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ASSOCIATION
OF GREAT BRITAIN

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OF GREAT BRITAIN
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KORNERUPINE CAT'S-EYES FROM SRI LANKA (CEYLON)

By H. J. KOREVAAR, F.G.A.,
Ter Aar, Netherlands,
and
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National Museum of Geology and Mineralogy, Leyden, Netherlands

INTRODUCTION

Last year one of the authors (Korevaar), visiting Sri Lanka, bought a parcel of 125 cat's-eyes from a gem dealer in Galle. Although he knew that these stones could not possibly be chrysoberyls, he was not able to identify them with the naked eye only. The dealer gave the information that the cutters are not much interested in this type of cat's-eye because it is not hard enough to compete with "real cat's-eye", which, of course, is chrysoberyl. Anyway, according to the dealer, these stones originate from the Weligama gem gravels in the Matara district.

Back in Holland, Korevaar contacted the Dutch Gem Laboratory, which is housed in the National Museum of Geology and Mineralogy in Leyden, to identify these cat's-eyes, since this type of gemstone cannot easily be identified by the usual testing methods only. The authors, therefore, worked together and the results of their investigations seemed interesting enough to publish.

PROPERTIES

The total weight of the whole parcel was 99·47 carats. This meant that the average weight of one stone was under one carat. All the stones were oval cabochon cut, the average size being approximately $6 \times 5 \times 3$ millimetres.

Their colour was greenish to dark yellowish green. All the stones showed a good cat's-eye effect and were translucent to transparent. In Fig. 1 three stones, now in the collection of the National Museum of Geology and Mineralogy in Leyden, are shown. They have the registration numbers RGM 151 780 to RGM 151 782. Their weights are 0·77, 0·62 and 0·65 carats respectively.

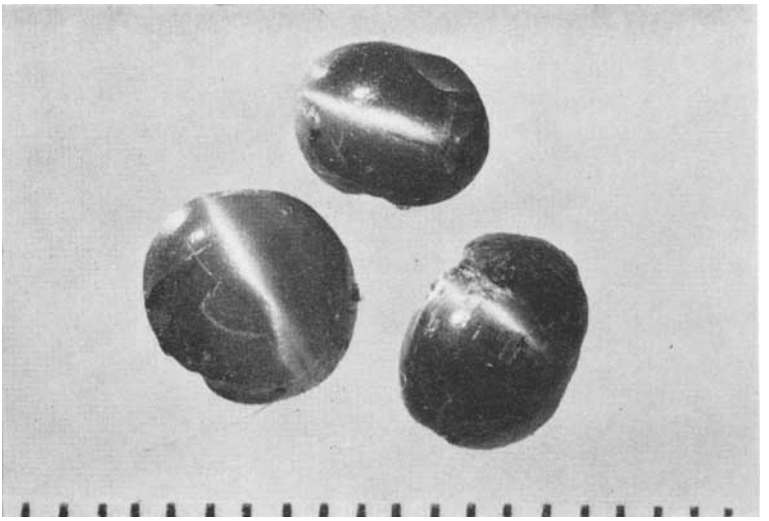

FIG. 1. Some kornerupine cat's-eyes out of a parcel of 125 stones (with millimetre scale).

All these cat's-eyes behaved in the same way in methylene iodide, viz. they just sank in this liquid. Ten stones, weighing 11·69 carats all together, were selected to measure their specific gravity. This was found to be 3·337 for all stones together, while the density of the stones individually varied from 3·329 to 3·350, with an average of 3·338 It should be noticed that the smallest of these stones was 0·79 carats, while the biggest one was 1·43 carats. Although ethylene dibromide was used as an immersion liquid, together with a very accurate hydrostatic balance, it is known from

experience that with such small stones accurate results may hardly be obtained.

To measure the refractive indices, six stones were provided with a flat polished base. They all gave readings at 1·680 and 1·668 for the highest and lowest refractive index respectively.

All these cat's-eyes had a strong pleochroism in tones of yellow-green and reddish. Their absorption spectra, however, were not very distinct. Some weak bands in the green and the blue part of the spectrum were observed.

X-ray powder photographs of two stones gave a pattern of diffraction lines, characteristic for kornerupine. The x-ray data of photograph RGM 201 952, taken from cat's-eye RGM 151 782, are as follows:

d (*in* Å)	*Intensity*	*d*	*I*	*d*	*I*
10·51	8	2·40	3	1·490	7
8·07	4	2·29	4	1·440	4
6·89	6	2·12	4	1·412	6
4·10	1	2·09	8	1·373	3
4·02	6	2·07	4	1·320	3
3·42	7	1·992	3	1·298	3
3·36	8	1·878	3	1·274	4
3·01	10	1·767	4	1·209	3
2·84	2	1·677	6	1·150	3
2·77	4	1·598	3	1·035	2
2·70	4	1·543	5	1·026	2
2·62	10				

INCLUSIONS

The cat's-eye effect is apparently due to a needle-like structure or to oriented needle-shaped inclusions (Fig. 2), the composition of them being unknown.

