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IDENTIFICATION CHARACTERISTICS OF FLUX GROWN SYNTHETIC ORANGE SAPPHIRES

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INTRODUCTION

During the last few years, the gemstone market has been flooded with many new man-made substances giving effectively similar appearances to those of the natural species. Apart from the historically famous flame-fusion synthetic corundums, which are now abundantly manufactured by V. D. Djévahirdjian SA in Monthey, Switzerland, and the Austrian production of ruby by Professor P. O. Knischka (Knischka & Gübelin, 1981; Gunawardene, 1983 a), most of the new corundum varieties, particularly synthetic rubies, are now made in U.S.A. and Japan. Among many American manufacturers Chatham is credited as being the producer of three prized varieties of corundum synthetically, employing a flux method. His creations are the flux grown ruby, blue and orange sapphires. The latter is made to represent the colour of natural 'Padparadschah' sapphire found in Sri Lanka. However, a vast production of synthetic flux grown orange sapphire sufficient to satisfy the market has not yet been

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TABLE 1. COMPARISON OF PHYSICAL PROPERTIES IN NATURAL AND SYNTHETIC ORANGE SAPPHIRES

	'Padparadschah' sapphire from Sri Lanka	Orange sapphire from Tanzania	'Verneuil' made synthetic orange sapphire	'Chatham' made synthetic orange sapphire	'Inamori' made synthetic orange sapphire
Colour	pinkish-orange to pinkish-yellow with areas of orange-brown and pinkish-orange.	brownish-orange	orange.	reddish-orange with patches of yellowish-orange, orange-brown, pinkish-orange, whitish-yellow.	reddish-orange with purplish-pink, pinkish-orange, yellowish-orange areas.
Refractive indices	e = 1.760—o = 1.768 −0.008 (Gübelin, 1968)	e = 1.763—o = 1.771 −0.008 (Gunawardene, 1984	e = 1.762—o = 1.770 −0.008 (Nassau, 1980)	e = 1.672—o = 1.770 −0.008 (Kane, 1982)	
	e = 1.761—o = 1.769* −0.008	e = 1.765—o = 1.773* −0.008	e = 1.762—o = 1.770* −0.008	e = 1.759—o = 1.767* −0.008	e = 1.760—o = 1.768* −0.008
Specific gravity at 4 °C	3.99±0.01 (Gübelin, 1968)	$4.00^{+0.06}_{-0.02}$* (Gunawardene, 1984)	4.00±0.05 (Nassau, 1980)	4.00±0.03** (Kane, 1982)	
	4.00±0.02*	$4.00^{+0.06}_{-0.02}$*	$4.00^{+0.01}_{-0.02}$*	$4.00^{+0.04}_{-0.01}$**	$4.00^{+0.04}_{-0.01}$*
Dichroism o−ray e−ray	yellowish-orange pinkish-orange	brownish-orange yellowish-green	orange-brown light orange	pinkish-orange yellowish-orange	reddish-yellow yellowish-orange
Luminescence Long-wave UV (366 nm) Short-wave UV (254 nm)	 strong pinkish-orange weak yellowish-pink	 inert inert	 weak chalky blue inert	 strong orange-red weak pinkish-red	 strong orange-red weak pinkish-red
Absorption spectrum	See Figure 2.	See Figure 3.	See Figure 4.	See Figure 5.	(Not measured)
Inclusions	Various crystal inclusions among which rutile needles and zircon with haloes are common. Colour zoning of weak blue and violet. Typical 'Ceylon feathers' forming 'fingerprints'.	Dislocation lines, tiny crystals of zircons. Crossed polars reveal distinct twinning planes. No zoning	'Strain knots' under + polars. Clouds of gas bubbles under high magnification. Rarely curved growth lines.	Flux formation in many forms such as feathers flags and other shapeless flux residues Platinum inclusions.	Less (or no) flux and platinum inclusions than in Chatham product. Fine distribution of a rather thin inclusion. Manufacturer reports a pulling method which causes less inclusions in the finished product.

*Analysed by the author in this investigation.
**Values are considered with faceted samples and not with crystal clusters.

achieved. Further, a similar colour variety of sapphire is made in Japan by Kyocera International Inc., in Kyoto, and marketed under the trade name 'Inamori grown Padparadschah'.

The new varieties of synthetic corundum made in America and Japan are extensively investigated and compared with the natural 'Padparadschah' sapphires and orange sapphires of Sri Lankan and East African origins respectively and with the Verneuil synthetics. The properties such as colour, refractive indices, absorption phenomena, ultraviolet behaviour and the internal characteristics are reported. The comparison stones used and the results obtained are given in Table 1.

GEMMOLOGICAL CHARACTERISTICS

Colour

Both the American and the Japanese synthetic sapphires appeared orange to reddish-orange in colour. They also revealed a distinct reddish-orange tinge in orange-yellow areas of the stone. Further, there can be patches of yellowish-orange, orange-brown, pinkish-orange or whitish-yellow in a single crystal or many such hues in clusters. A cluster of the Chatham product is shown in Figure 1.

FIG. 1. A crystal cluster of flux-grown synthetic orange sapphire marketed by *Chatham Created Gems, Inc.*, San Francisco, U.S.A. (10×).

FIG. 2. Absorption spectrum of 'Padparaschah' sapphire from Sri Lanka. (After Schmetzer *et al.*, 1982)

FIG. 3. Absorption spectrum of orange sapphire from Tanzania.

FIG. 4. Absorption spectrum of Verneuil-made synthetic orange sapphire. (After Schmetzer *et al.*, 1982)

The crystals observed were all transparent to translucent and on the clusters a nearly colourless *glossy coating* was evident. This appears to be a ceramic glaze and is found only on the faces of the crystals at the outside of the cluster. Colour zoning, ranging from orange-brown to whitish colour, is visible in cluster crystals much more than in faceted synthetic flux-grown orange sapphires.

Refractive Indices and Specific Gravity Determinations

The standard critical-angle refractometer used with Na_D light of 589.3 nm was used to measure the usual refractive indices for corundum gems. As given in Table 1, the stones used in comparisons gave the same optical refractivities. The specific gravity determinations were made by hydrostatic weighing, employing a Mettler PC 400 electronic balance with specific gravity attachments. The results obtained in five sample stones used in comparisons are listed in Table 1. The results were less certain with the clusters than the individual faceted specimens. The specific gravity was calculated at 3.702 on the crystal cluster. This rather low value may be due to the ceramic glaze coating on the bottom of the cluster. Furthermore, the enclosed gas bubbles in between the crystal groups would have contributed to the low specific gravity, which is very low for corundum. Considering these differences, it is advisable to rely on the common specific gravity value recorded for the fashioned stone rather than on the density of the cluster.

Absorption Spectrum

In regard to the coloration of orange sapphires many investigations are reported (Nassau, 1980; Schmetzer & Bank, 1981; Gunawardene, 1984). One of the most important gemmological determinations of the term 'Padparadschah' is dependent on the extensive analysis of the absorption spectra of orange or reddish-orange corundums. The colouring elements such as Cr^{3+} and Fe^{3+} are mainly responsible for the colour of 'Padparadschah' sapphire. As shown in Figure 2, the absorption peaks recorded for Cr^{3+} and Fe^{3+} are different to those of the curves of other orange sapphires of synthetic or natural origins (see also Schmetzer *et al.*, 1982). The Fe rich orange sapphire from Umba Valley shows dissimilar absorption curves to that of 'Padparadschah' sapphires from Sri Lanka (Figure 3). The Verneuil synthetic orange sapphire owes its colour to Ni^{3+} and Cr^{3+}

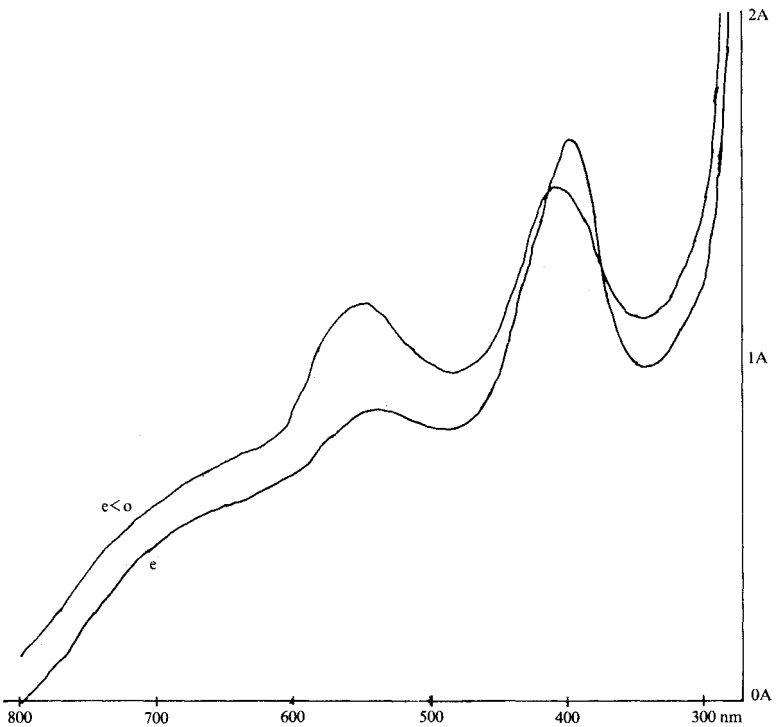

FIG. 5. The recorded absorption spectrum of synthetic orange sapphire made by Chatham using a melt diffusion process. The polarized curves for *o* and *e* rays were analysed by using a Pye-Unicam SP8-100 spectrophotometer.

(Figure 4) and does not cause much difficulty in recognition. As in other orange sapphires, referred to in this work, the absorption spectrum of Chatham-made synthetic orange sapphire measured by using a Pye Unicam spectrophotometer is shown in Figure 5. The absorption curves for *o* and *e* directions are given. It clearly indicates that the absorption spectrum of this new product is caused by Cr^{3+} and Fe^{3+} as in 'Padparadschah' gems of Sri Lankan origin. However, the absorption peaks are at different extinctions.

Therefore, a quantitative absorption spectroscopic analysis may lead to accurate results in discrimination of orange sapphire either of natural or of synthetic origin. Under the usual gemmological spectroscopic investigations, using a prism or diffraction-grating spectroscope, a clear distinction cannot be made in separating natural from synthetic orange sapphires made by Chatham or Kyocera.

Response to Invisible Radiations

In examination under long-wave ultraviolet having a peak wavelength at 366 nm the Chatham-made synthetic orange sapphire exhibited a fluorescence of strong reddish to yellowish-orange of varying intensities. The effect was weaker under short-wave ultraviolet radiation (254 nm). the stones used in the comparison gave the following results. The 'Padparadschah' sapphire from Sri Lanka fluoresced with a strong pinkish-orange glow. The synthetic orange sapphires made by Djévahirdjian were practically inert, as were the natural samples from Tanzania. However, the Japanese product revealed a similar fluorescent response to that of the Chatham-made synthetic orange sapphire. Further comparisons are repeated in Table 1.

Microscopic Examinations

To the gemmologist, the best available instrument within his reach, which can often quite conclusively determine the origin of a gem, is the microscope. For acquiring a positive answer, natural or man-made, the microscope, as most other instruments used in gem testing, has its limitations in certain instances. Most or all of the known natural or synthetic gemstones, particularly corundum gems, must be observed under the microscope and the *Chatham* and *Inamori* products so examined revealed characteristic and interesting inclusions.

The most diagnostic internal characteristics were solid inclusions of *flux* and *platinum*. The former appeared as residual particles or in the form of feathers having wispy veils, curly flags, nets or lace-like appearances. The platinum inclusions observed in these American synthetic orange sapphires revealed pseudohexagonal, trapeziform, triangular, needle-like and many

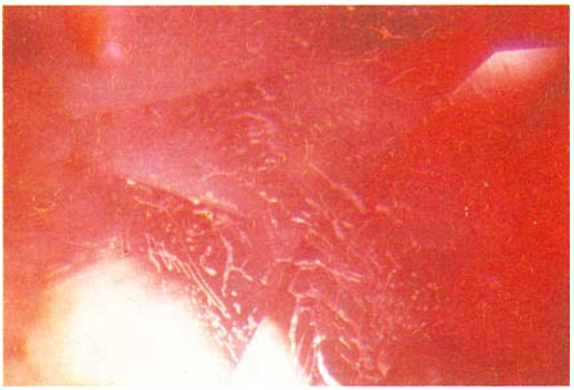

FIG. 6. Scenery of a lace-like flux feather in *Chatham*-made synthetic orange sapphire. (darkfield, 35×).

FIG.7. Irregular flux distribution in the new synthetic orange sapphire from America. They are rather similar to the feathers seen in natural rubies of Thai origin. (darkfield, 30×).

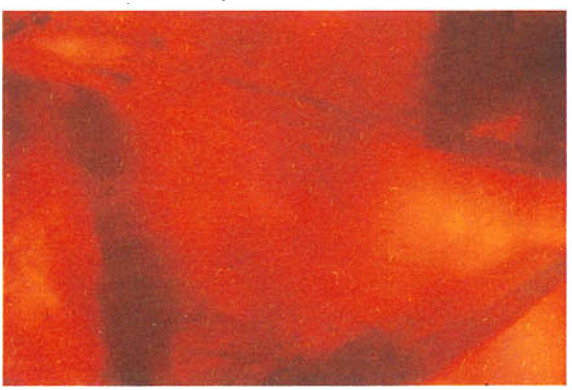

FIG.8. Diffused, branchy formations of a type of inclusion often observed in *Inamori* synthetic orange sapphire. (lightfield, 45×).

other irregular shapes. The exact outward appearance of a particular platinum particle can be studied from a definite angle of view, which should be selected after several rotations of the stone. Observed are also the zonal lines, similar to those seen in natural 'Padparadschah' sapphires of Sri Lankan origin, twin-planes and various negative crystal inclusions caused during the diffusion of the used flux.

Flux Inclusions

Developments achieved by many corundum manufacturers (Remeika, 1963; White & Brightwell, 1965) principally employ a type of flux in their synthetics. The dissolving of the flux is mainly dependent on the temperature and the pressure introduced at the time of crystallization. Such variations and extended periods of temperature/pressure environments cause the flux to be distributed in thin feathery formations or as remnants having irregular forms. A typical flux distribution forming a net is shown in Figure 6. Drops of flux, reminiscent of the feathers seen in Thai ruby, as in Figure 7, are commonly encountered in the new Chatham product. However, a lesser amount of inclusions (Figure 8) was noted in the Japanese product in comparison with the available Chatham orange sapphire grown by a flux. Rather confusing 'Ceylon feather' type flags of flux are often seen in the orange flux sapphires made by the American manufacturer (Figure 9). Similar to natural 'Padparadschah' sapphire from Sri Lanka, the colour distribution in the synthetic flux-grown orange sapphire is illustrated in Figure 10. Further, this particular photomicrograph reveals rather fine flux inclusions and rhomb-shaped platinum inclusions. The quite indistinct fingerprint-like flux feather of Figure 11 may mislead the inexperienced professional in identification. Therefore, further examination from different viewing angles is advisable. The flux residues (Figure 12) observed under reflected light clearly indicate the unnatural nature within the interior of the new synthetic orange sapphires. Reflections of the same nature were reported by Gunawardene (1983 a) in synthetic ruby.

Platinum Inclusions

If carefully examined, the recognition of platinum inclusions would provide conclusive means of separating the synthetic flux-

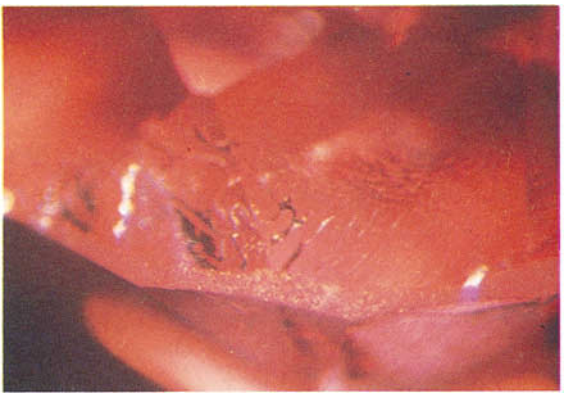

FIG. 9. The flux feather revealed in the *Chatham* product showing an appearance almost similar to the partly healed liquid feather abundantly observed in Sri Lankan 'Padparadschah' sapphires. (darkfield 28 ×).

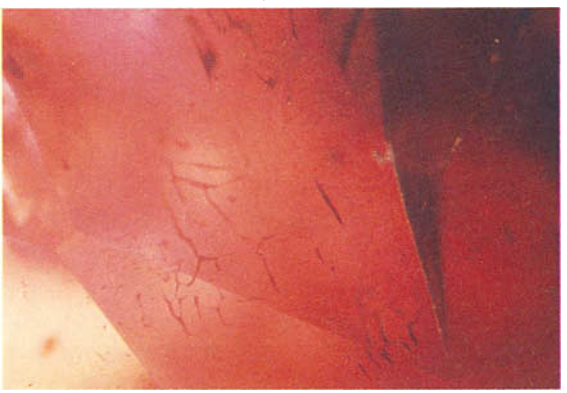

FIG. 10. General view of the new synthetic orange sapphire manufactured by *Chatham*. Flux inclusions, patchy coloration of yellowish-orange, orange and pinkish-purple areas and platinum inclusions. (darkfield and lightfield, 32 ×).

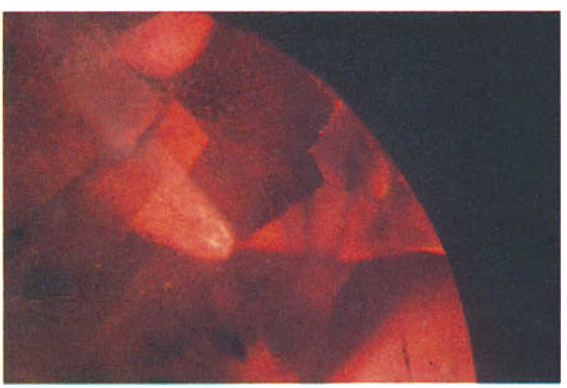

FIG. 11. Distributed flux feathers showing an indistinct appearance in the *Chatham product*. (lightfield, 25 ×).

FIG. 12. Metallic reflections from the residual flux under the microscope light are often encountered in the synthetic orange sapphires created by *Chatham*. (reflected light, 25×).

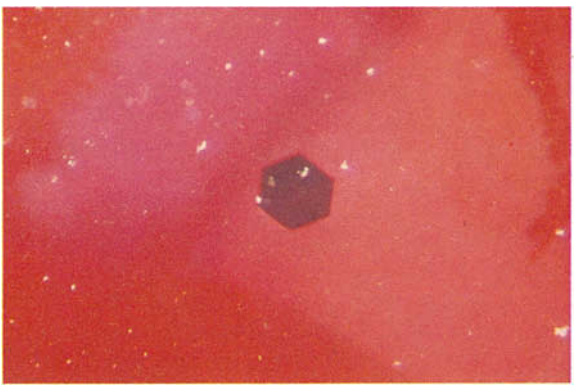

FIG. 13. Pseudohexagonal outward appearance of a platinum inclusion enclosed in a *Chatham* flux-grown orange sapphire. (transmitted light, 46×).

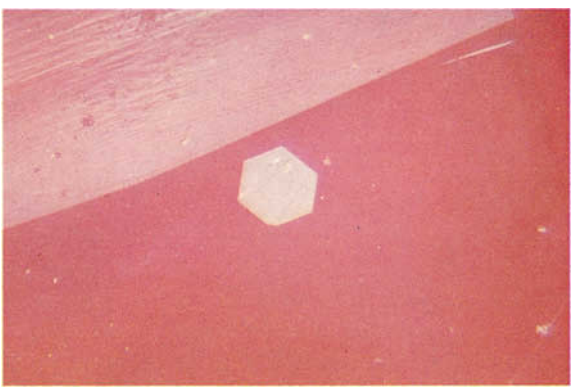

FIG. 14. The same inclusion as in Figure 13, under reflected light. (50×).

grown orange sapphires from those of natural origin. They assume various forms much like those seen in ℜ-ruby (Gunawardene, 1983 b). Their appearance under transmitted light is illustrated in Figure 13. As in Figure 14, the platinum platelets tend to reflect with a dull metallic lustre. The thickness of the platinum plate, shown in photomicrographs 13 and 14, was determined by a slow rotation of the stone with the inclusion concerned at a focus. This test revealed the thin nature of the platelets (Figure 15). A similar type of inclusion observable in natural 'Padparadschah' sapphire consists of various mica platelets. Such inclusions are, however, noted only in Sri Lanka corundums and appear characteristically under crossed polarized light. Inamori-made synthetic orange sapphires, as mentioned, contain less or no platinum inclusions and one such internal mark observed is shown in Figure 16. The needle-like platinum inclusions (see Figure 17) may cause difficulties if one is more accustomed to rutile needles, which are often seen in sapphires from Sri Lanka. However, the distinction is easy, if observed under reflected light. The high amount of light reflections from the surface of rutile cannot be compared to the dull metallic appearance of platinum.

Other Inclusions

Orange-brown to whitish zonings are rarely observed in the new orange sapphires made by using a melt-diffusion method. Zoning is more visible in crystal clusters than in faceted samples. Noted also are negative cavities due to dissolving of the flux or platinum. Similar to natural orange sapphires, the new product from Chatham also shows polysynthetic twinning lamellae (Figure 18) under crossed polars.

