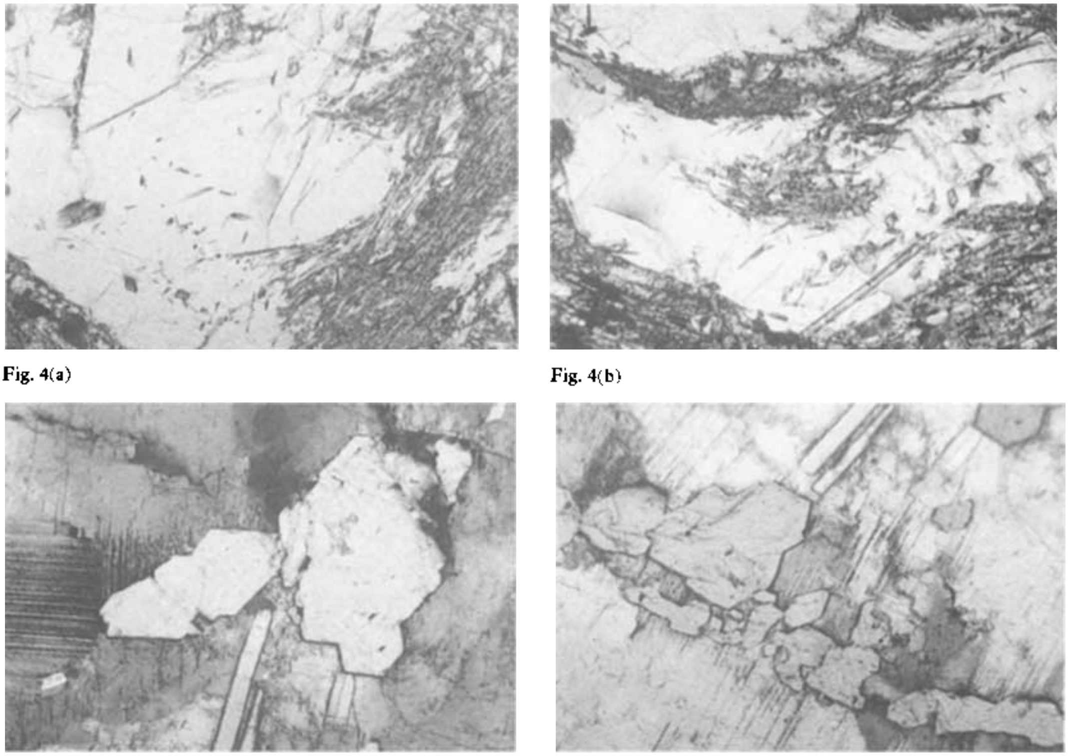

Fig. 4(a)

Fig. 4(b)

Fig. 4(c)

Fig. 4(d)

Fig. 4. Thin-section photomicrographs of emerald-bearing amphibolitic schist (a) and (b) and pegmatite (c) and (d). Note the presence of actinolitic inclusions in the metablastic emeralds of the amphibolite in contrast to the inclusion-free euhedral emerald crystals of the pegmatite.

Fig. 5. A 15m long adit in emerald-bearing pegmatite near the No.1 shaft (1987).

Fig. 6. Large emerald crystals, above coin, in pegmatite apophysis near the No.3 shaft. The adjacent altered zone consists of serpentinite, biotite-, tremolite-, and talc schists.

Fig. 7. Parcel containing small emerald crystal fragments. Mag. 2x.

largest producer with beryl occurring in many localities. This circumstance, combined with the fact that specific rock-types of the many Greenstone Belts are chromium-bearing, makes it very possible that further emerald discoveries of note may yet be made in Zimbabwe.

Properties of the Machingwe emeralds

The colour hue of the Machingwe emerald is a superb emerald green, including the smallest 'pinhead' sizes, and their brilliance is magnificent, very similar to the Sandawana emeralds. Most emeralds are rather small, broken pieces (Figure 7). Well-developed crystals were only seen in the fine grain-sizes.

The largest faceted and very clean Machingwe emerald was just under 5 carats in weight. The bulk of the faceted stones is, however, under one carat. Good quality cabochon cut emeralds occur in much larger sizes.

The chemical composition of a pale green and a deep green emerald sample of Machingwe mine was analysed by atomic absorption spectrometry (AAS) and inductively coupled plasma spectrometry (ICPS) methods. The results are listed in Table 1. The chemical data from two Sandawana emerald samples have been added. The latter results, however, were obtained by different methods in different periods and should therefore be evaluated with care.

The most noticeable differences with the Sandawana material are the contents of chromium, beryllium and iron. Part of magnesium, sodium and lithium should be attributed to the influence of inclusions (Böhmke, 1982).

The refractive indices and densities of a number of Machingwe emeralds were determined, giving the following (average) results:

N_e 1.584-1.586 and N_o 1.589-1.593 (eleven samples)
birefringence 0.006-0.008
density 2.761 g/cm^3 (eight samples)

A number of refractive index measuremens of the Machingwe emeralds have been put together with the data from other Zimbabwean emeralds in a diagram (Figure 8) as was previously published by Anderson (1978).

Although a deep red colour under the Chelsea colour filter was to be expected, it turned out to be a dull red, and not really very bright. This may be due to a lower chromium content and a higher iron content than emeralds from Sandawana (see Table 1).

Under ultra-violet light the emeralds are bright green; the short wave conditions of a lesser intensity, better described as greenish only.

The absorption spectrum is very distinct. Chromium lines in the red and a strong band in the yellow-green part of the spectrum, particularly in the samples with the finest colours, are easily seen, even with the simplest hand spectroscope.

Table 1: Quantitative geochemical analyses of African emeralds.

	'Machingwe' 1	'Machingwe' 2	Sandawana 3	Sandawana 4	Miku 5
SiO_2	67.42	67.11	65.00	63.84	62.23
Al_2O_3	13.60	12.81	15.50	18.06	15.41
Fe total	0.76	0.86	0.50	0.30	0.11
MgO	2.65	3.00	3.00	0.75	0.76
MnO			—	—	0.02
CaO	0.05	0.05	—	—	0.31
Na_2O	2.21	2.28	2.00	2.03	2.63
K_2O	0.04	0.03	—	0.05	2.89
Li_2O			0.15	0.10	—
BeO	11.24	11.88	13.60	13.28	11.90
Cr_2O_3			0.50	0.60	0.33
Cs_2O	0.04	0.04	—	—	—
H_2O+	—	—	—	1.07	2.59
H_2O-	—	—	—	—	0.06
Total	98.01	98.06	100.25	100.08	99.24
Sr	6.0	4.0			
Ti	39.0	32.0			
Co	113.0	111.0			
Mn	173.0	286.0			
P	61.0	48.0			
V	192.0	213.0			
Zn	66.0	49.0			
Li	730.0	637.0			
Ni	30.0	38.0			
Cr	1800.0	3970.0			

Main elements are in Wt.%, trace elements in ppm.
Nos. 1 and 2: resp. green and deep green emeralds from 'Machingwe', analysis by ICP (Induced Coupled Plasma) and AAS (Atomic Absorption Spectrometry) methods, Analytical Geochemical Lab. (analyst: Mrs. Ir. T.G. Djie-Kwee), Inst. Earth Sci., State University at Utrecht, The Netherlands;
No. 3: emerald from Sandawana, data from Böhmke, 1982, modified after Gübelin, 1958;
No. 4: emerald from Chingachura, near Sandawana, wet-chemical, spectrographic and flame photometric methods, data from Martin, 1962;
No. 5: emerald from Miku (Kafubu area, Zambia), data from Sliwa & Nguluwe, 1984.

The properties of the emeralds present in the felsic rocks or the schists are slightly different with respect to colour, i.e. chromium content, and inclusions.

As a general rule the Machingwe emeralds within the pegmatites are of a lighter green hue than the

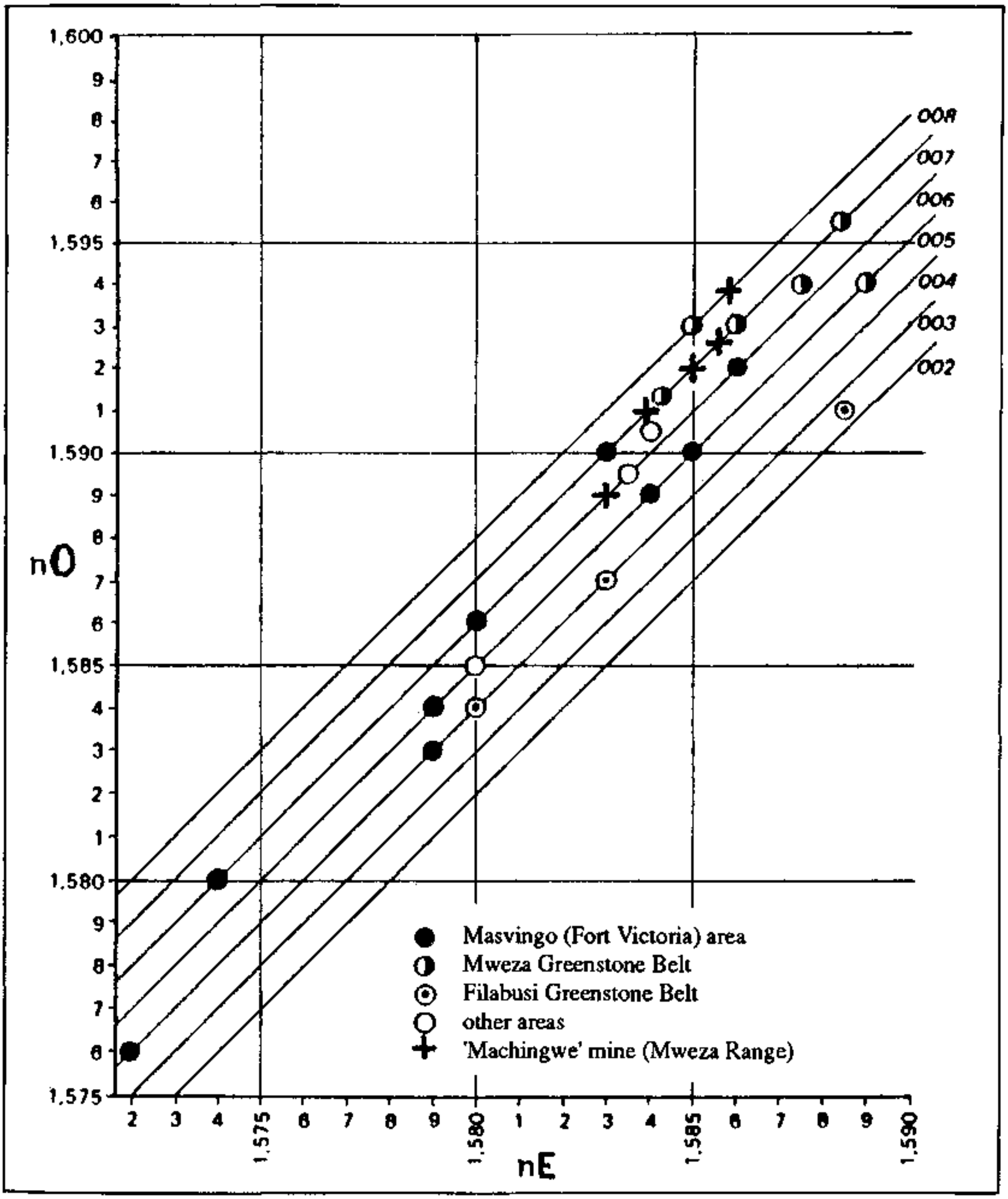

Fig. 8. Refractive indices and birefringence of Zimbabwean emeralds. Data from Anderson, 1978, and the present study.

poikiloblast-type in the adjacent (ultra)mafic rock of the altered zone.

On the other hand the pegmatite emeralds are relatively free of inclusions, in contrast to the emeralds from the altered zone. Microscopic investigation of the inclusions reveals (Figure 9), as expected, a great similarity to the Sandawana emeralds, which is demonstrated by an abundance of actinolite/tremolite needles, or at least long prismatic pale yellowish to brownish crystals of some member of the amphibole group, either clustered together as well as individual crystals pointed in different directions.

In some of the specimens flake-like inclusions can be seen, very likely consisting of colourless to light brown, distinctly pleochroic mica.

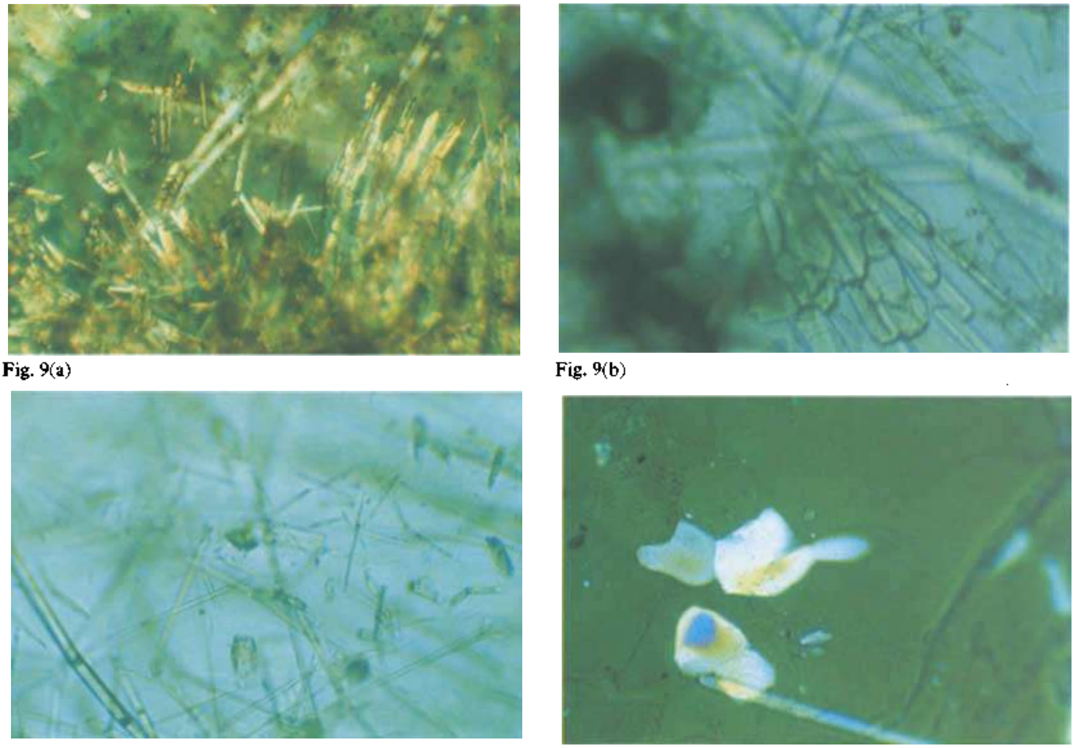

Fig. 9(a)

Fig. 9(b)

Fig. 9(c)

Fig. 9(d)

Fig. 9. Typical inclusions in emeralds from the 'Machingwe' mine: actinolite/tremolite needles either (a) densely accumulated (crossed nicols), (b) radially oriented or (c) at random; (d) fine needle with some mica flakes (crossed nicols).

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Crystallized and massive rose quartz deposits in Brazil

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Abstract

Brazilian rose quartz originates from granitic pegmatites which produce the bulk of massive rose quartz and the whole of the crystallized rose quartz. Other occurrences (eluvial, coluvial and alluvial) are almost insignificant.

The massive rose quartz pegmatites belong to a zoned type characterized by a blocky zone with giant crystals of quartz and K-feldspar, but without sodic substitution. Associated minerals are: schorl, cassiterite, niobotantalite, beryl (with scarce pale aquamarine), some phosphate minerals and, locally, weathered spodumene. The massive rose quartz makes up the whole or part of the core and/or joins together the K-feldspars of the blocky zone. The deposits are: Pé da Chapada, Córrego Piabanha, Olho d'Água, Boqueirão and Fazenda São Jorge (State of Minas Gerais), Córrego do Lodo, Ribeirão do Largo and Fazenda Conceição (State of Bahia), Borracha (State of Pernambuco) and Alto Feio (State of Paraíba). Geology, mining, mineralogy and production of each deposit is briefly quoted. Many occurrences of massive rose quartz in pegmatites are scattered in eastern Brazil.

The crystallized rose quartz pegmatites belong to a very differentiated type, frequently gem tourmaline-bearing with important Na substitution bodies. Associated minerals are: albite, muscovite, niobotantalite, beryl and locally typical phosphate minerals: eosphorite, wardite, roscherite, etc.

The deposits of crystallized rose quartz are concentrated in Minas Gerais State: Jequitinhonha valley near the towns of Araçuaí and Itinga (Lavra da Ilha, Laranjeira) and Rio Doce basin (Alto da Pitora). Seven small occurrences are also reported. The crystallized rose quartz belongs to a late stage of the pegmatite evolution. It is frequently found in vugs, perched upon quartz, feldspar or mica, and occurs single or in clusters, rosettes, crowns or irregular groups, rarely as sceptre. Prominent characteristics which allow us to recognize the origin of many specimens are emphasized.

Gemmological properties of rose quartz are reported.

Introduction

Less common than the other varieties of crystal quartz is the pink coloured crystallized and massive rose quartz, of which Brazil is probably, to date, the greatest producer. Our intention is to describe briefly the larger Brazilian deposits and occurrences of this gemstone.

Massive or crystallized Brazilian rose quartz originates from granitic pegmatites. Its occurrences may be classified as follows: pegmatites where the aforementioned mineral is extracted from the rocks; coluvium and eluvium above and in the neighbourhood of the pegmatites, and nearby alluvium. The first type produces the bulk of massive rose quartz, and the whole of the crystallized rose quartz. However it must be pointed out that rose quartz-bearing pegmatites belong to two types which are clearly distinct one from the other: massive rose quartz-bearing pegmatites without other associated gems (or some clear aquamarine) and crystallized rose quartz-bearing pegmatites, common producers of gem tourmalines. Using the textural-paragenetic evolution scheme of Vlasov (1952), supplemented by the knowledge of the Brazilian gem deposits (Cassedanne, in press), it is easy to mark the two models referred to above. The massive rose quartz-bearing pegmatites belong to a common and unique type, almost without substitution and with giant crystals, whereas the crystallized rose quartz-bearing pegmatites occur near the end of the pegmatitic evolution trend. The latter is Na-rich whereas the K-feldspar prevails in the first one.

In order to exemplify the above basic principles, the most important rose quartz deposit will be described. Other occurrences and deposits will then be listed. The last section will deal with crystallized rose quartz occurrences.

Massive rose quartz: The Alto Feio deposit

It is located in the State of Paraíba, 230 kilometres to the nortwest of the city of Recife, near a small town called Pedra Lavrada, and near the boundary between the States of Paraíba and Rio Grande do Norte. The region is located in a bush covered high plain and belongs to the Seridó Group (Seridó Formation, 1,570-1,100 million years (Ma)), made of biotite garnet schists which were intruded by several granites, mainly of the Brazilian tectonic cycle (about 500 Ma).

The deposit trends ENE-WSW, is a lenticular pegmatite, outcropping in a low EW hill, with an

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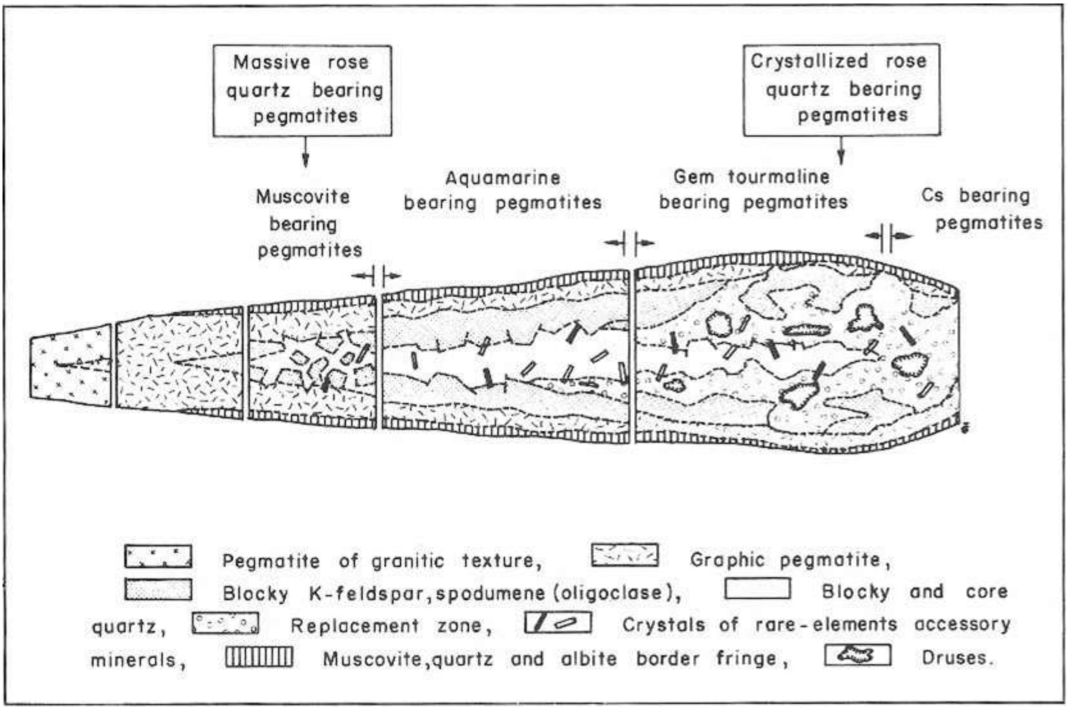

Fig. 1. Location of rose quartz-bearing pegmatites in a schematic section of different textural-paragenetic pegmatite types (Vlasov, 1952 – modified).

area of 500 × 80 metres (20,600 square metres after Almeida, 1946). The pegmatite lies between a fine grained rose coloured granite in the south and biotite garnet schists in the north. The deposit, discovered in 1928 was intensively worked on for beryl and tantalite during World War II and thereafter sporadically quarried, for the recovery of K-feldspar and rose quartz. The following zones succeed one another from the wall rock to the core:

– A few centimetres to a few decimetres thick band of fine grained mica,

– A centimetre grained pegmatite zone, with granitic texture and large prisms of schorl,

– A blocky zone with albite and quartz and giant crystals of K-feldspar, some of which reach up to 100 tons in weight. The area covers 6,800 square metres and massive rose quartz commonly surrounds the giant crystals,

– A lenticular core.

Minerals associated with the rose quartz: several decimetres long, milky to translucent quartz crystals, morion, citrine, muscovite, lepidolite, beryl (with some clear aquamarine), schorl (with very cracked blue and green uncommon tourmaline), garnet, zircon, manganese and iron phospates (predominantly heterosite), niobotantalite, uraninite, bismuth and bismutite and uncommon pyrite, chalcopyrite, chalcocite and covellite. Mining is by way of irregular quarries, the older ones having caved in. The larger excavations in development are in the west and the east of the pegmatite. Reserves are not available but very likely amount to several thousands of tons (Cassedanne & Cassedanne, 1978).