Distinct inclusions found amongst others in cat's-eye RGM 151 781 are blackish grains with a metallic high lustre and a short prismatic habit (Fig. 3). They were found to be rutile by means of x-ray powder photograph RGM 201 942.

Some of the cat's-eyes contain black submetallic flakes (Fig. 4). Those included in sample RGM 151 782 have been identified as graphite by x-ray powder photographs RGM 201 941 and RGM 201 949.

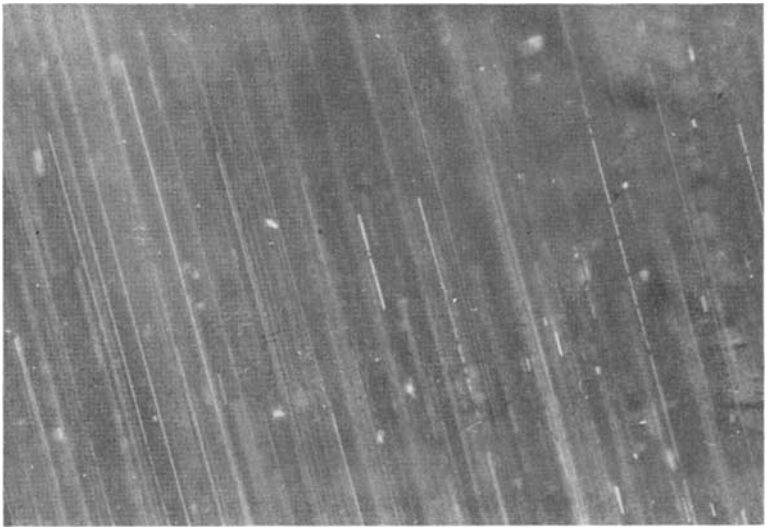

FIG. 2. Needle-like structure in kornerupine cat's-eye RGM 151 780. (60 ×)

FIG. 3. Rutile included in kornerupine cat's-eye RGM 151 781. (Reflected light; 60 ×)

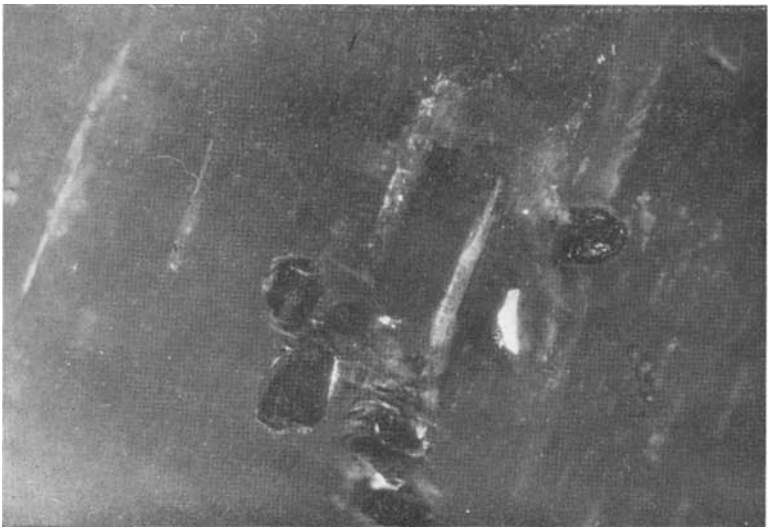

FIG. 4. Graphite flakes in kornerupine cat's-eye RGM 151 782. (Reflected light; 60 ×)

DISCUSSION OF THE RESULTS

Cat's-eyes of kornerupine are only mentioned very briefly in the literature. Recently, however, Crowningshield (1974) described a kornerupine cat's-eye of 7·57 carats. He considered it to be a rarity. The authors, however, ask themselves whether it is right to call them rare when 125 of such stones can be obtained at the same time, though they are all small. Moreover, on a recent trip to Sri Lanka in February 1976, the authors noticed a lot of these stones in the Ratnapura Gem Museum as well as in parcels of stones offered for sale by people in the street in Ratnapura. It is very likely, therefore, that in the near future kornerupine cat's-eyes will come on the market in large quantities.

With regard to the inclusions, one of the authors (Zwaan, 1974) has found the same type of rutile crystals as mentioned above in rhodolite garnet and almandine garnet from Umba, Tanzania, as well as in an almandine garnet from Sri Lanka (Zwaan, 1967). He has also found similar graphite inclusions in deep violet corundums from Umba, Tanzania (Zwaan, 1974), but not before in Ceylon gems. This is, however, not particularly strange, because both graphite and kornerupine may occur in the same type of rock,

namely in cordierite-gneiss. This type of rock is very common in Sri Lanka, graphite being a very important economic mineral in the island. It is very likely, therefore, that in the future included graphite will turn out to be as normal as included apatite in Ceylon gems.