SUMMARY AND OUTLOOK

The comparison of characteristics in orange sapphires of natural as well as synthetic origin is important to be documented in gemmological literature. The availability of the material from the flux method of production will undoubtedly increase, facilitated by further technical developments in this field. It is probable that larger stones may reach the market in the near future. Special care

FIG. 15. The platinum plate in Figures 13 and 14 now observed from the side. It appears very thin as usual like the plate-like inclusions. (transmitted light, 50×).

FIG. 16. Short, stubby plate-like prisms seen in an *Inamori*-grown synthetic orange sapphire. (reflected light, 32×).

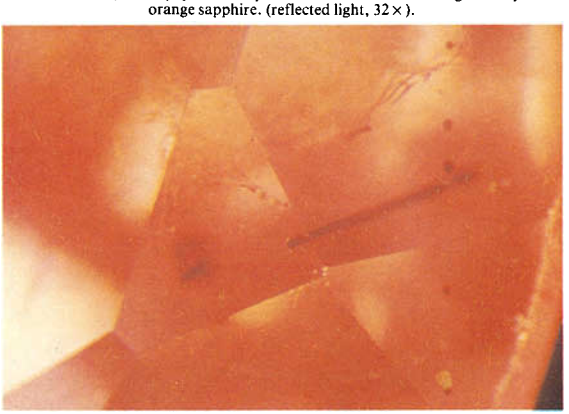

FIG. 17. Needle-like platinum inclusions with dull metallic lustre, embedded in a flux-grown synthetic orange sapphire made by the San Francisco firm. (transmitted light, 30×)

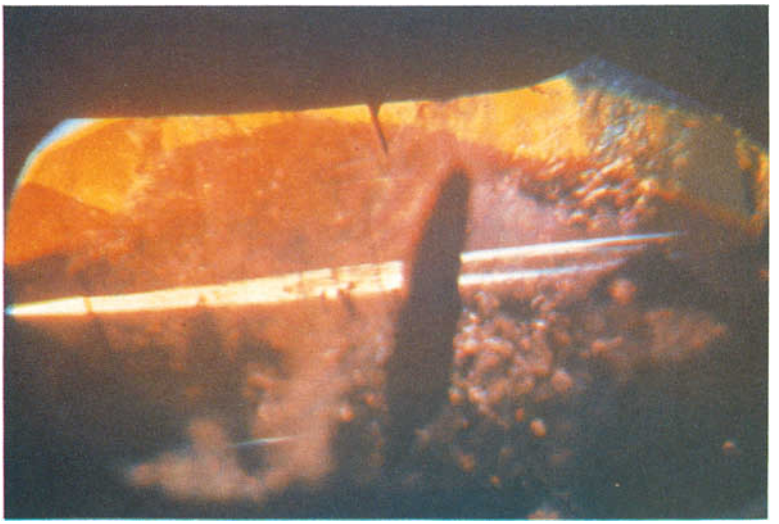

FIG. 18. Distinct twin planes noted in the *Chatham* product under crossed polars. (20×).

must be taken in dealing with the 'Padparadschah' colour sapphires in the trade, much more so than before. Those who are purchasing such coloured corundums in Asia or in Africa are advised to have the authenticity certified before the deals are concluded.

ACKNOWLEDGEMENTS

The author wishes to thank K. Arnoldi and Dr G. Lenzen, of the firm Litzenberger and Deutsche Gemmologische Gessellschaft respectively, for providing the Chatham-made synthetic orange sapphire which was presented to them by C. F. Chatham, of San Francisco, U.S.A. Acknowledged also are the excellent spectrophotometric analyses provided by G. Bosshart, Director of the Swiss Foundation for the Research of Gemstones in Zurich, and Dr K. Schmetzer, of Heidelberg University.

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EMERALD AND GREEN BERYL FROM BUCHA, MOHMAND AGENCY, NW. PAKISTAN

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ABSTRACT

Deep bluey green emerald and light green beryl occur sporadically in talc-carbonate-quartz rocks near Bucha (34° 24½′ N, 71° 36′ E). The host rocks have formed along shear zones due to the alteration of enclosing ultramafic rocks; however, the source of solutions responsible for this metasomatic process and introduction of Be is not clear. The beryl and emerald have high iron, the emerald also having higher MgO content and refractive indices than most natural emeralds. The crystals are variable in clarity and reach up to 10 mm in length; gem quality crystals, however, are less than 3 mm long.

INTRODUCTION

Several types of gems and precious stones, some of which are of the top quality, have been found in northern and north-western Pakistan. These include emerald, ruby, red spinel, sapphire, pink and yellow topaz, aquamarine, peridot, tourmaline, idocrase, epidote, garnet (red, green and honey), amethyst, quartz, and green diopside. Ornamental stones such as green (jade-like) rodingite, low quality lapis lazuli, nephrite and several varieties of marble also occur. It is expected that extensive investigations being carried out by various organizations, especially the Gemstone Corporation of Pakistan, will reveal additional occurrences, and Pakistan may emerge as a leading producer of gems and precious stones.

Emerald in Pakistan has been reported from several localities in Swat (Mingora, Charbagh, Alpurai), Mohmand (Prang Ghar, Gandao, Tsapari, Zankhae, and Tora Tigga), and an unconfirmed locality in Bajaur. In this paper we describe a light green beryl and a gem quality emerald recently reported (Rafiq & Jan, 1983) from Bucha (34° 24′ 30″ N, 71° 36′ E), eastern Mohmand Agency. (See Figure 1).

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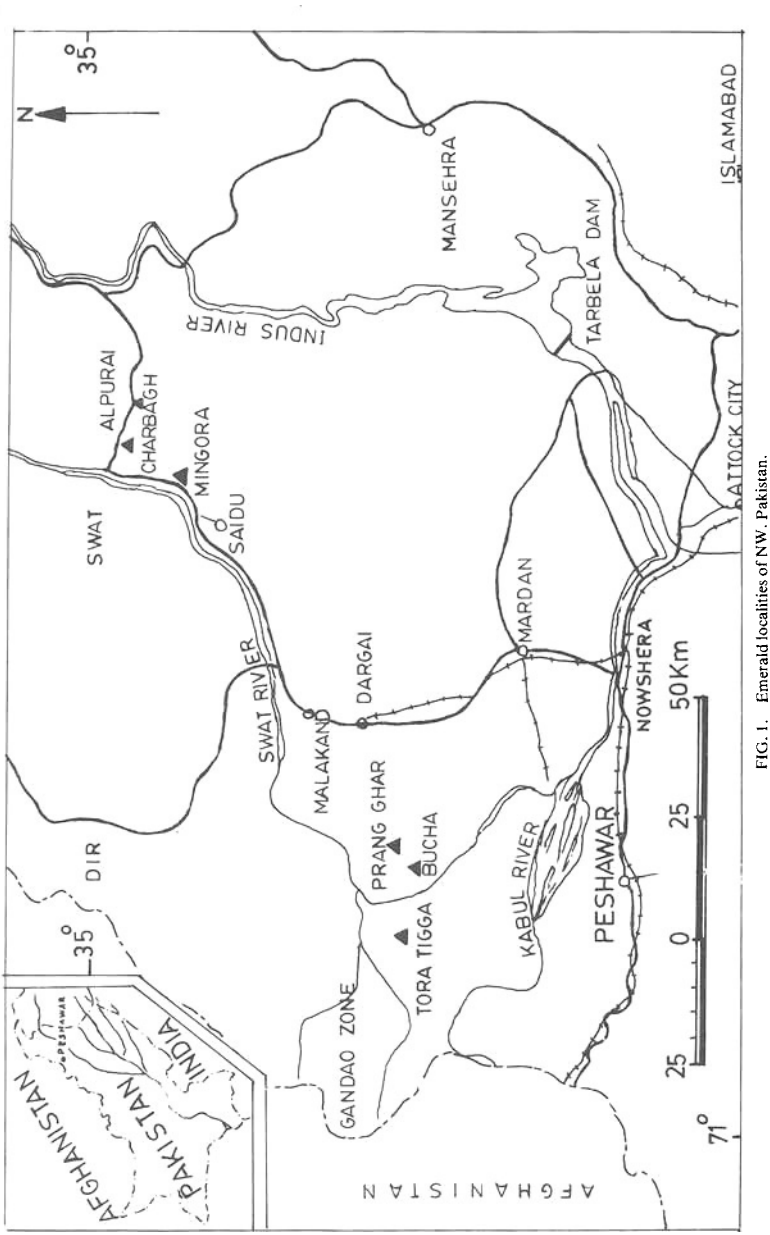

FIG. 1. Emerald localities of NW. Pakistan.

Geology and Petrography of Host Rocks for the Beryl

The Bucha beryl occurs in talc-carbonate and carbonate-quartz rocks enclosed in ultramafic rocks. Such rocks and associated quartz veins also host emerald and, in one place, a green Cr-rich tourmaline in Swat (Jan *et al.*, 1972, 1981). The Mohmand Agency emerald occurrences, similarly, are found in calcareous rocks and associated quartz veins (Arbab, 1972; Aslam *et al.*, 1982).

Ultramafic rocks in the vicinity of Bucha and Rang Mena are the westerly extension of the Skhakot-Qila-Utmankhel ophiolite complex described by Uppal (1972), Rafiq (1984) and Hussain *et al.* (1984). The complex represents a klippe (Malinconico, 1982), thrust southwards over rocks of the Indo-Pakistan Plate, probably during Late Cretaceous. The ultramafic members of the complex at Bucha contain large bodies, lenses and patches of talc-carbonate and carbonate-quartz rocks. These have a linear distribution and appear to have developed along shear zones. Steatite borders the ultramafics on the south and a black-wall chlorite-magnetite association on the north near Rang Mena. By analogy to other areas of the world, these rocks are regarded by us to be the product of alteration of the ultramafic rocks.

The talc-carbonate and carbonate-quartz rocks are closely associated in the field. They are mostly massive, but the former may locally display a poorly-developed schistose fabric. They are generally light to greenish grey with rusty brown surfaces and at places have the gross appearance of serpentinite. Their appearance, field relations and chemistry (discussed later) suggest that they are the alteration product of the host ultramafic rocks. If so, the carbonate-quartz rock may represent a more advanced stage of alteration than the talc-carbonate rock.

The talc-carbonate rock consists of a fine-grained matrix of talc (with or without opaque oxide) containing abundant aggregates of carbonate and coarse shreds and flakes of talc. A typical specimen of the carbonate-quartz rock consists of about ⅔ carbonate and ⅓ quartz, with small amounts of an opaque oxide (? chromite), dusty magnetite and talc shreds.

TABLE 1. PHYSICAL PROPERTIES OF BUCHA AND SWAT EMERALDS

Specimen	Absorption (in nm)	Strength of Absorption	Chelsea Filter	ε	ω	Inclusions
Light green Beryl (Bucha)	682.8 683.9 585.0	Weak to moderate Weak broad band	Light Brownish red	1.575	1.583	Fluid inclusions Feathers of Fe-oxide Siderite, tremolite/mica
Bluish green emerald (Bucha)	682.8 683.9 585.0	Strong Weak broad band	Dark Brownish red	1.590	1.600	Fluid inclusions Talc fibres Mica plates
Emerald (Swat)*	683 to 680 662, 646, 637 425-430 477-472	Strong Distinct to strong Weak	Red to pink	1.588 to 1.593	1.595 to 1.600	Two-phase inclusions Colour banding and zoning Calcite, dolomite

*Swat emerald values cover the range for seven stones (for details, see Gübelin, 1983).

The Bucha specimens are highly variable in colour and transparency. They range in colour from light green to grass green and bluish green. In some cases, one end of the crystals is light green and the other (growing direction) is grass green. The crystals are euhedral and reach up to 10 mm in length and 5 mm in breadth, but most are less than 3×2 mm. The smaller crystals are generally transparent, unfractured and more perfect than the large ones, which are translucent, fractured and dull due to impurities, iron staining and (?) alteration along fractures. Some of them contain fluid inclusions, brown iron oxide feathers along fractures, brownish carbonate (? siderite) and, in rare cases, mica flakes, talc and fibry tremolite inclusions.The small grain size of good quality emerald at Bucha does not make it of a high commercial value; the find requires further investigation of the area for possibly more valuable occurrences.

Absorption bands and refractive indices of two crystals are presented in Table 1, together with similar data for the Mingora (Swat) emerald (Gübelin, 1982). The absorption spectrum was determined with a hand spectroscope and RIs by dispersion method on crushed grains. The RIs of the oils were checked by refractometer immediately after each determination and the reported values are accurate to $\pm$ 0.002. The absorption spectrum contains chromium absorption lines (distinct in the case of emerald and weak in light green beryl) in the red region at 6828 Å and 6839 Å. There also are broad but weak Fe-absorption bands for both the varieties in the yellow region at 5850 Å due to their high Fe contents (cf. Gübelin, 1982).

The RIs of the Bucha crystals, especially emerald, are distinctly higher than those of pure beryl due to the high quantity of iron and chromium. Although not very different, the slightly higher values of ω and ε in the Bucha emerald, when compared to Mingora emerald, may be due to a higher Fe_2O_3 content in the former. Bank (1981), for instance, noted that an increase of ferric iron in some Zambian emerald is accompanied by an increase in the ω refractive index. The RIs of the Bucha emerald are higher than those found elsewhere (cf. Gübelin, 1982); the only specimens with comparable δ and refractive indices $\varepsilon = 1.592$, $\omega = 1.602$, according to Bank (1980), are from Kofubu, Zambia. The Bucha emerald, like that of Mingora, is dichroic with ε = light bluey green and ω = yellow green.

The quantities of some minor elements for the light green beryl (analysis 1) and dark bluish-green emerald (analysis 2) are presented in Table 2, along with analytical data for the Mingora emerald (Gübelin, 1982; Schrader, 1983). The analyses were performed in our laboratories, using a Unicam atomic absorption. Total iron was determined as Fe_2O_3; FeO could not be determined due to a scarcity of material. However, step-wise heating of the samples for several hours each at 100, 200, 400, and 500 °C produced no colour change, and we think that iron is mainly present in ferric state. A review of literature also suggests that iron is principally in trivalent form in beryl and emerald analyses.

TABLE 2. MINOR OXIDE CONTENTS OF BUCHA AND SWAT EMERALDS

	Cr_2O_3	Fe_2O_3	MnO	MgO	CuO	NiO	Na_2O	K_2O
1.	0.27	2.25	0.10	2.18	0.41	0.04	1.87	0.27
2.	0.83	2.10	0.10	1.91	0.11	0.02	2.14	0.08
3.	0.66	0.9	—	2.6	—	—	2.1	—
4.	0.8	0.4	0.0	2.7	—	—	2.1	—
5.	1.4	1.4	0.1	2.4	—	—	1.9	—
6.	0.2	0.7	0.002	0.6	—	<0.02	2.0	—

1. Light green beryl from Bucha, Mohmand Agency. } Analyst: M. Tahir Shah
2. Deep bluish-green emerald from Bucha, Mohmand Agency }
3. Emerald from Mingora, Swat. Analyst: M. Weibel (Gübelin, 1982).
4. and 5. microprobe analyses of two emeralds from (? Swat) Pakistan (Hänni, 1982). Anal. 4 contains 64.2% SiO_2, 14.8% Al_2O_3 and 0.1% V_2O_3. Anal. 5 contains 63.7% Sio_2 and 13.7% Al_2O_3.
6. Neutron Activation analyses of emerald from (? Swat) Pakistan. Average oxide values calculated from element percentages of two samples (Schrader, 1983). Contains also >0.05% V and 0.14% Sc.

It has been suggested that green coloration in emerald can not only be caused by Cr but also by Mn, Ni, V and Fe (cf. Schrader, 1983). However, a comparison of the analyses of the Bucha crystals suggests that the emerald here owes its colour to the presence of chromium ions. The values for Mn, Fe, and Ni are similar and therefore should have a similar effect on the colour of the two types of crystals. The Mn contents of the two analyses are several times higher than those reported for natural emeralds, as are the Cu

values (especially in analysis 1). If not overestimated, such high values are surprising. Both the specimens have higher Fe_2O_3 than those of natural emeralds from elsewhere (Gübelin, 1982; Hänni, 1982; Schrader, 1983).The Mingora emerald has a slightly higher quantity of MgO than in Bucha. The presence of sideritic carbonate inclusions and iron oxide films along fractures in the Bucha crystals must have added to the high Fe_2O_3 content of the analyses.

PARAGENESIS

Field relations, the high Mg, Ni, Cr contents of the emerald, and the presence of chromite grains in the host rocks suggest that the latter have developed at the expense of the surrounding ultramafic rocks. A talc-carbonate rock with minor accessory minerals contains 445 ppm Mn, 60 ppm Cu, 120 ppm Zn, 6600 ppm Cr, and 1635 ppm Ni. The high values of Cr and Ni and low value of Mn clearly suggest that this rock has an igneous (ultramafic) rather than sedimentary (dolomitic) parentage (cf. Leake, 1972). A similar origin for the talc-carbonate ± fuchsite ± chlorite rock hosting emerald in Swat was proposed by Jan *et al.* (1981). We reject the idea of Gübelin (1982) that the emerald host rocks in Swat were initially dolomitic.

It appears that hydrothermal or pneumatolytic solutions carrying CO_2 penetrated along shear zones and converted the ultramafic rocks into talc-carbonate and carbonate-quartz assemblages. The presence of thick quartz veins about 50 m from the emerald occurrence lends further support to this idea. These solutions, probably, also carried small quantities of Al, Be and Na, wheareas the host rocks supplied Cr, Mg, Fe for the formation of green beryl and emerald. However, the ultimate source of the solutions is not clearly understood. Whether the hydrothermal activity was related to the Cambrian granitic gneisses or alkaline carbonatites (of unknown age) found ~15 km to the north-east is difficult to assess. Butt (in preparation) suggests that in the Swat area the emerald mineralization was caused by hydrothermal solutions related to the granitic gneisses and generated during an (alpine) thermal event. This process cannot be proposed for the Bucha and other emerald occurrences in Mohmand because of the lack of close association between the granitic gneisses and emerald mineralization.

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CHATOYANCY IN CHRYSOBERYL CAT'S-EYE FROM PEGMATITES OF TRIVANDRUM DISTRICT, SOUTHERN INDIA

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ABSTRACT

Chrysoberyl and its variety cat's-eye occur extensively in innumerable small pegmatite bodies and alluvial gravel beds or Trivandrum district. Investigations of chrysoberyl cat's-eye suggest that chatoyancy may be caused by the presence of acicular the crystals of sillimanite along micro-fractures.

INTRODUCTION

The cat's-eye effect or chatoyancy in minerals is presumed to be caused by the more or less fibrous structure of the minerals (Kraus & Slawson, 1947), inclusions of needle-shaped crystals (Smith, 1972), or short needles and tubes running parallel to the long axis of the crystal (Arem, 1977), In quartz cat's-eye these inclusions have been identified as rutile and amphibole (Smith, 1972). Asterism in quartz from Ratnapura, Sri Lanka, is caused by needles of sillimanite and in sapphire by microscopic cavities (Wuthrich & Weibel, 1981) and rutile needles (Sahama, 1982).

The fibrous inclusions in chrysoberyl cat's-eyes remain at present mineralogically unidentified, although in some instances they represent acicular crystals (Smith, 1972). The present paper reports the findings of studies on chrysoberyl cat's-eyes from pegmatites of Trivandrum district, southern India under SEM with attached microanalyser.

CHRYSOBERYL FROM PEGMATITES OF TRIVANDRUM DISTRICT

Chrysoberyl occurs in innumerable highly weathered small complex pegmatite bodies of early Palaeozoic age in parts of Trivandrum district in Kerala and in the adjoining areas of Tamil Nadu (Soman *et al.*, 1982). The pegmatite field has a strike length of 50-70 km and a width of 30-35 km within Trivandrum district. Rocks of the Khondalite suite, encompassing garnet-sillimanite gneiss and garnet-biotite gneiss, and intermittent bands of enderbites and garnet-bearing granites of Precambrian age are the country rocks.

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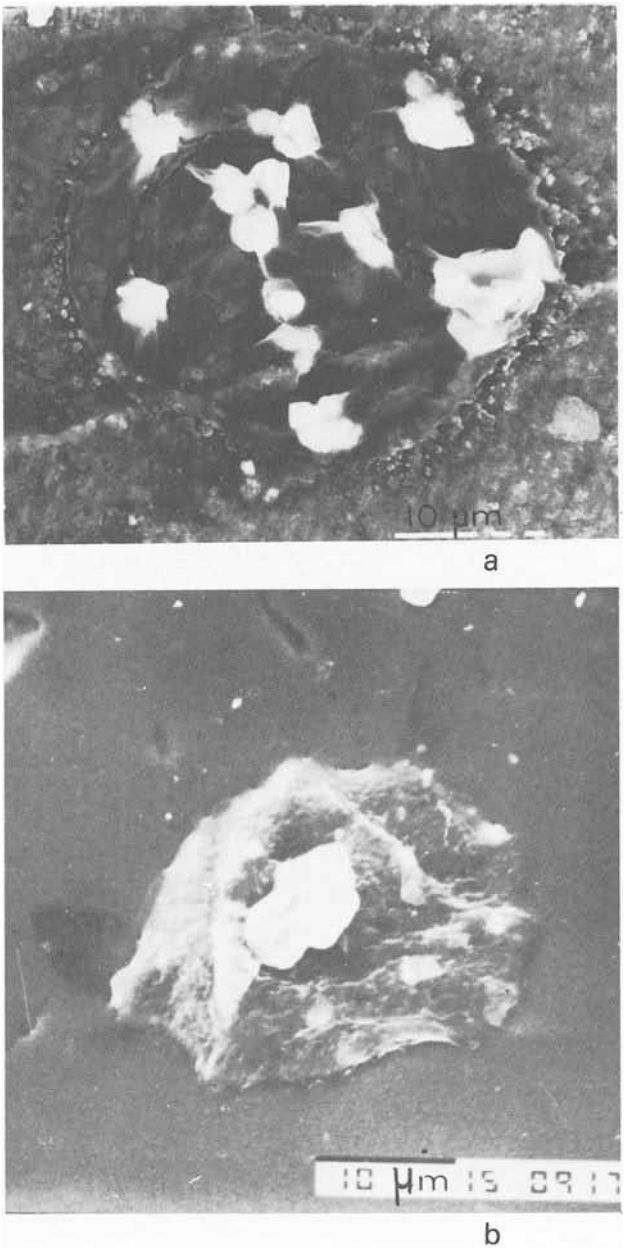

FIG. 1 (a), (b). SEM photomicrographs of mineral inclusions in chrysoberyl cat's-eye (with scales in micrometres).