Rose quartz, always xenomorphic, occurs as irregular masses reaching up to tens of tons in weight, with a variable network of fissures, either surrounding giant K-feldspar crystals or in several metres long lenses in the core of the pegmatite. The colour varies from vivid pink to milky or a very light pinkish, in several hues, but never reaches intense colours. The rose quartz is transparent, translucent, misty or opalescent. An almost regular banding is common, due to very milky strips, a few millimetres thick, rich in minute two-phase inclusions. On exposure to sun light the colour of the rose quartz fades comparatively quickly: specimens of the dumps mined some years ago turned milky as happened to the front of many houses within the neighbourhood of the mine, houses previously adorned during their erection with small pieces of rose quartz. The masses of the latter are fractured and locally, iron and manganese oxides invade the fissures, resulting sometimes in fine dendritic specimens. Microscopic veils and two-phase inclusions are common in the rose quartz which exhales a

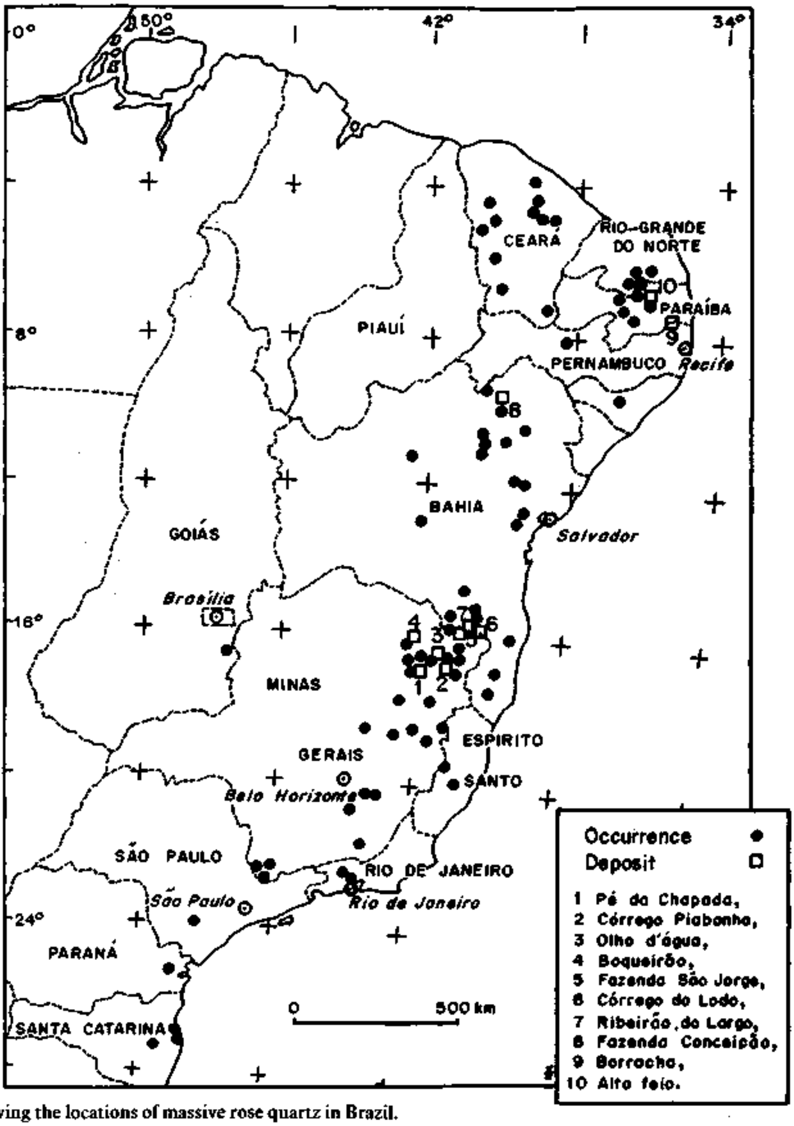

Fig. 2. Map showing the locations of massive rose quartz in Brazil.

fetid H_2S odour when broken. Its physical properties are classical. Some examples exhibit asterism after proper cutting.

Rose quartz from the Alto Feio is used for ornamental purposes (mainly ground and wall covering) and carving, sorted blocks of tens of kilograms being commonly extracted. Translucent homogeneous 'eyes' are always small.

Other massive rose quartz deposits

Besides the deposits, hereunder described, where the size of its concentration allows economic working, the massive rose quartz is a minor constituent of many Brazilian granitic pegmatites. It is found from Santa Catarina in the south to the Ceará in the north, mainly in the "Eastern pegmatitic Province" that obliquely crosses the east of Minas Gerais and enters into Espirito Santo and southern Bahia States, as well in the "Borborema pegmatitic Province" which overlaps the States of Paraíba and Rio Grande do Norte. The rose quartz is disseminated or in masses variable in size but is almost always small, with light colour. This scattering explains the many quotations found in the literature. The localities frequently reported without more information, particularly by Ferraz (1929), Leonardos (1936), Calmbach (1938) and Mendes (1973 & 1975) are plotted on the map.

In the mineralized pegmatites the rose quartz makes up the whole or part of the core and/or joins together with K-feldspar crystals of the blocky zone. The thickness of the core, lens or string-shaped, varies from a few metres to more than 15; its length locally reaches up to 300 metres. In the core of the pegmatites occurs an heterogeneous mixture of massive rose and milky quartz chunks haphazardly located and sized and sometimes heavily fractured. Associated minerals inside the rose quartz are rare: mainly schorl in needles or in scattered large prisms near the contact between the core and the blocky zone of the pegmatite. Unweathered, faded quartz cores remain as long walls above the plains of the Borborema region.

In the blocky zone, the rose quartz is also mixed with the milky one and welds the giant K-feldspar crystals. It occurs generally unmixed, rarely associated with some druses of quartz, a little schorl and/or beryl. The mineralogy of rose quartz-bearing pegmatites is always simple: quartz, K-feldspar, sometimes albite, biotite, schorl, muscovite and some beryl, niobotantalite and apatite or spodumene, practically without collectors' specimens.

Mining in all deposits is by way of rudimentary quarrying. Blast holes are almost always manually bored, very rarely using a pneumatic drill. After blasting, sorting takes place with the use of a sledge-hammer for the large blocks and a light-hammer for the small good coloured pieces and for translucent eyes. Output is stock-piled until it is transported, frequently with a short intermediate horse stage as far as the nearby road suitable for trucking. Translucent eyes are withdrawn daily from the deposit. Morion and window quartz crystals are by-products in some places.

At present the Brazilian massive rose quartz production occurs in four States: Minas Gerais, Bahia, Pernambuco and Paraíba. The deposits (plotted with a number on the map) are described hereunder from South to North.

Pé da Chapada

(= Santana, Lagoão). The Pé da Chapada deposit began production in 1987 and is located 20 kilometres north-west of Caraí, on the right bank of the São Joãozinho creek. It is a N70°E running and 70°NW or vertical dipping pegmatite of which the wall rock is a fine grained grey granite. Various

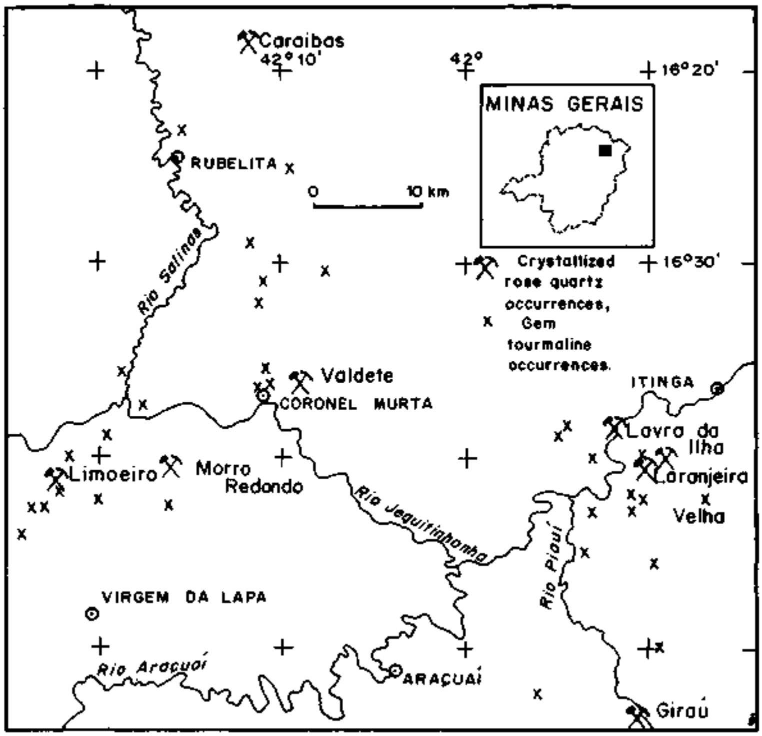

Fig. 3. Map showing the occurrences of crystallized rose quartz in Minas Gerais, Brazil.

Fig. 4. Lavra do Bianor (Minas Gerais). View of the quarry with the massive rose quartz core in the foreground.

small quarries are located all along the pegmatite, about 50 metres in length. The core is string-shaped, 0 to 2.5 metres wide. The rose quartz is of good medium colour with some chunks almost pinkish-red and sub-translucent. The relative lack of fissures allows the recovery of blocks several tens of kilograms in weight. Associated minerals are: schorl, morion, window quartz crystals (= quartz à fenêtre or jacaré) with some biotite, hematite, muscovite and scarce aquamarine. In the south a thick eluvium was worked out: production exceeded 400 tons.

Córrego Piabanha

(= Lavra Schupp). This deposit, known more than 100 years ago, 14 kilometres South of Joaima, produces, as regards colour, the best rose quartz in Brazil. The mine operates a NS running, subvertical, zoned pegmatite containing a large core in the south and many giant crystals in the north. The mining takes place within three large quarries, one of which is more than 30 metres in height. The width of the pegmatite reaches 16 metres and its length 300 metres. K-feldspar crystals of more than a metre long are surrounded by rose quartz that also occurs in irregular masses of several tons in weight. Hues, banding and fissures vary in the deposit. The most common colour is bright pink, almost reddish-pink. The quartz is translucent to almost transparent or milky sometimes with an incipient banding. Also NS fissures parcel out the core, many of them are sealed and allow the recovery of large blocks. Sorting is manual, the darker specimens commonly being small in size. Dumped fragments, more than 50 years old, do not show any fading. Schorl, bottle-green apatite and large weathered lathes of spodumene are associated. Production figures are unknown but exceed two thousand tons (Cassedanne, 1981).

Olho d'Água

(= Ilha Alegre, Lavra do Bianor). Located 25 kilometres east north-east of Itaobim, on the left bank of the Jequitinhonha river, this N50°E running, vertical pegmatite with giant crystals, is 15 to 20 metres wide and known along 60 metres in length. The wall rock is a fine grey granite. The rose quartz occurs in the core and between the feldspar crystals; it is massive, homogeneous or with little banding and large translucent eyes. Recovery should be 60% run of mine quartz. Actual production exceeds 300 tons. More than 0.8 metre long schorl prisms are found in the rose quartz with which are associated: bluish-white beryl, biotite and some columbite. Some vugs are coated with long grey to milky quartz crystals. This deposit as well as that of Pé da Chapada are currently the main producers in Minas Gerais State.

Fig. 5. Alto Feio (Paraíba). Giant K-feldspar crystal, 3 m in height, surrounded by massive rose quartz of the blocky zone.

Boqueirão

(= Zé de Tônia, Cóbico and Cubículo). In the neighbourhood of Salinas, it is a N50-60°E running, highly SE dipping pegmatite which reaches 25 metres in thickness and 100 metres in length. Wall rock is a grey granite. Mining is by way of a 25 metres high quarry and several adits. In the string-shaped core, the rose quartz is highly fissured and banded and only blasted for the recovery of translucent eyes. The sorted monthly production amounts to some tens of kilograms. The sorted pieces are commonly walnut to fist size. Associated minerals are: a little beryl, columbite, biotite, amethyst, hematite, schorl and quartz crystals with clay inclusions.

Fazenda São Jorge

(= Veredinha, Boqueirão). In the south southwest of Vitória da Conquista, near the boundary between the Minas Gerais and Bahia States, this deposit is an EW running, 30-40°S dipping well zoned pegmatite with a width of 8 to 10 metres, mined along a length of 120 metres. The wall rock is a highly dipping micaschist. Many irregular lenses and chunks of fetid rose quartz are scattered in the core of the pegmatite, with a parallel banding either to the dip or to the fissures that transect the core. 30% of the blasted quartz would be suitable for sale, with non-fading medium colour. Production probably exceeds 1000 tons. Irregular schorl crystals concentrations occur in the deposit.

Fig. 6. Lavra do Bianor (Minas Gerais). Large schorl crystal in quartz. Length of the ball-pen: 14 cm.

Fig. 7. Alto Feio (Paraíba). Massive rose quartz, with light banding in the central quarry. Length of the ball-pen: 15 cm.

Fig. 9. Córrego Piabanha (Minas Gerais). Sorted translucent dark pink quartz.

Fig. 10. Alto Feio (Paraíba). Massive medium rose quartz ready for shipping.

Córrego do Lodo

(= Fazenda Mangerona). 23 kilometres to the south south-west of Macarani, near the boundary between Bahia and Minas Gerais States, this deposit, found in 1957, is a NS20°E running, 60°W dipping, 8 metres wide pegmatite, known along a length of 40 metres. Working was by way of a quarry 25 metres high. Rose quartz occurs in the core and surrounding giant K-feldspar crystals. Colour is medium good with a recovery of 60% from the blasted ore. Several hundreds of tons were produced before temporary abandonment. Several decimetres long lathes of biotite, large twinned muscovite flakes, schorl, window quartz crystals and some beryl are associated with the rose quartz.

Ribeirão do Largo

(= Quartzo róseo). 30 kilometres south south-west of Itambé, this deposit is an N50°E running, vertical, a few metres wide pegmatite known along a length 50 metres. Rose quartz is scattered into the string-shaped core of milky quartz, and fades after some years of exposure to sunlight. A little schorl is associated. Production should exceed 200 tons.

Fazenda Conceição

(= Flamengo). North north-east of Jaguarari and 13 kilometres from the Flamengo railway halt, this deposit is an N20°W running, 25°SW dipping, 6 to 8 metres wide pegmatite. Working is by way of a 30 × 15 metres quarry, 10 metres in height. Rose quartz occurs between giant K-feldspars of the blocky zone which is surrounded by a thick granitic zone with large graphic texture. The fetid rose quartz, with low fracturing is of good medium colour with white strips and grey patches. Large schorl crystals and a small amount of beryl and muscovite are associated. Several hundreds of tons were produced before the present flooding of the quarry.

Borracha

(= Sitio Novo). North-west of Nazaré da Mata, near the boundary of the Paraíba State, this recently discovered deposit, located in a small creek, is made of blocks and large boulders. These outcrop in an ellipsoidal EW area 50 × 30 metres in size, probably resulting from a pegmatite not yet unearthed by erosion. The fetid rose quartz, with a medium good colour shows white and grey chunks, some banded and some almost reddish-pink translucent zones. Production exceeds 150 tons.

Before concluding it must be pointed out that production from the deposits formed by the decomposition of pegmatites is low to very low. The eluvium that covers some pegmatites allows the local mining of from some tens and up to one hundred tons of massive rose quartz, as in the Pé da Chapada deposit. Here the rose quartz occurs as blocks and little rounded boulders reaching up to 1 cubic metre in volume. They generally are partly sunk into the soil and the regolith. Working is always easy. With the creeping action, the blocks run downwards, sometimes accumulating upon a flat of the hill slopes, downstream of the pegmatite (Córrego do Lodo colluvial occurrence, for instance), before reaching the bottom of the nearby creeks. A little rose quartz was produced from isolated or scattered blocks sunk in gem-bearing alluvium, worked either for chrysoberyl (Córrego do Fogo, north of Minas Gerais State) or for aquamarine (Malacosta, Espirito Santo State). However, these occurrences compared with pegmatite deposits are almost insignificant.

Crystallized rose quartz deposits

In contrast to the massive quartz deposits, the deposits of crystallized rose quartz are generally concentrated in the Minas Gerais State; the bulk lying in the Jequitinhonha valley near the towns of Araçuaí and Itinga. A few others belong to the Rio Doce basin and are located south-east of Governador Valadares.

Previously some good specimens of crystallized rose quartz were recovered during mining of the Sapucaia pegmatite, near Galiléia. In 1969, the discovery of the deposit known as "Lavra da Ilha" made the region of Itinga and Araçuaí a very famous place worldwide due to the abundance of crystallized rose quartz. Besides this there is always easy access for collectors and museums in arranging samples of rose quartz material. Here, the specimens are preserved for mineralogical purposes or used 'in natura' – in their natural state for mounting in modern jewellery.

The main producers, which are the deposits of Lavra da Ilha, Laranjeira and Alto da Pitora, will be described briefly hereunder and the other occurrences listed (see detailed map). Prominent characteristics which allow us to recognize the origin of many specimens presently found in the mineral market will be emphasized.

Lavra da Ilha

The deposit is located 40 kilometres west south-west of Itaobim on an island of the Jequitinhonha River, dry only during low-water stage, that is to say from June to October. The island, located on the right side of the river is approximately 500 metres in length at an elevation of 250 metres.

There is a heterogeneous pegmatite partially covered by unsorted alluvium, striking 40°E, dipping vertically, with a wall rock of quartz micaschist. Workings have uncovered the pegmatite in an

Fig. 8. Lavra do Bianor (Minas Gerais). Sorting massive rose quartz using a sledge-hammer.

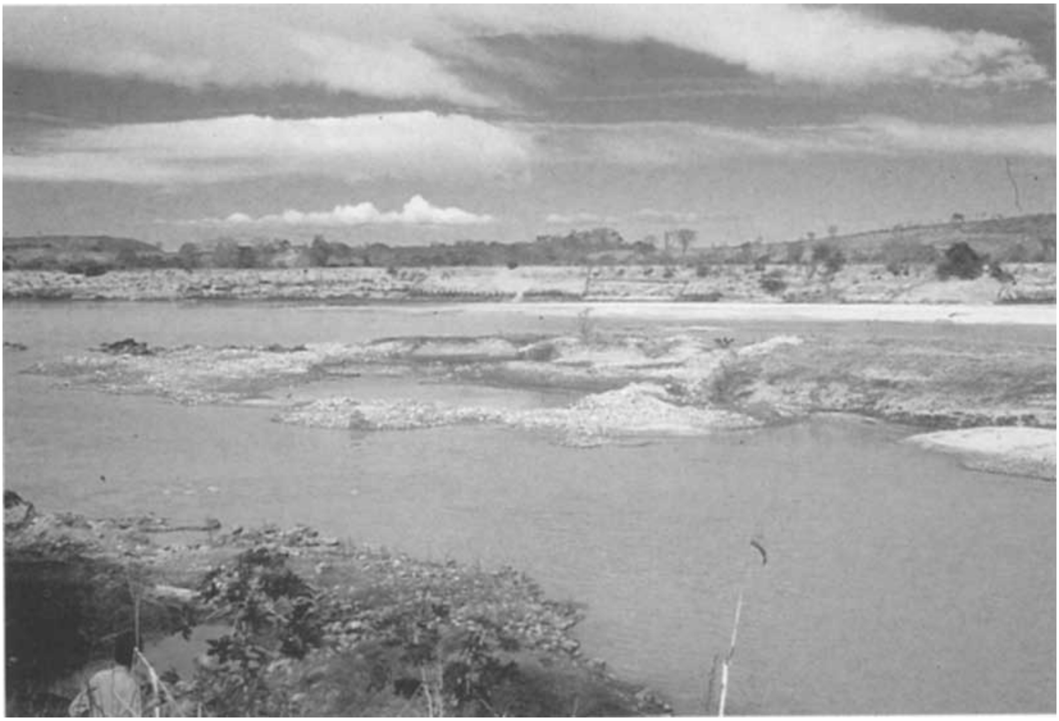

Fig. 11. Lavra do Ilha (Minas Gerais). The quarry, located near the end of the island flooded by the Jequitinhonha river (July 1989).

irregular quarry 50 × 10 metres in extent, 15 metres deep, which is flooded and sand-covered during every annual inundation. The pegmatite, of medium grain size is composed essentially of muscovite with feldspar on both sides of the quartz core, with sodic replacement bodies and small vugs in the vicinity of the core, where crystallized rose quartz is found. Associated minerals within the deposit are: pale green diamond-shaped muscovite, fine groups of sphalerite crystals, niobotantalite, cassiterite and milky beryl. The phosphate minerals are abundant: gem amblygonite, eosphorite, roscherite, rockbridgeite, montgomeryite, wardite, whiterite, collinsite, apatite and vivianite, resulting in part from the weathering of the triphyllite, many of them being excellent collectable specimens (Cassedanne & Cassedanne, 1973).

The crystallized rose quartz belongs to a late state in the pegmatite evolution. Colour ranges from light purplish-pink to light pinkish-white. The crystals vary from translucent to quite transparent or opalescent and their faces are occasionally striated or show growth figures. Variation of shades in one crystal is very rare. The matrix of the rose quartz crystals is generally milky or translucent automorphic or sheared quartz of the first stage. A thin film of chalcedony is common between the two types of quartz. Less frequently the matrix is composed of other minerals. The rose quartz stands as a quite regular coating upon the matrix, but more often it is in radial clusters and parallel or interpenetrated aggregate crystals passing through transparent to rose colour. The most spectacular specimens are those which are occurring as a crown of doubly terminated individuals around a white or translucent quartz crystal of decimetre size. The sizes of the individual crystals vary from a few millimetres to two centimetres with one or two terminations. The association with clusters of eosphorite (predominant), roscherite, wardite and/or apatite allows the quick recognition of the source of specimens coming from this deposit.

Fig. 12. Alto da Pitora (Minas Gerais). Small clusters of crystallized rose quartz. The sceptre is 1.5 cm long.

Laranjeira Velha

(= Ademar). This deposit is located in the neighbourhood of the Lavra da Ilha. It lies in the Laranjeira creek, a right hand tributary of the Jequitinhonha river. Workings started in early 1979 at the top of a small hill, where many excavations irregularly scattered in a subcircular-shaped area (approximately 600 metres in diameter) were dug in search for gem tourmaline. In May of 1979, a deeper pit reached the unexpected pegmatite, covered by the eluvium. The pegmatite runs NW-SE with a northeastern dip of 20°, a width of some metres and an approximate extension of 100 metres. It is zoned with large grain size. Near the core there are irregular vugs that contain crystallized rose quartz, with cleavelandite, gem tourmaline and translucent quartz crystals with stepped faces. Size and shape of these vugs are variable but may reach up to one metre in length. Associated minerals are: amblygonite, lepidolite, beryl, spodumene, cassiterite, niobotantalite, arsenopyrite and, as phosphate minerals: frondelite, heterosite, moraesite, phosphosiderite, cyrilovite and wardite (Cassedanne & Cassedanne, 1980).

The rose quartz occurs either as a partial or whole crown around the quartz crystals that may be transparent or milky, sometimes fetid when broken, and additionally, it may fill up the interstices between the translucent quartz crystals. Crowns are the most spectacular specimens. Their axis of symmetry may be the same as that of the supporting quartz or they may be undulating. Some specimens display a cluster of crystals lying upon a face of a milky quartz crystal; this may resemble the 'quartz flowers' which occur in the amethyst region of southern Brazil. Small crowns of crystallized rose quartz around tourmaline prisms are also known to occur, being outstandingly beautiful specimens. The crowns are made of interpenetrating small prisms and rhombohedrons with their axes subparallel or divergent to the surface: the result is dazzling. Growth figures on the crystal faces are common as repeated 'sceptre' forms. A thin coating of powdery white quartz sporadically covers the rose quartz groups. Colours range from light pink to purplish-pink, reminding one of the famous samples from the Sapucaia mine in the same State. The crystals are transparent to translucent with, on the whole, a relatively homogeneous coloration. However, light variation of shade may be observed with a lens.