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NOTES FROM THE LABORATORY

By A. E. FARN, F.G.A.,
The Gem Testing Laboratory, London Chamber of Commerce and Industry

AT the beginning of 1975—or even a little earlier, in late 1974—we commenced movements towards obtaining and installing a powder diffraction camera. Almost immediately we were beset with problems, which may or may not have been gemmological but certainly affected our gemmology in the laboratory. The laboratory, of course, began as a pearl testing station for the trade, and gems (i.e. stones) followed as an ancillary study. So when our x-ray generating set broke down *several* times in quick succession we were put out! This, as well as the interior upheaval due to heated ventilation being installed (plus exterior pavement lighting to our basement), made life infinitely variable between frustration and despair. Needless to say, on each occasion when the x-ray set broke down we had plenty of undrilled and part-drilled pearls needing to be tested by the x-ray method. Our important pearl customers were reasonable and patient, appreciating our predicament, but some of the non-pearl merchants (i.e. those who dabble in all jewellery) were not so understanding

and gave us an extra half hour in which to x-ray their pearls with a non functioning set!

It was during this period of pearl pause that we were also negotiating the installation of the x-ray powder diffraction camera. Each time I was asked to report upon progress to our patient Trades Section Committee I had to reply in the negative—appropriate enough on the subject of cameras, but I should have been happier had my replies been more positive. As the year developed, however, we were able finally to fix the day and at the end of our financial year (terminating our fiftieth anniversary) we had in fact a powder camera installed.

As with all new presents (for it was partly subscribed for by the Diamond Trading Company) we were very keen to try it out. The equipment itself is expensive and so are the special films and the large amounts of developer, fixer, and electricity used in obtaining one negative. As a commercial laboratory testing gems for the trade we need to earn our keep, and obviously testing by such sophisticated methods will be expensive and reserved for very particular items, where customer requirements are imperative and costs will be agreed, incurred and met! Universities and museums are fortunate in being geared for such work, with funds usually available or allocated.

* * *

We were asked to look at some material said to be from a new source in a new colour, consisting of three small, faceted, mauve stones. They ultimately proved to be scapolite. Gemmological circles are very small, and just one day later we saw another and larger specimen, reputedly mauve scapolite and stated to come from Tanzania. We were subsequently told that the first three stones also came from Tanzania. Usually mauve or pinkish scapolite is fibrous chatoyant and comes from Burma. This material was optically clean and clearly of faceting quality. There were some (not diagnostic) inclusions (see Figs. 1, 2 and 3).

On the first three small stones we did routine tests, i.e. density, refractive indices, hardness, fluorescence and/or phosphorescence under long- and short-wave ultraviolet light. We asked and received permission to bombard them with x-rays, since we believed a colour change could occur (and it did). The largest stone (received the second day) received the same treatment (less x-ray fluorescence, etc.)

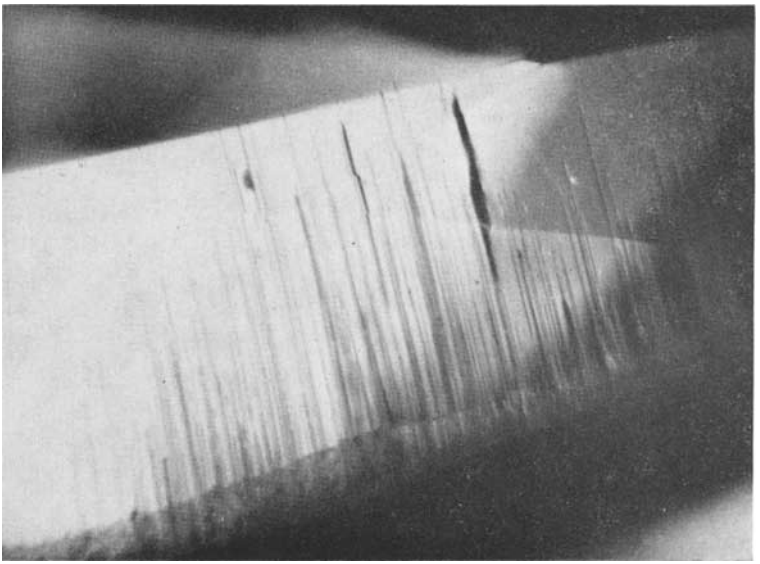

Fig. 1.