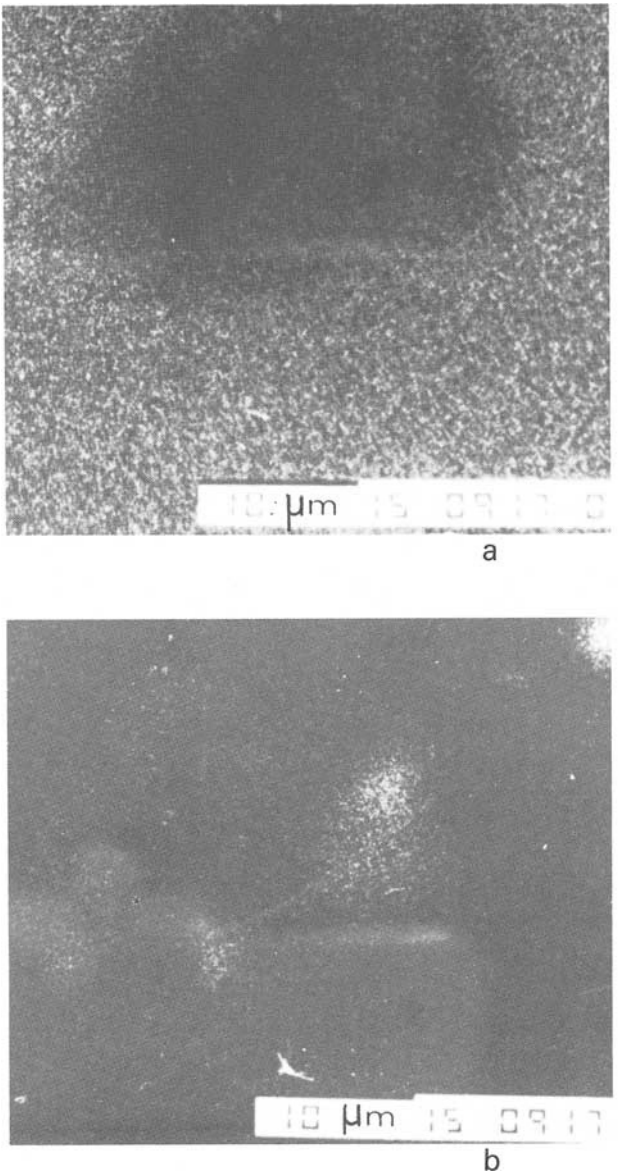

FIG: 2 (a). X-ray scanning photograph of Al distribution in chrysoberyl with inclusion as in Figure 1 (b).
(b). X-ray scanning photograph of Si distribution in chrysoberyl with inclusion as in Figure 1 (b). (Scales in micrometres).

The chrysoberyl occurs in pegmatites with potash felspar, smoky and transparent quartz, biotite, plagioclase, muscovite, tourmaline, garnet, beryl, apatite, sillimanite, ilmenite, monozite, cheralite, zircon, corundum, topaz and columbite (Soman & Nair, 1983). It is also recovered from alluvial gravel beds. Chrysoberyl crystals, commonly associated with quartz, are found to be cracked and in some places corroded. Cat's-eye is a very prominent variety of chrysoberyl found in this area.

DISCUSSION

Two specimens of chrysoberyl cat's-eye were examined under a JEOL scanning electron microscope with attached microanalyser.

SEM photomicrographs of chrysoberyl cat's-eye show presence of micro-fractures filled with acicular mineral inclusions (Figure 1 (a), (b)). X-ray scanning of the inclusions showed that they consist of Al and Si (Figure 2). Intensity of Al distribution in the inclusion is less than in chrysoberyl, while Si is higher in the inclusions. Abundance of sillimanite within the country rocks as well as in pegmatites, and its formation in pegmatites after crystallization of chrysoberyl, x-ray scanning data (Figure 2 (a), (b)) and the shape of inclusions (hexagonal acicular crystals, Figure 1 (a)) together suggest that chatoyancy in chrysoberyl cat's-eye from Trivandrum district may be due to the presence of acicular crystals of sillimanite along micro-fractures. This view is further supported by the findings of Wuthrich & Weibel (1981) that asterism in quartz from Ratnapura, Sri Lanka, is caused by needles of sillimanite.

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GREEN SPHALERITE FROM ZAIRE

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ABSTRACT

The cause of colour from dark-green sphalerite from Kipushi, Zaire, investigated by chemical and optical methods is discussed in this paper. The colour is brought about by cobalt, which shows an absorption-maximum at 670 nm in the spectrum of sphalerite. This absorption-maximum is based on a $^4A_2 \rightarrow {}^4T_1(P)$ transition of Co^{2+} in the tetrahedral crystal field of sphalerite.

INTRODUCTION

Several faceted sphalerites from Kipushi, Zaire, with a remarkable dark-green colour, first described by Quintens *et al.* (1984), were investigated. Sphalerite is an important zinc-ore and is only seldom considered worthy to be cut. Based on the minor hardness of 3.5 to 4 and a perfect cleavage to the rhombododecahedron {011} the treatment is difficult, as is the case with many ore-minerals. Sphalerite is in the gem-trade, because of its high refractive index of n = 2.369 and its dispersion of 0.156—an interesting stone for collectors.

At the present time, the most important mines are in Spain and Mexico with stones of mainly yellow and red and infrequent green colours.

The chemical composition of sphalerite is ZnS; it is cubic, and thus each atom is surrounded by 4 neighbour atoms, lying at the edges of a regular tetrahedron. Zinc can be substituted in the sphalerite-structure by elements having a similar ion-radius, in which case iron is the most frequent substitute. Pure sphalerite is colourless and transparent; with higher iron-content the transparency is reduced and the colour gets darker. According to Deer *et al.* (1977) sphalerite can be coloured by certain elements: yellow by Ge, Ca, Cu, Hg, Cd, red by Sn, In, Ag, Mo, and green by Co and Fe.

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ANALYTICAL METHODS AND RESULTS

In order to study the cause of colour, the element contents of ZnS were determined by neutron activation analysis (NAA) and electron-microprobe-analysis (EPMA). The results are listed in Tables 1 and 2. Especially investigated have been cobalt and iron, which according to Deer *et al.* (1977) bring about the green colours in sphalerite.

TABLE 1. Neutron-activation analyses in ppm

	Green Sphalerite from Zaire	Yellow Sphalerite from Spain
Na	20.7	5.9
Mn	22.4	9.8
Co	744.2	n.d.
Cu	972.7	721.3
Ga	2.7	17.9
Pd	145.9	243.7
Cd	3942.9	1509.5

Table 1 shows an enrichment of the elements Na, Mn, Cu and Cd in green sphalerite from Zaire in comparison to a yellow stone from Spain. In the yellow sphalerite from Spain no Co could be found, in the green sphalerite from Zaire the content of Co is with 740 ppm relatively high. To secure the assumption that Co causes the dark-green colour of the sphalerite from Zaire, further specimens from this mine and yellow, orange and red sphalerites from Spain were investigated with EPMA. Wavelength-dispersive analyses were carried out, the detection limit lying at 100 ppm. The results of Table 2 show that along with Co, Fe is present, which cannot be traced back to chalcopyrite inclusions, because EPMA

TABLE 2. Electron-microprobe analyses from green Sphalerites from Zaire in ppm.

	S1	S2	S3
Fe	802.5	682.5	617.5
Co	837.5	890.0	797.5
Cd	4137.5	4372.5	4260.0

can only analyse the surface of the samples. In the yellow, orange and red sphalerites from Spain no Co could be detected and Fe was present only as a trace-element.

For the definitive clarification of the cause of colour a reflection-spectrum from green sphalerite was recorded (Figure 1). This shows a reflection-minimum and thus an absorption-maximum at 670 nm. This maximum is brought about, according to Marfunin (1979), by a $^4A_2 \rightarrow {}^4T_1(P)$ transition of Co^{2+} in the tetrahedral crystal field of sphalerite.

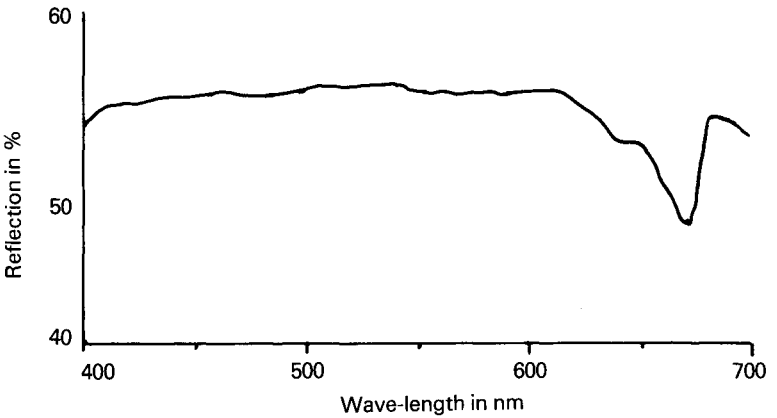

FIG. 1. Recorded absorption curve of Sphalerite.

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COLOURLESS ENSTATITE FROM EMBILIPITIYA, SRI LANKA

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Orthopyroxenes of different colours have been reported from Kenya, Tanzania, India and Sri Lanka. Colourless specimens of this mineral, viz. enstatite, have recently been found in the gem gravels of the Embilipitiya region of Sri Lanka (Figure 1). The mineral was mined near the northern bank of the Chandrika Wewa reservoir at a depth of about one metre (Figure 2). The other gem minerals found with colourless enstatite in these gem gravels were brown enstatite, kornerupine and iolite. The colourless enstatite consisted mainly of fragments and small chips showing easy cleavage (Figure 3). Although the specimens were flawed and contained many inclusions, a few specimens produced attractive gemstones after faceting. The largest tranparent cut specimen was 19.5 ct. Several specimens showed chatoyancy.

The physical and optical properties of the colourless enstatite are given in Table 1.

TABLE 1. Physical and optical properties of Sri Lanka gem enstatite.

	Green and Brown Enstatite of Ratnapura	Colourless Enstatite of Embilipitiya
n_x	1.665 (±0.001)	1.658 (±0.001)
n_z	1.675 (±0.001)	1.668 (±0.001)
DR	0.01	0.01
SG	3.23	3.25

Chemical analysis of the colourless enstatite was done by using an electron microprobe and the results showed a high magnesium content. The iron content was small. (Table 2).

The accompanying microphotographs (Figures 4 to 11) depict typical mineral inclusions in the colourless enstatite. Quartz was the most frequent mineral inclusion observed, and it exhibited well shaped and also partly corroded forms.

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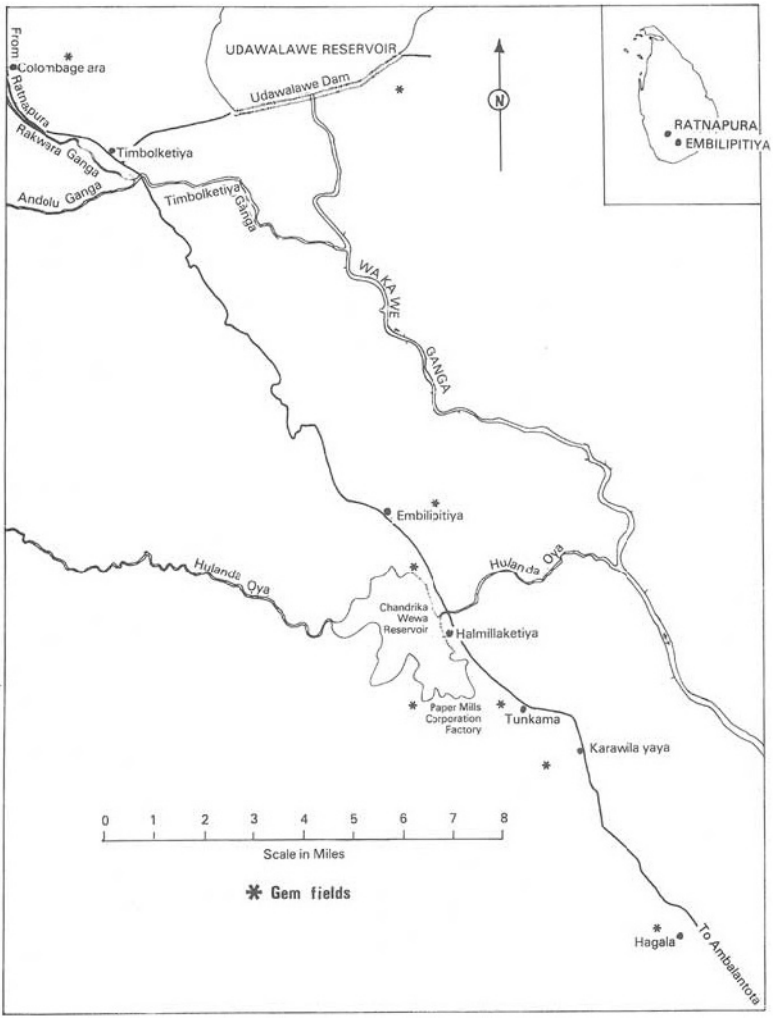

FIG. 1 Gem mining areas in the Embilipitiya district of Sri Lanka.

FIG. 2. Gem mining in Chadrika Wewa.

FIG. 3. Rough fragments of colourless enstatites from Sri Lanka.

FIG.4. Colourless enstatite, Sri Lanka. Partly well shaped, partly corroded crystals of quartz. ×27.

FIG. 5. Colourless enstatite, Sri Lanka. Iron oxides are localized in the brownish-red areas: also present are colourless transparent crystals of quartz. ×15.

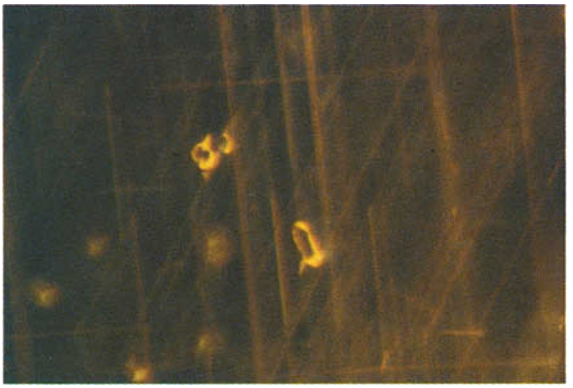

FIG. 6. Colourless enstatite, Sri Lanka. Tiny crystals of zircons with haloes amidst rutile needles. ×45.

FIG. 7. Colourless enstatite, Sri Lanka. Rod-like colourless transparent crystals. ×32.

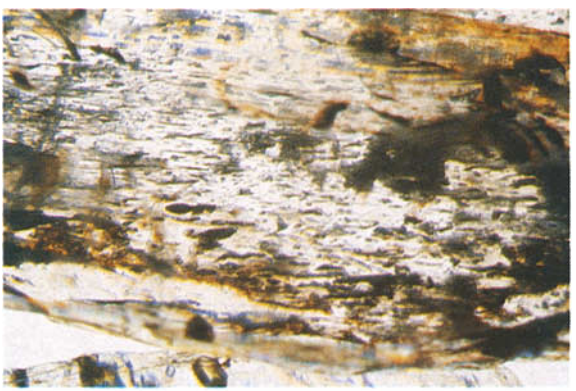

FIG. 8. Colourless enstatite, Sri Lanka. Healing fractures indicated by iron oxide surfaces, brownish micaceous laminae, and minute two-phase inclusions. ×15.

FIG. 9. Colourless enstatite, Sri Lanka. Minute crystals of apatite among dense silk of rutile needles. × 10

FIG. 10. Colourless enstatite, Sri Lanka. Healing fractures indicated by irregular iron oxide surfaces and elongated minute two-phase cavities. Brassy single crystals of pyrite are present. × 8

FIG. 11. Colourless enstatite, Sri Lanka. At the girdle a large, inside smaller crystals of quartz. × 12

TABLE 2. Electron Microprobe Analyses of Orthopyroxenes, Sri Lanka

Colour	Colourless		Greenish		Pale Brown	
Mineral	Enstatite		Enstatite		Bronzite	
Locality	Embilipitiya		Ratnapura		Ratnapura	
	%	Atomic Ratio	%	Atomic Ratio	%	Atomic Ratio
SiO_2	58.9	1.98	55.0	1.881	56.8	1.964
Al_2O_3	1.7	0.067	6.6	0.266	2.1	0.086
TiO_2	0.03	0.001	0.15	0.004	0.03	0.001
Cr_2O_3	—	—	0.02	0.001	0.31	0.008
FeO	1.0	0.028	5.5	0.157	6.6	1.91
MnO	—	—	0.1	0.003	0.14	0.004
MgO	38.0	1.904	32.8	1.672	33.5	1.727
CaO	0.10	0.004	0.10	0.004	0.21	0.008
Na_2O	0.02	0.001	0.04	0.003	—	—
Total	99.75		100.16		99.69	
Cations calculated to O = 6		3.986		3.987		3.988

The x-ray diffraction pattern of the colourless enstatite was taken using an x-ray diffractometer (model Jeol/JDX 85). Lattice parameters were determined using NaCl as an internal standard. The peaks selected for the lattice parameter determinations were (420), (321) and (610). Instrumental conditions were ¼° per min. scan, Kv, 40mA, 1000 cps. The XRD pattern was identical to that of enstatite, reference J.C.P.D.S. 22-714, the lattice parameters being $A_O = 18.50$ Å, $B_O = 8.75$Å. $C_O = 5.19$Å, space group Pbca.

The writer is grateful to Prof. Dr E. Gübelin, Prof. G. Graziani, Dr Charles Arps, and Mr R. L. Jayasooriya for their valuable assistance and advice.

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AN ACCESSORY FOR GEMMOLOGICAL REFRACTOMETERS

By AGUSTI MOLINÉ SALA, F.G.A.

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This paper describes an accessory to the gemmological refractometer, which makes the handling of stones to be tested easier and permits one to obtain reliable information thanks to the steady working of the attachment.

Continuing new discoveries of materials of interest as gems, synthetics or imitations makes it necessary for the gemmologist to proceed cautiously. Identification of gems must be backed by irrefutable evidence. That is why it is very important to use each instrument to its fullest potential. One of the best and most conclusive is the refractometer, and I have designed and built a very simple device for this instrument, which simplifies considerably the rotation of the tested gem while allowing constant working conditions which give the maximum information in the shortest working time,

The examination of a parcel of gems can be a demanding exercise. Given the technical accuracy of the instrument, it is a paradox that accurate readings must ultimately depend upon the ability of the operator to effect hand movements which will allow correct figures to be obtained. Procedure is usually thus:

(1) Make sure the gem to be tested has a perfectly flat and polished surface with a minimum diameter of approximately 2 mm (cabochons are not considered, as they cannot be tested using the accessory);

(2) Carefully clean the instrument prism and the gem, then apply a droplet of contact liquid to the glass;

(3) The gem must then be centred on the prism, and rotated a few degrees at a time, avoiding any lateral displacement;

(4) To obtain good optical contact it is advisable to maintain light pressure on the gem, especially in the case of small stones which may be raised by the surface tension of the liquid and give inaccurate readings—this must be done with care if the stone is not to scratch the prism;

(5) While carrying out these operations the observer must also look through the eyepiece and write down his observations.

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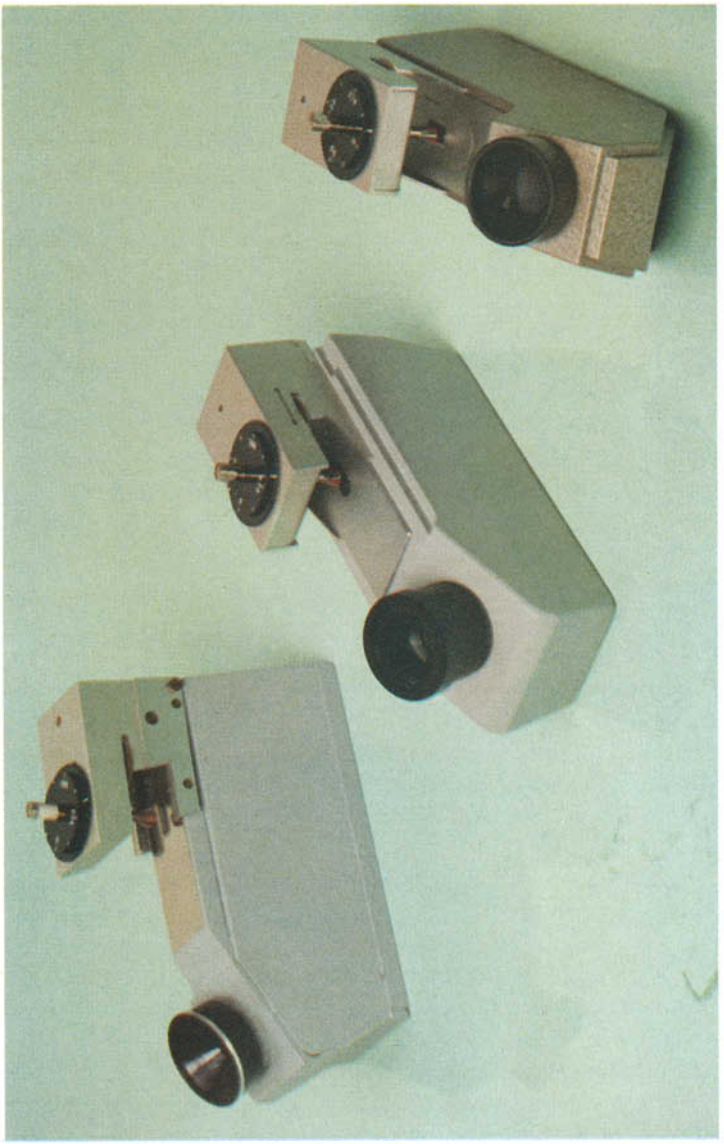

FIG. 1. Any brand of refractometer can be fitted: from left to right, a Rayner 'S', a Shibuya, and a Topcon.