Black or greenish-blue to water-green elbaite, sometimes with chatoyancy, is commonly associated with the rose quartz; but crystallized phosphate minerals never occur. This observation permits easy distinction from the samples produced at the Lavra da Ilha pegmatite.

Fig. 14. Laranjeira (Minas Gerais). Crown of crystallized rose quartz around a grey transparent quartz crystal upon a matrix of K-feldspar and tourmaline.

The other occurrences in the tourmaline-bearng area are of little or no importance. They include:

Caraíbas

(= Mariano Dias). Near the Rubilita town, this pegmatite has produced some light coloured crystallized rose quartz samples, associated with green gem tourmaline.

Valdete

A few crystallized rose quartz specimens were produced in this pegmatite located near Coronel Murta. The main specimen features remind one of those of the Laranjeira samples. Millimetric sized pyrite crystals and purplish apatite are scattered upon the rose quartz.

Limoeiro

Famous for its gems, years ago (Cassedanne & Lowell, 1982), this deposit produced in July 1989 groups of crystallized rose quartz perched upon grey quartz crystals with a milky shell, associated with diamond shaped light yellow muscovite plates. Some crowns around milky quartz crystals, several centimetres in diameter, were also recovered.

Morro Redondo

In the south of Barra da Salina, very good examples of crystallized rose quartz were recovered in an old gem tourmaline occurrence called Morro Redondo. The recent reopening unearthed fine large crystallized rose quartz crowns around doubly terminated translucent quartz crystals which reach up to 25 centimetres in length.

Laranjeira

A rich green and blue gem tourmaline eluvium with clusters and rosettes of good crystallized rose quartz was discovered in December 1989, 2 kilometres north north-east of the Laranjeira Velha deposit. Below the eluvium more than 20 prospect adits cross the sub-horizontal, N70°E running pegmatite.

Giraú

In the upper Piauí creek, this thin pegmatite produced in 1988 a few tens of kilograms of good well coloured, crystallized rose quartz specimens. The crystals, frequently doubly terminated occur as crowns and rosettes perched upon or around gem tourmaline prisms of an outstanding green or blue colour. Phosphate minerals are unknown here.

In the Rio Doce valley, the *Sapucaia* pegmatite mine is of historic interest. East south-east of Governador Valadares, this lens-shaped deposit 100 × 40 metres in size, vertical, well zoned, was a great producer of beryl and mica during World War II. Its mineralogy is very complex having many phosphate minerals. A small quantity of rosettes, crowns and chalice-shaped deep pink crystallized rose quartz specimens were recovered during mining activities in the 1940 and 1950 decades.

Alto da Pitora

The crystallized rose quartz production begun in the first days of 1989 in this deposit, an old gem tourmaline producer, from an extensive eluvium. The deposit, located 50 kilometres east south-east of Governador Valadares, north-east of Galiléia, on the northern slope of the Serra da Pitora range, is an almost vertical dipping, NE-SW running pegmatite, with a wall rock of coarse granite with lens-shaped micaschist xenoliths. The pegmatite is 1.5 to 5 metres wide, zoned, medium grained with a straight central blocky zone made of large K-feldspars, several decimetres long, spodumene lathes and grey and milky quartz. Parallel fissures with either gently NE or 20°SE dips cut the pegmatite and are frequently associated with small elongated vugs that contain milky quartz crystals, hydrothermalized K-feldspar and late albite, with some muscovite, upon which rose quartz crystals are perched. Other less common associated minerals are; schorl, late sericite and chlorite, cassiterite, niobotantalite, pyrite, amblygonite, beryl and rare lepidolite. Iron and manganese oxides are widespread and stain many specimens. Working is by way of twenty or so adits along the pegmatite, some of them reaching up to 80 metres in length, with irregular rooms and pits. Adits explore the pegmatite about 300 metres in extension and 60 metres in height. C. Vasconcelos, from Governador Valadares, assures us that approximately 1,000 kilograms of crystallized rose quartz were produced until October 1989 with 100 kilograms of superior quality and 100 of very good colour.

The rose quartz crystals occur in clusters, in groups of sub-parallel prisms, isolated (single) or sometimes in crowns around quartz crystals; it is commonly similar to that previously reported in the other deposits. Irregular and repeated variations of sections along the *c* axis are common as are growth figures on the faces; small perfect sceptre specimens also occur. Many samples starting as hexagonal prisms end with several terminations due to the change into parallel smaller crystals during a late development stage. Variations of shade from transparent to pink are common in the samples. Sometimes clusters of small sericite plates are scattered upon the rose quartz.

The lack of phosphate minerals and tourmaline is typical of the Pitora specimens, which are frequently free of matrix.

Gemmological properties

In the deposits the rose quartz varies from strong rose-pink to almost white, it is always cloudy or fissured and never entirely clean, although some material may be found which is sufficiently clear and translucent or almost transparent to cut into faceted stones. However, the material is mainly used for ornamental purposes as production of figurines, house or ground facing, ash trays, book ends, eggs, spheres, cabochons, beads and small carved objects. Material from some deposits fades after long exposure to light or sun.

Despite the fact that much of the material may be marred by cracks, the density of the rose quartz

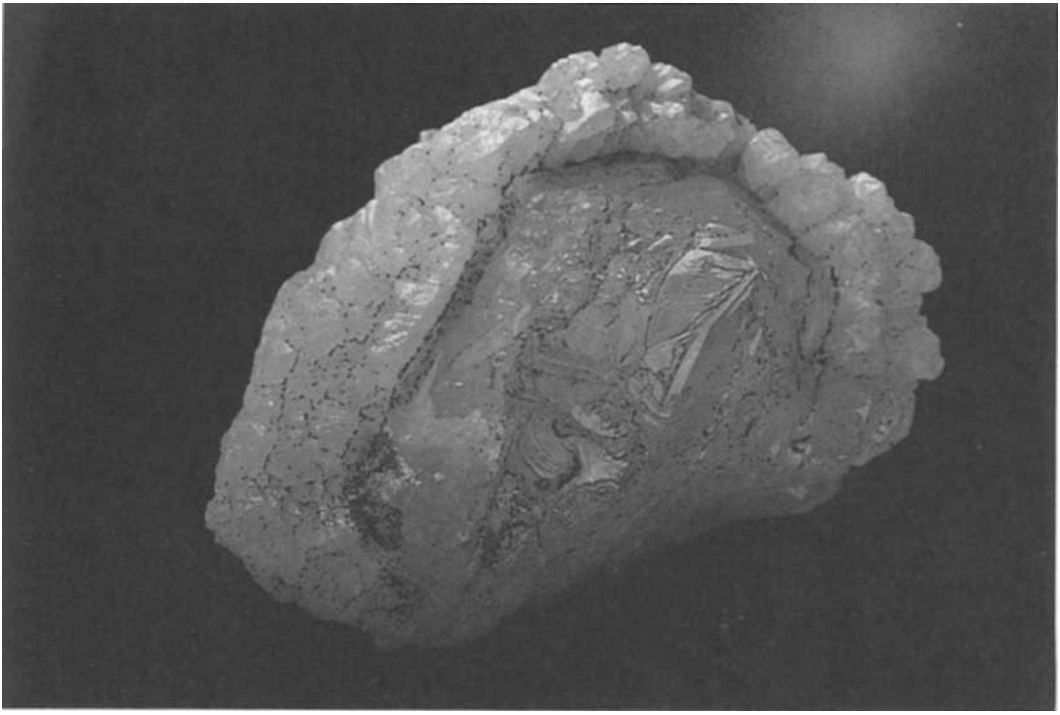

Fig. 13. Lavra da Ilha (Minas Gerais). Crown of crystallized rose quartz around a grey translucent quartz crystal, without matrix (sample collected in 1969). Length of the specimen: 17 cm.

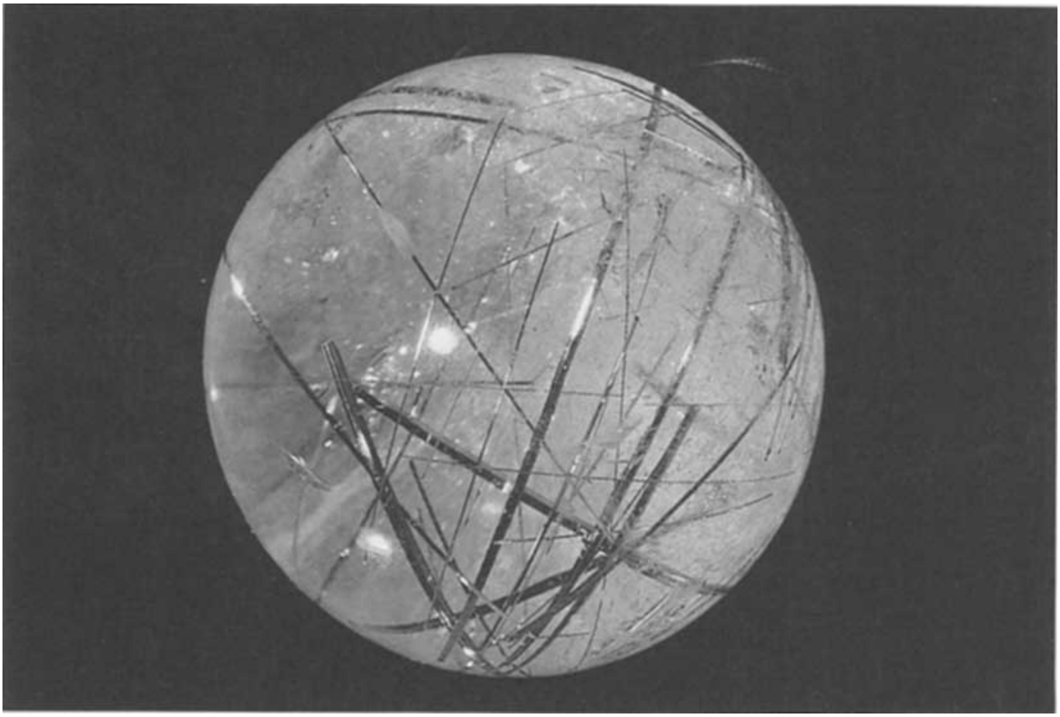

Fig. 15. Rose quartz cabochon with tourmaline needles.

does not vary very much from rock crystal (2.65). Acid, heat and shock resistant (when not heavily fissured), the rose quartz crystal has a conchoidal fracture.

The refractive indices are very constant too and have the values of 1.544 for the ordinary ray and 1.553 for the extraordinary ray. The sign of refraction is, therefore positive and the birefringence is 0.009. Rose quartz shows a fairly strong pleochroism in the deep coloured material (dark pink/light pink), but the effect disappears greatly from the paler material and in the very pale material little or no dichroism can be observed. Rose quartz may be almost translucent, cloudy, nearly opaque or almost transparent, rarely opalescent with a vitreous lustre and shows little fire. The value of dispersion between the B and G interval is only 0.013 (Webster, 1970). There is no distinctive absorption spectrum and rose quartz shows a very little luminescence under ultraviolet light. There is no radioactivity. On heating the pink colour vanishes at about 575°C.

Much rose quartz contains microscopic needles of rutile oriented in definite crystal directions in the host crystal. These needles produce, by a diasterism phenomenon a star effect when the stone is viewed in the correct direction at a source of light. Star rose quartz is sometimes cut as round beads and spheres that reveal a six or twelve-sided star.

Centimetre long rutile or tourmaline needles are not rare in massive rose quartz; this material is used for cutting cabochons, beads, spheres and small figurines. In the fractures, iron and manganese oxides occur frequently as dendrites and allow the cut of unusual cabochons.

Internally, microscopic two-phase inclusions, milky veils, small secondary healing fractures and fissures with or without iridescence are the most common imperfections.

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Suggestions for photographing jewellery

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Abstract

Jewellery photography presents special problems with lighting, depth of field, and background. We conclude that difficulties in these areas are best dealt with by (1) choosing size, colour, and magnification of backgrounds that are appropriate for the purpose to which the photograph is to be used, (2) selecting a technique that maximizes depth of field, if depth of field is needed, (3) using as many lights as possible to emphasize reflectable colour, transmittable colour, and background colour, (4) having on hand mirrors, magic markers, tape, plasticine, and pieces of pseudo-suede, and (5) designing formats that are artistically pleasing and as original as possible.

Introduction

The purpose of this paper is to help you to take better pictures and, by increasing your knowledge, improve the standard of jewellery photography in general. Light, depth of field, background, and special effects are discussed.

Light

There are four principal sources of light for photography of jewellery: sun, light boxes, electronic flash, and incandescent light (Blaker, 1965a; Mineo, 1966; Feininger, 1976; Grossman, 1981). Sunlight is excellent, but if too bright, will cast harsh shadows. These can be softened or removed by using small mirrors cut from sheets of reflective plastic vinyl. When held in place by tape to objects, such as film spools, they can direct additional light where it is needed. By painting the surfaces of the mirrors with a black magic marker to leave only small unexposed areas, small spots of light can be delivered precisely as desired. In the field a small piece of plasticine behind a piece of jewellery can elevate it above the background so that the background will be out of focus. A word of caution: since colour values are at their best at mid-day and shift to red and blue values in the early morning and late evening respectively, pictures should be taken at mid-day if possible.

The second choice of light is a light box. Light boxes use a circular or rectangular fluorescent tube around the upper inner surface of a metal frame. They can be bought in a variety of sizes and come with instructions on how to correct colour for use with daylight film. Usually a magenta colour correction filter is needed to prevent an unpleasant greenish tint. Light boxes are portable, cast virtually no shadows, and can be used with different backgrounds. Their major disadvantage is that they can occasionally produce unwanted highlights on polished surfaces especially beads and rounded objects. However, carved pieces of stone, even though highly polished, can usually be satisfactorily photographed. The method, furthermore, avoids hot spots produced by other techniques. With light boxes, backgrounds can be placed under them and kept out of focus by photographing jewellery on supported non-reflecting glass. In this way coloured backgrounds do not reflect upon the jewellery itself and shadows are not cast.

A third light source is electronic flash. Electronic flash can produce harsh shadows like bright sunlight. These can be made less harsh by using a soft box. A soft box is a collapsible structure which diffuses light and is designed to fit over a flash gun head. It is made of fabric, weighs little, and comes in a variety of sizes. Small ones are useful when working in the field. In the studio they are unnecessary since inexpensive sheets of mylar can be used in front of the lights or flash guns. If backlighting is employed, the shadows produced in front of photographed objects can be reduced with light reflected from reflectors made of metallic cloth, foil, or white card (Figure 1).

The fourth choice is incandescent lighting, usually tungsten and or halogen. In most instances, powerful incandescent lamps are unsatisfactory for photographing jewellery especially jewellery that has specular reflections, be they from metal or gemstones. They should not be used close to the subject, since they tend to produce a flat appearance. Lighting is better controlled with multiple small sources such as fibre-optic wands. The latter can be positioned to direct light in almost any

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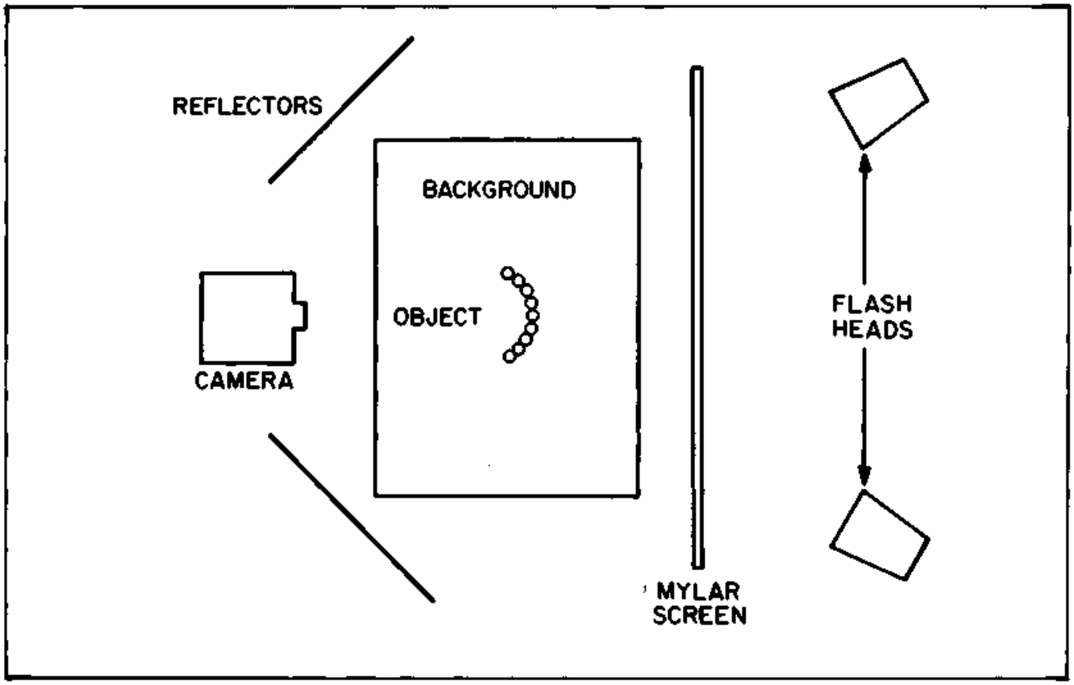

Fig. 1. Backlighting provides a background of varied intensity and highlights that are on the upper rim of the subject and not on the surfaces of interest. To soften frontal shadows, light should be diffused at the source and then reflected onto the subject being photographed.

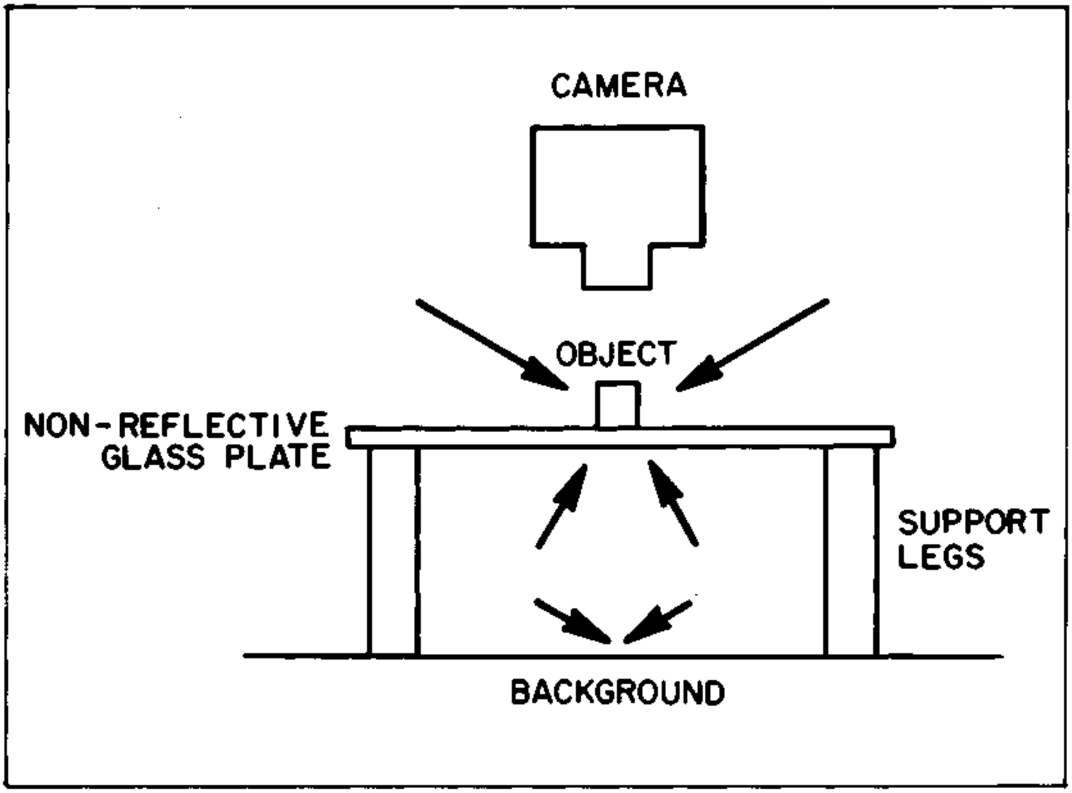

Fig. 2. The flat appearance produced by direct lighting from a single source can be improved by using fibre-optic wands. By mounting jewellery on non-reflecting glass above the background, multiple wands (indicated by arrows) can be directed to produce spotlight backgrounds, high lights and full lights on the subject itself, and transmitted light through gemstones if they are not backed.

direction. Furthermore, the light can be diffused and intensity varied as needed. Figure 2 illustrates how a piece of jewellery might be photographed. The object is placed on a supported plate of non-reflecting glass. The arrows indicate how two fibre-optic wands can be directed to produce a light on the background, two to illuminate the subject from above, and two to illuminate the subject from below if the jewellery has unbacked transparent stones. One need not stop at six lights. In some instances more may be better. The lights on the background produce either a spotlight or a vignetted effect depending on their intensity. If there are transparent coloured stones in open backed settings, small snoots or fibre-optic needles, which can direct light in a fine beam, can be used to illuminate them from behind to bring out colour. The major advantage of incandescent artificial lighting is that one can see the results of one's lighting and make whatever adjustments are necessary.