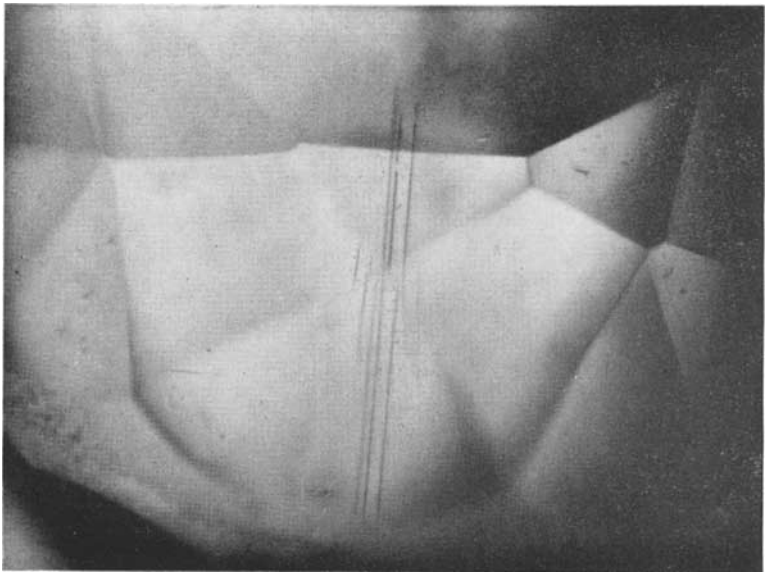

Fig. 2

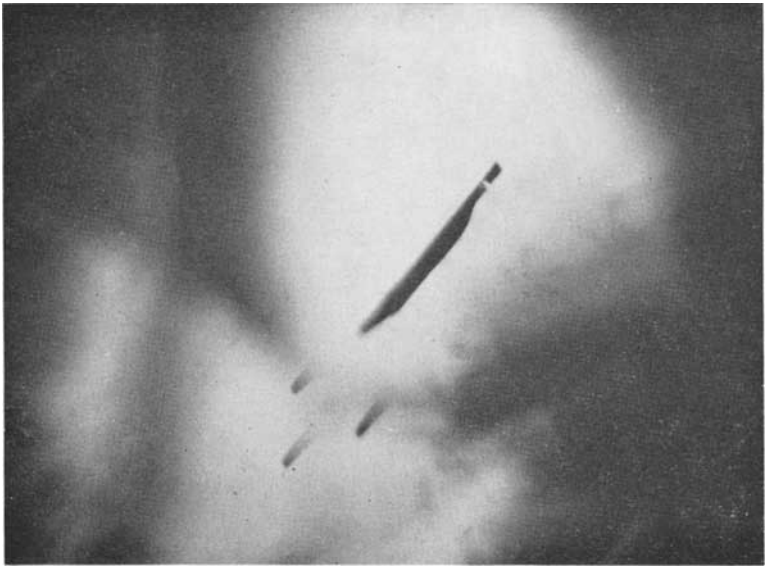

Fig. 3
FIGS 1, 2 and 3. Inclusions in mauve scapolites. (*Photo. K. Scarratt*)

When we did our routine tests we decided that since we were dealing with an apparently new material we should try out our powder camera. Alan Clewlow, who had a broad outline understanding of its characteristics, did our very first powder scraping and achieved a fine clear negative on 35 mm film showing a pattern of concentric lines of varying strengths, looking rather like the cross-section of a pearl. We now had to decide just what these lines represented. To an expert in this technique it was simple, to us an exciting beginning. Our very good friends at the Institute of Geological Sciences, with whom we have established a good working accord, read the picture for us and identified it as *Scapolite*. To each his own specialization: had it been a spectrum or a radiograph of a pearl, we would have been the experts!

The first three small scapolites were oval, faceted and mauve, looking somewhat like amethyst or synthetic sapphire imitating alexandrite or perhaps a natural spinel. One needs to see a colour to appreciate it, rather than form an opinion based upon someone else's description. Beauty is in the eye of the beholder, colour likewise. The three small stones were collectively checked for density with a result of 2·58. The largest (second day) stone was

found to have a density at first of 2·59 and later on of 2·61: perhaps the higher density is the more acceptable. The refractive indices of the stones showed them to be uniaxial, negative in sign. The table facets of the first three were very small, and some parallax occurred, the readings being 1·535–1·540, with only the smallest perceptible movement of the lower reading—in fact it looked like form birefringence as seen in agates. The largest stone gave readings of 1·537–1·542, which caused us some concern at the disparity. Possibly this was caused by the small table facets, but scapolite is like garnet in being a member or part of an isomorphous series, the terminal members being marialite (a sodium aluminium silicate) and meionite (a calcium aluminium silicate), and this could be an explanation of the variation in the optical figures. The smallest stone was checked for fluorescence under x-ray excitation: it fluoresced an orange colour and suffered a change of colour to a deeper hue. This coloration faded after a few hours and the stone is now back to normal. All of the scapolites were inert under long- and short-wave ultraviolet light. They had a hardness between 5 and 6.