Combining these actions with observations slows down the operation, and if we consider the care needed to obtain correct readings it becomes necessarily a long one. It is therefore useful to have a mechanical device applied to the refractometer which should make it almost an ideal instrument.

This is an accessory applied to the top of the refractometer, after removing the cover, and attached by using the hinge sockets. The contrivance can be lowered or raised like the cover in order to place the stone in position. With a small modification it can be adjusted to any make of refractometer (Figure 1). Its appearance blends with the profile of the instrument. Size is 55 × 30 × 45 mm and weight 38 grams (for a model made to fit Rayner 'S' or 'Dialdex' instruments).

It is built in anodized aluminium. Inside there is a system of gears which transmit movement to a vertical shaft which is held centrally over the glass prism. This shaft has a movement of 7 mm, which allows it to lift high enough to position the gem and adjust to different sizes of unmounted stones. Its lower end is cone shaped and lined with foam rubber so that it will fit the pavilion of most stones. The shaft, and therefore the gem, is rotated by means of a handwheel which protrudes slightly at the right of the device.

The following advantages result:

(1) By not rotating the stone by hand the risk of scratching the glass prism is greatly reduced;

(2) The shaft's weight (5 grams) ensures a constant optical contact between the gem and the prism surface;

(3) The gem is rotated centrally on the prism without displacements of any kind.

Originally the device was made just to rotate the stone. Later someone suggested the idea of measuring the degrees of rotation and I added a couple of wheels to the upper part of the main shaft. The top is graduated in 90° and 45° arcs and rotates with the shaft to which it is attached; the lower wheel is free and is used to zero the top one (Figure 2).

The instrument has been called a 'declinometer' by J. Figueras (1976), whose original work inspired its design, since it measures the rotation of the stone on the refractometer prism surface. But this name is already in use for an instrument connected with compass bearings and to avoid any kind of confusion with the

English translation it may be called a 'rotameter', since the coarse angular measurement facility warrants it.

This device is especially useful when it is necessary to identify a series of stones by establishing RI, birefringence, and optical sign. It will allow the students to make these observations easily in the practical classes when using the refractometer.

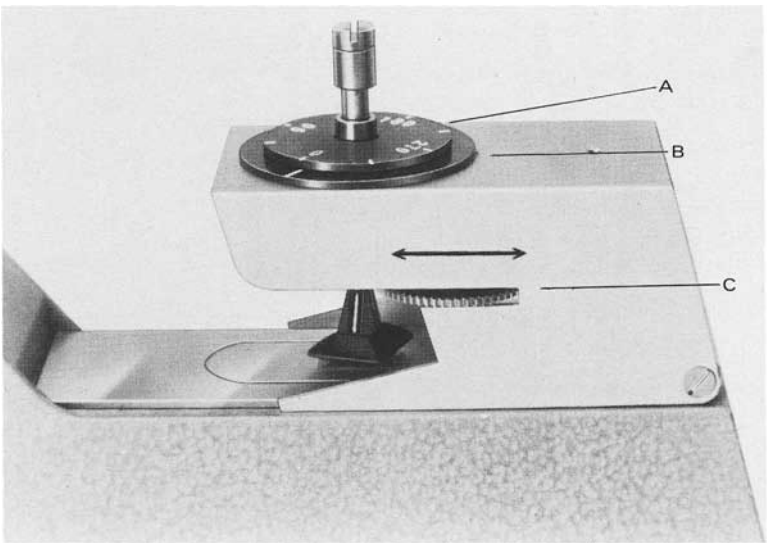

FIG. 2. The accessory fitted on a Topcon refractometer. (a) Graded wheel. (b) Wheel for zeroing the graded wheel. (c) Wheel for operating the device.

The observer can now concentrate on the observation of readings through the eyepiece, since a simple movement of the side wheel will rotate the stone as needed and can be repeated as many times as necessary with the guarantee that the stone will remain correctly adjusted on the prism. This concentration on the refractometer scale will immediately allow uniaxial or biaxial character and optical sign to be seen, separating tones of similar RI, like quartz and cordierite, tourmaline and brazilianite, apatite and topaz, etc. The least movement of the shadow edges on the scale can be observed when the gem is rotated quickly, a move

which is not possible without this device. It also avoids contaminating the fingers with contact liquid and, thanks to the graduated wheel, allows the degree of rotation of the stone to be calculated. If necessary the variations in RI of the test facet can be recorded graphically according to its orientation during a complete rotation.

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ELECTRON SPIN RESONANCE SPECTRA OF NATURAL AND SYNTHETIC SAPPHIRES AT S-BAND (2-4 GHz)

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INTRODUCTION

In a series of previous papers (Troup 1969, Scala & Hutton 1975, Hutton & Barrington 1977, Hutton 1979, Anderson, Hutton & Troup 1981, Troup & Hutton 1983) we have discussed the use of electron spin resonance (ESR) spectroscopy for the identification of gemstones, and in particular, for the distinguishing of natural from synthetic stones. In the last paper of the series we intimated that a wavelength of about 10 cm, corresponding to a frequency of 3000 GHz, might well be more useful to the practising gemmologist, because modern electronic techniques would enable the apparatus to be made much smaller than the 3 cm wavelength (10 GHz) we have been using. Prior to making a prototype apparatus aimed at commercial accessibility, it is of course necessary to verify the possibility of using the lower frequency spectra for gem identification, and perhaps to build up a collection of spectra. We were motivated to do this when we received a 14 ct golden sapphire to test, because it was too large to fit into the 3 cm wavelength resonant cavity.

APPARATUS

The spectrometer was of conventional reference-arm bridge design: the radiofrequency head, capable of operating over the frequency range 2-4 GHz, (S-Band) simply replaced the 10 GHz head of a commercial Varian ESR spectrometer (Froncisz *et al.*, 1979). The cavity was of dimensions approximately $25 \times 10 \times 2.5$ cm; modes at 2.0, 2.9 and 4.0 GHz (nominal) were available. The comparatively large size of the cavity reduces the 'filling factor' (ratio of field in sample volume to total field) but increases the 'Q' ($2\pi \times$ ratio of energy stored to power dissipated per cycle) so that not much sensitivity is lost in comparison with 10 GHz operation because of the lower filling factor. Sensitivity is lost, however, because it also varies roughly as the square of the observation frequency used. However, as will be seen, stones not much above a ct in weight gave adequate signals for identification.

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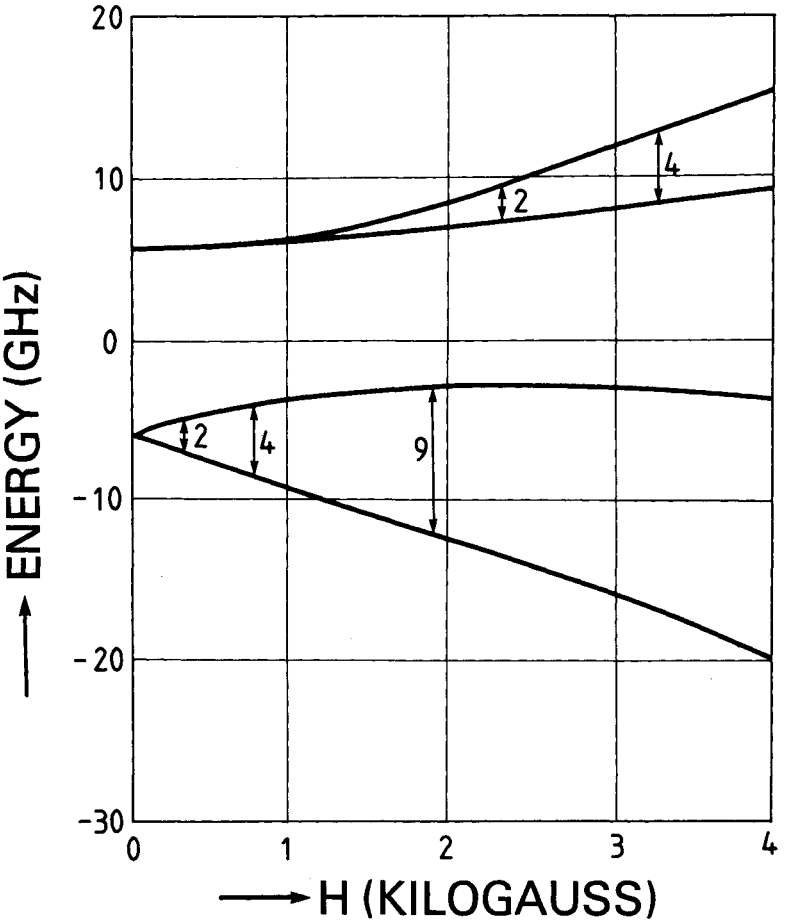

FIG. 1. The ground-state levels of the Cr^{3+} ion in the Al_2O_3 lattice with the steady magnetic field perpendicular to the *c*-axis. The low-field transitions observed at ~9 GHz, ~4 GHz and ~2 GHz are shown.

The samples were placed in a standard 10 mm diameter test-tube, and rotated until the DC magnetic field was perpendicular to the trigonal axis. This is always possible, since sapphires are uniaxial.

SAMPLES

The samples used were (a) synthetic blue sapphire (boule); (b) synthetic yellow sapphire (boule); (c) synthetic pink ruby (boule);

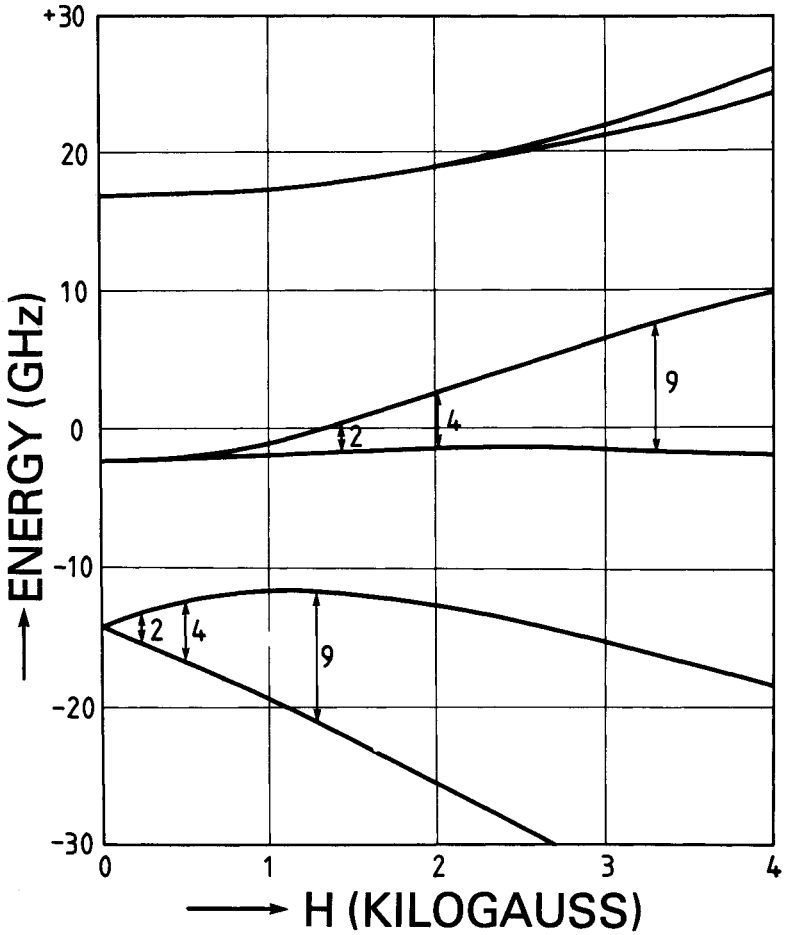

FIG.2. The ground-state energy levels of the Fe^{3+} ion in the Al_2O_3 lattice with the steady magnetic field perpendicular to the c-axis. The low-field transitions observed at ~9 GHz, ~4 GHz and ~2GHz are shown.

(d) 3 known natural golden sapphires; (e) the 14 ct golden sapphire (which turned out to be natural) brought to us for testing.

SPECTRA

Figures 1 and 2, respectively, show the lowest energy levels for Cr^{3+} and Fe^{3+} in Al_2O_3, plotted against the steady magnetic field, when this is perpendicular to the *c*-axis. Figure 3 shows the behaviour of the comparatively low-field lines for Cr^{3+} and Fe^{3+} as

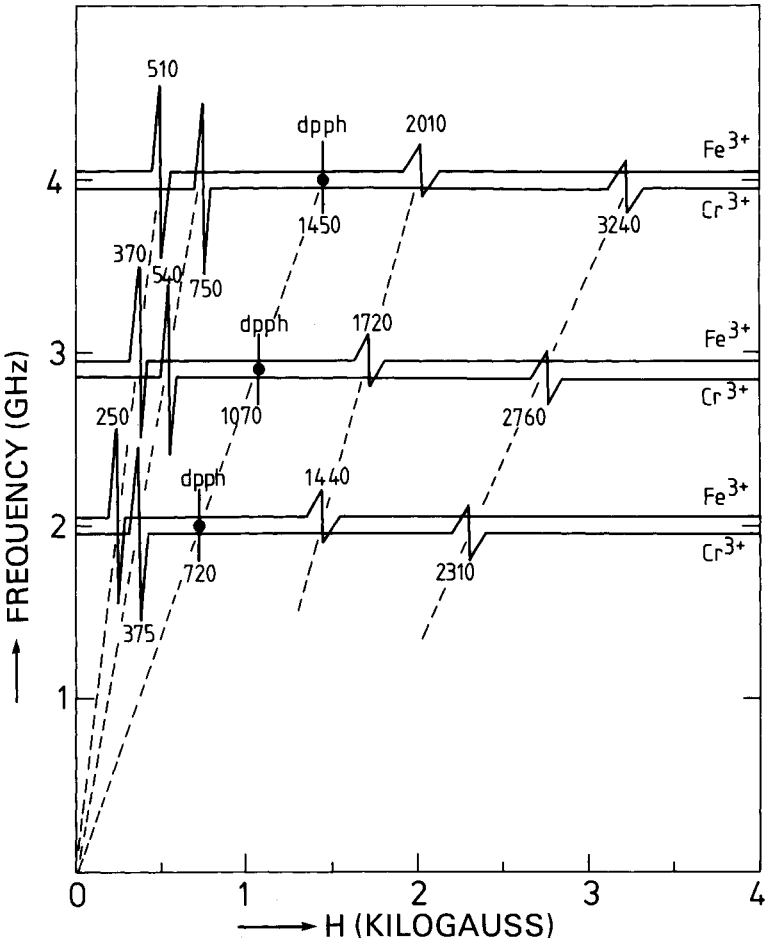

FIG. 3 Behaviour of the comparatively low-field transitions with frequency for the Cr^{3+} (lower lines) and Fe^{3+} (upper lines) in Al_2O_3 with the steady magnetic field perpendicular to the c-axis. Note how the lowest-field Fe^{3+} transition is consistently lower than the lowest field Cr^{3+} transition. 'dpph' means the 'marker' signal from the free radical $\alpha-\alpha$ diphenyl picryl hydrazil, which gives the field value for which $g' = 2$ (see text).

the frequency is changed from ~4 GHz to ~3 GHz to ~2 GHz. 'dpph' ($\alpha-\alpha$ diphenyl picryl hydrazil) is a readily available organic substance which contains one unpaired electron (free radical) per molecule, and which is therefore used as a magnetic field 'marker' and also to verify whether the apparatus is working well. For the sake of brevity, we do not show the signals from all the samples at all the frequencies used in our investigations.

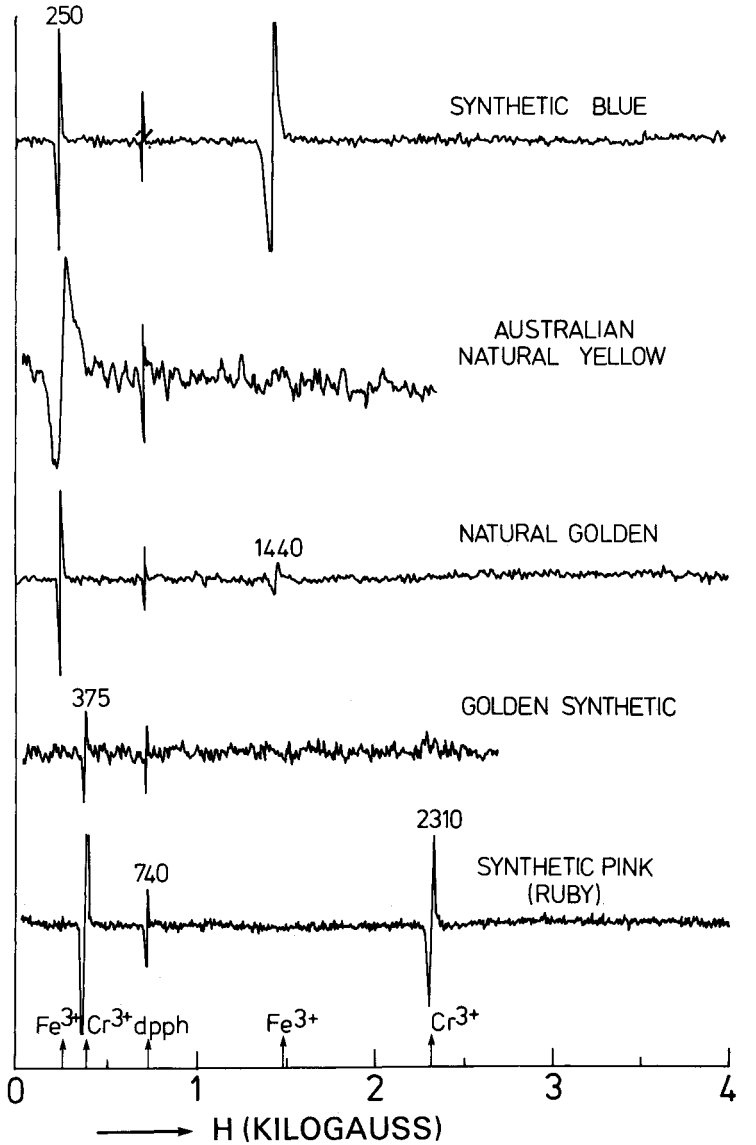

FIG. 4. ~2 GHz spectra of various sapphires: a synthetic blue, an Australian natural yellow, a natural golden, a golden synthetic, and a synthetic pink sapphire. The golden synthetic is of more modern manufacture than the ones used in previous work, shows no Fe^{3+} signal, and a very small Cr^{3+} signal in comparison with the other synthetics (note the signal to noise ratio in the various cases).

The 2 GHz spectra for some of the samples are shown in Figure 4. If the magnetic field (induction) at which a line occurs is B, and the frequency of observation is f, then

$$hf = g'\beta B$$

where h is Planck's constant, β is the Bohr magneton (atomic unit of magnetic moment) and g' is the 'effective g-value'—a constant determined by the ion under observation and the experimental conditions. For dpph, g' is very close to 2. For the lowest field lines in sapphire, when B is perpendicular to the trigonal axis, for Cr^{3+}, $g' \sim 4$, and can go no lower; for Fe^{3+}, $g' \sim 6$, and can go no lower. Thus the presence of a line at $g' \sim 6$, and no (or very low intensity) line at $g' \sim 4$, with B perpendicular to the trigonal axis, is a definitive test for natural golden sapphire.

DISCUSSION

It is quite clear that the 2-4 GHz region can be used to identify gemstones by ESR. In particular, the low magnetic fields necessary for positive characterization of Cr^{3+} and Fe^{3+} in sapphire, required to distinguish natural from synthetic golden sapphire, leads us to the strong belief that a commercial apparatus could be developed. We did not attempt to perform any measurements with *c*-axis parallel to the DC magnetic field, because we did not have the possibility of rotating the magnet about the sample, since the cavity is so large. This could be overcome later by using a different cavity design.

ACKNOWLEDGEMENT

We are grateful to Ms Carole O. Anderson for the loan of three known natural sapphires.

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[*Manuscript received 27th June, 1984*]

GEMMOLOGICAL ABSTRACTS

ALEXANDER (P. O.). *Looking for diamonds? Try geobotany.* Indiaqua, 36 (1983/3), 34-8, 17 figs, 1983.

Author shows that the presence of a kimberlite pipe can be seen in the luxurient plant growth it supports in marked contrast to the poor fertility of the surrounding country rock. R.K.M.

BALFOUR (I.). *Famous diamonds of the world, XVII. The 'Orlov' diamond.* Indiaqua, 36 (1983/3), 127-31, illus., 1983.