Depth of field

When photographing flat jewellery such as necklaces, depth of field is rarely a problem. However, it is often necessary to maximize depth of field, when taking pictures of jewellery that is bulky for its size, like bracelets or small objects under high magnification. This can be done in three ways. First, one can use a small aperture (Lefkowitz, 1979; Blaker, 1989b). The two factors that determine depth of field are magnification and aperture opening. The smaller the aperture the greater the depth of field and the improvement in focus. Second, one can use either a view or field camera both of which allow tilting of the lens board and film plane, thereby extending depth of focus (Shaman, 1977; Stroebel, 1986). These large format cameras are relatively heavy, usually take considerable time to set up and, as a consequence, restrict the number of photographs that can be taken in a day. They do, however, produce negatives that are large enough to be retouched. The third choice is scanning light photomacrography (McLachlan, 1964; Schram, 1981; Root, 1985; Gerakaris, 1986). See Figure 3. This technique uses multiple light sources to produce a plane of light that is less than the depth of field of the camera's lens. The lens of the camera is opened in a dark room while the object is mechanically raised through the plane of light. The camera is focused in this plane of light so that, as the object passes through it, it is painted by the light and the entire image is recorded in focus. Unfortunately scanning light photomacrography systems are expensive and are not without their detractions. They

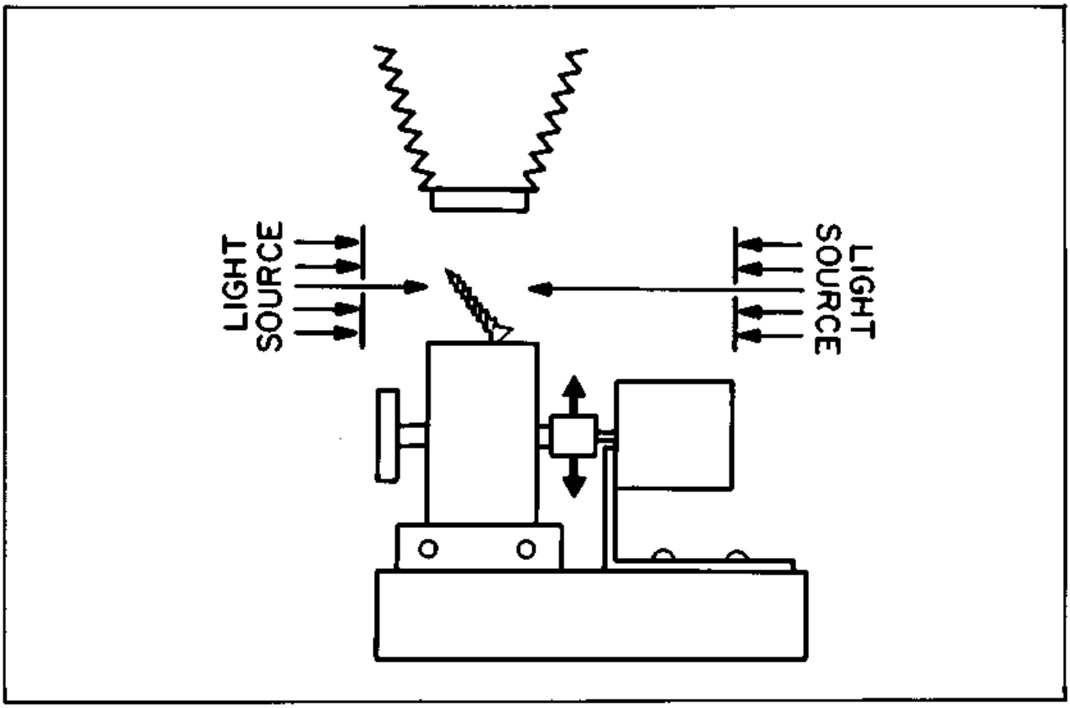

Fig. 3. Scanning light photomacrographs are produced by photographing the object in a dark environment as it is mechanically moved through a plane of light less than the depth of field of the lens. By focusing on the object in the plane of light, the entire image recorded appears in focus. Magnification is limited only by the width of the plane of light and vibration.

are cumbersome to carry. When photographing faceted stones, specular reflections can be very troublesome. Finally, exposures must be approximated so that the method is wasteful of film.

Background

We tender five suggestions to optimize background (Blaker, 1965b; Blaker, 1989a). First, select a background that is appropriate for the use to which the picture is going to be put. Second, if coarse textures are to be used, photograph them at least partially out of focus. Third, be inventive with colour and light. Fourth, be sure, if jewellery is being photographed under magnification, that no dust is present. Fifth, do not be afraid to try unusual backgrounds. Each of these points deserves brief discussion.

The background should be aesthetically chosen and relate well in size to the object being photographed. Colour is important as well. There are no rules about colour. Most people find, however, that greys, blacks, and neutral blues are more satisfactory than bright yellows, greens, and purples. If you have a need for bright colours, consider using silks and rayons that have colours with more colour saturation than dyed materials like paper and cotton.

Cloth fabrics used for background have texture. These are often disconcerting if in focus. A small piece of black plasticine can be shaped to raise a piece of jewellery sufficiently that texture is poorly perceived by the camera. If there is concern that the plasticine is going to leave an oily mark on the background, it can be placed on a coin. For work in the field, a piece of black or maroon pseudo-suede, as well as mirrors, magic markers, tape, and plasticine, are useful to have available. Pseudo-suede can be brushed free of dust and washed when dirty. Another reason for not placing jewellery with metal surfaces directly on coloured fabrics is that the metal will often take on the colour of the background. A small piece of non-reflecting glass that can be supported by film spools is a useful addition to the camera bag.

Taking pictures of jewellery at high magnification introduces the problem of dust. Canned air with a fine tubular nozzle is a convenient way to blow away dust, but should not be carried on airplanes, since pressure changes can cause explosions. Small brushes work well on glass and if one uses velvet, pseudo-suede, or other fabric backgrounds, sticky tape of any sort can be very helpful.

Be creative about backgrounds. Most hobby shops sell plastic acrylics that look like marble, granite, slate, sandstone, etc. that make excellent as well as inexpensive backgrounds. Also available are wood veneers, coloured woods, slates, sands, and sand papers, feathers, flower petals, silks, velvets – even human and non-human models – the list is endless. Backgrounds can also be made by projection to introduce colours, abstract patterns, textures, and scenery.

Special effects

Spectacular pictures are great challenges to take and reputations of photographers are made on these. The following are a few suggestions on how to achieve special effects but, with a little imagination, others can be developed.

If one wishes to photograph a group of stones at right angles to their tables, this can be done with a black background by mounting the stones upright on a black matte acrylic surface with black plasticine or, if another background colour is required, by gluing them to a piece of non-reflecting transparent glass raised above a background colour as needed and photographing straight on. If one uses large format film, one can then retouch the negatives with emulsion paint. One can also mount the stones with their tables on the glass and photograph them with the camera beneath them facing upwards.

To photograph a piece of jewellery on an exotic setting like clouds, ocean waves, or desert, put the object on a mirror and mount the background picture on a card parallel to and above the mirror. Then photograph the jewellery with the background reflected on the mirror.

One of the biggest problems in taking pictures of gemstones is photographing emeralds. Irrespective of their original colour, the colour reproduced is frequently murky. Films do not exist that consistently record a good emerald green. Sometimes it is necessary to retouch a poor green with Kodak emulsion paint to get a satisfactory colour.

Finally, how can one photograph a long thin bracelet? True, one can photograph it diagonally or perhaps partially curled upon itself, but a more attractive alternative method exists. Using a black reflecting acrylic surface and standing the bracelet on its side, one can often obtain a striking image of the bracelet and its reflection. Polished metals or mirrors can also be used as reflecting surfaces.

Summary

In conclusion we would like to emphasize five points. First, select backgrounds of size, colour, and magnification appropriate to the purpose for which the photograph is to be used. Second, choose a technique that maximizes depth of focus, if depth of field is needed. Third, use as many lights as necessary to optimize reflective colour, transmitted colour, and background colour. Fourth, to be always prepared to take pictures of jewellery, have available pieces of pseudo-suede, mirrors, magic markers, tape, and plasticine. Fifth, and by no means least important, design formats that are artistically pleasing and as original as you can make them.

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Vulcanite or gutta-percha? That is the question

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Fig. 1. Moulded gutta-percha 'hand' brooch of similar design to that of the vulcanite brooch illustrated as Figure 7.10 in Helen Muller's book *Jet*.

Abstract

Both moulded gutta-percha, and vulcanite, have been used to imitate jet jewellery of Victorian age. Due to gutta-percha's softness, and its low moulding temperature, this natural rubber is less likely to be found today than jet imitations that have been moulded under heat and pressure from man-made thermosetting vulcanite. The results of this investigation suggest that gutta-percha jewellery can be effectively distinguished from vulcanite jewellery by a combination of careful hand lens examination, judiciously applied hot point tests, and differential solubility tests.

Introduction

Moulded vulcanite (Figure 1) and gutta-percha (Figure 2) are two look-alike imitations that may confuse gemmologists when they attempt to identify articles of Victorian jewellery purported to be manufactured from jet. Indeed the jet expert, Helen Muller[1], has stated that gutta-percha [*sic*] is 'a natural plastic obtained from the milky secretion of a tree *Dichopsis gutta*' that was '... not durable and it is most likely that those pieces of jewellery described as gutta-percha are in fact made of vulcanite'.

As my experience with alleged gutta-percha or vulcanite jewellery does not support Helen Muller's unequivocal statement; and, as the gemmological literature is remarkably vague about the identifying

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features of both jewellery grade gutta-percha and vulcanite; perhaps the time is appropriate when the sources, methods of manufacture, chemistry and gemmological properties of both these materials should be described.

What is gutta-percha?

Gutta-percha[2,3] is a soft, heat sensitive, inelastic greyish to brownish solid substance obtained by evaporating the milky latex of two species of Malaysian tree – the no longer cultivated *Palaquium gutta**, and the commercially cultivated *P. oblongifolia*.

Source

Before Western explorers discovered the Malaysian Peninsular, its Malay and Chinese inhabitants used gutta-percha to manufacture large, light, fibrous textured drinking bowls that they called *mazers*. Early European explorers mis-identified the wood-like texture of these bowls, so their journals recorded that the mazers they acquired had been manufactured from 'mazer wood'. This misunderstanding was the historical source of the oft-quoted 'mazer wood tree' origin for gutta-percha.

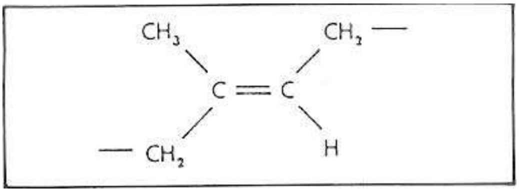
For over 200 years, from the early 17th century, 'mazer wood' was brought into Europe as a curiosity. However, by the early 1840s 'maser wood' had been correctly identified as being an evaporated plant sap product. It was subsequently named gutta-percha. In 1848, gutta-percha was first used commercially to sheathe the newly introduced underwater telegraph cables of Ernst Werner von Siemens. Interestingly, late in the 19th century, gutta-percha was replaced for this purpose by the much more durable and recently discovered insulating material – vulcanite. By the 1850s Europe was infatuated by gutta-percha, and all manner of utilitarian and decorative objects were moulded from it – including the gutta-percha golf balls, or 'gutties', used by golfers from the late 19th century until the 1920s.

The source for gutta-percha, latex, is usually collected from deliberately felled trees, since gutta-percha latex only flows very slowly from tapping incisions cut through the bark of standing trees. At harvest, mature trees yield sufficient *Palaquium* latex to furnish 1-2 kg of gutta-percha. When this milky suspension is boiled over open wood fires it yields a solidified mass of gutta-percha.

Chemistry

Gutta-percha is a naturally occurring polymer of isoprene, formed from covalently linked linear chains of isoprene mer (polymer) units. Gutta-percha has a molecular weight of about 30,000.

Fig. 2. Simple moulded vulcanite pendant.



Isoprene polymer

Individual polyisoprene chains, forming gutta-percha, are held together by weak fields of attraction known as Van der Waals forces. In nature, gutta-percha predominantly occurs as crystalline alpha gutta-percha – a linear trans-polyisoprene form, having its chain forming CH_2 units located on opposite sides of the double bond. This linear structure gives gutta-percha some mechanical strength and reduced plasticity.

When naturally occurring crystalline alpha gutta-percha is heated above 65°C it melts. Extremely slow cooling of this melt will allow alpha gutta-percha to recrystallize. But, more rapid cooling,

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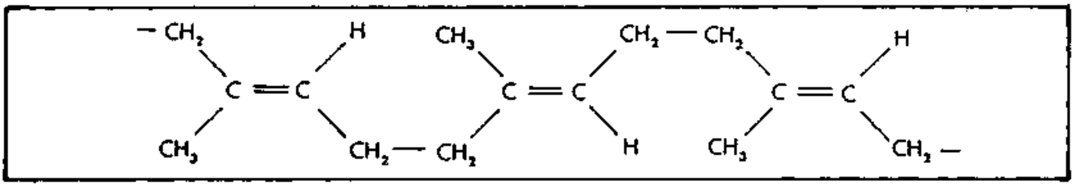
**Palaquium gutta* is the current name for the tree *Dichopsis gutta*, quoted by H. Muller.



Trans-polyisoprene (Alpha gutta-percha)

such as the rate of cooling that occurs when gutta-percha latex is evaporated to yield solid gutta-percha, will yield crystalline beta gutta-percha having a distinctive diagonal linear structure.

Jewellery grade gutta-percha

When gutta-percha is formulated, for thermoplastic moulding purpose (e.g. to create imitations of jet), gutta-percha must be remelted and filled with inert materials such as zinc oxide and/or chalk, and various waxes and resins. Subsequent heat softening, and moulding, of this filled gutta-percha will, on cooling, yield a mixture of about 60% beta gutta-percha and 40% amorphous gutta-percha. This jewellery grade gutta-percha has the following gemmological characteristics:

Colour: Reddish to brownish grey
Surface texture: Fibrous to coarsely granular
Hardness: 1 (easily scratched by the finger nail)
Tenacity: Brittle
Sectility: Readily pared with a sharp blade
Specific gravity: 0.96-1.0 (pure gutta-percha)
1.2-1.9 (filled gutta-percha)
'Spot' refractive index: SR 1.58 (difficult to determine due to the solubility of gutta-percha in refractometer fluid)
Lustre: waxy
Diaphaneity: Opaque
Solubility: Insoluble in water. Readily soluble in common organic solvents e.g. toluene* (toluol), chloroform, ether
Thermal stability: Softens and becomes pliable between 40-50°C. Melts between 65° and 70°C. An applied hot point will yield a distinctive odour that does not resemble that of burning rubber.

The greyish or brownish fibrous to granular surface of moulded gutta-percha jewellery is invariably painted black or dark brown, to simulate the smooth, highly lustrous, black polished surface attained by jet.

With increasing age, oxidation causes jewellery grade gutta-percha to become brittle, while its surface tends to become crazed by a reticulated pattern of superficial cracks. Additionally, with age painted gutta-percha surfaces tend to lose much of their coating.

What is vulcanite?

Vulcanite[4,5] is a man-made thermoset solid manufactured by compounding natural rubber or *caoutchouc* with up to 32% sulphur at 168°C and 90 psi (0.62×10^6 N/m^2) of steam pressure. The process of vulcanization was discovered in the late 1830s, with the vulcanization process being patented by the American Charles Goodyear in 1842.

Source

Caoutchouc, the natural rubber of Central and South American Indians, is produced from the

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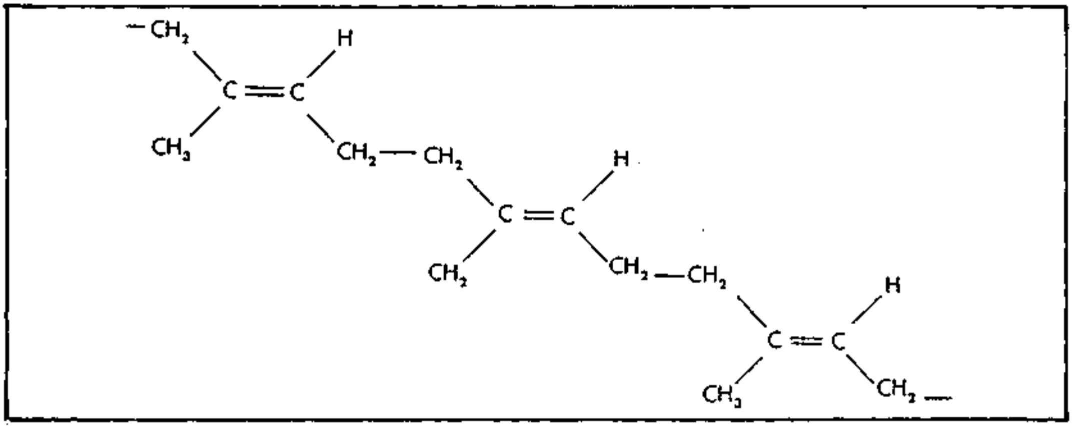
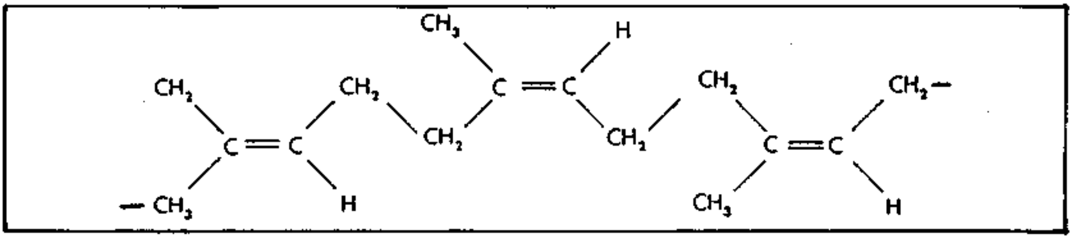
*CAUTION: Hepatotoxic, carcinogenic.



Trans-polyisoprene (Beta gutta-percha)



Cis-polyisoprene (Natural rubber)

dried milky latex of several tropical trees including: the *Sephonia elastica* of Brazil, the *Castilloa elastica* of Cental America, the *Ficus elastica* of south-east Asia, and the *Urceola elastica* of the island of Borneo. The latex, from which natural rubber is derived, is primarily an aqueous suspension of microscopic particles of *caoutchouc*. Natural rubber latex has a specific gravity which may vary from 1.02 to 1.41, depending on its *caoutchouc* content.

Recovery of natural rubber from latex involves the following steps:

1. Solidification of rubber from the latex: by evaporation in sunlight or artificial heat; or by acetic or citric acid precipitation. Evaporated 'biscuit' is creamy white, odourless, and has a specific gravity of 0.915.
2. Solid impurities are removed from the 'biscuit' by shredding and protracted washing with water.
3. Cleaned 'biscuit' is consolidated and compressed in steam heated trays into thick sheets of natural rubber.

Simple global economics soon dictated that naturally gathered Brazilian Para rubber was soon replaced by cultivated plantation rubber from south-east Asia. In Europe and America, *caoutchouc* became known as *India rubber*; as a consequence of its initial major use as an efficient eraser of black pencil marks from paper.

Chemistry

Structurally, natural rubber is also an isoprene polymer (polyisoprene) – having its isoprene polymer units covalently linked in a kinked 'cis' form (linking CH_2 groups on the same side of the double bond).

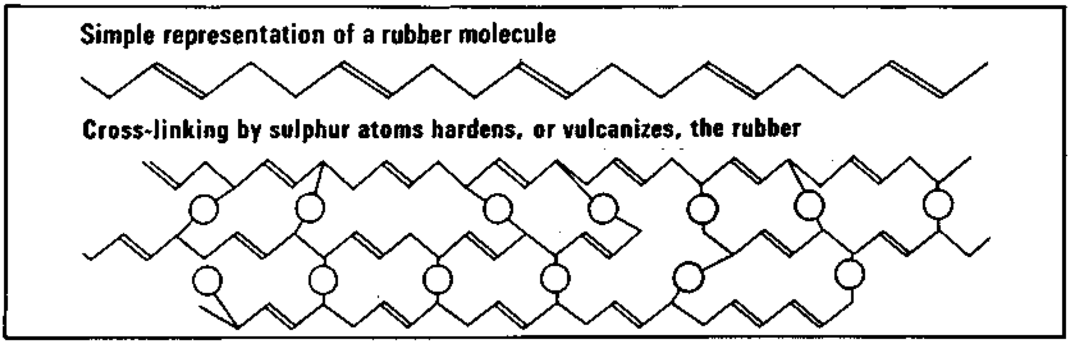
It is this kinked chain-like structure that gives natural rubber its elasticity. Structurally, natural rubber and gutta-percha are both isoprene isomers.

However, it was soon discovered that natural rubber became hard and brittle in cold weather, yet was sticky in hot weather. Experiments to increase the usefulness of natural rubber, led to the discovery that by chemically reacting natural rubber with sulphur, until all the double bonds of natural rubber were saturated, stable man-made hard rubber or vulcanite was formed.

Jewellery grade vulcanite

Thermosetting black jewellery grade vulcanite, or 'ebonite', was soon formulated for use in the creation of relatively inexpensive moulded imitations of the then popular jet. 'Ebonite' was formulated to contain 50% natural rubber, 30% sulphur, 3% black pigment, and 17% fillers. Jewellery grade 'ebonite' vulcanite has the following gemmological characteristics:

Colour: Black, but with time oxidation modifies the vulcanite hue to brown, khaki, then yellowish brown
Surface texture: Compact
Hardness: 1-2 (Not scratched by finger nail, but just scratched by gypsum)
Tenacity: Tough



Vulcanite

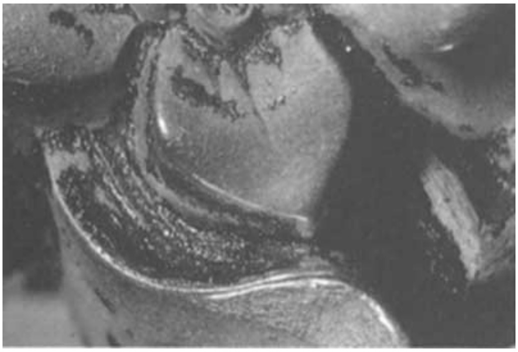


Fig. 3. Granular brownish surface of the gutta-percha brooch (Figure 1) illustrating the significant loss of its black coating.

Fig. 4. Smooth brown surface of the vulcanite pendant shown in Figure 2.

Sectility: Readily pared with a sharp blade
Specific gravity: 1.20+ (depending on filler content)
'Spot' refractive index: SR 1.60/1.61
Lustre: Waxy-resinous (velvety) when freshly polished. Tends to become finely pitted with age.
Diaphaneity: Opaque
Solubility: Insoluble in water, alcohol, glycerol, acetone, and aliphatic hydrocarbons; but somewhat soluble in aromatic hydrocarbon solvents, such as toluene
Thermal stability: Will not soften without decomposition in a flame. A judiciously applied hot point will yield the acrid odour of burning rubber.

Distinguishing gutta-percha from vulcanite

As both thermoplastic moulded gutta-percha, and thermoset moulded vulcanite, have been used to imitate Victorian jet jewellery, the challenge of positively identifying these relatively uncommon jet imitations should be of some interest and importance to practising gemmologists.

Unfortunately, as most vulcanite or gutta-percha jewellery contains other jewellery components, such as metallic pins and clips, determination of their specific gravity is usually impossible. Additionally, attempts to determine 'spot' refractive indices for vulcanite or gutta-percha jewellery can be somewhat difficult due to the complex shapes in which these materials are commonly moulded; the solubility of gutta-percha in refractometer contact liquid; and the presence of a pigmented coating on gutta-percha jewellery that will not yield the true refractive index of this material.

Therefore, the distinction between vulcanite and gutta-percha must be made on the basis of the following tests:

1. Hand lens and/or low-power microscopic examination
   ... looking for evidence of the black or brown coated surface that is often partly missing from the greyish or brownish fibrous or granular surface of gutta-percha (Figure 3). In contrast, vulcanite is evenly coloured, and of uniformly smooth texture throughout its mass (Figure 4).

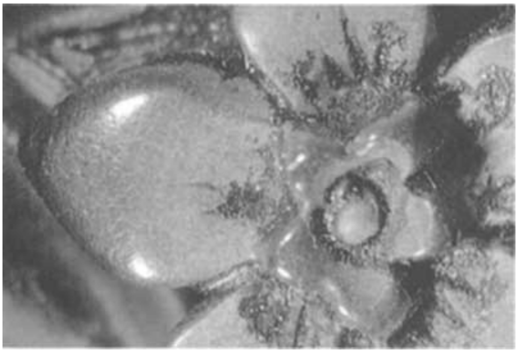


Fig. 5. Uncoated, crazed surface of the gutta-percha brooch shown in Figure 1.