Obviously with new source material we could carry out only non-destructive tests—especially as the stones were on loan for our investigation for the benefit of the trade. We have since been donated one stone for the laboratory's collection by Mr E. A. Thomson, of Thomson Gems, to whom our most grateful thanks are due. The largest of the mauve scapolites was sent to Mr B. W. Anderson for his information and appreciation: he states that the high density material of 2·61 is possibly 80% marialite and 20% meionite. The variations possible in scapolite impress the need for careful checking of refractive indices and densities. Photo-coloration by x-ray could be disconcerting, but mercifully most readers do not possess such equipment in their home laboratories. Stones which colour quickly by low heat and/or bombardment equally lose it fairly quickly.

* * *

Since that first exciting use of the powder camera, we have built up a series of *known* examples for our film library. We have been supplied with standard patterns by our friends in the Gemological Institute of America (Los Angeles laboratory) and some more by Pete Dunn, of the Smithsonian Institution, Washington, D.C.

We have also received as a gift a book of reference entitled "Inorganic Index to the Powder Diffraction File"; this too came from Los Angeles—a typically friendly American gesture. Although I have formally on behalf of the London Chamber of Commerce Gem Testing Laboratory written an official letter of thanks, it is perhaps opportune here and now in the *Journal of Gemmology* to say "Thank you" to our American counterparts for their many friendly gestures.

* * *

Another stone sent to us for examination by the owner of the largest of the mauve scapolites was a blue transparent faceted stone in a packet marked "Azurite". This proved to be blue apatite, giving a uniaxial negative reading of 1·635–1·639 and a density of 3·22. It fluoresced blue under x-ray excitation and a "dusty" green under short-wave ultraviolet and was practically inert under long-wave ultraviolet. The colours seen as viewed through the dichroscope were blue and greenish blue, of not too wide a disparity. Viewed by microscope some long thin needle-like cavities were seen, but are not diagnostic—also black hexagonal crystals (see Fig. 4).

* * *

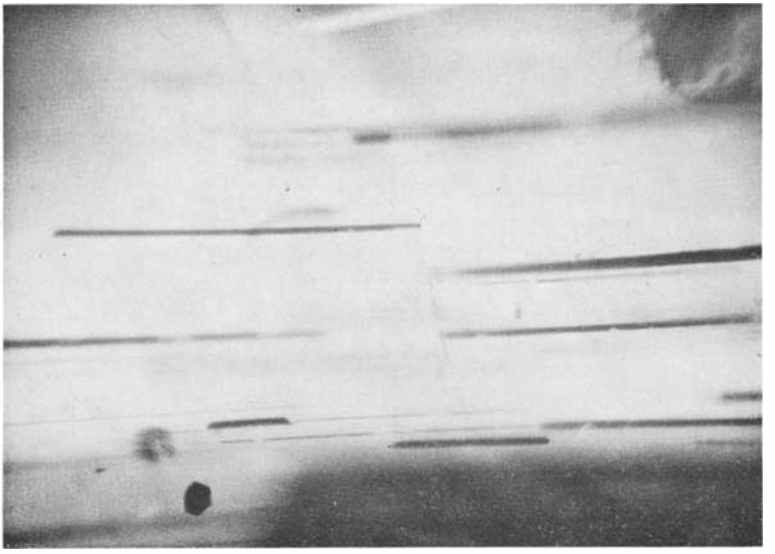

FIG. 4. Needle-like cavities and black hexagonal crystals in blue apatite. (*Photo. K. Scarratt*)

Another new stone (new, that is, to us) came in a ring. The customer paid us the usual compliment of expecting us to do an on-the-spot test under "while you wait" conditions. Since we have always fancied ourselves at speedy testing we are hoist with our own petard by such a request. Is it a challenge we can seldom fail to rise to, or is it some sort of gemmological masochism which allows pride to reply promptly "Send it along"? Well, the oval red stone mounted in a not too difficult-to-view setting arrived with the potential purchaser and the standard Hatton Garden story of a customer waiting in his office, etc., etc. The red stone did not look like a ruby, a spinel or a garnet, nor for that matter did it look like a red tourmaline.

I always use a 10 × lens before I do any formal instrument test, since I fully believe one can extract much early information from this type of examination. Very often to fly to flexible fibre optics and a powerful microscope or to cheat a little by taking a quick absorption spectrum spoils the pleasure of real gemmology. Mlle Dina Level, the now retired inclusions expert of the Paris laboratory, speaks of the 10 × lens as the jeweller's "third eye". The 10 × lens detected crystalline inclusions plus dichroism (or was it dichromatism?) or at any rate two tones of red. The girdle of the stone was bordered by the setting, but crown and base were both fully on view. The colour could have been that of an East African ruby with just too much iron damping the exuberance of chromium. Having tested in earlier days many tens of thousands of rubies (calibré sizes mostly) one develops a feeling for knowing when a synthetic is on parade, even though one does not immediately see curved lines and/or bubbles. Random cutting of a synthetic causes incorrect colour or, as we say, "it looks wrong". It was the base of the stone which looked wrong: the top was O.K. So, with doubts aroused by the 10 × lens, I could now proceed formally.