Now in the U.S.S.R. Diamond Fund collection in the Kremlin, the origin and history of this 189.6 carat rose-cut stone is 'legend, fact, supposition and theory', and there seem to be connexions with the Great Mogul Diamond. The latter was 'lost', and it is suggested that it was recut either as the Orlov or as the Koh-i-noor. After various robberies and intrigues the stone was purchased in Amsterdam by Count Grigori Orlov, a former lover of Grand Duchess Catherine, wife of Peter III. The latter was deposed and murdered and the crown went to Catherine the Great. Orlov presented her with the diamond but did not regain his former position of favour. It was Catherine who had it set in the Imperial Sceptre, where it rests today. R.K.M.

BALFOUR (I.). *Famous diamonds of the world, XVIII. The 'Star of Sierra Leone'* Indiaqua, 37 (1984/1), 129-31, illus., 1984.

An account of the finding of this 968.9 carat cleavage. Sold to Harry Winston, it was cut to yield a 143.20 carat emerald cut, which was flawed and eventually recut to give seven stones totalling 53.54 carats; a total of seventeen stones was obtained, the largest 53.96 ct and a total weight of 238.48 ct. R.K.M.

BATCHELOR (R. A.), KINNAIR (J. A.). *Gahnite compositions compared.* Mineralog. Mag., **48**, 3, 425-9, 2 figs, 1984.

A blue mineral from Nigeria was identified as the gahnite variety of spinel by wet chemical methods (using atomic absorption spectrophotometry). The composition was found to be 36.7% ZnO, 3.58% FeO and 0.12% MgO. RI was 1.79 and SG between 4.4 and 4.59. The gahnites from different parts of the world appear to fall into two groups, one of metamorphic origin and rich in Mg, and Mg-poor stones showing affinities with igneous rocks. The Nigerian material falls into the latter group. It is possible from the observations made to suggest that there is a diadochy within the zinc spinels between (Zn + Mn) and (Fe + Mg). M.O'D.

BRIGHTMAN (R.). *Chrysoberyl from Anakie, Queensland.* Aust. Gemmol. **15,** 7, 241-2, 2 figs, 1984.

Found among cut sapphires, this yellow-green stone gave RI 1.756-1.768, biaxial birefringence 0.012, SG 3.74, with strong absorption band from 425-458nm, much broader than usual, while constants are higher than expected in normal chrysoberyl. R.K.M.

BROWN (G.). *The diamondiferous kimberlite pipes.* Wahroongai News, **18,** 7, 12-14, 1 fig., 1984.

Discusses nature and origins of kimberlite. Diamondiferous pipes are very rare, may come from 250 km below surface and contain two main types of ultra-mafic nodules, the commoner peridotitic, and eclogitic. Diamonds found in either type, or not at all. Kimberlite thought to act only as transporting medium, not as parent rock. R.K.M.

BROWN (G.). *The problem of colour.* Wahroongai News, **18,** 9, 21-8, 1984.

A paper adapted from 'Colour in fixed prosthodontics' by Prestom (J. D.) in which Mr Brown, himself a dental expert, has drawn parallels with the problems in understanding colour in gemmology. R.K.M.

BROWN (G.). *Some thoughts on lustre.* Wahroongai News, **18,** 9, 17-18, 1984.

An attempt to rationalize and explain this physical characteristic of polished surfaces. It has been poorly defined in some textbooks in the past. R.K.M.

BROWN (G.). *Some interesting reactions in marble.* Wahroongai News, **18,** 7, 20-1, 1984.

Traces reactions from lime to a variety of different marbles, a mass of formulae which may or may not be useful. R.K.M.

CONNELLAN (M.), POZZIBON (L.). *The Australian ideal design for round brilliants.* Aust. Gemmol. **15,** 7, 219-26, 243-6, 16 figs, 1984.

Suggested new proportions for diamond brilliants are justified by elaborate but rather confusing diagrams and mathematics. The one diagram which depicts the side view of the proposed cut shows it without break facets on the base. It is not clear whether this omission is part of the design. The proportions and angles have been arrived at by computer and there is some suggestion that cutting should also be computer controlled. Authors suggest that the design and cutting methods could be used to advantage with coloured stones, with a constant pavilion angle of 39°40′ for all gems. R.K.M.

GRAZIANI (G.), GÜBELIN (E.), LUCCHESI (S.). *Report on the investigation of an emerald from the Kitwe District, Zambia.* Aust. Gemmol., **15,** 7, 227-34, 12 figs in colour, 1984.

An emerald from schist localities near Kitwe established that this highly included material has an origin different from that of the chrome-rich emeralds of the Miku deposits. RI 1.580-1.586, SG 2.794 with variations due to the many

inclusions which were identified as rutile, chrysoberyl (a new inclusion in gems), quartz, apatite, and margarite and muscovite micas. R.K.M.

GURNEY (J.). *Sea diamond developments.* Indiaqua, 36 (1983/3), 13-17, illus., 1983.

A general report on the diamond dredging operations along the Namaqualand coast. Problems have been encountered due to the normally rough seas along the straight coast line, which limit recovery to about five days per month. R.K.M.

JONES (A. K.). *Argyle gathers momentum.* Indiaqua, 37 (1984/1), 19-21, illus., 1984.

Text of address to Belgian Chamber of Commerce in Australia outlining discovery, development and forecast output of AK1 kimberlite pipe at Argyle in N.E. Western Australia. A yield of 7 ct per tonne is offset by small sizes of stones and a 5% fine gem content. R.K.M.

KOIVULA (J. I.). *Mineral inclusions in Zambian emeralds.* Aust. Gemmol., **15**, 7, 235-9, 7 figs in colour, 1984.

Emeralds from the Miku/Kafubu deposit SW. of Kitwe were examined and darvite tourmaline, limonite, magnetite, mica, rutile, haematite and apatite inclusions were found, most of which are illustrated in this author's excellent pictures. RI 1.581-1.588, SG varied from 2.71 to 2.82; chromium absorption was clearly identified. These Miku emeralds would appear to be less included than those from the Kitwe deposit. Author draws parallels with other schist-type deposits such as Habachtal in Austria. [A misprint makes 'rutile' into 'futile'. R.K.M.

LEITE (C. R.), BARELLI (N.), SARDELA (I. A.). *Oriented enstatite inclusions in natural diamond.* Mineralog. Mag., **48**, 3, 459-60, 1984.

A twinned diamond consisting of at least four distinct crystals and coming from the Tibagi River deposits of Paraná, Brazil, showed six colourless euhedral crystal inclusions which were found to be enstatite and forsterite. M.O'D.

LEITHNER (H.). *Topas und Beryll aus Namibia.* (Topaz and beryl from Namibia.) Lapis, **9**, 9, 24-9, 10 figs in colour, 1984.

Gem quality crystals of beryl with well developed faces are found in various locations in Namibia. Beryl of various colours, including aquamarine, is found at Rössing, east-north-east of Swakopmund. M.O'D.

MILLS (M. W.). *Kunzite.* Lapidary J., **38**, 4, 546-52, 7 figs (5 in colour), 1984.

A survey of the kunzite variety of spodumene with special reference to cutting, where the greatest hazard is in sawing. M.O'D.

O'DONOGHUE (M.). *Man-made gemstones.* Gems and Mineral Realm, **16**, 2, 35-6, 1984.

Natural and synthetic spinel are discussed with particular reference to blue material grown by the Verneuil process and recently seen on the market. The colour is much brighter than that usually associated with spinel and resembles that shown by treated blue topaz. Means of distinguishing the natural from the synthetic material are given. (Author's abstract.) M.O'D.

O'DONOGHUE (M.). *Some beryl minerals—3.* Gems and Mineral Realm, **16,** 2, 37-8, 1984.

The emerald deposit at Santa Terezinha, Bahia, Brazil, is discussed. (Author's abstract.) M.O'D.

O'DONOGHUE (M.). *The literature of mineralogy—9.* Gems and Mineral Realm, **16,** 2, 40-2, 1984.

Among the items discussed are the short course notes published by the Mineralogical Society of America under the title of 'Reviews in Mineralogy': particular attention is paid to the volumes on oxide minerals, pyroxenes and orthopyroxenes. The new Italian journal, 'Rivista Mineralogica Italiana', is also discussed. (Author's abstract.) M.O'D.

O'DONOGHUE (M.). *New light on some old gem friends—zircon.* Gems and Mineral Realm, **16,** 2, 43-4, 1984.

A review of the zircon family of gemstones with particular reference to testing. (Author's abstract.) M.O'D.

SANDEMAN (D.). *Stones seen—mysterious cabochons.* Aust. Gemmol., **15,** 7, 240, 2 figs, 1984.

Describes two black cabochons supposed to be natural glass from Indonesia. RI 1.525, SG *ca* 2.63, bubbles, inclusions identified as mullite, in radial, sheaf-like and acicular forms with some chatoyance. Not possible to confirm natural origin with any certainty. R.K.M.

STEVENS (E.). *The nature of inclusions, 1.* Wahroongai News, **18,** 7, 7-11, 1 fig, 1984.

Discusses temperature ranges needed for mineral deposition, changes expected at given heats and so on. Quotes Roedder (E.) of U.S. Geological Survey (Scientific American (1970s)) on subject of healed cracks containing fluids. R.K.M.

TABURIAUX (J.). *La perle et la perle de culture. Pt 1.* (Pearl and cultured pearl. Part 1.) Revue de Gemmologie, 79, 21-3, 3 figs in colour, 1984.

Review of the natural and cultured pearl market. M.O'D.

WARD (C. M.). *Titanium and the color of staurolite.* Am. Miner., 69, 541-5, 2 figs, 1984.

The colour intensity of staurolite seems to be related to the titanium content and it is suggested that the colour is caused by Fe^{2+} $-Ti^{4+}$ charge transfer. It is also thought that the titanium is located in the tetrahedrally co-ordinated Fe site. M.O'D.

WRIGHT (P.). *Artificial jade joins list of manufactured gems.* The Times newspaper, No. 62024, p.14, 31st December 1984.

By mixing the constituent materials (sodium, aluminium, silica) in powder form and heating to 2700°F, withdrawing the melt and allowing it to cool to a glassy solid,

then crushing the glass and refiring to the same temperature and exposing to pressures of up to 440 000 lb/in^2 in a diamond-making press in the same laboratory at Schenectady, N.Y., where the first (synthetic) diamonds were made, R. de Vries and J. Fleischer have made cylindrical-shaped pieces of white jadeite, ¼ inch in diameter and ½ inch long: green or lavender synthetic jadeite can be produced by adding traces of chromium or manganese to the starting powder mix, and samples have been made with layered combinations of colours. J.R.H.C.

Russian diamonds. Wahroongai News, **18,** 7, 17-19, 3 figs. 1984.

Discoveries of diamondiferous gravels in Vilyin River basin and pipes at Zarnista, Mir and Udachnaya, with further commercial deposits in basins of Olenk, Muna and Aldan Rivers, all in western Yakutsk region, together make this a major diamond area. Inhospitable swamp lands due to permafrosted subsoil make mining difficult. Product and mode of origin seem to be similar to those for diamonds found in other parts of the world. R.K.M.

Xinhua. Indiaqua, 36 (1983/3), 25, 1983.

News bulletin reports a 92.86 carat diamond discovered at Tancheng, Shandong Province in China. The same area produced 158.78 and 124.27 carat stones in 1979 and 1981. R.K.M.

Zale gem puts others in the shade. The Times newspaper, No. 61993, p.6, 1 fig., 22nd November 1984.

The 890 ct Zale diamond, illustrated surrounded by diamonds totalling 890 ct, is an almost flawless canary-yellow gem from an unknown locality in Africa—a surface stone, not mined. It is expected to weigh 550 ct (larger than Cullinan I), if cutting is successfully finished in eighteen months time, and will be displayed in the Smithsonian Institution, Washington D.C., before and after cutting. J.R.H.C.

BOOK REVIEWS

KITAIGORODSKY (A. I.). *Mixed crystals.* Springer, Berlin, 1984. pp.xiv. 388. DM120.

This book attempts to cover a widening gap between a number of small specialized disciplines, each relying on studies of crystal structures and compositions for their work. The term crystal has widened its meaning to include such topics as cell membrane structures and polymer crystallinity. The book begins with a discussion of phase diagrams and particle packing, continuing with free energy in solid solutions, x-ray scattering and intermetallic compounds. The formation and types of organic solid solutions, polymers and biopolymers complete the book, which has an index and a bibliography. M.O'D.

STEVENS (G.). *Gemmology questions and answers.* Available from Ladybird Gem Merchants, Shop 112, Second Gallery, The Strand, Arcade, Sydney, N.S.W. 2000, Australia. pp.85. $12.

300 simple questions are given to assist the gemmology student. Some of the answers given are too simple and some of them are wrong (for example, the behaviour on the refractometer of a uniaxial stone whose table facet is cut at right angles to the optic axis is to show maximum birefringence during a complete rotation). However, the book, if carefully read and checked, does provide a useful revision tool. M.O'D.

ASSOCIATION NOTICES

OBITUARY

Mr E. R. Bohe, F.G.A. (D. 1956), San Diego, Ca, U.S.A., died on 2nd March, 1984.

Mr Leslie Green, F.G.A. (D. 1961 with Distinction), Rainhill, Prescot, died in July 1983.

NEWS OF FELLOWS

Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., who is Curator of the Earth Sciences Collections, The British Library, encourages anyone with a serious interest in the literature of gems and minerals to feel free to contact him at the Library (Science Reference Library, 9 Kean Street, London WC2B 4AT: telephone 01-636 1544, extension 674). Enquiries should not be at text-book level. The Science Reference Library is free to all without formality. Collections include all monographs and serials of importance from all countries.

On 16th and 17th June, 1984, at the City University, Mr O'Donoghue and Mr P. G. Read, C.Eng., F.G.A., conducted a course for Precious Stone Training Services Ltd. The course was designed as an instrument pre-Diploma Examination refresher session. On 19th June, 1984, Mr O'Donoghue conducted a one-day Preliminary Examination revision course for the same company.

On 17th September, 1984, Mr O'Donoghue gave a lecture on 'Gemstones', illustrated by specimens of rough and cut stones, to the Merton Scientific Society.

On 16th to 27th October, 1984, Mr O'Donoghue visited Japan and gave lectures on modern developments in synthetic gem materials to audiences of the Gemmological Information Centre of Japan in Tokyo, Fukuoka and Osaka. He also visited the research laboratories of the Seiko company.

MEMBERS' MEETINGS

London

On 18th September, 1984, at the Flett Theatre, Geological Museum, Exhibition Road, South Kensington, S.W.7., Mr J. Rouse, M.A., G.G., gave an illustrated talk on 'Colour grading systems and techniques' and Mr D. McColl, F.G.A.A., gave an illustrated talk on 'The development of a classification and appraisal system for precious opal'.

On 27th November, 1984, at the Flett Theatre, Mr P. G. Reed, C.Eng., F.G.A., gave an illustrated talk on New Instruments and Identification Techniques.

On 27th November, 1984, at the Flett Theatre, an Extaordinary General Meeting was held at which Mr J. R. H. Chisholm was elected a Vice-President of the Association (see page 452 below).

Midlands Branch

On 28th September, 1984, at the Society of Friends, Dr Johnson's House, Birmingham, Miss J. I. Platts, F.G.A., Chairman of the South Yorkshire and District Branch, gave an illustrated talk on her recent visit to the opal fields of Coober Pedy.

On 26th October, 1984, at the Society of Friends, Mr F. Carrigan gave a talk on 'Jewels used in regalia'.

On 30th November, 1984, at the Society of Friends, Mrs Edna Holloway gave a talk on 'Ivory Carving and Netsuke'.

North West Branch

On 20th September, 1984, at Church House, 1 Hanover Street, Liverpool, Mr P. G. Read, C.Eng., F.G.A., gave a talk entitled 'Distinguishing between natural and synthetic gems'.

On 18th October, 1984, at Church House, the Annual General Meeting was held at which Dr John W. Franks, F.G.A., and Mrs Edna Cartmel were re-elected Chairman and Secretary respectively.

On 15th November, 1984, at Church House, Mr R. Wood, F.G.A., and Mr Reynolds gave a talk entitled 'Ruppenthal's, story of and gem display'.

South Yorkshire and District Branch

On 4th October, 1984, at the British Horological Institute, Upton Hall, near Newark, Mr J. A. W. Hodgkinson, F.G.A., gave a talk and demonstration to branch members and a group of retail jewellers on instruments, their uses and limitations.

On 1st November, 1984, at Sheffield City Polytechnic, Mr J. A. W. Hodgkinson, F.G.A., gave a talk entitled 'Keep the moth in your diamond'. The title referred to inclusions which, he urged, should not be regarded necessarily as a detriment, but as a unique feature of added interest in a particular stone.

ANNUAL REUNION OF MEMBERS AND PRESENTATION OF AWARDS

The Annual Reunion of Members and the Presentation of Awards took place in Goldsmiths' Hall on Monday, 12th November, 1984. The Chairman, Mr David Callaghan, F.G.A., presided at the Presentation of Awards in the Livery Hall and opened the proceedings by welcoming all those present, including some who had come a long way—from America, Belgium, France, Germany, India, Spain, Sweden and Switzerland. There had been examination centres in some 30 different countries, including 29 centres in U.S.A. and 22 in the U.K., which had involved a lot of organization by the Association's staff, and throughout the world 715 candidates had sat for the Preliminary Examination and 459 for the Diploma. The Tully Medal—an award difficult to achieve, which had not been won in the last seven years—was to be presented this year to two students, one from Spain, one from U.S.A., and was to be presented—as were the other awards—by Mr Keith Mitchell, F.G.A., who had himself won the Tully Medal fifty years ago—in 1934, a year in which the list of Diploma winners included the names of Norman Harper, later to become a distinguished Chairman of the Association, and Robert Webster, whose outstanding contributions to gemmology were well known: Mr Mitchell had been elected a Vice-President of the Association earlier in the year.

Continuing, Mr Callaghan then said that amongst those in the Hall was Mrs Eunice Robinson Miles, a distinguished gemmologist from America, who was present to receive an Honorary Fellowship. She was born in Connecticut, and after studing mineralogy at university she was Assistant Curator at the Mineralogical Department of the American Museum of Natural History in New York from 1942 to 1952. In 1953 she joined the Gemological Institute of America and was the first—and at that time only—woman working in the G.I.A. laboratory in New York. For some years she taught gemmology and now is primarily concerned with education. She had also written numerous articles, particularly on the colouring of diamonds.

The Chairman then presented Mrs Miles with a framed Certificate, after which he called upon Mr Keith Mitchell to present the awards to the successful examination candidates.

Mr R. Keith Mitchell, F.G.A., Vice-President, then presented the awards and delivered the address which is printed in full below.

The Vice-Chairman, Mr Noel Deeks, F.G.A., thanking Mr Mitchell, said that he had mentioned many other people but had been very modest about himself. He had been in the jewellery trade for fifty-one years* and was still connected with it. He had made a major contribution to gemmology by encouraging hundreds of others to take the examinations. In earlier years he had taught gemmology at the Chelsea Polytechnic and later became the Instructor for the Association's Correspondence Courses. At one time there were 243 students taking the Preliminary subjects and sending in papers every fortnight for him to mark. One of them had the name of Deeks.

Then, before the proceedings were concluded, Mr Callaghan announced the opening of the Basil Anderson Appeal for the purpose of raising £25000 to purchase a spectrophotometer to be placed on permanent loan with the British Gem Testing Laboratory, which will be celebrating its sixtieth year in 1985. Developed by Pye-Unicam Ltd at Cambridge, the instrument is to be known as the Basil Anderson Spectrophotometer in memory of the late B. W. Anderson, who pioneered the use of the specroscope in the identification of gemstones.

*Mr Mitchell was transferred to the Jewellery Department of Mappin & Webb Ltd in 1933.—Ed.

ADDRESS BY MR R. KEITH MITCHELL, F.G.A., VICE-PRESIDENT.

Mr Chairman, Ladies and Gentlemen,

It has given me a lot of pleasure to come here and present Gemmological Diplomas and Diamond Certificates to these successful candidates, at least a dozen of whom have travelled from far countries to be with us tonight. All are most welcome! More than twice their number will receive their Diplomas overseas, for the examinations were held in some 92 different centres in other countries as well as in 22 here in Britain.

Four of the five special prizes have been handed over tonight. Two of these, the Anderson Medal and the Anderson/Bank Prize, were originated by Professor Hermann Bank, of Idar-Oberstein, in honour of the eightieth birthday of our great pioneer gemmologist, B. W. Anderson, in 1981. Sadly, Basil Anderson, guide mentor and friend to so many of us, died early this year, and these two prizes must now be regarded as awards in his memory. The recipients should take great pride in them, for he was a remarkable man.

I am pleased to see that, after a gap of several years in which no Tully Medal was awarded, our examiners have found, not one, but two students whose very excellent work tied for this our highest award. Some of you may wonder about the origin of this medal, for Bristow John Tully died a long time ago in 1929, just a month or two after I first came into the trade.* He was a gem dealer who later opened a Bond Street shop which specialized in rare stones. He was another pioneer of the early days of gemmology, an instructor and lecturer who never actually sat one of our examinations. In the early twenties he ran the Correspondence Courses and was Director of Examinations. He designed a large table refractometer with a rotating dense glass hemisphere which made the observation of birefringent RIs very easy. The switch to arms production killed this off and it was not made again after the war, which was a pity for it was a nice instrument. The dies for the medal were presented by Mrs Tully in 1930 in his memory. For several years it was our only major prize, until Rayners offered the two which are now presented in their name.