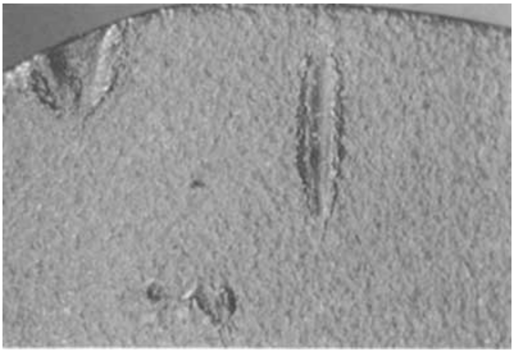


Fig. 6. Response of the surface of gutta-percha to an applied hot point of 150°C.

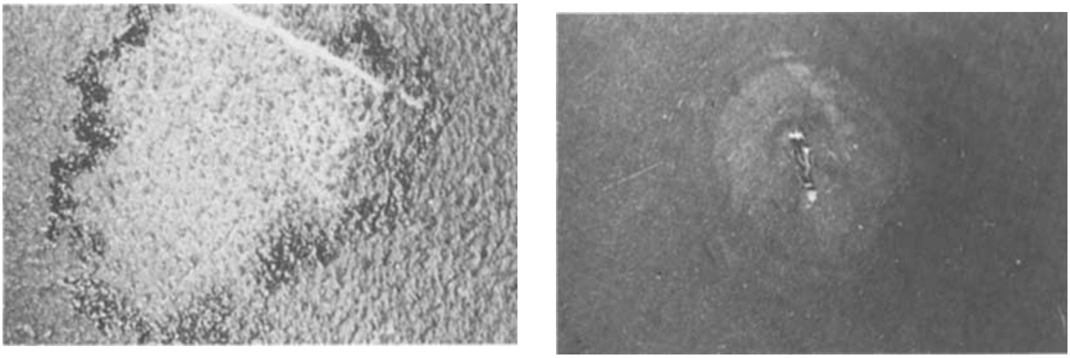


Fig. 7. Response of polished surfaces of gutta-percha and vulcanite to an applied drop of toluene. Note the extensive softening of the gutta-percha surface (A) compared with the minor softening of the vulcanite surface (B) – as indicated by the scratch.

Note: The uncoated surface of moulded gutta-percha frequently crazes with increasing age (Figure 5).

2. A judiciously applied hot point test
   ... low heat (appx. 60°C) will readily soften gutta-percha (Figure 6);
   while,
   ... vulcanite will only char at much higher temperatures, yielding the odour of burning rubber.
3. A judiciously applied solubility test
   ... a minute drop of toluene will rapidly soften gutta-percha (Figure 7A); but only slightly soften the surface of vulcanite (Figure 7B).

Muller claims[1] that ... 'Because vulcanite is thermoplastic, only one cut is necessary in the chain link which can then be opened when heated and slipped onto the next link and closed again. Thus distinguishing jet from vulcanite chains is merely a question of ascertaining whether the links have one or two joins'... should be treated with caution; for it is most unlikely that thermosetting vulcanite also displays thermoplastic properties. One simply cannot join two pieces of thermosetting vulcanite together by heat softening and fusing them with hand pressure. Gutta-percha chains, on the other hand, can be quite easily heat sealed at a working temperature much below 100°C.

Conclusion

As both moulded vulcanite and gutta-percha may be found imitating jet, gemmologist must be able to effectively distinguish these materials. Careful observation for the presence of a coating, and a judiciously applied hot point and/or suitable solubility test should provide the effective distinction between gutta-percha and black vulcanite or 'ebonite'.

A plea

As this research has been based on specimens of vulcanite and gutta-percha jewellery loaned from Australian collections, they may represent a biased sample of jet imitations. The author would be delighted to correspond with other gemmologists who share an interest in these two uncommon organic gem materials.

Acknowledgement

The author is greatly indebted to N. Mackay, Curator of Specimens for the Western Australian Branch of the Gemmological Association of Australia, for the loan of study specimens of vulcanite and gutta-percha; and to Helen Muller and her husband for their helpful review of this paper.

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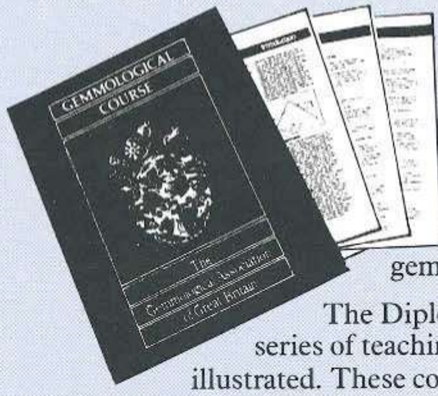

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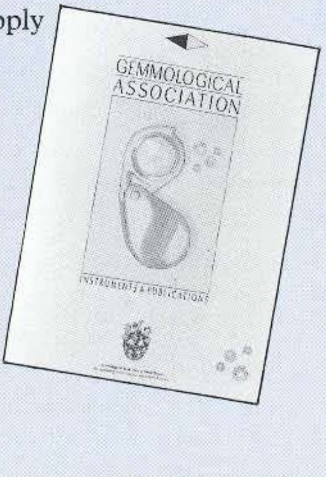

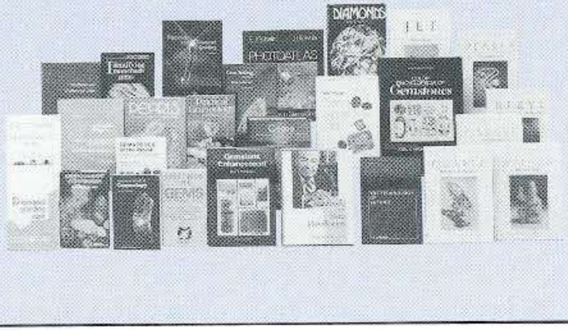

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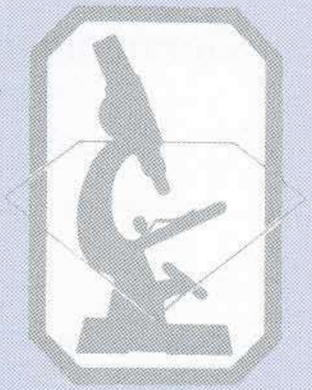

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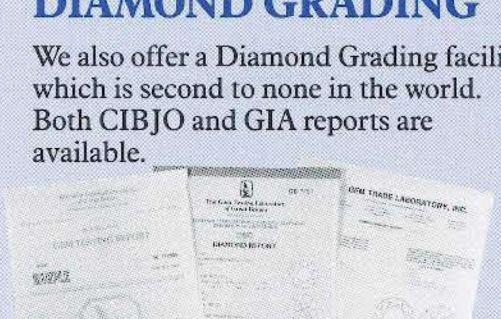

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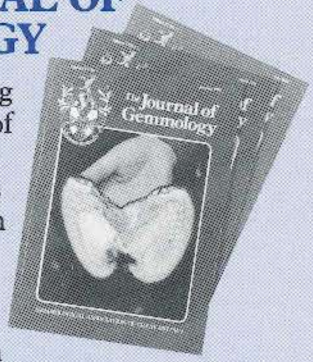

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Gemmological investigation of a synthetic spinel crystal from the Soviet Union

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Abstract

A transparent purplish-red octahedral synthetic spinel crystal grown in the Soviet Union was studied. The properties were investigated to determine if the material could be identified using standard gemmological tests. It was also examined by means of energy dispersive X-ray fluorescence, UV-visible spectrophotometry and infrared spectrometry to document these properties.

Introduction

For gemmologists, so-called synthetic spinel – in colours other than red – has never been considered a problem synthetic. The mass-production of this material has always been by the flame-fusion 'Verneuil' process, which requires that excess alumina be present in the structure (Nassau, 1980). This sets up a distinctive pattern of internal strain in the boules that, in cut stones, is quite easily recognizable in a field of polarized light. This distinctive anomalous double refraction has been variously called a 'cross-hatch effect' or 'tabby extinction' by gemmologists.

This excess alumina enrichment also results in an abnormally elevated refractive index and a slightly higher specific gravity than would normally be encountered in most colours of natural spinel. Because of this, until now, the separation of natural from most synthetic spinel has been one of the easiest and most straightforward of the synthetic-versus-natural separations that a gemmologist is likely to face.

In the case of red synthetic spinel, however, the ratio of Al_2O_3 to MgO must be virtually identical to that found in nature (1 to 1) if the chromium dopant is to give the desired red colour (Nassau, 1980). Because of the variable burn-off rates of Al_2O_3 and MgO, it is very difficult to grow red synthetic spinel by the flame-fusion method.

With flux growth, however, the chemical components do not suffer from high-temperature burn-off symptomatic of flame-fusion growth above 2200°C. So the commercial growth of synthetic red spinel by the flux-melt method is feasible from a technical, if not economic, standpoint.

At a fall 1989 gem and mineral show held in Denver, Colorado, U.S.A., Mr. Bill Vance, a local gemmologist, noticed two large transparent intense red octahedral crystals that looked like fine gem-quality spinels. They were in the possession of a gentleman from the Soviet Union. Mr. Vance was told that the crystals were 'synthetic spinel grown hydrothermally in the Soviet Union'. He was able to purchase the smaller of the two crystals but was told that the larger one was not for sale. He was not able to determine if these crystals are being produced in quantity for commercial sale.

Because of his crystal's unusual size and quality Mr. Vance contacted the authors to find out if this apparently new type of synthetic might be of interest for detailed gemmological investigation and description.

It has been long known that gem-quality spinel crystals have been grown experimentally by methods other than flame fusion. In 1848 J.J. Ebelmen was probably the first to successfully grow synthetic spinel in a borate flux (Nassau, 1980). The book "Color Encyclopaedia of Gemstones" (Arem, 1987) mentions flux-grown red and blue synthetic spinel. One of the authors has personally examined a collection of small pink and light blue octahedrons grown by a flux-melt process. But such methods of crystal growth were considered experimental and were always deemed too costly for the production of synthetic spinel in general – particularly when flame-fusion material in colours other than red could be produced quite easily and at very little cost.

A recent ICA Lab Alert (Bank and Henn, 1989) described a flux-grown synthetic red spinel octahedron weighing 13.14 carats. At 17.19 carats the crystal purchased by Mr. Vance is the largest synthetically grown octahedron yet studied. And its colour is equal to a fine colour in natural red spinel. Therefore, considering the new (Soviet) source, and in view of the transparency and pleasing red colour, a thorough gemmological investigation was carried out.

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Gemmological characteristics

Crystal description

Other than size, the first thing that strikes the observer about this crystal is its obvious quality. It is a transparent, near-perfect octahedron with one truncated (cube face) tip so that the crystal can be balanced on point rather than resting on an octahedral face (Figure 1).

On a Mettler PC400C electronic diamond balance, the spinel crystal was determined to weigh 17.193 carats with corresponding measurements of 14.79 × 13.40 × 11.76 mm.

Colour

The daylight colour could be described as an intense slightly purplish-red. In artificial incandescent light, a very slight orange component was present. Under fluorescent illumination the orange component was eliminated and the purplish overtone was somewhat stronger, resulting in a purplish-red body colour. Direction of observation had no effect on the colour appearance as expected for an isotropic gem species. GIA GEM Instruments ColorMaster notation was C-20-11-18.

Refractive index

The synthetic spinel crystal had sufficiently flat octahedral faces to allow flat facet refractive index readings to be taken. Using a Duplex II refractometer and a near-monochromatic, sodium-equivalent light source, the refractive index was determined to be 1.719. This value is within the range previously determined for natural spinel and as such does not offer any means of separation.

Specific gravity

Methylene iodide, with a 3.32 specific gravity, was used for standard sink-float testing to estimate specific gravity. The spinel crystal readily sank in this liquid when submerged just below the surface and released. When compared to the sink rate of an 8.25 carat round brilliant flame-fusion synthetic sapphire, the spinel sank visibly slower. But its sink rate was virtually identical to that of a 1.71 carat natural purplish-pink spinel crystal and to that of a 3.21 carat emerald-cut light blue flame-fusion synthetic spinel as well.

Because of its weight and apparent quality, the synthetic spinel crystal's specific gravity was determined by hydrostatic testing. Three separate runs were carried out at room temperature. The average specific gravity for those three runs was 3.58 ± 0.01. This value for specific gravity falls within the range established for natural gem-quality spinel.

Ultraviolet fluorescence

Under darkroom conditions the spinel crystal was examined against a non-fluorescent black background using both long-wave and short-wave ultraviolet radiation. Contrast control goggles were worn to help eliminate secondary reflections. Samples of both natural red and pink spinel from Burma and Sri Lanka were used as comparison stones.

The fluorescent reaction to long-wave radiation was a strong purplish to orangy-red that seemed to vary slightly with direction, while the short-wave fluorescence was only slightly weaker, a moderately strong slightly orangy-red. Additionally, under short-wave, some of the edges between crystal faces appeared superficially chalky and, in certain directions, yellowish-orange. There was no purplish overtone under short-wave radiation. No phosphorescence was detected from either wavelength when the ultraviolet lamp was switched off.

With the exception of the slight chalkiness to short-wave, the fluorescence characteristics of this synthetic spinel crystal were almost identical to those shown by the natural red and pink spinel comparison stones.

Visible light spectroscopy

A Beck prism spectroscope with an illuminated wavelength scale was used to determine the visible light absorption characteristics for the synthetic spinel crystal. Because of its euhedral octahedral form and high transparency the crystal behaved as a 'window' being ideal for transmitted light spectroscopy. The crystal showed general absorption in the violet and blue from 400 to 450 nanometres, a diffused weak absorption band between 580 and 630 nm, a strong, fine line at 680 nm, and a strong fluorescent line in the deep red at 690 nm.

Once again, because natural red spinels show similar absorption characteristics, visible light absorption as observed through a hand spectroscope is of no value in separating this synthetic spinel from natural gems of similar colour.

UV-visible absorption spectroscopy was performed using a Pye Unicam 8800 spectrophotometer. The spectrum of this synthetic as viewed with the spectrophotometer is similar to that of natural red spinel. However, the 'chromium lines', which appear as two weak, sharp bands around 650 nm in the spectrum of natural red spinel, were just one, much broader band in the spectrum of the synthetic sample.

Chelsea colour filter reaction

When the synthetic spinel crystal was placed on the tip of a fibre optic illuminator and examined in several directions with a Chelsea colour filter, the colour through the filter was a strong orangy-red.

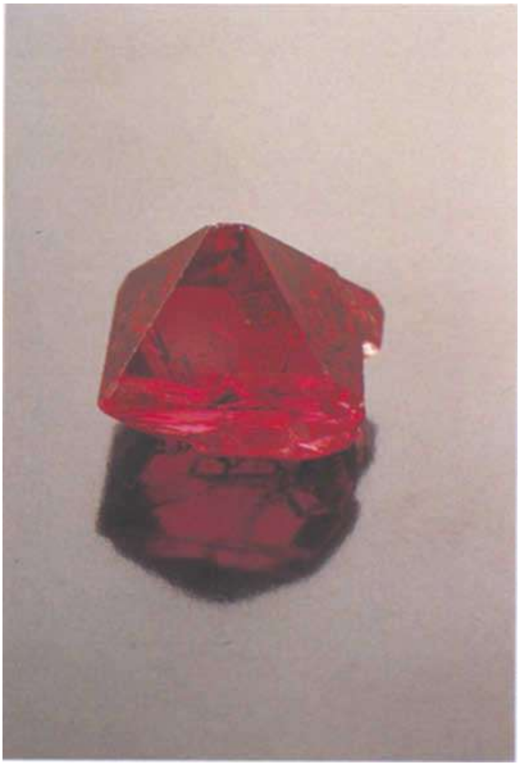

Fig. 1. Transparent synthetic spinel crystal weighing 17.193 carats reportedly grown in the Soviet Union. *Photograph by Robert Weldon.*

Fig. 2. Primary flux inclusions in the synthetic spinel crystal. Magnified 20×. *Photomicrograph by John I. Koivula.*

Fig. 3. The truncated surface that appears to be the point of attachment or growth-nucleation of the synthetic spinel. Magnified 5×. *Photomicrograph by John I. Koivula.*

Fig. 4. Brightly reflective and iridescent air-filled fractures resulting from strain as observed in the synthetic spinel. Magnified 10×. *Photomicrograph by John I. Koivula.*

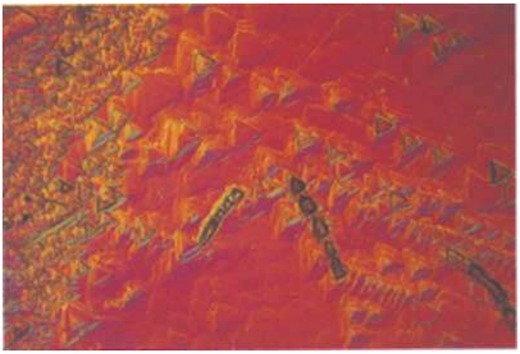

Fig. 5. Triangular etch features observed on the octahedral face of a *natural* spinel crystal. Magnified 80×. *Photomicrograph by John I. Koivula.*

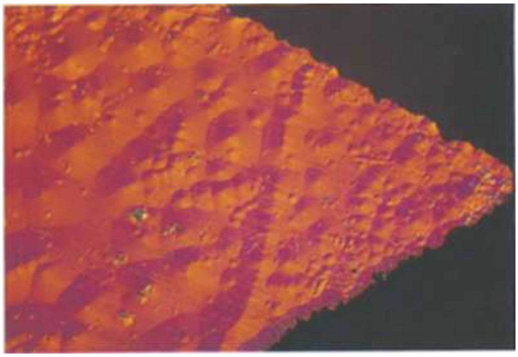

Fig. 6. Growth hillocks on an octahedral face of the flux-grown *synthetic* spinel crystal. Magnified 80×. *Photomicrograph by John I. Koivula.*

Natural spinels of similar body colour show virtually the same orangy-red colour when viewed through the filter. This test therefore does not provide a means of natural-versus-synthetic separation.

Magnification

A standard gemmological microscope equipped for a variety of illumination techniques, including polarized light, shadowing and oblique illumination, was used to study the synthetic spinel crystal both internally and externally.

Surprisingly, because it was represented as hydrothermal, the crystal contained what appeared to be primary flux inclusions of a deep orangy-brown colour with an angular to jagged profile (Figure 2). These inclusions formed a pyramid-shaped phantom in near-perfect alignment with the external faces of the octahedron that was centred just under the surface of the truncated octahedral tip. The truncated surface was pitted and ridged in a manner indicating that it was the surface of crucible attachment during growth (Figure 3).

The crystal also showed some brightly reflective and iridescent air-filled fractures (Figure 4) that seemed to have their point of origin at or near the phantom of dark inclusions. In polarized light, strain was observed in association with the fractures and flux-like inclusions suggesting that perhaps the pyramid-shaped phantom delineated the original borders of a growth discontinuity and that the fractures are the result of strain.

Externally, closer inspection of the major crystal revealed three small secondary satellite modified octahedral crystals protruding in parallel growth from one octahedral face (cover picture). Most natural spinel crystals which have not been subjected to mechanical water erosion show either virtually smooth surfaces or, on close inspection, slight signs of chemical dissolution in the form of minute triangular etch pits (Figure 5) on their octahedral faces. The smooth-appearing octahedral surfaces of the synthetic crystal, however, were covered with semi-circular growth hillocks (Figure 6) of a type not yet reported on natural spinel crystals.

Infrared spectrometry

The mid-infrared absorption characteristics of the synthetic spinel crystal were studied using GIA's Nicolet 60SX Fourier-transform infrared spectrometer. The results of this testing showed that while two very weak broad features were observed in the mid-infrared at about 3620 and 3375 cm^{-1}, they do not compare in intensity with the features observed in hydrothermal materials. Additionally, no intense broad absorption centred at 3600 cm^{-1} (indicating the presence of hydroxyl groups) was detected. Hydroxyl groups indicate the presence of water and have been observed in all natural and synthetic hydrothermally-grown materials, including natural and synthetic emeralds and amethysts. The absence of this feature rules out hydrothermal growth as the means of synthesis and indicates that the crystals were grown from a melt. The additional observation of inclusions typical of flux-grown synthetic materials proved that this octahedral crystal was grown by a flux-melt technique.

Chemistry

Using GIA's Tracor Northern Spectrace 5000 energy dispersive X-ray fluorescence system, a bulk qualitative chemical analysis was done on the synthetic spinel crystal. In addition to the expected magnesium, aluminium and chromium, trace amounts of iron, nickel, vanadium and molybdenum were detected. Molybdenum is a common component of fluxes used to grow gem materials. Titanium, a common component of natural spinels, was not detected.

Conclusion

Red is generally considered the most valuable colour of natural gem spinel. Because of the precise ratio of magnesium to aluminium required it has always been very difficult to grow using the flame-fusion technique. The appearance of large flux-grown synthetic crystals, however, may mean that faceted synthetic red spinels will become available commercially. The extent to which these flux-grown synthetic red spinels are being manufactured in the Soviet Union (and marketed) is not yet known. However, because large crystals have now been reported in both West Germany (Bank and Henn, 1989) and the United States, it is possible that there may be a serious marketing effort on a worldwide scale.

So far, to our knowledge, only large transparent rough crystals have been seen. But faceted stones of high clarity weighing several carats could be easily cut from such crystals. If they are, without flux inclusions to identify them as synthetic, they will be very difficult for the jeweller-gemmologist to identify because all of the standard gemmological properties such as refractive index, specific gravity, UV fluorescence, spectrum, etc., shown by these synthetics are virtually identical to those properties in natural red spinels.

Acknowledgements

Mike Moon in GIA's research department provided the infrared spectral data and part of the qualitative chemical analysis, while Meredith Mercer, also of the GIA research department, performed the UV-visible spectrophotometry. The authors are thankful to Mr Bill Vance for the loan of the specimen for this study.

References

Arem, J.E., 1987. *Color Encyclopaedia of Gemstones*, Van Nostrand Reinhold Company, New York, New York.

Bank, H., Henn, U., 1989. *Flux Grown Synthetic Red Spinel From U.S.S.R.*, ICA Laboratory Alert Number 26.

Nassau, K., 1980. *Gems Made by Man*, Chilton Book Company, Radnor, Pennsylvania.

[*Manuscript received 26 January 1990.*]

Gemmological Abstracts

BENJAMIN, M., 1990. Letter. Imitation opalized shells. *Australian Gemmologist*, 17, 7, 277-8.

The dealer who supplied the opalized shell dealt with in the November issue of *Australian Gemmologist* by John Koivula, states that their artificial structure was fully obvious both to him and to Susan Johnson who passed them on to the GIA. R.K.M.

BRACEWELL, H., 1990. Gems around Australia. Part 3. *Australian Gemmologist*, 17, 7, 265-9, 15 figs, mostly coloured.

Continuing the Round Australia search, the Hart's Range is dealt with, offering zircon, garnet, feldspar, beryl, tourmaline, kyanite, epidote, ruby, iolite and chrysocolla. Paper comments on dirty condition and appalling language of young aborigines (self-imposed problems), but aborigine elders were gentlemanly and Mrs Bracewell found them a delight to deal with. R.K.M.

BROWN, G., 1990. Some rare ivories. *Australian Gemmologist*, 17, 7, 256-62, 23 figs.

A dental expert deals with the rare ivories from walrus, including fossil tusks preserved in Arctic cold for perhaps 2000 years, crocodile teeth, tiger teeth, boar teeth and dugong tusks. R.K.M.