Immersion, although messy, is the quickest way to determine difficult inclusions. However, no particular trouble occurred in this instance: curved structure lines of a flame fusion Verneuil synthetic ruby gave the answer, but the upper portion yielded no refractive index at first sight. This could have been due to poor polish on the table facet, but such was not in fact the case. A high-reading almandine garnet of just over 1·81 was found by the use of phenyldi-iodoarsine—a nasty liquid, but useful. Carefully placing the stone across the small beryllium window of our x-ray set, we

saw the base of the stone fluoresce and phosphoresce, whilst the top half remained inert. With the spectroscope, light transmitted through the stone gave only a strong ruby absorption spectrum. This could be dangerous, if one took crystalline inclusions plus absorption spectrum of ruby as sufficient (and they are) to prove a natural ruby. This brings me back to the good old 10 × lens. Slick sophisticated methods could have caused some trouble for an unwary gemmologist.

A glancing beam of light played across the table of the stone enabled a grazing incidence absorption spectrum to be obtained. This gave faint indications of the familiar three bands in the green as part of an almandine spectrum. Thus we finished by 100% complete proof of an unfamiliar unusual doublet, undoubtedly devised to deceive.

* * *

A customer brought us a parcel of mixed rough stones, thirty pieces all told. "Please identify" were the words on the advice note. Gemmologically it was a piece of cake, except that perhaps one portion caused a little indigestion.

There were twenty-seven almandine pyropes, two rough peridots and one yellow rough. The yellow rough almost suspended in density liquid in which quartz slowly sank. It matched ethylene dibromide (R.I. = 1·54) and was doubly refracting, somewhat lack-lustre. It had quite a few inclusions (see Fig. 5), but the hackly surface prevented a proper view of its interior. A little discussion followed upon the worth of following it further—it seemed to be quartz. However, one factor stood out—quartz is remarkably steadfast in its density but this seemed fractionally less dense: could it be the inclusions, etc., etc.?

The matching liquid of ethylene dibromide was not really 100%. As I have often been warned, cajoled and coaxed by Mr B. W. Anderson, we decided we could not let this anomaly pass. A careful density established it as 2·63, too low for quartz and perhaps a little too high for feldspar. The refractive indices of this doubly refracting stone would possibly settle the matter but so far we had not had recourse to asking our customer (a lapidary) to have a flat polished on the rough. We decided that if it were feldspar we could check its absorption spectrum and effects under short- and long-wave ultraviolet light. Yellow orthoclase from Madagascar shows a reddish/orange glow under both long- and short-wave

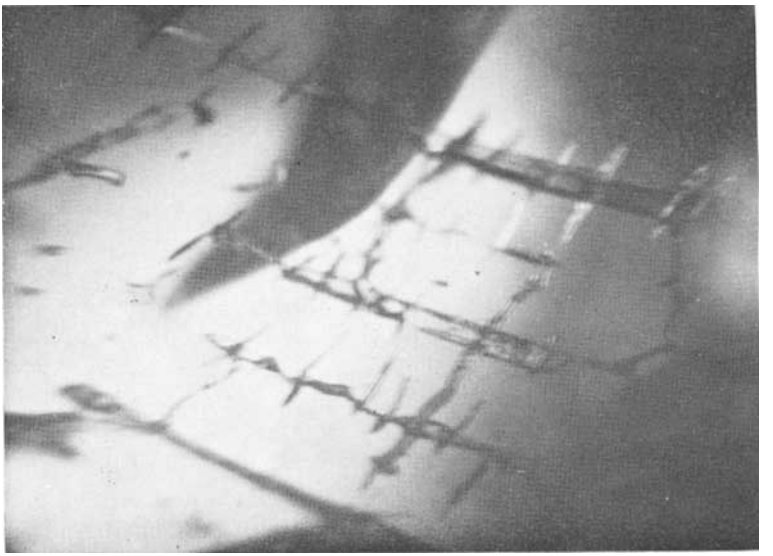

FIG. 5. Inclusions seen in yellow scapolite. (*Photo. K. Scarratt*)

ultraviolet light and a stronger effect under x-ray excitation. This we checked, and as is not unusual in our laboratory we could not agree upon the interpretation of the colours seen.

This sort of testing takes place in a busy day during which we may well be dealing with pearls by x-ray, stones set in jewellery, a carving or two and lately powder diffraction photography with our new camera. Sometimes three people at the same time need the dark-room to develop a film, to load a cassette or to view fluorescence with ultraviolet light. When these situations occur and the dark-room is occupied, we diversify in modern manner and carry out other tests meantime: this is necessary to keep work up-to-date and avoid queueing. This combination of testing and flitting from pillar to post has its hazards and its rewards. We have a mixed variety of skills, ages and techniques, and so what one may miss another will see, and what I forget my colleagues will diplomatically recall to my memory. In this particular case we had proceeded thus far with our yellow rough and stopped for more pressing and profitable testing. On a return to discussion of our yellow stone, K. Scarratt noticed a faint hint of violet on one rough edge. Had

we missed this before? Had it been there all the time? Or, more exciting, had it photocoloured by x-ray irradiation? Secondly, what yellow stone would or could photocolour? Scapolite seemed to fit the bill. Now we had moved from probable quartz to possible feldspar to potential scapolite.