Just fifty years ago I, too, walked up on to this rostrum to collect my Diploma, and I am now going to break with tradition to tell you a little about those far off days.

In 1934 the First World War had been over for 16 years. The second instalment lay, quite unsuspected, five years in the future. The world was, as it is today, in the grip of a serious economic depression, known to us then as 'the Slump'. There was no Welfare State and unemployment was a grave problem which a 'dole' of about 50 pence a week did little to alleviate, and it was not finally solved until the Second World War brought full employment. If you had a job, no matter how poorly paid, you worked hard to keep it.

It was a world without many things which we now regard as essential. There was no television. Rayon was the only artificial fibre and nylon, polythene, terylene and a hundred other plastics had yet to be invented. There were no transistors, no tape-recorders, no computers, no radar and no jet aircraft. Nuclear physics was in its infancy, and the atom bomb was eleven years in the future.

*Mr Mitchell entered the buying department of Mappin & Webb Ltd in 1928.—Ed.

In 1934 we had been off the Gold Standard for a couple of years and that metal had rocketed from £4.20 to an unheard-of £6.90 per fine ounce. Silver, which in 1931 had, for one day, reached an all-time low of 5 pence an ounce, had recovered to a slightly more respectable 9 pence. A year or so later dealers were offering beautiful Victorian diamond jewellery at prices based on a figure of £8 per carat for melée stones. Those commodities cost far more today, not because they have increased in true value but because the good old Pound Sterling has been allowed to decline grotesquely in purchasing power until it is roughly equivalent in this respect to a 1934 sixpence (2½ new pence for those who may not remember real money).

Gemmology in 1934 was far simpler in structure than it is today, but we had fewer sophisticated instruments with which to work. The feverish search for laser materials, with its off-spin of new synthetics, was far in the future, and we contended only with synthetic corundums and spinels. Such things as the artificial colouring of diamonds by radiation were almost unknown, for radium was the only source of such particle bombardment. Anderson, our new lecturer, had introduced the 1.81 refractometer liquid, the crossed filter technique and absorption spectroscopy only that year. The course in 'Mineralogy for Jewellers', which was Chelsea Poly's name for gemmology at that time, was restricted to trade members only. But that trade tended to be disinterested, and we had little encouragement from some employers.

In that year twenty-one students, all British, sat the Diploma examination. All of them passed—nine with distinction, a feat which has yet to be equalled.

The enthusiasm of Anderson was contagious and we almost lived for gemmology. Some of our students were to become well-known in later years, like Robert Webster, author of the massive text-book *Gems* and *Practical Gemmology,* and Norman Harper, who was to be Chairman of this Association for some thirteen years. These and others made for fierce competition in our examination, which was probably not all that much easier than those set today. Personally I still have occasional nightmares in which I find myself with three questions to answer and only ten minutes in which to do it. Some of you will know the feeling.

Coming back to the present, I would like first to say a few words to those students who did not achieve a pass grade this year. They are unlikely to be here, but these words will be printed and may get to them one way or another. To them I say 'Don't be down-hearted! No examination is the end of the world, and some well-known gemmologists have had to take more than one shot at this one. Don't give up! If you do have to go over the ground a second time, then your gemmology will almost certainly be better founded as a result. Have another go!'

Successful candidates can forget those few words. You have passed a difficult test, and most of you will be feeling a certain degree of euphoric pride in achieving this milestone which marks the culmination of two or more years of hard, unremitting study—an end in itself, since all of you, both here and elsewhere, are now qualified gemmologists and are to be congratulated most heartily on that fact!

Last year Professor Bank quoted Goethe to make his point. I shall let Churchill underline mine. In no way do I wish to minimize your achievement when I say that your Diploma should be regarded, in his words, as 'the end of the beginning'. The old chap was talking about a very different conflict, but the warning is still apt. We, in the Gem Trade, handle some of the most highly priced substances on this planet, and we must be certain that they are what they are said to be.

Gemmology doesn't stand still. It is a progressive study. New minerals are cut as gems, new synthetics are made, new deceptions are contrived and new ways of dealing with all these things have to be worked out. You will never again be able to look at a stone without seeing it with a gemmologist's eye. You should now have a very valuable basic knowledge—but you haven't finished learning. You never will! In the years to come each gem intelligently examined will add to your experience and possibly teach you more. Use your lens at all times and your other instruments when you can. Read and re-read your Journal until you understand it. Seek out new books on the subject! Ask for information! Cultivate an enquiring mind! If you find something new or interesting, share the discovery by writing about it in the Journal.

In that way you may arrive at the fiftieth anniversary of this evening's ceremony ready to say, as I do now, 'I have never stopped learning about gems!'

That future meeting will be in the year 2034. Doesn't that sound strange? I shall not be there. At the age of 122 I won't be able to get up that marble staircase! But it is possible that one of the younger people who have received Diplomas tonight could stand here in my place. Then he, or she, may perhaps hear a small echo, or a chuckle, from somewhere up there near that wonderful ceiling and possibly will recall my words. I shall do my best to be here in spirit!

Thank you! And good luck to you all!

COUNCIL MEETING

At the meeting of Council held on Tuesday, 9th October, 1984, at the Connaught Rooms, London, W.C.2., the business transacted included the following:

(1) Mr A. E. Farn's resignation from the Council on his appointment as an Examiner in Gemmology was accepted;

(2) Mrs Eunice Miles was elected an Honorary Fellow;

(3) Mr J. R. H. Chisholm was nominated for election as a Vice-President of the Association and it was agreed that an Extraordinary General Meeting on 27th November should be called for the purpose;

(4) the following were elected to membership:

FELLOWSHIP

Adlam, Raymond J., Glasgow. 1984
Altenloh, Jacques C. P. J., Brussels, Belgium. 1984
Anderton, Brian G., Glasgow. 1984
Au-Yeung, Siu Man, Kowloon, Hong Kong. 1984
Baxendale, John F., Widnes. 1984
Beckwith, John M. E., Stockton on Tees. 1964
Blankestijn, Janna G., Leersum, Netherlands. 1983
Boreham, Kevin M., Truro. 1984
Cass, Laurence, Harrow. 1984
Chan, Hung C., Hong Kong. 1984
Chan, Suk H., Victoria, Australia. 1984
Cheung, Chi K., Hong Kong. 1984
Chieveley-Williams, John P. E., Poole. 1984
Chinn, Jeffrey, St Helier, Jersey, C.I. 1984
Corbin, Janet R., Liverpool. 1984
Donoghue, Martin D., Glasgow. 1984
Foote, Lisa A., Brisbane, Qld, Australia. 1984
Fox, Kathleen P., Townsville, Qld, Australia. 1984
Goodchild, Gordon E., Colchester. 1984

Goodchild, Kathleen J., Colchester. 1984
Gould, Henriette, Johannesburg, S.Africa. 1962
Henwood, Amelia R., Basingstoke. 1984
Jennings, Melvyn, Greetland. 1984
Jones, Julia D., Wolverhampton. 1984
Koseki, Norio, Fukushima-Shi, Japan. 1984
Lai Wing-Cheong, Robert, Shatin, N.T., Hong Kong. 1983
Lal, Vispi R., Churchgate, Bombay. 1984
Law, Bik W., Kowloon, Hong Kong. 1984
Leung, Pui F., Yuen, N.T., Hong Kong. 1984
Markus-Pothof, Helga, Wageningen, Netherlands. 1983
Massey, Steven M., Bowden. 1984
Mochan, Yan N., Glasgow. 1984
Morgan, Leon D., Aylesham. 1984
Nial, Brian L., Southport, Qld, Australia. 1984
Nelson, Maja T. A., London. 1984
Palomaki, Jukka Afto J., Katinala, Finland. 1983
Preston, Mitchell R., Morpeth. 1984
Rich, Frederick S., London. 1984
Robertson, Anne N., Gerrards Cross. 1984
Robertson, Neil, Kangaroo Pt, Qld, Australia. 1984
Sanchez Rodriguez, Raul de J., Las Palmas, Canary Is. 1983
Scamp, Colin P. D., Plymouth. 1984
Slack, Richard D., Lower Penarth. 1984
Smith, Clifford N., Leeds. 1984
Tomren, Jan I., Notodden, Norway. 1984
Tudor-Pole, Thomas A. J., London. 1984
van Dijk, Peter, Leimuiden, Netherlands. 1984
van Loenen, Willem J., Lopik, Netherlands. 1983
Wagstaff, Edith H. C., Bury, Lancs. 1984
Wickramasinha, Tudor, London.1984
Wiggin, Richard C., Midland, Texas, U.S.A. 1983
Wightman, David F., Aintree. 1984
Williams, Dawn L., Cheadle Hulme. 1984
Woolf, Tania, London. 1984
Yip, Ki F., Kowloon, Hong Kong. 1984

TRANSFERS FROM ORDINARY MEMBERSHIP TO FELLOWSHIP

Apland, Ken A., Cottage Grove, Oreg., U.S.A. 1984
Asagai, Toshiki, Osaka, Japan. 1984
Bae, Sang K., Seoul, Korea. 1984
Bartlett, Lynne, London. 1984
Bell, Robert D., Durban, S. Africa. 1984
Bennett, Norman P. J., Plymouth. 1984
Berger, Clark J., London. 1984
Beveridge, Ronald R., Adelaide, S. Australia. 1984
Blackburn, Mary-Rose, Pembroke. 1984
Buddington, Jeffrey P., Hyannis, Mass, U.S.A. 1984
Chang, Julius, Hong Kong. 1984
Chang, Yu-Mei, Tokyo, Japan. 1984
Cirone, Monica A., San Jose, Ca, U.S.A. 1984
Coffin, Martin R., Carlisle. 1984
de Vilmorin, Marie, London. 1984
Duguid, Keith B., Eiffel Flats, Zimbabwe. 1984
Dunn, Nigel P., Brierley Hill. 1984
Eaton, Anne, Lymm. 1984
Ehlenbach, Richard J., Winchester, Mass, U.S.A. 1984

Ely, Jana M., London. 1984
Fein, Murray, Whitestone, N.Y., U.S.A. 1984
Fitzgerald, Jennifer G., London. 1984
Gibson, Dorothy, Chatham, N.J., U.S.A. 1984
Gosling, Robert G., Adelaide, S. Australia. 1984
Guinand, François, Neuchatel, Switzerland. 1984
Hennessy, Linda L., Sydney, N.S.W., Australia. 1984
Holden, Patti, Market Harborough. 1984
Hookins, Gary C., Thames Ditton. 1984
Hosaka, Masahiro, Kofu, Japan. 1984
Kamioka, Hitomi, Tokyo, Japan. 1984
Kessler, Paul, Wolverhampton. 1984
Koseki, Norio, Tokyo, Japan. 1984
Kumarasuriar, G. K. K., Colombo, Sri Lanka. 1984
Lewton-Brain, Charles J., Halifax, N.S., Canada. 1984
Lim, Pauline, Kingswinford. 1984
Loup, Daniel L., Geneva, Switzerland. 1984
Maruo, Tatsuzo, Hyogo Pref., Japan. 1984
Moir, Richard C., Sydney, N.S.W., Australia. 1984
Payne, Michael D., Royal Tunbridge Wells. 1984
Peshwa, Krishna V., Pune, India. 1984
Porter, James W., Coventry. 1984
Puig Ovejero, Josep Mª, Barcelona, Spain. 1984
Quam, Maurice D., Saint Paul, Minn., U.S.A. 1984
Quick, Fiona A., Harare, Zimbabwe. 1984
Santiago Gonzalez, Antonia, Tenerife, Canary Is. 1984
Stoecklein, Patricia A., Trafalgar, Ind., U.S.A. 1984
Suzuki, Setsuko, Rokugo, Japan. 1984
Taylor, Caroline H. B., Guildford. 1984
Turner, Starla E., San Francisco, Ca, U.S.A. 1984
Uesugi, Tohru, Osaka, Japan. 1984
Walker, Frank D., Dallas, Tex., U.S.A. 1984
Warriner, E. R., Solihull. 1984
Wong, Christine H., Hong Kong. 1984
Woolley, Joseph G., Nelson, N.Z. 1984
Wurm, Lise A., San Francisco, Ca, U.S.A. 1984
Yap, Ching-Siew, London. 1984

ORDINARY MEMBERSHIP

Abramson, Pamela J., Orlando, Fla, U.S.A.
Ackroyd, Jonathan, L., Dunsfold.
Addison, Nicola E., London.
Aimoto, Masako, Kofu, Japan.
Alexander, Jane E., Singapore.
Anderson, Jeremy F., Northwood.
Anwar, Haroon M. G., Rastanura, Saudi Arabia.
Arias, Antonio, Madrid, Spain.
Armand, Marcel, Auckland, N.Z.
Austen, Susan L., Teignmouth.
Azzopardi, Paul, Kappara, Malta.
Baba, Toshiro, Osaka, Japan.
Biffer, Howard N., New York, U.S.A.
Bracewell, Hylda M., Brisbane, Qld, Australia.
Bram, Carol B., Hong Kong.
Bramlett, Christopher L., Albemarle, North Carolina, U.S.A.
Brasseur, Nathalie P. C., Dusseldorf, W. Germany.

Brinkmann, Hans H., Dickesbach, W. Germany.
Burton, Nicholas J., Fradley.
Carroll, Elizabeth K., Auckland, N.Z.
Castro, Kevin D., Napa, Ca, U.S.A.
Caswell, Amelie M., Hayle.
Chappron, Alan J., Bellevue, Wash., U.S.A.
Cole, John, Blackpool.
Coleman, Rachel R., Newbury.
Costello, Seamus A., Kilkenny, Ireland.
de Ceballos-Romay, J. Fernando, Mazzaine, Mexico.
della Torre, Isabelle, Geneva, Switzerland.
de Witte, Maarten J., Urbana, Ill., U.S.A.
Diyaljee, Wayne V. S., London.
Droste, Gregory S., Evansville, Ind., U.S.A.
Endo, Chiaki, Yamanashi, Japan.
Endo, Katumi, Kofe Yamanashi, Japan.
Fedell, Jean M., Crystal Lake, Ill., U.S.A.
Fessel, Robert P., Paulding, Ohio, U.S.A.
Finkleman, Steven L., Chicago, Ill., U.S.A.
Frank, Anita, Toronto, Ont., Canada.
Furuya, Tsukasa, Yamanashi, Japan.
Gardiner, Margot, Glasgow.
Gemmell, Ian G., Wairoa, N.Z.
Glaveau, Beatrice, Paris, France.
Grant, Louis A. G., Iver Heath.
Green, Gwynneth M., Barnt Green.
Hallier, Michele, Paradise Valley, Ariz., U.S.A.
Holt, Judith A., Chorley.
Homer, Sylvia, New Paltz, N.Y., U.S.A.
Horsup, Alexine, London.
Hyeon-Ka, Tae, Chung Nam, Korea.
Imai, Fumio, Kansas City, U.S.A.
Johnson, Gerald D., Kennewick, Wash., U.S.A.
Jones, Lloyd E., Auckland, N.Z.
Kasai, Kenji, Yamanashi, Japan.
Kienstra, Therese S., Alton, Ill., U.S.A.
King, Adrian J., Walsall.
Landolt, Karin, Beijing, China.
Lee, Alan R., Eastbourne.
Lee, Dong Ho, New Jersey, U.S.A.
Lee, Kay C. R., Seattle, Wash., U.S.A.
Liebermann, Louis B., Joliet, Ill., U.S.A.
Lim-Weissleib, Sin L., Paris, France.
McGlinchey, Kevin C., Derry City, N. Ireland.
Macaulay, Elizabeth A., Windhoek Gooo, Namibia.
Mathews, Paul C., Warmbaths, N. Transvaal, S. Africa.
Maurer, Michael G., Falls City, Nebr., U.S.A.
Mehdi, Jonathan, Herzliah Pituah, Israel.
Melinn, John, Dublin, Ireland.
Mills, Edwin T., Ely.
Mills, Ganny, Hong Kong.
Milton-Stevens, Christopher, Bath.
Mitchell, Virginia C., Shreveport, La, U.S.A.
Mohamed, Mohamed S., Colombo, Sri Lanka.
Mohlemkamp, Margaret I., Gordon, N.S.W., Australia.
Molina, Alfredo J., Phoenix, Ariz., U.S.A.
Mueller, Ralph D., Scottsdale, Ariz., U.S.A.
Munsterman, Henry B., Temple, Tex., U.S.A.
Murrell, Vernon, Croydon.
Nazeer, Mohamed H. M., Colombo, Sri Lanka.
Nechemias, Alan, San Francisco, Ca, U.S.A.
Nielsen, Krystina M., Lorain, Ohio, U.S.A.
Patten, Andrew W., Ilchester.
Pazolides, Constantine A., Thessaloniki, Greece.

Perrott, Christopher J., London.
Ramsay-Rae, Philippa, London.
Rhomberg, Markus, Innsbruck, Austria.
Rock, Barbara A., Athens, Greece.
Root, Charles K., Brownwood, Texas, U.S.A.
Sagar, Jayendra, Muharraq, Bahrain.
Seibert, Jack, Upper Arlington, Ohio, U.S.A.
Senanayake, A. W. Dharma, Singapore.
Shah, Rupam C., Manama, Bahrain.
Shepherd, Frederick J., Chislehurst.
Simmerman, Dianna L., Hong Kong.
Stachura, Joseph P., Jr., Uxbridge, Mass, U.S.A.
Starling, Lynn B., Colorado, U.S.A.
Stewart, Robert M., Swanmore.
Steyn, Johannes J., Chingola, Zambia.
Suhail, Mohamed N., Colombo, Sri Lanka.
Sweeney, Jerome, Kuala Lumpur, Malaysia.
Takeuchi, Masayo, Yamanashi, Japan.
Tezuka, Akira, Yamanashi, Japan.
Tivol, Thomas S., Kansas City, U.S.A.
Tsuruta, Einori, Alameda, Ca, U.S.A.
Tucker, Charles, Swaffham.
Turatti, Maya, Versoix, Switzerland.
Unwin, Derrick J., London.
Wako, Hisashi, Yamanashi, Japan.
Watanabe, Tatuo, Yamanashi, Japan.
Wendon, Jonathan L., Bonvilston.
Whittaker, Maureen J., Halandrion, Greece.
Williams, Bret J., Waikato, N.Z.
Williams, Philippa J., Towcester.
Wolanski, Patricia L., Dallas, Tex., U.S.A.
Wong, Wing K., Telok Kurau, Singapore.
Wood, Francis, Clifton, York.
Wright, John C., Hong Kong.
Xanthopoulou, Celia, London.
Young, Gabrielle E. M., Wareham.
Zanacchi, Lorenzo, Mombasa, Kenya.

EXTRAORDINARY GENERAL MEETING— A NEW VICE-PRESIDENT

John Richard Harrison Chisholm, M.A., F.R.S.A., F.Z.S., M.R.I., F.G.A. was elected a Vice-President of the Association at an Extraordinary General Meeting of the Association on 27th November, 1984.

J. R. H. C. was born in 1905 and educated at Westminster School and Christ Church, Oxford. He practised as a solicitor from 1932 until 1974. His work encompassed a range of legal problems, but life assurance and pension funds were a major interest. He was director of a number of companies and a past Chairman of the Life Assurance Legal Society.

During the last months of the Second World War he spent several weeks in bed with what his doctor called 'a low-grade infection of the lungs' and his wife, Marie-Louise, chanced upon Selwyn's 'Retail Jewellers Handbook' in the local library; they both found it fascinating. Among the advertisements in the end-pages was one for the National Association of Goldsmiths and another on the same page for the Gemmological Association which mentioned the Correspondence Course. In a bantering fashion husband and wife bet each other that they couldn't pass the Diploma examination; both started the correspondence course.

So started the gemmological career of our new Vice-President. He passed the Diploma examination in 1950, but had only seen the gemmological instruments the day before the examination and only learned to cope with them by the end of the practical examination.

In 1955 he was appointed an Examiner in Gemmology (with Dr G. F. (now Sir Frank) Claringbull and Mr B. W. Anderson) and from then on was in sole charge of the Preliminary examination—setting papers and marking the answers. After Dr A. J. Allnutt was appointed as an Examiner in 1963 and took over the Preliminary Examination, J. R. H. C. became primarily responsible for one of the Diploma papers.

In 1953-55 he had written articles for the Journal (as well as some 'Letters to the Editor') and from the late 50s Gordon Andrews (then Secretary of the Association) had been sending him printers' galleys to correct for the Journal. On Gordon Andrews' retiral in 1973, J. R. H. C. was appointed Editor of the Journal—a post he still holds. The present high standing of the Journal worldwide is largely due to his efforts over the past decade. He retired from the post of Examiner in 1982 after 27 years meticulous service.

Chronicled above (in outline only) is a magnificent record of service to the Association, and to this must be added many years of free legal advice on many problems concerned with Association affairs.

There are other sides to this man: he was a Special Constable in 1926, the year of the General Strike in Britain; he served in the Home Guard from 1940-45 and 1952-58, retiring with the rank of Major, and in the Civil Defence Corps from 1950-52 and 1958-68. As late as 1971 he gained his private pilot's licence and lists the Elstree Flying and the Athenaeum as his clubs.

John Chisholm well deserves his election as Vice-President and to the small circle of devoted Fellows who have served the Association so well for so many years.

E.A.J.

GEM DIAMOND EXAMINATION, 1984

In the Post-Diploma Gem Diamond Examination 41 candidates sat and of these 40 succeeded in passing. The following is a list of the names of the successful candidates arranged alphabetically.