BROWN, G., 1990. The appropriateness of GAA's gemmological nomenclature, 1990 Presidential address. *Australian Gemmologist*, 17, 6, 216-18 and 248-50.

Grahame Brown argues cogently for a commonsense approach to naming gem substances and decries the misuse of names which is apparently common in Australia. He summarizes rules laid down by the Commission set up by the International Mineralogical Association and by CIBJO. He goes on to analyse the degree of acceptance and to discuss the use of the word 'synthetic' and the often confused multiplicity of names applied to synthetics. Much of what he said applies world-wide. R.K.M.

BROWN, G., 1990. Biron synthetic pink beryl. *Australian Gemmologist*, 17, 6, 219-20, 2 figs.

A new synthetic morganite for which the author quotes constants, SG 2.68 and RI 1.571-1.578, DR 0.007, saying that these are 'considerably' lower than for natural morganite. The Biron synthetic has moderate orange fluorescence in LWUV. R.K.M.

BROWN, G., 1990. Gemmological study club lab report. *Australian Gemmologist*, 17, 6, 221-30, 22 figs in colour (not sequentially numbered).

Describes or investigates, oiled ruby; rainbow lattice sunstone; silicon imitating hematite; Keppel Bay variscite; quartz soudé 'amethyst'; Dungowan (Tamworth) nephrite; Aqua Aura; Australian prasiolite; ß quartz, and Argentinian rhodochrosite. (Suggests that natural radiation has converted some prasiolite to amethyst. Prasiolite is normally obtained by heating amethyst, and the heat of the tropical sun has been known to do this, so the report seems to indicate a reversal of that process.) R.K.M.

BROWN, G., BRACEWELL, H., 1990. Mt Philp aventurescent iolite. *Australian Gemmologist*, 17, 6, 231-4, 15 figs in colour.

Located 55 km SE of Mt Isa, this deposit yields a deep blue iolite with inclusions of hematite platelets, pinite, apatite (?), and a possible amphibole. Constants are in line with Mt Isa iolites, the hematite giving the Mt Philp material an aventurescent sheen. R.K.M.

BROWN, G., KELLY, S.M.B., BEATTIE, R., BRACEWELL, H., 1990. Gemmology study club reports. *Australian Gemmologist*, 17, 7, 279-86, 24 figs, some in colour.

The Club reports on a chalcedony with dendrites of copper minerals from Mt Isa which provides a new ornamental material; a pair of mottled black-dyed cultured pearls had been waxed; faceted colourless calcite; natural pale yellow sapphire which had been heated to give the rarer colourless variety; a purple triplet of colourless synthetic spinel; a diamond etched by heat; a colour-change (purple to blue) didymium doped cubic zirconia; various new Russian quartz synthetics; turquoises with brecciated texture; reconstructed kauri gum carvings; scenic Peruvian common opal and a natural pearl necklace with a single imitation pearl at its centre, a fair match which was easily detected by lens. [Abstracter finds the unconventional numbering of illustrations for this paper confusing and rather irritating.] R.K.M.

BROWN, G., LINTON, T., 1990. Treasure Chest gem tester. *Australian Gemmologist*, **17**, 7, 274-5, 1 fig.

'Yet another' thermal conductivity probe which gives results which are 'probable' rather than 'positive', suitable for single diamonds but not for continuous use, nor for other species. R.K.M.

BROWN, G., SNOW, J., BRIGHTMAN, R., 1990. YAGG: a gemmology study club report (not indexed). *Australian Gemmologist*, **17**. 6, 239-42. 10 figs in colour.

A report on yttrium aluminium gallium garnet, $Y_3(Al,Ga)_5O_{12}$ (doped with chromium), made by Dr J. Osman of JO Crystal Co, Calif. True silicates are viscous when melted and tend to finish as a glass. So these silica free 'garnets' are simpler to synthesise. YAGG was made in a flux of lead and other oxides and imitated tsavorite, the green vanadium grossular garnet. 2000 carats were produced before rising costs brought the enterprise to a halt. H 8+, SG 5.05, RI 1.88, Chelsea filter, bright red, LWUV strong red, chromium spectrum, inclusions of yellow/brown flux, platinum(?) and veil-like healed cracks. R.K.M.

FRITSCH, E., SHIGLEY, J.E., ROSSMAN, G.R., MERCER, M.E., MUHLMEISTER, S.M., MOON, M., 1990. Gem quality cuprian-elbaite tourmalines from São José da Batalha, Paraíba, Brazil. *Gems & Gemology*, **26**, 3, 189-205, 18 figs in colour.

A detailed account of the exceptionally fine blue and green copper-rich elbaite from Paraíba, Minas Geraes. RIs vary around 1.619-1.639, SG 3.04. Some stones heated to convert bluish-purple to fine green or blue, which colours are also found naturally. R.K.M.

FRYER, C.W., ED., CROWNINGSHIELD, R., HURWIT, K.N., KANE, R.E., HARGETT, D., 1990. Gem trade lab notes. *Gems & Gemology*, **26**, 2, 153-8. 18 figs in colour.

'Pearls' cultivated using mantle tissue without nacre-producing cells, were coated with black/brown calcareous concretion. A coral imitation was identified as barium sulphate, with plastic and colouring agent, 'spider-web' structure detected, RI 1.58, SG abt 2.33, H 2 to 3.

A diamond octahedron with etched channels is illustrated; a rare purple diamond was type IaA and had no 550nm line. A yellow glass egg fluoresced strongly, very radio-active, probably uranium glass. An unusual banded lapis lazuli is illustrated.

A grey baroque salt-water cultured pearl had its bead markedly off-centre. A large old natural baroque pearl had been trimmed up, half-drilled in four places and a hole plugged with another pearl.

Semi-transparent sodalite cut into some 2000 small beads looked very like synthetic sapphire; a faceted pink spinel lacked octahedral inclusions but had polysynthetic twin planes, oriented needles and a bluish tone in transmitted light; an antique looking Russian blue stone earring was paste, with old-cut diamonds and a post-revolution hallmark which dated it after 1917 (?); a blue three stone ring had deep Sri Lankan-cut synthetic sapphires set with diamond chips (cleavage flakes?), the intact silver and gold setting looked antique, but synthetic sapphires were first made in 1910. R.K.M.

FRYER, C.W., ED., CROWNINGSHIELD, R., HORWIT, K.N., KANE, R.E., HARGETT, D., 1990. Gem trade lab notes. *Gems & Gemology*, **26**, 3, 220-7, 20 figs in colour.

An 8.38 ct emerald dyed with green oil and with green dop wax on its girdle was detected, both enhancing the colour, poor chromium absorption and light pink through colour filter suggest a pale stone artificially improved by the dye; a superb chatoyant 31.04 ct carved horse head was identified by spot RI 1.75 and by 445nm absorption band as chrysoberyl, carved in Idar-Oberstein.

A light bluish-green diamond was identified as electron irradiated by colour zoning around the culet which was visible when the stone was immersed; a mottled 4.26 ct black diamond was natural with electro-conductive areas which suggested type IIb, but clear areas fluoresced blue to LUV and yellowish-green to SUV, confirming type I diamond, probably the many graphite inclusions accounted for colour and conductivity; a number of laser-drilled diamonds have resulted in cleavage cracks and branched drill-holes, in one case the laser hole reached an included diamond octahedron which would not be improved by such treatment (and inclusion could have been made more obvious if an air gap was created).

A Mexican opal had a large egg-like whitish inclusion, most obvious in transmitted light; a new type of cultured pearl nucleus from Japan is illustrated, made from powdered oyster shell, plastic-bonded and coloured, it is used to nucleate black or grey pearls, the nacreous layer is unusually translucent and drilling causes the binding plastic to melt.

A necklace of natural fresh-water pearls of a dark brownish purplish-pink, from San Angelo lakes and rivers in West Texas, selected over 15 years from many thousands found, is probably rare (but not very attractive). Naturally black or grey Polynesian cultured baroque pearls were compared with similar baroque blacks from Japan and were found to have larger nucleii.

Montana sapphire rough is being investigated to determine whether it has been heat-treated or surface diffused. A 63.65 ct colourless sapphire from Sri Lanka is described and illustrated, as is a natural cobalt spinel with colour change from blue to purple. R.K.M.

Guo, J.F., Wang, F.Q., 1990. Chicken-blood stone. *Australian Gemmologist*, **17**, 7, 262-5, 2 figs in colour.

Changhua, or chicken-blood stone is an altered silicic tuff rock, with cinnabar inclusions which make it a fine red, a symbolic colour for the Chinese. Historically a seal stone, it is today used more for other carvings. H 2 to 3, SG 2.6 to 2.9, RI 1.53 to 1.60, waxey lustre, fine specimens rare and can command high prices. R.K.M.

Hanano, J., Wildman, M., Yurkiewicz, P.G., 1990. Majorica imitation pearls. *Gems & Gemology*, **26**, 3, 178-88, 17 figs in colour.

Describes the history and products of Majorica SA, a Spanish factory for imitation pearls of high quality. Although these are said to be closely similar to salt-water cultured pearls in appearance, detection is a simple application of the same tests as for other imitation pearls. R.K.M.

Hargett, D., 1990. Jadeite of Guatemala: a contemporary view. *Gems & Gemology*, **26**, 2, 134-41, 10 figs in colour.

A fascinating account of the rediscovery of jadeite by the Ridingers in the Zacapa region of Guatemala in 1974. Further discoveries were made and green, 'blue', white, 'black' (dark green) and variegated green, some with pyrite, are now known. Jadeite was mined and greatly valued in several pre-Colombian civilizations and their artifacts have been found from Peru to Mexico. The new material is used to make copies of these, and as beads and cabochons. 'Black' material is most sought, but bluish jadeite is rarest. R.K.M.

Hlaing, U.T., 1990. Burmese zircon. *Australian Gemmologist*, **17**, 6, 237-9, 3 figs.

A short paper covering crystal proportions, heat treatment and analysis, not all of which is easy to follow. H.K.M.

Hlaing, U.T., 1990. Myanmar diamonds from north to south. *Australian Gemmologist*, **17**, 7, 278.

Octahedral, trisoctahedral and hexoctahedral diamond crystals, often distorted and colourless, found in alluvial areas near Mong-mit, Toungoo and Mergui in Burma (Myanmar). (Those diamonds I have seen from these regions have been small, white, with exceptionally lustrous curved faces.) R.K.M.

Hughes, R., 1990. Talkin' 'bout gem testing instruments. *Australian Gemmologist*, **17**, 6, 242-6.

A second instalment of rather flippant criticism of design, efficiency and high cost of Western gemmological instruments, this time on dichroscopes, refractometers, immersion cells and stone holders. [It now seems possible that these papers may be a preliminary hype for the author's declared intent to manufacture such items. Hopefully we may yet see well-designed, super-efficient instruments produced by cheap skilled labour in Bangkok, at prices suited to the pockets of hard-up gemmologists the world over. Go to it Mr Hughes!] R.K.M.

Kane, R.E., Kammerling, R.C., Koivula, J.I., Shigley, J.E., Fritsch, E., 1990. The identification of blue diffusion-treated sapphires. *Gems & Gemology*, **26**, 2, 115-33, 23 figs in colour.

Surface-blued sapphires are increasingly prevalent. Near colourless faceted and polished stones are packed in a powder of alumina and titanium and iron oxides, and heated for several hours at above 1700°C. This causes blue to diffuse into the suface to about 0.15mm, which in many stones has been increased to about 0.42mm by further heatings. The colour tends to penetrate more at facet junctions and around the girdle. High temperatures destroy lustre and stones need repolishing, which tends to remove blue unevenly.

To the eye the stones look like normal well-coloured sapphires, but breaks or depressions in the surface are not repolished and remain dark blue. High temperatures affect inclusions in the usual ways.

The general blotchiness of colour is the main clue to this treatment, and is best seen by the naked eye, with the stones immersed in a glass dish of liquid over a strong but diffuse light source. Methylene iodide (di-iodomethane) is the best liquid, but water or glycerine are also suggested.

Geuda rough, which fails heat treatment to improve colour, is being fashioned and then given this blue-diffusion treatment. The stones are natural but the thin layer of colour has been diffused synthetically and should be declared as such. Any subsequent repolishing or re-cutting would largely remove it. R.K.M.

Kane, R.E., Kampf, A.R., Krupp, H., 1990. Well-formed tsavorite gem crystals from Tanzania. *Gems & Gemology*, **26**, 2, 142-8, 7 figs in colour.

Euhedral crystals of tsavorite are extremely rare, but H. Krupp obtained several while on a visit to Tanzania. The gem is found in association with tanzanite on both sides of the border with Kenya.

Gemmological properties are described, with emphasis on the perfection of these crystals from the Karo-pit in the Merelani Hills. Stones up to 14 carats have been cut. R.K.M.

Koivula, J.I., Kammerling, R.C., 1990. An unusual Indian aquamarine. *Australian Gemmologist*, **17**, 7, 270-2, 5 figs.

Found near Kangyam in Madras, this 41 ct aquamarine had constants within the normal range for the material, with faint but anomalous absorption and strong pleochroism. Parts of the stone are so strained that they show biaxial figures with the conoscope. R.K.M.

Koivula, J.I., Boehm, E., Kammerling, R.C., 1990. Diamond grit-impregnated tweezers: a potentially destructive gemological tool. *Gems & Gemology*, **26**, 2, 149-51, 6 figs in colour.

Demonstrates the considerable damage done to a ruby rotated just once with its table in contact with these tweezers, which are unsuitable for any stone other than diamond, and even that can be scratched! R.K.M.

Koivula, J.I., Kammerling, R.C., 1990. Gem news. *Gems & Gemology*, **26**, 2 159-68, 16 figs in colour.

Research for new synthetic materials of equivalent hardness to diamond calculates that a carbon nitride would have almost the same bulk modulus. A plant set up at Ipoh in Malaysia by Belgian companies is processing 900,000 diamonds a year; Botswana produced 13 million carats in 9 months of 1989, a new crushing plant at Jwaneng comes into use soon. Intraco of Singapore join Russian Almaz to deal in diamonds, coloured stones, etc; a new Angolan field at Lucapa is being prospected; Argyle are training cutters near Beijing, China, to process Australian diamonds; kimberlite pipes are being drilled for diamond potential in Michigan; a joint Swiss/Sri Lankan project will cut diamonds and coloured stones at Katunayake free trade zone; Mwadui mine, Tanzania, is expected to run out in nine years and they are searching for more diamond pipes; Australian Molopo are prospecting for diamonds and gold in Botswana by aeromagnetic methods.

Coloured stones

A glass-capped plume agate doublet is described in detail; light emerald-green tourmaline from Paraíba, Brazil, and greenish-blue apatite, claimed to come from the same area, seen at the Tucson Show, but apatite most likely Madagascan; some bluish-green apatite was sold as emerald in Kenya; zoned white and green chrysoprase from Goias, Brazil, investigated and found to fluoresce greenish-blue in UV light, chrysoprase is normally inert; good quality jadeite exists in Niigata, Japan, in green, blue, purple, black and white but little is mined owing to inaccessible terrain and bad climate, other deposits in Hokkaido and Hyogo prefecture also not exploited.

Idaho opal is assembled as cat's-eye triplets, with quartz or glass tops and chalcedony backs; San Carlos Indian Reserve, Arizona, produces about 600 kg cabochon grade peridot a month, October to March, too hot other months, 15 kg small sizes are facet grade; a Patagonian Jurassic chalcedony fossil pine cone is illustrated; while at Chantaburi, Thailand, Dr H.A. Hänni of Switzerland, saw ruby rough reportedly from Vietnam, similar to Burmese, Pakistani and Afghan material – he feels that heat treated this might rival Burma or East African ruby.

A quartz, opal and pyrite rock found near Lafayette, Louisiana, gives cabochons speckled with play of colour; a yellowish-brown chatoyant topaz was the first seen by News editors; Hector Barbosa tells of his discovery of the Paraíba tourmaline mine. Some tourmaline cat's-eyes examined in Idar proved to be doublets, clear tourmaline cemented to fibrous tourmaline base; they also report assembled bi-colour tourmalines.

Synthetics and simulants

Plastic cameos with backs misshapen like shell cameos are illustrated; 'emerald' crystals from S. Africa were quartz with green cementing agent, coated with limonite and mica flakes, RI as for quartz, spectrum indicated a dye similar to that used for stained jadeite, bubbles in soft cement and a piece of emerald included in one 'crystal', these were similar to fakes described earlier by Dr Hänni; 'rhodochrosite' beads, bought in Mexico, were massive calcite, dyed pink, which left traces on an acetone swab. R.K.M.

Koivula, J.I., Kammerling, R.C., 1990. Gem news. *Gems & Gemology*, **26**, 3, 228-38, 15 figs in colour.

Diamonds

News from Brazil; Botswana; Sierra Leone; Australian prospecting in Hunan, China; Goa; India; Borneo; of Sri Lankan investment; Thai auction of smuggled diamonds; new find of diamonds near Archangel'sk; Soviet visit to Israel cutting plant; Israeli cutting in Warsaw and Bucharest, and widespread diamond exploration in Australia.

Coloured stones

A fossil mushroom found in amber from The Dominican Republic is an estimated 40m years old and the best one known; a greenish-blue cat's-eye apatite is said to be a new variety; Zimbabwe emerald mines are described; unusual greyish-brownish-green chatoyant cabochon was identified as diopside, and a fine iolite cat's-eye is described and illustrated.

A team of geologists have investigated Inner Mongolia, China, and report many gem sites of commercial significance.

A chatoyant opal was unusual in being a true cat's-eye, with weak pleochroism; a chatoyant scapolite had two weaker light bands which make it effectively a star stone; an unusually carved tanzanite is illustrated before and after heating to a blue colour; a rare tanzanite cat's-eye is also depicted; the sugilite mine near Kuruman, S. Africa, is increasing production.

Aqua aura gold-film bluing of faceted gems is now a commercial process; Mexican opal coated with dark plastic on one side to enhance the play of colour on the other, is described and the coating illustrated; and another opal had been sugar-treated and the entire stone coated with plastic, thicker on the base where an RI of 1.56 was obtained.

Synthetics and simulants

Prof. P.O. Knischka of Steyr, Austria, reports producing synthetic ruby crystals over 5cm long, capable of yielding cut stones of 67 carats, a half crystal of accordion-like stepped growth is illustrated and said to have glassy two-phased inclusions and platinum platelets, colours available – light, medium or dark Burmese or Thai purple.

A fake emerald originating in Madagascar was submitted to Jean-Paul Poirot of the Paris laboratory, who identified it as green fluorite roughly shaped to a hexagonal prism and cemented to tourmalinized rock by plastic mixed with mica, M. Poirot points out that green fluorite has a similar absorption to emerald and is pink through the Chelsea filter, but it fluoresces violet with LWUV and the cement fluoresced yellow/white.

A carved 'jade' sphere from Hong Kong proved to be a calcite/serpentine rock which had been selectively dyed in various shades of green and brown, and then waxed. R.K.M.

Kopf, R.W., Hurlbut, C.S., Koivula, J.I., 1990. Recent discoveries of large diamonds in Trinity County California. *Gems & Gemology*, **26**, 3, 212-19, 7 figs in colour.

Former geologist and miner, Edgar J. Clark, found four large diamonds of record sizes for California in alluvial sand and gravel of the Hayfork Creek tributary of Trinity River, Northern California, in the late 1980s. Weights 3.90, 14.33, 32.99 and 17.83, they were named Jeopardy, Serendipity, Doubledipity and Enigma, and were complex twinned crystals with encrusted faces, none of cuttable quality, but smaller gem quality stones have been found when placer mining for gold and platinum group minerals in that area. R.K.M.

Kovacs, E., 1990. Letter. Preliminary assessment of gem identification system (GIS) software. *Australian Gemmologist*, **17**, 7, 276-7.

Argues case for computerized system. Editorial comment points out that expert computer programming cannot substitute for training and experience. R.K.M.

Linton, T., 1990. Radiation alert. *Australian Gemmologist*, **17**, 7, 278.

Some Meltler balances B5, B6, and M5 imported into Australia before 1960 have been found to contain radium 226, but are unmarked as radiation hazards. They should be withdrawn for expert decontamination. R.K.M.

Linton, T., Brown, G., 1990. Medo Hand vacuum tweezers, model MH-100 and Linicon LV-125 vacuum pump. *Australian Gemmologist*, **17**, 7, 272-3, 2 figs.

A new approach to the problem of stones which fly from conventional tweezers. Works well sucking stones into a close hold, and blowing loose dust from instruments. Weight 1.2 kilos, price $A295, efficient but at DbA 60 at 1 metre, noisy! R.K.M.

Mitchell, R.K., 1990. Letter to the editor. *Australian Gemmologist*, **17**, 7, 275.

A further note on the word 'profilated' in reference to 'profiled' bubbles in some synthetics, pointing out that it was coined by our late and very good friend Basil Anderson, and not by Robert Webster, another excellent but regrettably deceased friend. (Author's abstract) R.K.M.

Schmetzer, K., 1990. Hydrothermally grown synthetic aquamarine manufactured in Novosibirsk, USSR. *Gems & Gemology*, **26**, 3, 206-11, 9 figs in colour.

A single specimen of Russian synthetic aquamarine described in careful detail, had constants within the normal range for natural material, but nickel from the stainless steel crucible was detected by spectrophotometer, while infrared spectroscopy proved hydrothermal origin. Tested stone contained many tell-tale inclusions which reduce its acceptability as a gem. Absence of significant amounts of sodium and magnesium also indicated synthesis. R.K.M.

Trioani, T., 1990. Rare-earths. *Australian Gemmologist* **17**, 6, 235-6.

A brief account of the so-called 'rare earth' elements. R.K.M.

Book reviews

HUGHES, R.W., 1990. *Corundum.* (Butterworth Gem Books.) Butterworth-Heinemann, London. pp. xviii, 314. Illus. in black-and-white and in colour. £35.00.

Presumably out of deference to the importance of the material described, this is a larger work than the others from the same Butterworth stable. This is one of the few monographs dedicated to a particular species to be published in English during this century and is welcome on that score alone. The first chapter deals with the history of corundum, with reference to early literature and, like succeeding chapters, includes its own bibliography. The second chapter describes chemistry and crystallography and here it is pleasing to see text diagrams taken from Goldschmidt's *Atlas der Krystallformen*; in this book the Goldschmidt diagrams have been relabelled and improved for the modern reader. Most gem monographs, for space reasons, have to be sparing with this kind of illustration and they are both useful and relevant here.

The book continues with physical and optical properties with useful notes on thermal expansion and thermal conductivity, optical properties, colour, luminescence, absorption spectra (with notes on the use of the hand spectroscope) and pleochroism. The effect of pleochroism on cutting is well illustrated by text diagrams.

The chapter on inclusions follows and again black-and-white photographs and text figures help the reader even when he has the Gübelin inclusion books. Thai corundum is described particularly closely and since some of this material is the subject for enhancement this is a valuable feature here. Diagrams also show how primary fluid inclusions may be trapped in gemstones and illustrate zonal primary liquid inclusions; the healing of a crack is also usefully depicted.