Would the customer play ball? We telephoned, giving details of the rest of the parcel, and by dint of full explanation not only obtained permission to go ahead but also an optical flat was polished. On the spinel refractometer the stone had refractive indices of 1·544–1·556, uniaxial, negative in sign. We then placed the stone optical flat down on the beryllium window of the x-ray generating set and gave it a good dose of x-rays for two minutes. To our great pleasure we found a neat circular patch of pinkish violet hue which penetrated probably a millimetre. We now felt fairly happy that we had a yellow scapolite. Hindsight, of course, helps, but we agreed that had we not had a discussion on colour by x-ray excitation and had not four of us taken a long look, we might not—or K. Scarratt might not—have seen that first touch of violet on a rough stone. We also agreed that if this stone were cut and mounted in ring or brooch it could easily pass a quick refractometer check as quartz. It is a somewhat sobering thought that, did we not at times *not* fully agree, or if we failed to query a stone merely because of a small isolated anomaly, we could easily fall down on the job.

A BRIEF LOOK AT THE SANCY DIAMOND

*By E. A. JOBBINS, B.Sc., F.G.A.,**
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IN January 1976 we were invited to examine the Sancy Diamond in the Institute laboratories, but for security reasons the stone was available for a short time only. Famous historical diamonds of this calibre are rarely removed from safes, and it seemed appropriate that our good fortune should be shared by two professional gemmologists, A. E. Farn of the London Chamber of Commerce Gem Testing Laboratory and the late Robert Webster, their gemmological consultant. Little did we know, during that short time in the laboratory, that this was the last time that we should be able to discuss gemmology with Robert Webster and draw upon his great fund of knowledge which was always so generously shared with others.

The Sancy diamond is pear-shaped and approximates to a double rose cut, with mostly triangular facets but with a central

FIG. 1. General view of the Sancy Diamond, as seen in January 1976 (×3 approx).

*Published by permission of the Director, Institute of Geological Sciences.

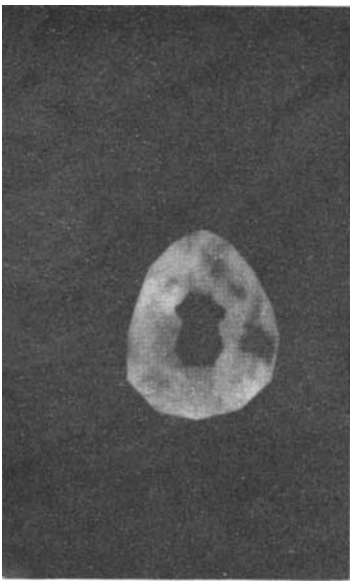

FIG. 2. Contact immersion photograph taken by short-wave ultraviolet light, showing the total light transmission through the two parallel facets (above and below), but only partial transmission elswhere due to internal reflections by the many other facets. Same size.

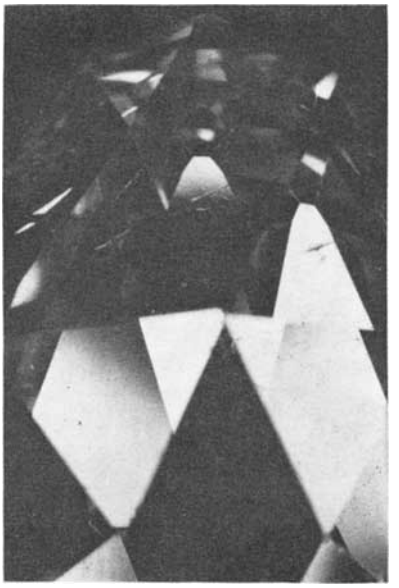

FIG. 3. Enlarged photograph (×4·5 approx.) showing small flaw near surface (repeated by reflection in the facets) on right hand side.

pentagonal facet on each side, the latter facets being roughly parallel to each other. There are slight scratches on one of the pentagonal facets. The maximum dimensions of the stone are 25·7 mm long, 20·6 mm wide and 14·3 mm deep. The weight is 11·0464 grams or 55·23 metric carats, and the specific gravity (determined in toluene) is 3·519.

The stone is reasonably clean, apart from a small flaw near the surface (repeated by reflection in the facets) which is shown in Figure 3. Comparison stones were not available to us and we were, therefore, unable to colour-grade the stone, but the general appearance suggests a good colour. The stone is lively and the fire (dispersion) is well displayed. The general appearance of the stone is shown in Figure 1; unfortunately there was not sufficient time to take a series of views from different angles.