Amos, Gillian L., Pontypridd.
Avargues Perles, Antonia, Barcelona, Spain.
Bercott, David S., Glasgow.
Bishop, Ian C., London.
Bisset, Ross, London.
Bolton, Robert G., Menston.
Castell Andujar, Joaquin, Barcelona, Spain.
Collado Castelles, Mª Dolores, Barcelona, Spain.
Collins, Glen M., Glasgow.
Condrup, Jonathon R., London.
Darmudas, Nathaniel R., London.
Doughty, Michelle Susanne, London.
Firth, Barbara, London.
Fryer, Frederick A., London.
Garcia Gisbert, Rocio, Barcelona, Spain.
Genis Perez, Manuel, Barcelona, Spain.
Gonzales Violan, Francesc, Barcelona, Spain.
Guerrero Ramon, Desamparados, Barcelona, Spain.
Houghton, Mark W., Cheshire.

Hutchinson, Marjorie E., London.
John, Bryan C., Carmarthen.
McFarlane, Patricia A., London.
Mehta, Anoop K., London.
Moreno Valero, Eloy, Barcelona, Spain.
Noguera Borel, Agnes, Barcelona, Spain.
Orchant, Lewis, Glasgow.
Pedersen, Julie, Merseyside.
Perera, Priyani A. M., Sri Lanka.
Pike, Corinna A. W., Putney.
Pritchard, Janet M., London.
Salloway, Nigel J., London.
Sanchez Rodriguez, Raúl de J. Barcelona, Spain.
Sealey, Ralf E., London.
Smith, Ian J., Rochdale.
Soni, Anu, London.
Subramaniam, Manoharan, Farnborough.
Wells, Bruce I., Glasgow.
Whittingham, Jill E. A., Farnham.
Woodhouse, M. L., Chatham.
Young, William R., London.

EXAMINATIONS IN GEMMOLOGY, 1984

In the 1984 Examinations in Gemmology 459 candidates completed the Diploma Examination and of these 198 succeeded in passing, 28 of them with Distinction. In the Preliminary Examination 715 sat and 408 passed.

Upon the recommendation of the Examiners the Tully Memorial Medal has been awarded both to Miguel Angel Pellicer Garcia, of Barcelona, Spain, and to Dorothy Gibson, of Chatham, New Jersey, U.S.A.

The Anderson/Bank Prize for the best non-trade candidate of the year in the Diploma Examination was awarded to Jane Francis Cassandra Goad, of London.

The Rayner Diploma Prize for the best candidate of the year whose main income is derived from activities essentially connected with the jewellery trade was awarded to Michael D. Payne, of Royal Tunbridge Wells.

The Anderson Medal for the best candidate of the year in the Preliminary Examination was awarded to Gwynneth M. Green, of Barnt Green, Worcs.

The Rayner Preliminary Prize for the best candidate of the year under 21 years of age whose main income is derived from activities essentially connected with the jewellery trade was awarded to Jill Snider, of Downsview, Ontario, Canada.

The following are lists of the successful candidates arranged alphabetically.

DIPLOMA EXAMINATION

TULLY MEMORIAL MEDAL

Pellicer Garcia, Miguel Angel, Barcelona, Spain.
Gibson, Dorothy, Chatham, N.J., U.S.A.

Anderson/Bank Prize
Goad, Jane F. C., London.

Rayner Diploma Prize
Payne, Michael D., Royal Tunbridge Wells.

QUALIFIED WITH DISTINCTION

Banks-Lyon, Rodney, Bristol.
Barlow, Alice M., Appleton, Wis., U.S.A.
Berger, Clark J., London.
Cahill, Cynthia E., Bangkok, Thailand.
Caracciolo, Marie E., McLean, Va, U.S.A.
Chieveley-Williams, John P. E., Poole.
Chu, K-C. Quinnie, Toronto, Canada.
Dagli, Yogeshkumar P., Bombay, India.
de Vilmorin, Marie, London.
Ehlenbach, Richard J., Winchester, Mass, U.S.A.
Ely, Jana M., London.
Gibson, Dorothy, Chatham, N.J., U.S.A.
Goad, Jane F. C., London.
Jerndell, Bo E. O., Stockholm, Sweden.
Kikano, Margo M., London.
Lal, Vispi R., Bombay, India.
Malkani, Monica, Bombay, India.
Payne, Michael D., Royal Tunbridge Wells.
Pellicer Garcia, Miguel Angel, Barcelona, Spain.
Quick, Fiona A., Harare, Zimbabwe.
Rich, Frederick S., London.
Root, Jerold B., Bethesda, Md, U.S.A.
Stoecklein, Patricia A., Trafalgar, Ind., U.S.A.
Taylor, Caroline H. B., Ripley.
Turner, Starla E., Hillsborough, Ca, U.S.A.
van Wenum, Elbertha G., Amsterdam, Netherlands.
Williams, Dawn L., Cheadle Hulme.
Yin, Anna W. Y., Hong Kong.

QUALIFIED

Adlam, Raymond J., Glasgow.
Alexander, Nicholas A., Johannesburg, S.Africa.
Altenloh, Jacques C. P. J., Brussels, Belgium.
Anderton, Brian G., Glasgow.
Apland, Ken A., Cottage Grove, Oreg., U.S.A.
Asagai, Toshiki, Osaka, Japan.
Au-Yeung, Siu M., Hong Kong.
Bae, Sang K., Seoul, Korea.
Bartlett, Lynne, London.
Bastiaanse, Paul A., Eindhoven, Netherlands.
Baxendale, John F., Widnes.
Bell, Robert D., Pinetown, S.Africa.
Bennett, Norman P. J., Plymouth.
Berger, Joel D., Silver Spring, Md, U.S.A.
Beringen, John J. G., Utrecht, Netherlands.
Bernal Garcia, Jose E., Barcelona, Spain.
Beveridge, Ronald R., Adelaide, S.Australia.
Blackburn, Mary-Rose, Pembroke.
Bonvehi Sola, Joan, Barcelona, Spain.
Boreham, Kevin M., Truro.
Brown, James E., Sheffield.
Buddington, Jeffrey P., Hyannis, Mass, U.S.A.
Budhwani, Amin M., Bombay, India.
Calatayud Llorca, Francisco, Barcelona, Spain.
Calduch Sendra, Mª Esmeralda, Barcelona, Spain.
Calje, Nicoline, Schoonhoven, Netherlands.
Cartmell, Fiona A., Wembley.

Casanovas Ramon, Mª Rosa, Barcelona, Spain.
Cass, Laurence, London.
Chan, Boon T., Penang, Malaysia.
Chan, Hung C., Hong Kong.
Chan, Jacqui B. H., Penang, Malaysia.
Chan, Suk H., Hong Kong.
Chang, Julius, Hong Kong.
Chang, Yu-Mei, Tokyo, Japan.
Cheung, Chi K., Hong Kong.
Chinn, Jeffrey, St Helier, Jersey, C.I.
Cirone, Monica A., San Jose, Ca, U.S.A.
Coffin, Martin R., Carlisle.
Corbin, Janet R., Liverpool.
Courtenay, Jutta W., Hong Kong.
Cox, Jennifer M., Redhill.
D'Cruz, Jeffrey C., Bombay, India.
Dent, Peter J., Guildford.
Dewan, Shobha, Hong Kong.
Dixon Phillip, John G., Wallasey.
Donoghue, Martin D., Glasgow.
Duckett, Karen L., Long Preston.
Duguid, Keith B., Eiffel Flats, Zimbabwe.
Dunn, Nigel P., Brierley Hill.
Eaton, Anne, Lymm.
Ellis, Julia L., Aylesbury.
Fein, Murray, Whitestone, N.Y., U.S.A.
Ferran Estrada, Alejandro, Barcelona, Spain.
Fitzgerald, Jennifer G., London.
Floriach Devant, Mª Teresa, Barcelona, Spain.
Foote, Lisa A., Brisbane, Qld, Australia.
Fox, Kathleen P., Townsville, Qld, Australia.
Franks, Karen M., Manchester.
Gafner, Antoinette, Liestal, Switzerland.
Galindo Merino, Mª del Carmen, Barcelona, Spain.
Giel, Caroline, Schoonhoven, Netherlands.
Glover, Howard N. G., Wallasey.
Gol Perlasia, Jose Mª, Barcelona, Spain.
Goodchild, Gordon E., Colchester.
Goodchild, Kathleen J., Colchester.
Goossens, Xavier A., London.
Gosling, Robert G., Adelaide, S.Australia.
Graham, Kimberley E., Toronto, Canada.
Guinand, François, Neuchatel, Switzerland.
Hall, Michael J. B., Oxshott.
Hansen, Jo Anne, Corvallis, Oreg., U.S.A.
Harding, Richard W., Solihull.
Hennessy, Linda L., Sydney, N.S.W., Australia.
Henwood, Amelia R., Basingstoke.
Hilton, Barbara W., Riverside, Ca, U.S.A.
Ho, Hay-ming J., Hong Kong.
Ho, Frankie K. K., Hong Kong.
Holden, Patti, Market Harborough.
Hookins, Gary C., Thames Ditton.
Hosaka, Masahiro, Kofu, Japan.
Hunt, Jill M., Totnes.
Jacobson, Karl F., Ignacio, Colo, U.S.A.
Jennings, Melvyn, Halifax.
Jhaveri, Prateik R., Bombay, India.
Jones, Julia D., Wolverhampton.
Kamioka, Hitomi, Tokyo, Japan.
Kessler, Paul, Wolverhampton.
Kobesen, Johannes B. A., Amstelveen, Netherlands.
Koseki, Norio, Tokyo, Japan.
Kothari, Prajesh R., Madras, India.
Kotila, Brian W., Don Mills, Ont., Canada.
Kranz, Kurt B. G., Brisbane, Qld, Australia.
Kumarasuriar, Geetha K. K., Colombo, Sri Lanka.
Law, Bik W., Hong Kong.
Leung, Pui F., Hong Kong.
Lewton-Brain, Charles J., Halifax, N.S., Canada.
Lim, Pauline, Kingswinford.

Loup, Daniel L., Geneva, Switzerland.
Lui, Elizabeth S. H., Hong Kong.
MacFadyen, Donald A., Scarborough, Ont., Canada.
McKearney, Michael C., London.
Maruo, Tatsuzo, Hyogo Pref., Japan.
Massey, Steven M., Bowden.
Maughan, Raymond J., Townsville, Qld, Australia.
Mochan, Yan N., Glasgow.
Moir, Richard C., Kenthurst, N.S.W., Australia.
Morgan, Leon D., Aylesham.
Morin Reyes, Maria Luisa, Tenerife, Canary Is.
Muchlinski, Michael, Clacton-on-Sea.
Murray, Jacqueline K., Whalton.
Nancarrow, Peter H. A., West Horsley.
Nelson, Maja T. A., London.
Nial, Brian L., Southport, Qld, Australia.
Parisée, Claudette, Vanier, Ont., Canada.
Paul, Wesley T., Kandy, Sri Lanka.
Payne, Susan E., Sheffield.
Peltonen, Stella P., Stockholm, Sweden.
Peshwa, Krishna V., Pune, India.
Porter, James W., Coventry.
Preston, Mitchell R., Morpeth.
Puig Ovejero, Josep Mª, Barcelona, Spain.
Quam, Maurice D., St Paul, Minn., U.S.A.
Remmereit, Jan, Oslo, Norway.
Rikkoert, Jasper D., Schoonhoven, Netherlands.
Robertson, Anne N., Gerrards Cross.
Roberston, Neil, Brisbane, Qld, Australia.
Rojals Garcia, Montserrat, Barcelona, Spain.
Rooijmans, Eric Frederik T. W. L., Eindhoven, Netherlands.
Ros Hernandez, Julio, Barcelona, Spain.
Rosenblatt, Robert L., Salt Lake City, Utah, U.S.A.
Rundgren, Mats E., Stockholm, Sweden.
Salas Alonso, Jose V., Barcelona, Spain.
Sane, Hemant S., Bombay, India.
Santiago Gonzalez, Antonia, Tenerife, Canary Is.
Scamp, Colin P. D., Plymouth.
Seiz Ortiz, Vicente J., Barcelona, Spain.
Shah, Syed S. A. H., Manchester.
Slack, Richard D., Nantwich.
Smith, Clifford N., Leeds.
Snider, Jill, Downsview, Ont., Canada.
Solis Mariscal, Mª Angeles, Barcelona, Spain.
Sugathapala, Reginal, Zurich, Switzerland.
Suzuki, Setsuko, Yamanashi, Japan.
Tomren, Jan I., Notodden, Norway.
Toole, Michael L. A., Vancouver, Canada.
Trusselle, Richard J., Tring.
Tudor-Pole, Tom A. J., London.
Uesugi, Tohru, Osaka, Japan.
van Dijk, Peter, Leimuiden, Netherlands.
van Grinsven, Helena A., Arnhem, Netherlands.
van Roy, Anne E. J., London.
Visvanathan, Chettiar, Coimbatore, India.
Vogler, Karl J., Basel, Switzerland.
Wagstaff, Edith H. C., Bury, Lancs.
Walker, Frank D., Dallas, Tex., U.S.A.
Warriner, Elizabeth R., Solihull.
Wickramasinha, Tudor, London.
Widmer, Thomas, Aarau, Switzerland.
Widmer, Walter L., Colombo, Sri Lanka.
Wightman, David F., Liverpool.

Witjes de Vaal, Geertje, Oisterwijk, Netherlands.
Wong, Christine H., Hong Kong.
Woolf, Tania, London.
Woolley, Joseph G., Nelson, N.Z.
Wright, Frank A., Riverside, Ca, U.S.A.
Wurm, Lise A., San Francisco, Ca, U.S.A.
Yap, Ching-Siew, London.
Yip, Ki Fung, Hong Kong.
Zwyssig, Urs, Bangkok, Thailand.

PRELIMINARY EXAMINATION

Anderson Medal
Green, Gwynneth M., Barnt Green, Worcs.

Rayner Preliminary Prize
Snider, Jill, Downsview, Ont., Canada.

QUALIFIED

Abrahams, Roy H., Ruislip.
Addison, Nicola E., London.
Advani, Meena, Bombay, India.
Aggarwal, Kamal, New Delhi, India.
Alahendra, Jayatilaka, Kandy, Sri Lanka.
Alexander, Nicholas A., Benoni, S.Africa.
Allen, Vivien, Toronto, Ont., Canada.
Ambrose, Janice M., Brentwood.
Anderson, Vanessa K. A., Hong Kong.
Arno Fece, Nuria, Barcelona, Spain.
Ashraf, Ashfaq A., London.
Ashton, Joan, Hong Kong.
Athanassiades, Emmanouela, Attiki, Greece.
Baimbridge, Andrew C., Manchester.
Balejko, Dominik, Stockholm, Sweden.
Baquero Petricorna, Manuel, Barcelona, Spain.
Batalla Vivas, Francisco C., Barcelona, Spain.
Batalla Vivas, Jose I., Barcelona, Spain.
Bell, Heather L., Formby.
Berger, Joel D., Silver Spring, Md, U.S.A.
Bernadotte, Eva C., Stockholm, Sweden.
Beveridge, Ronald R., Seacombe Heights, S.Australia.
Bhaloo, Shamsudin G., London.
Blankenburg, Hans Ol, Fenwick, Ont., Canada.
Bram, Carol B., Hong Kong.
Brook, Judith M., Leicester.
Brooks, Simon R., Hornchurch.
Brouwer, Marietta H., Utrecht, Netherlands.
Brown, Jayne D., Sheffield.
Budhwani, Amin M., Bombay, India.
Burke, Melody, Camberley.
Buxton, Lynne H., Norwich.
Bydairk, Walter J., Ballston Spa, N.Y., U.S.A.
Cabre Bores, Nuria, Barcelona, Spain.
Cahill, Cynthia E., Bangkok, Thailand.
Calatayud Llorca, Francisco, Barcelona, Spain.
Calvet Pallas, Mª Teresa, Barcelona, Spain.
Campbell, Norma, Hong Kong.
Campillo Pastor, Marina, Barcelona, Spain.

Campos Ruiz, Mª Teresa, Barcelona, Spain.
Carmena Coelho, Jose A., Barcelona, Spain.
Chan, Boon T., Penang, Malaysia.
Chan, Chi K., Kowloon, Hong Kong.
Chan, Immaculata K., Hong Kong.
Chan, Jacqui B. H., Penang, Malaysia.
Chan, Suk H., Victoria, Australia.
Chan, Yiu W. S., Hong Kong.
Chang, Yu-Mei, Tokyo, Japan.
Chaparro Lameda, Daisy A., Barcelona, Spain.
Chau, Hing W., Hong Kong.
Cheng, Bakke P. K., Kowloon, Hong Kong.
Cheng, Alan O. L., Hong Kong.
Cheuk, David H. T., Hong Kong.
Cheung, Chi K., Hong Kong.
Cheung, King W., Hong Kong.
Chilvers, Alan, Guildford.
Ching, Chan Y., Hong Kong.
Chiu, Alan K. Y., Hong Kong.
Choi, Alex S. W., Hong Kong.
Cholat, Nicole B., Hong Kong.
Chooi, Siew T., London.
Chow, Joseph H. K., Hong Kong.
Church, Susan T., New York, U.S.A.
Clancy, Allan W., Queensland, Australia.
Coehoorn, Wilma, Schoonhoven, Netherlands.
Cooper, Berzes, London.
Cox, Jennifer M., Redhill.
Daniell, Mary L. S., Hong Kong.
Davis, Adrienne M., Liphook.
Davis, Howard T., Liphook.
Davis, Simon, Elstree.
D'Cruz, Jeffrey C., Bombay, India.
de Bruin, Ilonka L. J., Amsterdam, Netherlands.
Deelman, Peter J., Schoonhoven, Netherlands.
de Haer, Robert H., Schoonhoven, Netherlands.
de Heer, Petra C., Ede, Netherlands.
Dennis, Stuart G., Bath.
Depyjper, Raphael, Ryn, Netherlands.
Derks, Rudolf, Hettlingen, Switzerland.
Devereux, James P., Toronto, Ont., Canada.
de Vilmorin, Marie, London.
Dewever, Marc L. N., Sittard, Netherlands.
Dias, Mario H., London.
Dimaggio, Joseph C., Centerline, Mich., U.S.A.
Doerr, Bertrand R., Kuesnacht, Switzerland.
Dosanjh, Gurmeet S., New Delhi, India.
Dubbers, Maria T. H., Plasmolen, Netherlands.
Dunstall, Robert, Northampton.
Duque Camp, Susanna Ma, Barcelona, Spain.
Easterbrook, Steven, Bridgend.
Eaton, Anne, Lymm.
Edie, Anmie, Hong Kong.
Ellis, Trevor E., Rugeley.
Elson, Patricia D., Swansea.
Ely, Jana M., London.
Evans, Gareth D., Potters Bar.
Farley, Eileen J., Cabinteely, Dublin, Ireland.
Farre Brugue, Francisco, Barcelona, Spain.
Fernandes, Frank T., Bombay, India.
Fernandez Usac, Teresa, Barcelona, Spain.
Fernando, Ranamukadevege P., Kelaniya, Sri Lanka.
Fixter, Robert H., Lincoln, Nebr., U.S.A.
Fournel, Astrid, Aldeburgh.
Fox-Worthington, Peter J. J. E., Auckland, N.Z.
Frederick, Helen M., Wellington, N.Z.
Fry, Kate E., Bath.

Fujii, Shinichi, Tokyo, Japan.
Gafner, Antoinette, Liestal, Switzerland.
Gambetta, Anthony, Caerphilly.
Gamblen, Philip M., Barrie, Ont., Canada.
Garcia Monge, Jorge, Barcelona, Spain.
Georgopoulou Kyriaki, Marianna, Athens, Greece.
Gerhart, Anna M., San Diego, U.S.A.
Gol Perlasia, Jose Mª, Barcelona, Spain.
Gonggryp, Hendrik S., The Hague, Netherlands.
Goodchild, Kathleen J., Colchester.
Gosling, Robert G., Christies Beach, S.Australia.
Goumas, John, Athens, Greece.
Graupera Olle, Roser, Barcelona, Spain.
Gravett, Marian J., Barnet.
Green, Fionna E., Stonehaven.
Green, Gwynneth M., Barnt Green.
Gregoire, Stanislas, Ghent, Belgium.
Gresswell, Pauline T., Sheffield.
Grievson, Richard P., York.
Grillo Pont, Josep Mª, Barcelona, Spain.
Gualco, Fabiana, Genoa, Italy.
Gualco, Giuseppe, Victoria, Brazil.
Guasch Boliart, Arturo, Barcelona, Spain.
Gunn, Alice K., Burnaby, B.C., Canada.
Haalebos, Maud, Rotterdam, Netherlands.
Hall, Sylvia, Guildford.
Hampton, Malcolm J., Highcliffe.
Harding, Keith J., Worcester, Mass, U.S.A.
Harrison, Margaretha, Geneva, Switzerland.
Hashimoto, Masaki, Osaka, Japan.
Heelas, Anne I., Harare, Zimbabwe.
Heimbuch, Anita A., Flagstaff, Ariz., U.S.A.
Henderson, Mark M., Dundee.
Herold, Richard A. J., Salisbury.
Hildred, Ann B., Thatcham.
Hill, Arthur E., Jersey, C.I.
Hilton, Barbara W., Riverside, Ca, U.S.A.
Hinchliffe, Stanley E., Queensland, Australia.
Hitchman, Caroline A., Sunderland.
Hobbs, Fiona G., Winchester.
Hoi, Josephine B. S., London.
Holland-Grice, Terence H., Stoke on Trent.
Holt, Judith A., Chorley.
Howell, Lindsay J., St Aubins, Jersey, C.I.
Iacovou, Elena, London.
Ichiseki, Zenkoh, Tokyo, Japan.
Imai, Yoshiko, Tokyo, Japan.
Imashiro, Ayano, Tokyo, Japan.
Insa Sales, Juan M., Barcelona, Spain.
Ishizuka, Keiko, Kanagawa Pref., Japan.
Jacobs, Dalia, Kenton.
Jander, Margrit, Geneva, Switzerland.
Jayalath, Roshan J. D., Colombo, Sri Lanka.
Jhaveri, Prateik R., Bombay, India.
Johannessen, Penny M. F., Hong Kong.
Jones, Karen, Bangor.
Jones, Kevin P., Coventry.
Jones, Michael H., Northampton.
Jongenburger, Irma, Schoonhoven, Netherlands.
Joonoos, Roberta A., Colombo, Sri Lanka.
Jordan Figueras, Francisco, Barcelona, Spain.
Joslin, Shirley A., Hong Kong.
Juan Sampablo, Teresa, Barcelona, Spain.
Judge, Susan D., Hong Kong.
Juttmann, Gaby, Rotterdam, Netherlands.
Kai, Kock M., Hong Kong.