Nearly thirty pages are devoted to corundum enhancement and the reader will turn eagerly to this section in a book emanating from Thailand where so much treatment is carried out. Five major processes are listed for the heat treatment of corundum: they are removal of silk, development of silk, development of a blue colour from colourless material, removal of blue colour (the lightening of over-dark sapphires and the removal of the blue component from yellow-green sapphires to give a fine yellow) and development of yellow colour from white or pale yellow, mainly Sri Lanka material. The author makes the point that his information is second-hand and speculatory – this is, of course, for reasons of commercial secrecy on the part of those carrying out the treatments. One anecdote illustrates the dangers of treatment – read the book to find out the details! After describing irradiation and other forms of treatment the author outlines current thinking on disclosure.

Synthetic and composite corundum are described in chapter seven which is particularly exhaustive and contains a good bibliography. Fashioning is described in the next chapter and after sections on quality, famous stones and classification, we come to the geology of corundum and notes on world deposits. It should be said that the section on classification contains a great deal of information, particularly on Thai classification, not previously published and most interesting. Preference of different societies for particular colours is most valuable for dealers in corundum.

In the section on world deposits the history of the deposits is given as well as the current situation so far as this is known at the time of writing. Even better, different localities are given their own bibliography. The book ends with an index.

This is a first-class book, well-printed and quite well bound. All gemmologists should buy a copy.

M.O'D.

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

OBITUARIES

It is with great regret that we announce the death of **Sir Frank Claringbull, Ph.D., F.Inst.P., FGS**, on 23 November 1990, President of the Association and an Examiner for many years. A full obituary will be published in the April 1991 issue of *The Journal*.

Mr Albert ('Bert') C. Colclough, FGA (D.1964), Rainham, died in October 1990.

Miss Jean G. Lumsden, FGA (D.1951), Edinburgh, died on 12 October 1990.

NEWS OF FELLOWS

Mr Michael O'Donoghue spoke on gemstones to the South East Branch of the National Association of Goldsmiths on 18 October 1990 and to the Sevenoaks Hard of Hearing Club on 27 November 1990.

Dr R.M. Key and Mr J.O. Ochieng gave a lecture on 'Green garnets and blood-red rubies: a girl's best friend in East Africa' at the British Geological Survey, Edinburgh, on 17 December 1990.

MEMBERS' MEETINGS

London

On 14 November 1990 at the City Conference Centre, Mark Lane, London, Mr John I. Koivula, FGA, Chief Gemologist of the Gemological Institute of America, gave an illustrated lecture entitled 'Recent developments and observations in gemmology'.

Midlands Branch

On 26 October 1990 at the Society of Friends, Dr Johnson House, Colmore Circus, Birmingham, Mr Alan Hodgkinson, FGA, gave a lecture entitled 'Leave the moth in the diamond'.

On 16 November 1990 at the Society of Friends Mr Roy Huddlestone gave a lecture entitled 'The Cobra emerald mine in the Transvaal'.

North West Branch

On 17 October 1990 at Church House, Hanover Street, Liverpool, Mr Kenneth Scarratt, FGA, gave a talk on the work of the Gem Testing Laboratory.

On 21 November 1990 at Church House the Annual General Meeting of the Branch was held, at which Mr W. Franks, FGA, and Mrs Irene Knight, FGA, were re-elected Chairman and Secretary respectively.

ANNUAL GENERAL MEETING

On 29 October 1990 at Goldsmiths' Hall, Foster Lane, London EC2, the Annual General Meeting of The Gemmological Association and Gem Testing Laboratory of Great Britain was held.

Mr V.P. Watson, FGA, chaired the meeting, and welcomed members to the first Annual General Meeting of the joint company. Mr Watson reported that the Laboratory had given a first class service during the year, including gem testing, diamond grading and consultancy work. Negotiations had taken place during 1989 for the Laboratory to be able to provide GIA Diamond Certificates, and this service came into operation in October of that year. The Chairman thanked David Callaghan and Ken Scarratt for the tremendous amount of work they had undertaken during the year, particularly in connection with the proposed merger between the Gem Testing Laboratory and the Gemmological Association.

The Annual Report and Accounts were approved and signed.

Sir Frank Claringbull and Mr R. Keith Mitchell were re-elected President and Vice-President respectively.

Messrs D.J. Callaghan, N.W. Deeks, N.B. Israel, E.A. Jobbins, I. Thomson, V.P. Watson, K. Scarratt and Dr R.R. Harding, were re-elected to the Council of Management.

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

REUNION OF MEMBERS AND PRESENTATION OF AWARDS

Fig. 1. Tully Medallist Kathryn Anne Jarvis, receiving her award from Mr Eric Bruton.

The Annual Reunion of Members and Presentation of Awards was held on 29 October 1990 at Goldsmiths' Hall, Foster Lane, London EC2. Mr David Callaghan presided and welcomed those present, which this year included award winners from Canada, Finland, France, Greece, India, Kenya, The Netherlands, Spain, Switzerland and the USA. Mr Callaghan thanked the Worshipful Company of Goldsmiths for allowing the Presentation to be held once again in Goldsmiths' Hall, which had been closed for the past two years for refurbishment.

Mr Callaghan reported that the 1990 Examinations had been held at 61 centres in 24 countries.

Mr Callaghan then introduced Mr Eric M. Bruton, FGA. He said that as well as being Editor of the *Retail Jeweller*, the author of *Diamonds* and other books related to the jewellery trade, Mr Bruton has also written many books on crime. He has been an Examiner for the Association for a number of years, and has done a tremendous amount of work on the new Diamond Course. After making the presentations, Mr Bruton delivered the address which is printed below.

The vote of thanks was given by Mr Noel Deeks.

ADDRESS BY MR ERIC M. BRUTON, FGA

'It is a pleasant experience to be faced by so many successful people. You're lucky too. Not, of course, to have passed your examinations. I know you had to work hard to do that. As if we didn't know it, it was confirmed to me in an unlikely way last week.

'I was on a course. Nothing to do with gemmology. No one there knew I had any connection with it, or even what I did for a living. At lunch one day, I was talking to the man next to me. From Northumberland he was. He said: "I don't suppose you've ever heard about it, but there's a thing called gemmology" (he called it gem-nology, like most people who never heard of it). He went on to say that he'd been sailing and one of the crew was taking an examination. It was terribly hard, there were so many different subjects and he'd failed the first time. I think he must have succeeded this time and is possibly here tonight.

'I mention this for two reasons. The first is that knowledge of gemmology is spreading, albeit very slowly. It is shown by the people who now come on gemmology courses. You would of course expect those connected with the jewellery trade. And all those directly related, like jewellery designers, craftsmen, manufacturers and lapidaries. And those to whom a knowledge is valuable, dealers and brokers. Also related are geologists and mineralogists, even archaeologists. We've had a scientific worker in a government archaeological laboratory. We've had antique dealers, auctioneers, diamond sorters, insurance assessors, as well as the true amateurs who have discovered the spell of gems but otherwise have no connection with them or with jewellery.

'Oh, I forgot Customs officers! Way back in the 1960s, my wife and I were invited to stay with some tea broker friends in Ceylon. Naturally I took the chance to visit as many mines and gemmologists as possible. One day I was introduced to a prominent jeweller and gem dealer in Colombo. I asked him if he had a padparadschah sapphire as I'd never seen one. "Yes", he said, "yes I have". But I'd have to come back another day to see it. I supposed it was in a safe deposit elsewhere. But he continued, "If you are coming back tomorrow, you can see it then. Today it is under the floorboards... This afternoon we are having a *secret* raid by the Customs Department."

'A day or two later we were having breakfast when the 'phone rang. My friend said, "It's for you. The Chief Customs officer, Mr Da Silva. Can you go and see him this afternoon?" A nasty shock for breakfast time. Naturally I thought there had been some mistake, but couldn't imagine what I'd said or done to interest the Customs. Except that I'd been asking a lot of questions about 'FEECS', a government scheme to encourage exports by letting the exporter retain some hard currency. I'd found out how some unscrupulous gem dealers were recycling the same parcels of gems to change large sums of rupees into dollars or pounds. Anyway I went. Mr Da Silva was friendly, which was a relief. He' heard I was on the Council of the Gemmological Association. I have absolutely no idea how. He led me into another room where there were, I think, eight of his officers lined up. He introduced them one by one. Every one of them was an FGA! He said there were more FGAs in Customs than in the whole of the gem trade in Ceylon!

Fig. 2. Anderson/Bank Prize winner Susan Clark.

Fig. 3. The Rayner Diploma Prize winner Michele Corne Halstenbach.

Fig. 4. The Rayner Preliminary Prize winner Spencer Benham.

'A sequel was that the padparadschah jeweller asked me to swap a refractometer for an ancient bronze statue of Queen Kuveni. His youngest son was taking the Association's correspondence course and couldn't get a refractometer because of the exchange restrictions! I did of course. His son got his FGA and I've still got Queen Kuveni.

'Probably the most dedicated gem student ever was a Japanese. What we call a "mature student". To study for his gemmology exams in London, Mr Nemoto left his wife in charge of his jewellery shops in Japan for around four years, only returning occasionally. Apparently in Japan, the basic English course teaches the letters of the alphabet and how to write and understand words and sentences. If you want to speak English, you have to take another course. Mr Nemoto had only done the first course. So he couldn't really talk to anyone and certainly couldn't understand the lecturers. He made friends with some of the other students and used to copy out their notes in the evenings. A big problem was understanding diagrams. But he graduated, became an FGA, and went on to get his Diamond Diploma. Later he wrote out his impressions of Britain and the courses in longhand and had photocopies bound, which he brought to some of us who had instructed him. He still couldn't speak a sentence. One inexplicable diagram in the book was a cross-section of the Scottish Highlands. Perhaps he got it mixed up with his inclusions!

'Many outsiders are surprised at the varied subjects, a basic knowledge of which is needed for exams in gemmology. They may well be qualified in one or another of them.

'I said at the beginning that I was on a course last week and had another point to make. Having got through the basics, it's much easier to keep on learning. Don't let it drop. Read the journals, take other courses if you can. Above all keep asking questions of people who're supposed to know. Very often you'll find they don't. So try to find out for yourself. It's surprising how a simple question about something we take for granted can open up a surprising number of doors. I had that experience a couple of years ago. When you're examining a diamond, at certain angles you get an intense flash of light. Anyone who grades diamonds has seen it. I tried to work out how this happened in some detail but got into trouble, so I asked a specialist on the behaviour of light. A few days later he rang back to say it wasn't as simple as it had first appeared. The cause of the flash was very complex and involved with the two planes of polarization. So he was writing a scientific paper about it. You can ask questions like that. Commercial as well as scientific ones.

'You never can stop learning. Don't think for a moment you're 'there' when you get your diploma. Above all you will begin to find that learning is very enjoyable and you never, never, get bored. You young people have a bigger incentive to learn than any past generation. If you've read your newspapers you'll know that there is a rapidly increasing demand for skilled younger people in business. This will continue into the foreseeable future. More than ever before, those who succeed are those who have *learned how to learn.*

'Well, I hope you hear and note what I say. There is only one absolute certainty in this world. Everything CHANGES. It is the only fact you can rely on absolutely. That means you have to change too. On that note, it only remains to wish you well and every success from all of us.'

GEM DIAMOND EXAMINATION 1990

In the 1990 Gem Diamond Examination 41 candidates qualified, 4 with Distinction. The names of the successful candidates are as follows:

Qualified with Distinction

Bourdillon, Catriona, London.
Plumb, Helen L., London.
Ruiz Belver, Antonio J., Barcelona, Spain.
Vidal Ramia, Enriqueta, Barcelona, Spain.

Qualified

Andrews, Suzanne, London.
Arnau Graus, Concepio, Barcelona, Spain.
Arranz Garcia, Felix, Barcelona, Spain.
Barbara Sole, Rosa, Barcelona, Spain.
Barrabes Lacarda, Silvia, Barcelona, Spain.
Bassioudis, Vassilis, Thessaloniki, Greece.
Bauco, Robert, London.
Blasco Jimenez, Josep, Barcelona, Spain.
Bofill Montoro, Ana, Barcelona, Spain.
Boira Roges, Berta, Barcelona, Spain.
Caycedo, Miguel J., Ilford.
Duckett, Karen L., Long Preston.
Ferguson, Neil F., Balloch.
Fuller, Mark R., London.
Garcia Ferrandiz, Javier, Barcelona, Spain.
Garty, Anne M., Dundee.
Hossen, Iqbal H., Mauritius.
Hughes, David J., Cardiff.
Isern Truy, Enric, Barcelona, Spain.
Jain, Sanjay, Southall.
Keys, Malcolm H., Manchester.
Laborda Ferrer, Ma Angeles, Barcelona, Spain.
Law, Patricia M., London.
Lazaro Anglada, Ma Jose, Barcelona, Spain.
MacKinnon, Amanda L., Birmingham.
Mariona de Urquijo, Victoria E., Barcelona, Spain.
Meigh, Melanie J., London.
Morris, David C., Whitfield.

Osborne, Sean J., London.
Patel, Pankajkumar, Manchester.
Santacreu Rull, Montserrat, Barcelona, Spain.
Taylor, Richard P., Shrewsbury.
Usechi Espinosa de los Monteros, Amp, Barcelona, Spain.
Vataru, Monica, London.
Velaz Azpilicueta, Mercedes, Barcelona, Spain.
Vildiridis, Athanassios, London.
Worthington, Sally L., Bradford.

EXAMINATIONS IN GEMMOLOGY 1990

In 1990 Examinations in Gemmology, 551 candidates sat the Preliminary examination, 335 (61%) of whom qualified, 398 candidates sat the Diploma examination and 197 (49%) qualified, 10 with distinction.

The **Tully Medal** for the candidate who submits the best set of answers in the Diploma examination which, in the opinion of the Examiners are of sufficiently high standard, was awarded to Kathryn Anne Jarvis of Vancouver BC, Canada.

The **Anderson/Bank Prize** for the best non-trade candidate of the year in the Diploma examination was awarded to Susan Clark of London.

The **Rayner Diploma Prize** for the best candidate of the year who derives her main income from activities essentially connected with the Jewellery trade, was awarded to Michele Corne-Halstenbach of Geneva, Switzerland.

The **Anderson Medal** for the best candidate of the year in the Preliminary examination was awarded to Nicholas Nicolaidis of Harare, Zimbabwe.

The **Rayner Preliminary Prize** for the best candidate under the age of 21 years on 1st June 1990 who derives his main income from activities essentially connected with the Jewellery trade was awarded to Spencer Benham of Isle of Man.

DIPLOMA

Qualified with Distinction

Aryatilake, Bamunuarachchige, Maharagama, Sri Lanka.
Clark, Susan W., London.
Corne-Halstenbach, Michele, Geneva, Switzerland.
Huegi, Michael F., Gumligen, Switzerland.
Jarvis, Kathryn A., Vancouver, Canada.
Marcos-Pascual, Celia, Oviedo, Spain.
Pyzowski, Carl C., Frackville, Pa., USA.
Rodriguez-Fernandez, Margarita, Ujo-Asturias, Spain.
Vorasaph, Tracy, Bangkok, Thailand.
Willmott, Keith R., Colombo, Sri Lanka.
Weixuan, Yen, Wuhan, China.

Qualified – UK

Anver, Mohamed F., London.
Baldock, Janine R., London.
Barker, Damon A.N., Winchester.
Bing, Sara V., Exeter.
Bowler, Simon R., Birmingham.
Burt, Peter O.K., Deal.
Byrne, David M., Birmingham.
Charatan, Ivan L., London.
Cloke, Deborah J., Sevenoaks.
Colomb, Nanette D., London.
Copestick, Bruce J., Harpenden.
Davidson, Anthony, Newcastle on Tyne.
Dietz, Susanne C., Birmingham.
Downer, Martyn D., London.
Edwards, Susan M., London.
Farrett, Kirsten J., Dover.
Farthing, Russell, Colchester.
Fitzmaurice, Karl M., Glenamaddy.
Gademsetty, Subba R., London.
Gibson, Bracken G., London.
Green, Sheila M., Glasgow.
Henry, John M., Bolton.
Hinds, Andrew F., Rickmansworth.
Hollanders, David J., Maidenhead.
Inkpen, Michael S., Kingsbridge.
Jhaveri, Devang, London.
Jones, Colin P., Birmingham.
Johnston, Paul W., Belfast.
Jordan, Lynn P., Manchester.
Komppa-Vigar, Leena, Ampthill.
Lamb, Lois N., London.
Lancaster, Wendy, London.
Levy, Aaron N., London.
Lithiby, Jonathan P., Kingston-upon-Thames.
Liyanage, Don C.S., Ashford Common.
Lloyd, Susannah M.D., Chester.
Lynch, Kieran J., Coventry.
Mallett, Gillian E., Cambridge.
Mann, Alexandrina E., Nottingham.
Matthews, Lisa J., Winchester.
Meigh, Melanie J., Painswick.
McCosh, Samuel M., Birkenhead.
Offord, Philip A., Chandlers Ford.
Oldershaw, Caroline J.E., Penn.
Parkhill, Melanie J., Broadway.
Pettigrew, Louise, Eaglesham.
Platt, Karen K., London.
Rackley, Trevor, Wantage.
Ripley, Thomas, Stockton-on-Tees.
Sanson, Steven N.J., London.
Saywell, Neil, Nottingham.
Shammas, Siham, London.
Sim, Evelyn, Singapore.
Sinclair, Lesley, Stenhousemuir.
Smith, Karen, Dewsbury.
Smookler, Sheryl, London.

Spencer, Stephen R., Nottingham.
Spink, Michael C., London.
Tock, Graham B., Hull.
Van Heesewijk, Jacqueline, London.
West, Kenneth J., Hove.
Wilson, Nean E., Longniddry.
Woodham, Sharon, Lichfield.
Wright, John C., Solihull.
Wright, Michael J., Watford.

Qualified – Overseas
Alejo, Diedre K., Kowloon, Hong Kong.
Argirakou, Ioulja, Volos, Greece.
Aulosalo, Liisa, Eura, Finland.
Beentjes, Theodorus P.C., Uitgeest, The Netherlands.
Berlioz, Roger F., Kandy, Sri Lanka.
Bernad Soria, José M., Zaragoza, Spain.
Carlos Bertolin, Marti, Barcelona, Spain.
Bolaño Cid, Jordi, Barcelona, Spain.
Boyer, Alice M., Silver Spring, Md., USA.
Bubshait, Ahmed I., Manama, Bahrain.
Canty, Gavin, Papatoetoe, Auckland, New Zealand.
Cardó Sabater, Elisabeth, Barcelona, Spain.
Carter, Maurice W., Toronto, Canada.
Casas Royo, Jose A., Alfaro (La Rioja), Spain.
Cases Canes, Josep R., Barcelona, Spain.
Chan, Lais Sim Luisa, Hong Kong.
Chen Xiugin, Wuhan, China.
Chow, Marianne, Toronto, Canada.
Chu, Sin Yi Christine, Kowloon, Hong Kong.
Cogan, Joanne M., Omaha, Nebraska, USA.
De Jonge, Martin L., Nieuwegein, The Netherlands.
De Kam, Anneke, Rotterdam, The Netherlands.
Désir Valén, Aline, Zaragoza, Spain.
Dorab, Brian I., Hong Kong.
Druguet Torner, Maria E., Barcelona, Spain.
Einstoss, Philip M., Toronto, Canada.
Farkas, Susan, Vancouver BC, Canada.
Fernandes, Bevelyn E., Bandra, Bombay, India.
Fu, Lintang, Wuhan, Hubei Province, China.
Fung, Wai-Yin, Hong Kong.
Gini, Aspasia, Byron, Athens, Greece.
Gonzalez, Marie C.Y., Hong Kong.
Goyal, Sanjay S., Bombay, India.
Gunaratne, Ananda Lakshman, Kundasale, Sri Lanka.
Hayakawa, Taketoshi, Kanagawa Pref, Japan.
Holen, Yvonne, Utrecht, The Netherlands.
Hoogeboom, Paulus Nicolaas, Hoogland, The Netherlands.
Huerta, Sanchez Ana Ma, Barcelona, Spain.
Hui, Wah Kam, Kowloon, Hong Kong.
Hui, Wai Kwong, Hong Kong.
Hung, Chi Ling Vivian, Hong Kong.
Ip, Ting Cheong, Kowloon, Hong Kong.
Ishikawa, Noriko, Koto-ku, Tokyo, Japan.
Janse, Theodora J., Schiedam, The Netherlands.
Javeri, Anjali J., Bombay, India.
Jhaveri, Hina Sushil, Bombay, India.
Jinbo, Kazuko, Kita-ku, Tokyo, Japan.
Jones-Brunet, Catherine, Mississauga, Ont., Canada.
Jones-Napier, Pennye K., Washington DC, USA.
Jordi, Ibañez, Pueyo, Barcelona, Spain.
Kangas, Anne K., Helsinki, Finland.
Kermorgant-Abily, Claire, Hong Kong.
Kinev, Kathryn A., Atlanta, Ga., USA.
Kung, Kwai, Kowloon, Hong Kong.
Lai, Sau Ha Melody, Kowloon, Hong Kong.
Lai, Tik Shan Sana, Hong Kong.
Lam, Yick Man Raymond, Kowloon, Hong Kong.
Lamahewa, Ranjith, Idar-Oberstein, Germany.
Lees, John A., Waterford, VA, USA.
Leong, Kei Tong, Hong Kong.
Liao, Xiangjun, Wuhan, Hubei Province, China.
Li, Yali, Wuhan, Hubei Province, China.
Lo, Mun Shan Ivy, Hong Kong.
Lonka, Valtteri, Kuopio, Finland.
Lopezi Gracia, Anna Ma, Barcelona, Spain.
Lui, Kin Wah Kelvin, Hong Kong.
Luzondo Olea, Blancanieves, Barcelona, Spain.
Ma, Kiu Chu Kitty, Kowloon, Hong Kong.
Martinez Bautista, Santiago, Barcelona, Spain.
Matsumoto, Tamio, Minato-Ku, Tokyo, Japan.
Montgomery, Richard S., South Sathorn, Bangkok, Thailand.
Moreno Rastrero, Eduardo, Logroñ, Spain.
Mustchin, Vivienne, Birkdale, Auckland, New Zealand.
Naken, Tomoko, Kita-Ku, Tokyo, Japan.
Nazareth, Christopher T., Bombay, India.
Oza, Bhagvat M., Bombay, India.
Paez Martinez, Ma Lluisa, Barcelona, Spain.
Pandya, Neesha N., Bombay, India.
Parker, Duncan, Toronto, Canada.
Patterson, Debra A., Toronto, Canada.
Pehkonen, Kaarina A., Helsinki, Finland.
Perez Barrera, Jose Luis., Barcelona, Spain.
Porebska-Brozyna, Dorota., East Rutherford, NJ, USA.
Premarathna, Hennayake M.S., Maharagama, Sri Lanka.
Qi, Lijian, Wuhan, Hubei Province, China.
Ranatunga, Wasla M.T.K.B.R., Idar-Oberstein, Germany.
Ratnakumara, Dodangodage, Nugegoda, Sri Lanka.
Reveliotis, Christos, Athens, Greece.
Roberts, Anne M., Kowloon, Hong Kong.
Rudolphij, Willemiene P.C., Schoonhoven, The Netherlands.

Ruiz Domenech, Anna M., Torredembarra, Spain.
Schell, Martin A., Nonthaburi, Thailand.
Seufert, Karin G., Amsterdam, The Netherlands.
Shah, Anurag D., Nairobi, Kenya.
Shibata, Hirofumi, Osaka, Japan.
Skilton, Margaret, Pakuranga, Auckland, New Zealand.
Soung, Min Hee, Busan, Korea.
Suno, Michiko, Kobe-City, Hyogo Pref, Japan.
Tan, Min, Wuhan, Hubei Province, China.
Temelcoff, Catherine F., Toronto, Canada.
Terpilak, Thomas J., Bethesda, Md., USA.
Tuovinen, Petri, Kouvola, Finland.
Tsui Hiu Ying, Jeanie, Kowloon, Hong Kong.
Ueta, Kohei, Kochi-Ken, Japan.
van Acker, Alain A.A.M., Tilburg, The Netherlands.
Vakil, Hetal H., Bombay, India.
Vartiainen, Risto K., Rovaniemi, Finland.
Vela Clemente, Fernando, Binefar, Spain.
Velthuizen, Irmine H.S., Arnhem, The Netherlands.
Vilabella Fernandez, Ramon, Barcelona, Spain.
Wang, Manjun, Wuhan, Hubei Province, China.
Weston, Amy L., Baltimore, Md., USA.
Wong, King Suen, Kowloon, Hong Kong.
Wright, Wendy E., Toronto, Canada.
Wu, Haiou, Wuhan, China.
Yau Wai Ling, Janet, Hong Kong.
Zeeman, Walentin, Bunnik, The Netherlands.
Zhang, Liangju, Wuhan, Hubei Province, China.
Zoeter-Johannes, Simon, Rotterdam, The Netherlands.
Zugazagoitia Urresti, Aitor, Durango, Spain.

PRELIMINARY

Qualified – UK

Adams, Suzanne, Sutton.
Adams, Philip J., Staffordshire.
Allani, Magda, London.
Anderson, Nicola M., Falkirk.
Antoniou, Lucas G., Barnet.
Anver, Mohamed F., Harpenden.
Arnull, Edward E., Romford.
Bailey, David E., London.
Bailey, Lisa J., Birmingham.
Balducci, Annette L., Neston.
Ball, Chantal, Cheltenham.
Ball, David J., Cheltenham.
Barrett, Nicola J., Sutton-in-Craven.
Benham, Spencer H., Onchan, Isle of Man.
Blackwell, Barry Q., Bexhill-on-Sea.
Boyd, Heather K., Manchester.
Bradley, Michelle A., Norwich.
Briggs, Harry J., London.
Burgess, Ian D., London.
Corrall, Corrall E., London.
Clark, Susan W., London.
Clayton, Paul N., Wetherby.
Cochran, Marian E., Blackpool.
Collins, Heather, Coatbridge.
Collins, Stephanie, New Malden.
Colomb, Nanette, London.
Combe, Ian, Haddington.
De Silva, Nihal G., Mitcham.
Dietz, Susanne C., Kidderminster.
Duff, Wayne A., Harrow.
Durlacher, Noel H., London.
Euangelou, George C., Enfield.
Flint, Sara E., Leeds.
Fromming, David E., Aylesbury.
Gademsetty, Subba R., Chigwell.
Gallagher, Aileen, Wolverhampton.
Gemmell, James, Havant.
Gordon, Mark I., London.
Graham, Barry D., Glasgow.
Grant, John, Colchester.
Grant, Miranda J., Edinburgh.
Green, Allan A., Oxford.
Green, Christopher M., Slough.
Hamilton, Sandra L., Southampton.
Hamp-Gopsill, David, Burton-on-Trent.
Hanafi, Safluat M., London.
Hare, Rebecca M.A., Fleet.
Hendry, Adrian L., Stansted.
Henn, Christopher J., Tong, Nr. Shifnal.
Henry, John M., Bolton.
Hering, Peter J., Cambridge.
Hills, Margaret A., Tonbridge.
Hobbs, Peter G.A., Lavenham.
Hopper, Geoffrey C., North Harrow.
Hunter, Charlotte T., Northampton.
Jain, Neerja, Birmingham.
Jones, Stephen W., Carnetown, Mid Glam.
Judd, Guy A., Peterborough.
Jupp, Thomas H., London.
Jurukov, Vasil, London.
Kejriwal, Bindu, London.
Khimji, Priti, London.
King, Margaret A., Glasgow.
Laklia, Andrew T., Greenhithe.
Laurie-Lynch, Carl A., Birmingham.
Leathley, Adam B.D., York.
Lee, Mary F.A., Addlestone.
Leonard, Anri B., London.
Lithiby, Jonathon P., Kingston Hill.
Long, Ann D., Colchester.
Lowe, David J., Colchester.
MacIntyre, Jacqueline N., Edinburgh.
Madden, Adrien M., Harrogate.
Mason, Alec J., Retford.
Matthews, Lisa K., London.
Michelson, Max J., Lincoln.
Mildenhall, Caroline, Kemp Town, Brighton.

Mistry, Dharmesh, London.
Mitchell, Beverly J., London.
Model, John E., Hatfield.
Moydakis, Vaji L., Burnage, Manchester.
Nash, Helen E., Slough.
Nishino, Kiyoshi, Canterbury.
Offord, Philip A., Chandlers Ford.
Ogden, Anne-Marie, Ealing.
Papaceit, Gloria B., London.
Patel, Pankaj, Wembley.
Pattni, Dipesh S., Loughborough.
Peh, Angeline, Birmingham.
Penton, Keith, London.
Plaxton, George A., Helensburgh.
Pointon, Laurence B., Edgware.
Pollard, Adrain N., Cheshire.
Redgrove, Claire A., Selsey.
Richards, Keith, Stoneleigh.
Richards, Stephen, Eastbourne.
Rigby, Lesley C., Bawtry.
Roberts, Amanda, Wirral.
Robinson, Nathan J., Birmingham.
Rogers, John W.S., Stroud.
Sabbagh, Samuel J., London.
Sabbagh, Steven E., Manchester.
Schmidt, Simon P., London.
Scott, Sarah L., Norwich.
Shah, Fatehchand J., London.
Share, Stella A., Harrow Weald.
Smith, Gerard J., Wargrave.
Syn, Lucy, London.
Taylor, Victoria A., London.
Tees, Audrey, Glasgow.
Thomas-Everard, Lucilla, London.
Vannet, Mary A., Dundee.
Vaughan, Michael, Budleigh Salterton.
Vause, Corinne J., Collingham.
Walker, James D., Edinburgh.
Waller, Mark S., Bradford.
Webster, Kathleen A., London.
Welch, Lizanne, Somerset.
Wells, Andrew, Caterham.
White, Alison P., York.
Williams, Alison D., Dorking.
Williams, Ruby, London.

Qualified – Overseas

Abel, Arlan R., Minneapolis, Minn., USA.
Alvarez-Palacios, Ester, Asturias, Spain.
Anastassiou, Evagelia, Maroussi, Athens, Greece.
Anderson, Ekaterini, Piraeus, Greece.
Au, Chung King, Hong Kong.
Au, Sze Yin, Hong Kong.
Bakayianni-Sa Bou, Aristea, Nikea Piraeus, Greece.
Bernaus Vidorreta, Isabel, Barcelona, Spain.
Bevoort-Alwicher, Terrence J., Nymegen, The Netherlands.
Blancardi-De Jong, Iris S., Sospel, France.
Bosque Moral, Luis, Barcelona, Spain.
Campos Novergues, Begona, Barcelona, Spain.
Casacuberta i Ramirez, Josefina, Barcelona, Spain.
Chan, Bonnie Suk Kwan, Hong Kong.
Chan, Catherine Siu Man, Kowloon, Hong Kong.
Chan, Chi Keung, Kowloon, Hong Kong.
Chan, Francis Chi Man, Kowloon, Hong Kong.
Chan, Keziah, Hong Kong.
Chan, Lai Sim, Hong Kong.
Chan, Rosana, Hong Kong.
Chan, Sok-Han, Hong Kong.
Chau, Kwong Lim, Shatin, NT, Hong Kong.
Cheang, Chong Nun, Hong Kong.
Chen Munoz, Cristina, Barcelona, Spain.
Cheng, Siu Hing, Kowloon, Hong Kong.
Ching, Wai Yai, Shatin, NT, Hong Kong.
Cho, Eun-Gyeong, Seoul, Korea.
Chow, Marianne, Toronto, Ont., Canada.
Chow, Tze Joak, Kowloon, Hong Kong.
Chui, Yiu Wing, Hong Kong.
Chiu, Fan Chuck, Hong Kong.
Chudawala, Sucheta, Bombay, India.
Chung, Tsz Kin, Kowloon, Hong Kong.
Clavero Monzon, Alfredo, Barcelona, Spain.
Compte Jornet, Javier, Barcelona, Spain.
Crespo Leal, Juan Gines, Barcelona, Spain.
Cusco Tortajada, Montserrat, Barcelona, Spain.
Daalmeyeer-Verheyden, Gertruda, Leiden, The Netherlands.
de Kok, H., Zandvoort, The Netherlands.
Desai, Suryakant C., Nairobi, Kenya.
de Winter, Rene G., Amsterdam, The Netherlands.
Dikken, Paulien G., Hilversum, The Netherlands.
Dimitriadis, Milko M., Rhodes, Greece.
Dong, Jianhua, Wuchang, China.
Dukel, Dorinda M., Giessenburg, The Netherlands.
English, Dora Pang, Kowloon, Hong Kong.
Escola Folguera, Montserrat, Barcelona, Spain.
Escola Folguera, Teresa, Barcelona, Spain.
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Garcia Lopez, Carmen, Barcelona, Spain.
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Vorasaph, Tracy, Bangkok, Thailand.
Wenting, Eduard J., Wehl, The Netherlands.
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Wong, Leong-Man, Kwun Tong, Hong Kong.
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Yam, Linda Lin-Fong, Shatin, Hong Kong.
Yang, Mingxing, Wuchang, Hubei Province, China.
Yu, Yim Tonet, Kowloon, Hong Kong.
Yung, Si Yau, Sheung Shui, Hong Kong.
Zhang, Linxia, Wuchang, Hubei Province, China.
Zho, Xinmin, Wuchang, Hubei Province, China.
Zhu, Huiyuan, Wuchang, Hubei Province, China.
Zugazagoitia Urresti, Aitor, Barcelona, Spain.

MEETINGS OF THE COUNCIL OF MANAGEMENT

On 26 November 1990 at 27 Greville Street, London EC1N 8SU, a meeting of the Council of Management was held at which the business transacted included the election to membership of the following:

Fellowship

Aryatilake, Bamunuarachchige L., Maharagama, Sri Lanka. 1990
Beentjes, Theodorus P.C., Uitgeest, The Netherlands. 1990
Byrne, David M., Birmingham. 1990
Canty, Gavin, Auckland, New Zealand. 1990
Carter, Maurice W., Scarborough, Ont., Canada. 1990
Chow, Marianne, Toronto, Ont., Canada. 1990
Chu, Sin-Yi C., Kowloon, Hong Kong. 1990
Cloke, Deborah J., Sevenoaks. 1990
Cogan, Joanne M., Omaha, NE, USA. 1990
De Kam, Antje J., Hazerswoude, The Netherlands. 1990
Farrett, Kirsten J., Dover. 1990
Farthing, Russell, Colchester. 1990
Fung, Wai Y., N.T., Hong Kong. 1990
Gonzalez, Marie C.Y., Hong Kong. 1990
Goyal, Sanjay S., Bombay, India. 1990
Hasan, Zia-ul, Toronto, Ont., Canada. 1989
Holen, Yvonne, Utrecht, The Netherlands. 1990
Hoogeboom, Paulus N., Hoogland, The Netherlands. 1990
Huegi, Michael F., Guemligen, Switzerland. 1990
Hui, Fredy W.K., Victoria, Australia. 1990
Hui, Wah K., Kowloon, Hong Kong. 1990
Hung, Chi L.V., N.T., Hong Kong. 1990
Ip, Ting C., Shatin, Hong Kong. 1990
Johnston, Paul W., Belfast. 1990
Jones, Colin P., Birmingham. 1990
Jones-Napier, Pennye K., Washington DC, USA. 1990
Jordan, Lynn P., Manchester. 1990
Kermorgant-Abily, Claire, Bangkok, Thailand. 1990
Kinev, Kathryn A., Atlanta, Ga, USA. 1990
Kung, Kwai, Kowloon, Hong Kong. 1990
Lai, Sau H.M., Kowloon, Hong Kong. 1990
Lam, Yick-Man R., Kowloon, Hong Kong. 1990
Lamb, Lois N., London. 1990
Leong, Kei T.D., Ribeiro, Macau. 1990
Levy, Aaron N., London. 1990
Lieftinck, Felice A., Rotterdam, The Netherlands. 1989
Lopez Gracia, Anna M.S.I., Barcelona, Spain. 1990
Lui, Kin W.K., Causeway Bay, Hong Kong. 1990
Ma, Kiu C.K., Kowloon, Hong Kong. 1990
Matthews, Lisa J., Winchester. 1990
Meigh, Melanie J., London. 1990
Montgomery, R. Scott, Bangkok, Thailand. 1990
Mustchin, Vivienne, Auckland, New Zealand. 1990
McCosh, Samuel M., Birkenhead. 1990
Offord, Philip A., Chandlers Ford. 1990
Pandya, Neesha, Bombay, India. 1990
Parker, Duncan, Toronto, Ont., Canada. 1990
Patterson, Debra A., Toronto, Ont., Canada. 1990
Platt, Karen K., London. 1990
Schell, Martin A., Nonthaburi, Thailand. 1990
Shammas, Siham, Paris, France. 1990
Soung, Min-Hee, Busan, Korea. 1990
Tan, Min, Shenzhen, China. 1990
Tock, Graham B., Hull. 1990
Tuovinen, Petri R.J., Kouvola, Finland. 1990
Ueta, Kohei, Kouchi-Ken, Japan. 1990
Van Acker, Alain A.A.M., Tilburg, The Netherlands. 1990
Vartiainen, Risto K., Rovaniemi, Finland. 1990
Velthuizen, Irmine H.S., Arnhem, The Netherlands. 1990
Weston, Amy L., Baltimore, Md, USA. 1990
Wong, King S., Kowloon, Hong Kong. 1990
Woodham, Sharon, Birmingham. 1990
Wright, Michael J., Watford. 1990
Wright, Wendy E., Toronto, Ont., Canada. 1990
Zoeter, Johannes S., Rotterdam, The Netherlands. 1990

Ordinary Membership

Bascombe, Freida, N.T., Hong Kong.
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Bessent, Christopher P., Bath.
Blancardi, Iris, Sospel, France.
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Durlacher, Noel H.E., London.
Egner, Valerie S., London.
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Kneebone, Garfield D., Penzance.
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Leblans, Isabelle, Louvain La Neuve, Belgium.
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Macdougall, Louise J., Watford.
Maeda, Katsuya, Hyogo-Ken, Japan.
Nash, Helen E., Slough.
Patel, Pankaj, Wembley.
Pearson, Christopher M., Hayes.
Presland, Patrick I., Market Drayton.
Ruhmer, Fiona J., London.
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Stergiou, Basil, Bristol.
Swift, Tania K.P., London.
Thomas-Everard, Lucilla D.M., London.
Tucker, William J., Douglas.
Tzortzopoulos, Theodore, Athens, Greece.
Watanabe, Tatsuo, Tokyo, Japan.
White, John W., York, Pa, USA.
Wu, Mei W., Harlow.
Zafer, Raymond D., Twickenham.

On 9 January 1991 at 27 Greville Street, London EC1N 8SU, a meeting of the Council of Management was held at which the business transacted included the election to membership of the following:

Fellowship
Aulosalo, Liisa H., Turku, Finland. 1990
Einstoss, Philip M., Toronto, Canada. 1990
Elias, Abdul H., London. 1983
Jarvis, Kathryn A., Vancouver, Canada. 1990
Jones-Brunet, Catherine, Mississauga, Canada. 1990
Vorasaph, Tracy, Bangkok, Thailand. 1990
Willmott, Keith R., Colombo, Sri Lanka. 1990

Ordinary Membership
Antoine, Ian, London.
Burrow, Denis W., Gravesend.
Day, James P.M., Tunbridge Wells.
Diamantopoulos, Moschos, Athens, Greece.
Faithfull, John W., Leicester.
Friedland, Melissa, London.
Ibbott, Jane, London.
Kwok, Chi K., Kowloon, Hong Kong.
Meza, Samwel P., Glasgow.
McFarlane, Neil R., Alloa.
Ng, Soon H., London.
O'Brien, Gillian M., North Berwick.
Ogezi, Agbaji E., Jos, Nigeria.
Paterson, Lea M.F., Brighton.
Pout, Margaret E., Guildford.
Thurlwell, Christopher, Tunbridge Wells.
Van Papen, Lorraine, Guildford.
Walter, Keith, Peebles.
Whelan, Stella A., Morecambe.

COVER PICTURE – OCTOBER 1990 ISSUE

The necklaces (left to right) were fashioned from the following materials: microcline (amazonstone); lavender jadeite; lapis lazuli; labradorite; nephrite jade; tiger's-eye; malachite; common opal ('chloropal'); tourmaline; moss agate/cornelian; golden coral (shell rondels); matt quartzes.

Letters to the Editor

From James B. Nelson
Nelson Gemmological Instruments

Dear Sir,

In Peter Read's article on 'Reflections on reflectivity' (*Journal of Gemmology* 1990, **22**, 97-102), a drawing was given of a profile of a hypothetical quartz gemstone.

The first thing which caught my eye was the pavilion angle of 45°. Gem faceting practice forbids the use of such a pavilion angle, even for quartz stones[1]. With this angle, I would see internal reflections of myself in the table, as with a right-angle prism.

A 45° pavilion also implies that any rays entering the stone's table at a zero degree angle of incidence would leave the table exactly parallel to the incident beam. The drawing showed an emergent angle far from zero.

Having been stimulated to learn more about this new strange optical behaviour, the accompanying diamond profile was examined. This time I was armed with a schoolboys' protractor and a familiarity with Snell's law. The celebrated Dutchman would have been intrigued to see how his physics have changed since his time. Most things, particularly prices, have changed, but even $E = mc^2$ has not risen to $E = mc^3$.

May I make a plea for authors to have more compassion for beginners in gemmology who would have to struggle in vain to make sense out of such diagrams which are only qualitatively but not quantitatively correct?

It is always a serious matter if a student's confidence has been shaken, but particularly so when moving into a new territory.

Yours etc.,
J.B. Nelson

15 November 1990
2 McCrone Mews, Belsize Lane, London NW3 5BG.

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[1] Harding, B.L., 1975. Faceting limits. *Gems & Gemology*, XV, 3, 78-88.

From Peter G. Read

Dear Sir,

I am grateful to Jamie Nelson for drawing attention to the apparent error in my sketch of the profile of a hypothetical quartz gemstone. However, the error in the sketch was confined to an incorrect labelling of the pavilion angle, and not to the ray path as he assumed.

To make the point that the pavilion angle of a quartz gem must be increased over that of a brilliant cut diamond (in order to achieve total internal reflection) I had increased this angle so that this condition was *just* achieved for quartz's critical angle of 40.33 degrees. Unfortunately I then labelled this angle as 45 instead of 43 degrees, at which latter angle the path for ray 1 in my sketch is substantially correct. I trust that this error has not offended any lapidary reader of *The Journal* (who in any case would rarely use the diamond profile for quartz).

Regarding Nelson's amusing comment on $E = mc^2$, I must also confess to have taken some license with the velocity of light in the diamond sketch in that the angles of refraction should have been drawn more realistically to acknowledge diamond's refractive index of 2.417 (increasing the in-air angles with respect to the normal for rays 1 and 2 would put this right). In mitigation I would point out that engineering sketches (as opposed to fully dimensioned drawings) usually bear the legend 'do not scale', so perhaps I should have taken this precaution and thus avoided the application of Nelson's protractor!

I am indebted to my learned colleague's critical eye, and hope that the offending sketch still conveyed the importance of a gem material's critical angle when determining its pavilion angle, which was after all my prime objective. I also hope that no student of gemmology has had his 'confidence shaken' by the 'qualitative' nature of this sketch, or has felt obliged to reach for his protractor!

Yours etc.,
Peter G. Read

30 November 1990
68 Forest House, Russell-Cotes Road, Bournemouth, Dorset BH1 3UB.

From Peter G. Read

Dear Sir,

With reference to my note on the 'Detection of synthetic emeralds by thermal conductance', which appeared in the October 1990 issue of *The Journal*, I have since been loaned four more synthetic emeralds by Alan Hodgkinson. I tested these stones under the same constraints as those tested previously, with the following results:-

	Average of 5 readings
Biron (hydrothermal), 1.04ct	98
Lechleitner coated (hydrothermal), 2.26ct	129
Lechleitner 'sandwich' (hydrothermal), 0.68ct	106
Linde crystal (hydrothermal), 3.72ct	84

This appears to confirm that the 'solid' hydrothermal stones, in common with the previously tested flux-melt synthetic emeralds, also have a much greater thermal conductance than the natural stone.

During a subsequent telephone call from Nigel Israel, who like myself evaluated the original Gemtek 'Gemmologist' (a forerunner of the Alpha-test instrument), I learned that he had found it possible to discriminate between peridot and sinhalite using this instrument. In confirming this, I obtained the following figures:-

Peridot	102
Sinhalite	64

As the RI and SG of the two stones are similar, and it is not always easy to determine their differing optic signs or discover the additional band in sinhalite's spectrum, this adds yet another useful test feature to the Alpha-test instrument.

Yours etc.,
Peter G. Read

7 December 1990
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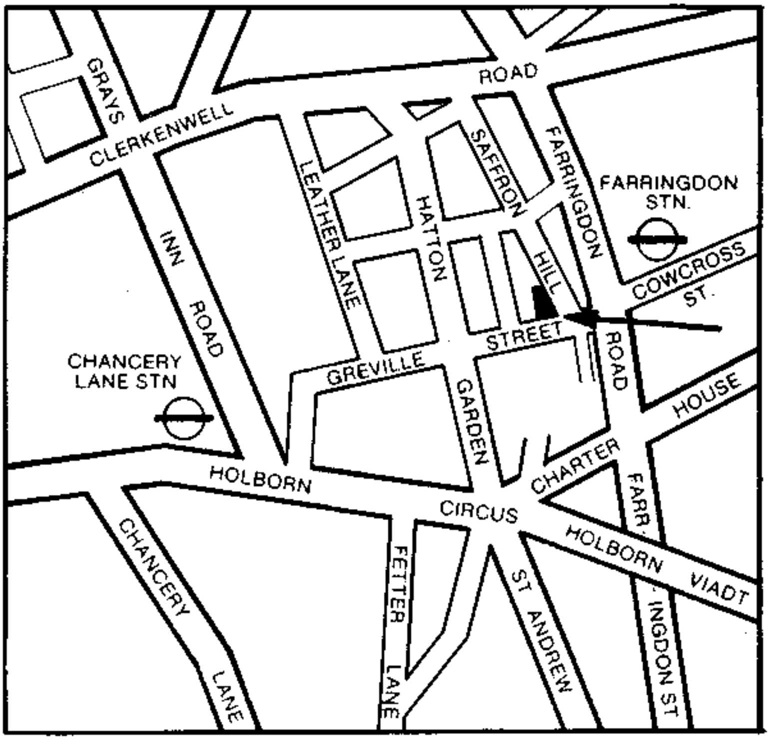
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