Kaleel, Mohamed I., Colombo, Sri Lanka.
Kaller, Douglas, New York, U.S.A.
Kallner, Anders B., Johanneshov, Sweden.
Kamioka, Hitomi, Tokyo, Japan.
Karan, Dorothy C., Ras Tanura, Saudi Arabia.
Kawamoto, Midori, Tokyo, Japan.
Kenny, Alice, Liverpool.
Kirstein, Mark H., Eastbourne.
Kittel, Gerhilde A., Toronto, Ont., Canada.
Knight, Norman H., New Milton.
Kobesen, Johannes B. A., Amstelveen, Netherlands.
Kochhar, Narinder J. S., London.
Kol, Elizabeth A., Schoonhoven, Netherlands.
Kong, Grace W. F., Hong Kong.
Koopman, Peter P., Ryn, Netherlands.
Koster, Anita, Schiedam, Netherlands.
Kotila, Brian W., Don Mills, Ontario, Canada.
Krieger, Sabine M., Stockholm, Sweden.
Krot, Carine, Amsterdam, Netherlands.
Kruithof, Pieter, Amsterdam, Netherlands.
Kuehn, Wolfgang, Surrey, B.C., Canada.
Kumar, Jain J., Delhi, India.
Labastire, Sylvie, London.
Lai, Christina C. K., Hong Kong.
Lambert, Zahava, Willowdale, Ont., Canada.
Langdon, Ingrid, Corpus Christi, Texas, U.S.A.
Lapiccirella Galbiati, Franca, Florence, Italy.
Larson, Len, Thornton, Colo, U.S.A.
Lau, Rosanna W. Y., Hong Kong.
Lau, Yun W., Hong Kong.
Law, Tai S., Hong Kong.
Layhe Cook, Judith A., Warwick.
le Pavoux, Angela D., St Saviour, Jersey, C.I.
Leatham, Claire, Wakefield.
Lee, Chiu W. F. T., Hong Kong.
Levi, Mandy S., Birmingham.
Lewis, Doreen E., Llangattock-Vibon-Avel.
Liyanaarachchi, Tudor P., Colombo, Sri Lanka.
Lloyd, Jeremy J., Birmingham.
Lloyd George, Kim A., Hong Kong.
Lockhart, James M., London.
Lovering, Paula G., Otago, N.Z.
Luff, Kenneth H., Sidcup.
Lury, Janine D., Nairobi, Kenya.
Ly, Khai, Cabramatta, N.S.W., Australia.
Macan Markar, Noorul N., Colombo, Sri Lanka.
MacAulay, Elizabeth W., Windhoek, Namibia.
McColgan, Phillip G., Roath.
McIntosh, Stewart F., Glasgow.
McKee, Marjory, Harrogate.
McLaren, Margaret E., Nairobi, Kenya.
MacMillan, Susan M., London.
Madden, Denise E., Hong Kong.
Magee, Alyson M., Londonderry, N.Ireland.
Mak, Connie L. S., Hong Kong.
Marchese, Anne M., Toronto, Ont., Canada.
Marti Beltran, Fernando, Barcelona, Spain.
Marti Martinez, Nicolas, Barcelona, Spain.
Martin, Eric, Whitby.
Maruo, Tatsuzo, Hyogo Pref., Japan.
Masin, Roy, Soestdijk, Netherlands.
Massey, Joanne, Macclesfield.
Matsumoto, Chigako, Tokyo, Japan.
Meade, Christopher, Cleckheaton.
Michaelson, Peter J., London.
Minton, Annie P., Harrow Weald.
Mitchell, David C., Birkenhead.

Mohideen, Mohammed F., Colombo, Sri Lanka.
Moir, Christopher R., Biggin Hill.
Mok, Raymond W. M., Hong Kong.
Mora Gine, Mª Dolores, Barcelona, Spain.
Morrison, Andrew H., Newport, Gwent.
Morrison, Sadie, Guernsey, C.I.
Morrison, Stephen P., London.
Moss, David P., Calderstones.
Mouncer, Sara, Tunbridge Wells.
Mulder, Mieke, Amsterdam, Netherlands.
Murphy, Francis E., Halifax, N.S., Canada.
Nagasaka, Hiroko, Yamanashi-Ken, Japan.
Nakazawa, Hiromi, Tokyo, Japan.
Nelson, Deborah A., London.
Ng, Raymond K. Y., Hong Kong.
Ngai, Ramon P. C., Hong Kong.
Nieto Martinez, Mª Faustina, Barcelona, Spain.
Niklewicz, Danusia, Santa Monica, Ca, U.S.A.
Nishihara, Akio, Kanagawa Pref., Japan.
Ocampo, Antonieta, Hong Kong.
Ogawa, Katsuhiko, Tokyo, Japan.
Ohata, Keiichi, Saitama Pref., Japan.
Ohshiro, Kenji, Tokyo, Japan.
Okayasu, Tetsuya, Tokyo, Japan.
Oliver Echevarria, Mª Teresa, Barcelona, Spain.
Olsen, John R., Dhahran, Saudi Arabia.
Olsen, Sandra A., Dhahran, Saudi Arabia.
Or, Wai L., Hong Kong.
Osborne, Malcolm G., Bordon.
Overbeek, Louise A. M., Riethoven, Netherlands.
Pajaron Gamon, Mª Loreto, Barcelona, Spain.
Palmer, Valerie G., London.
Papadopoulos, Costas, F., Athens, Greece.
Pascual Roige, Mª Merce, Barcelona, Spain.
Pascual Torres, Jose Luis, Barcelona, Spain.
Patterson, Shannon F., Ohio, U.S.A.
Pattni, Rama, Leicester.
Pattni, Shushil S., Loughborough.
Paul, Michael S., Kandy, Sri Lanka.
Payette, Francine, Vancouver, Canada.
Perera, Callistus R., Colombo, Sri Lanka.
Perrott, Christopher J., London.
Perry, Nellie, London.
Persen, Timothy, G., Porirua, N.Z.
Pieris, Ishita K., Mount Lavinia, Sri Lanka.
Pledger, John D., Torrington.
Poelen, Ellen B., Molenhoek, Netherlands.
Poole, Jennie E., Leeds.
Potgieter, Ernestine, Cape Town, S.Africa.
Preston, Karen L., Burnley.
Prezio, Tony, Mississauga, Ont., Canada.
Pungerl, Natasha B., London.
Ragsdale, Lisa L., Toronto, Ont., Canada.
Ramsay-Rae, Philippa A., London.
Rapin, Katia, Tannay, Switzerland.
Redon Aymerich, Sara, Barcelona, Spain.
Rehbinder, Anne C. M., Vallentuna, Sweden.
Reyman, Mark E., New York, U.S.A.
Reynolds, Gerald N., Arlington, Texas, U.S.A.
Richards, Colleen H., Hong Kong.
Rideemahaliadda, Nandani K., Colombo, Sri Lanka.
Robinson, Stanley, Saint Lucia, Australia.
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Roige Bragulat, Rosa A., Barcelona, Spain.

Ruiz Roser, Emilio, Barcelona, Spain.
Ross, Howard D., Harare, Zimbabwe.
Roucouna, Catherine, Athens, Greece.
Rupasinghe, Mahinda S., Mainz, W. Germany.
Sakai, Osamu, Tokyo, Japan.
Saldon Rojas, Yolanda, Barcelona, Spain.
Sally, Mohammed Feroze, Kandy, Sri Lanka.
Sally, Niazbie, Kandy, Sri Lanka.
Samaranayake, Ravinda, Colombo, Sri Lanka.
Sammoon, Fareeda N., Colombo, Sri Lanka.
Sanders, Adam, Ware.
Sasaki, Kiyoshi, Ehime Pref., Japan.
Satoh, Mari, Tokyo, Japan.
Savin, Vincent G., Rickmansworth.
Saxena, Yogesh N. S., Hyderabad, India.
Scandella, Stefano, Liestal, Switzerland.
Schlüssel, Roland, Geneva, Switzerland.
Schmidt, Roger E., Auburn, Mich., U.S.A.
Schouten, Piet H., Aadenhaag, Netherlands.
Scott, Rebecca J., Auckland, N.Z.
Shah, Nilesh K. R., London.
Shea, Laura L., Hong Kong.
Shimizu, Yoshimi, Yamanashi, Japan.
Shu, Yau L., Hong Kong.
Siegel, Paul L., New York, U.S.A.
Small, Yvonne, Southampton.
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Snare, Melanie J., Islington, Ont., Canada.
Snider, Jill, Downsview, Ont., Canada.
Snijders, Nanny, Hapert, Netherlands.
Soderberg, Anette B., Solna, Sweden.
Spencer, Jonathan P., Bristol.
Squelch, Bruce C., Queensland, Australia.
Stacey, George S., Queensland, Australia.
Stanbury, Derek C., Birmingham.
Stather, Memory H., Hong Kong.
Stavast, Jean M., The Hague, Netherlands.
Stenberg, Danuta, Stockholm, Sweden.
Stephenson, Timothy, Creetown.
Stevens, Graham W., Taunton.
Sturman, Nicholas P. G., London.
Sugathapala, Reginal, Zurich, Switzerland.
Szeto, Raymond K. C., Hong Kong.
Taank, Avinash, Ilford.
Taank, Joshna, Ilford.
Tack, Barry C., East Grinstead.
Takesi, Maenaka, Tokyo, Japan.
Tam, Man W., Hong Kong.
Tanabe, Takao, Tokyo, Japan.
Tanno, Yuriko, Tokyo, Japan.
Tassabehji, Basima, Prestbury, Cheshire.
Tatlock, John, Washington, D.C., U.S.A.
Taylor, Alec E., Lasswade.
Taylor, William W., Brisbane, Qld, Australia.
Temani, Tikam C., Jaipur, India.
Thevathasan, Nuala A., Colombo, Sri Lanka.
Thornley, Joan A., Green Bay, Wis., U.S.A.
Towler, Colin T., Lime Acres, S.Africa.
Tsaktani, Michael, Athens, Greece.
Tsotros, Alexios, Johannesburg, S.Africa.
Tsui, Joseph H. H., Hong Kong.
Tsui, Tommy K. W., Hong Kong.
Turnbull, Daniel A., Mount Vernon, Glasgow.
Valencia Garcia, Amparo A., Barcelona, Spain.

van Dergiessen, Wilma, The Hague, Netherlands.
van Dyk, Delene, Pretoria, S.Africa.
van Grinsven, Helena A., Arnhem, Netherlands.
van Oyen, Johannes P., Wijchen, Netherlands.
van Valkenburg, Eric, Tucson, Ariz., U.S.A.
van Veen, Reinier M., Tilburg, Netherlands.
Vashishtha, Chancha, Jaipur, India.
Vassiliades, Dionyssi, Athens, Greece.
Vik, Elisabeth S. B., Oslo, Norway.
Visvanathan, Chettiar G., Coimbatore, India.
Vittachi, Nedra, Colombo, Sri Lanka.
Voce, Elizabeth M., Topsham.
von Sierstorpff, Monika G. F., Cologne, W. Germany.
Waddington, Clive, Harrogate.
Wakabayashi, Hisao, Tokyo, Japan.
Walker, Donald H., London, Ont., Canada.
Walmsley, Shereen B., Preston, Lancs.
Wang, Yvonne, Hong Kong.
Watanabe, Mashahiro, Tokyo, Japan.
Waters, Bernard F., Rotorua, N.Z.
Watson, Jane, Sutton Coldfield.
Watson, Margery E., London.
Watson, Thomas N., London.
Wezel, Annemarie, Schoonhoven, Netherlands.
Wickramasinha, Himalie V., London.
Widdop, Jeffrey R., Blackpool.
Wijesinghe, Neville D. L., Dehiwala, Sri Lanka.
Wijetunga, Lettietia C., Colombo, Sri Lanka.
Wilcox, Margaret, Marlow.
Willis, Carolyn L., Sutton Coldfield.
Wilson, Jacqueline A., Cockermouth.
Winckler, Patricia J. W., Colorado, U.S.A.
Winton, Paul R., London.
Wong, Eva W. Y., Hong Kong.
Woodward, Elizabeth, London.
Wright, Lee P., Birmingham.
Yamashita, Junko, Tokyo, Japan.
Young, Dilys M. W., Hong Kong.
Young, Patrick P. C., Taiwan.
Zaveri, Narendra I. Z., Bombay, India.
Zwyssig, Urs, Bangkok, Thailand.

EXAMINATIONS 1985

The examination dates for 1985 are as follows:

Gem Diamond Examination:

Theory and Practical: Monday, 10th June

Examinations in Gemmology:

Preliminary (Theory):Tuesday, 25th June

Diploma: Theory, Wednesday, 26th June

Practical, Thursday, 27th June (in London the practical examination may be held on other days in that week)

The *last* date for receiving examination entry forms is 31st March.

THE FELLOWSHIP—F.G.A.

It has come to the notice of the Association that a number of candidates who have been successful in the Diploma Examination and received the Association's Diploma in Gemmology have been describing themselves as F.G.A. when they are not entitled to do so. It should be clearly understood that the holder of the Association's Diploma is not automatically entitled to the Fellowship and should not be described as F.G.A. unless he or she has applied for and been elected to the Fellowship and has paid all subscriptions up to date.

CANADIAN GEMMOLOGICAL ASSOCIATION— FIRST GRADUATION CEREMONY

On Friday, 19th October 1984, the Canadian Gemmological Association held its first Graduation Ceremony at the Central Technical School in Toronto. Dr Warren Boyd presided and almost two hundred people were present.

An Honorary Fellowship was awarded to Dean S. M. Field, F.G.A., who was a founder member of the Association and its first President. Mr Harry Wheeler, F.G.A., Vice-President of the G.A. of G.B., was also awarded an Honorary Fellowship for the help and assistance given to the Canadian Association enabling it to set up its own examinations in gemmology.

Mr Wheeler then introduced Mr Eric Bruton, F.G.A., who gave a most interesting talk on diamonds.

Afterwards the D.S.M. Field Gold Medal was awarded to the top students of the year in the First Year Course, Mr A. J. Lewis (1983) and Mrs G. A. Kittel (1984). The W. D. Goodger Award to the top student of the Second Year Course was presented to Mr A. J. Lewis. Then Mr Harry Wheeler handed out British Diplomas to those Canadian candidates who had qualified in the 1984 examinations.

Finally F.C.Gm.A. Diplomas were presented to 1984 candidates who had qualified in the first Diploma examination held by the Canadian Association, followed by the award of Special Diplomas to members of the Canadian Association who had qualified in earlier years in examinations held by the G.A. of G.B., G.I.A., G.A.A. or the German G.A.

Mr W. D. Goodger closed the evening by thanking Eric Bruton and Harry Wheeler for coming to Toronto for the event and everyone else for being present to make the evening such a success.

ASIAN INSTITUTE OF GEMMOLOGICAL SCIENCES

The A.I.G.S. has announced a number of courses in January, February and March 1985. For particulars of courses and other information apply to AIGS Registrar, 987 Silom Road, Rama Jewelry Building, 4th Floor, Bangkok 10500, Thailand.

LETTER TO THE EDITOR

From Peter J. Crowcroft, Ph.D.,
Hong Kong.

Dear Sir,

Several years ago the *Journal* published an article of mine which examined the Beilby flow theory of gemstone polishing (J. Gemm., 1981, XVII (7), 459-65). The Beilby theory has been passed down uncritically through the gemmological textbooks over the last thirty years as the mechanism by which the polishing process occurs. My article showed that the theory is false and that this had been proved conclusively in the 1950s and 1960s. Two groups of workers at that time published detailed scientific papers which specifically examined the theory and concluded that there was no evidence at all to support it. None of this, however, has ever appeared in the gemmology texts or journals. After I finished the Beilby paper I started to examine the texts in more detail on other topics. I soon realized that many things in them were substantially out-of-date or, in some cases like Beilby, wrong. No matter where you looked one could easily find a topic for a paper to bring it up to date.

I concluded that the most recent editions of the traditional gemmology texts* are written at a level of scientific knowledge and philosophy of the 1950s. Gemmology is certainly one of the most multi-disciplined of the sciences: physics, chemistry, geology with some botany and zoology are represented. However, gemmology texts have recognized virtually none of the vast explosion of knowledge which has taken place in each of these fields over the past thirty years. It is incredible to realize that the traditional texts contain no references to any scientific journals and papers. They only reference other gemmology texts and journals which are in a similar state.

So then, if the texts are out of date, what is the status of gemmology today if one looks for progress in its component sciences? The answer is very good. Consider the following journals (to name just eight out of over at least fifty):

Nature
Science
The American Mineralogist
Canadian Mineralogist
Physics & Chemistry of Minerals
Journal of Materials Science
Neues Jahrbuch für Mineralogie Abhandlungen
Applied Spectroscopy

In these journals are to be found literally hundreds of articles over the past twenty years dealing with such items as the origin of colours in sapphire, tourmaline, beryl, emeralds, fluorites and kyanites, the crystal structure and physical properties of topaz, the structure and chemistry of garnets, a crystal and chemical study of kornerupine, the chemistry of amber, the origin of tektites, and so on. These papers use the latest instrumentation, for example, Mossbauer, x-ray fluorescence, infrared and Raman spectroscopy, nuclear magnetic and electron paramagnetic resonance, electron microprobe microscopy, etc. Implicit in these papers are the analysis and discussion of the results in terms of currently accepted scientific theory and

*The Gemmology texts I have used are *Gems, Gemmologist's Compendium* and *Practical Gemmology* by Webster, *Handbook of Gem Identification* by Liddicoat and the recent *Beginners Guide to Gemmology* by Read.

philosophy—for example, general molecular orbital theory, structure of the solid state, crystallography, classic geometric and physical optics, classic electromagnetic theory. As a result of this work the crystal structure, chemistry, optical properties, origin of colour, correlation of structure to spectra, luminescence, etc. for minerals and crystalline solids are basically known and understood.

Thus I believe the challenge for gemmology in 1985 is clear. Gemmology needs to be modernized. This is not because of some abstract search for truth, but it is a very practical requirement, which must take place if gemmologists are to face the new developments such as heat-treated, irradiated and the latest synthetic gem materials. One cannot face these products of the 1980s with the knowledge and methods of an earlier era. Not to modernize could well lead to a loss of confidence by the public in gemmology. There is nothing to be afraid of in this modernization. There is not one theory, technique or concept mentioned above which cannot be explained in a technically correct, easily understandable and nonmathematical manner. There is in fact one excellent example of the type of upgrading and education process I am calling for. This is the work over the past few years by Kurt Nassau. What I am advocating is for a 'Nassau' to be done on the rest of gemmology.

Yours etc.,
Peter Crowcroft.

5th December, 1984
1302 World Trade Centre, Causeway Bay, Hong Kong.

CORRIGENDA

On p.269 above, in line 3, for 'Revista' read 'Rivista'

On p.272 above, in line 21, for 'such clean' read 'such inclusions in clean'

On p.275 above, in line 6, for 'taaféite' read 'taafféite' and, in lines 7/and 8,/for 'taffeite' read 'taaffeite'

On p.279 above, in line 24, for 'is was' read 'this was (or is)'

On p.282 above, in line 32, for 'deviethods' read 'devising methods'

On p.287 above, in line 8, for 'until the War' read 'until 1937, when he married,'

On p.288 above, in line 3 from bottom, for 'Rudoe' read 'Ruhoe'

In Vol. XVIII, at head of pp. 782-816 (even numbers), for 'XVII' read 'XVIII'

Historical Note

The Gemmological Association of Great Britain was originally founded in 1908 as the Education Committee of the National Association of Goldsmiths and reconstituted in 1931 as the Gemmological Association. Its name was extended to Gemmological Association of Great Britain in 1938, and finally in 1944 it was incorporated in that name under the Companies Acts as a company limited by guarantee (registered in England, no. 433063).

Affiliated Associations are the Gemmological Association of Australia, the Canadian Gemmological Association, the Gem and Mineral Society of Zimbabwe, the Gemmological Association of Hong Kong and the Gemmological Association of South Africa.

The *Journal of Gemmology* was first published by the Association in 1947. It is a quarterly, published in January, April, July, and October each year, and is issued free to Fellows and Members of the Association. Opinions expressed by authors are not necessarily endorsed by the Association.

Notes for Contributors

The Editor is glad to consider original articles shedding new light on subjects of gemmological interest for publication in the *Journal.* Articles are not normally accepted which have already been published elsewhere in English, and an article is accepted only on the understanding that (1) full information as to any previous publication (whether in English or another language) has been given, (2) it is not under consideration for publication elsewhere and (3) it will not be published elsewhere without the consent of the Editor.

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

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

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