The fluorescences of the stone by ultraviolet light are extremely interesting. By short-wave (235·7 nm) UV light the stone

fluoresces a distinct yellow, but we saw no phosphorescence on cutting off the radiation. By contrast, under long-wave (365 nm) radiation the stone fluoresces a pale salmon-pink, with a very noticeable greenish-yellow phosphorescence. This behaviour is not common and, in itself, would serve as a good identification test for the stone. We were unable to detect any absorption spectrum when white light was passed through the stone.

Contact immersion photographs (by exposing photographic paper upon which the stone rests in water to short-wave UV light) reveal that the stone is transparent to this radiation (235·7 nm) and would appear, therefore, to be a Type II diamond, as are many other large diamonds. This transparency is well demonstrated in Figure 2, which shows the total UV light transmission through the two parallel central facets (above and below), but only partial transmission elsewhere due to internal reflections by the many other facets.

In conclusion we should like to thank the owners of the Sancy diamond for allowing us the opportunity of examining the stone. The assistance of our colleagues in various ways is gratefully acknowledged.

THE INTERNATIONAL SYSTEM OF UNITS AND ITS APPLICATION TO GEMMOLOGY

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WITH the continuing trend of conversion to the metric system, we can foresee a time in the not too distant future when all the sciences and technologies of the world will use the same set of units. Undoubtedly, this will be "SI"—the Système International*. The following is an outline of this system and a brief discussion of its relevance to the field of gemmology, particularly with respect to the varied units used in spectroscopy.

The International Bureau of Weights and Measures (BIPM) has been studying the problem of units and their names for many years. Based on a series of resolutions and recommendations of the General Conference on Weights and Measures (CGPM), BIPM has published "SI Le Système International d'Unités", OFFILIB, 48 rue Gay-Lussac, F 75005 Paris (revised edition 1973). An official English translation has been prepared jointly by the National Physical Laboratory, U.K., and the National Bureau of Standards, U.S.A., and published in the U.K. by Her Majesty's Stationery Office, London, 1973, under the title "SI The International System of Units".

The base units of SI are given in Table 1, and the SI prefixes to be used with these and other derived units in Table 2. There are also many derived units with special names, e.g. newton N for force, pascal P for pressure, etc., but the majority of these has little relevance to gemmology.

TABLE 1. SI BASE UNITS

Quantity	*Name*	*Symbol*
length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature†	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

†Celsius temperature is expressed in degrees Celsius (symbol °C)

*Use of the SI units as mentioned in this article is included among the recommendations of the Royal Society (see J. Gemm., 1976, XV, 3, 164), which, however, do not specifically refer to the metric carat.—Ed.

TABLE 2. SI PREFIXES

Factor	*Prefix*	*Symbol*
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

It may be noted that temperature °C = "degrees Celsius" is the same as "degrees centigrade". The absolute temperature K (note the absence of the degree sign) is obtained by adding 273·15 to the °C value. Both K and °C units are the same size, differing only in the starting point of the two scales (absolute zero and the freezing point of water, respectively).

Refractive index and other optical constants as well as specific gravity are all ratios and therefore have no units. Length and mass units are the ordinary metric ones, with the following exceptions:

(i) Since μ is a prefix, as listed in Table 2, the length micron μ is not permitted and now becomes micrometre, abbreviation μm; similarly millimicron mμ becomes nanometre, abbreviation nm.

(ii) For volume litre l, ml, etc., may continue to be used, although the cubic metre m^3, dm^3, cm^3, etc., are the SI units. The use of the ångström unit Å (= 0·1 nm) is discouraged.

(iii) The use of the metric carat is "deprecated". (It does, however, seem unlikely that gemmologists will soon surrender this unit for the gram!)

The frequency, previously given in cycles per second or sec^{-1}, becomes hertz, abbreviation Hz.

Absorption and emission (fluorescence) features in spectra are described in many different ways, and conversion from one to

TABLE 3. VARIOUS WAYS OF SPECIFYING THE COLOUR SPECTRUM

Name and Symbol	Wavelength Descriptions			Energy Descriptions		
	Wavelength λ			Frequency ν	Wave-number $\tilde{\nu}$	Energy E
Unit and Symbol	ångström Å	nanometre nm	micrometre μm	hertz Hz	cm^{-1}	electron-volt eV
Colour*						
Infrared	300,000	30,000	30	$1{\cdot}00 \times 10^{13}$	333	0·041
Infrared (near)	10,000	1,000	1·0	$3{\cdot}00 \times 10^{14}$	10,000	1·24
Red	7,000	700	0·70	$4{\cdot}29 \times 10^{14}$	14,300	1·77
Orange	6,500	650	0·65	$4{\cdot}62 \times 10^{14}$	15,400	1·91
Yellow	6,000	600	0·60	$5{\cdot}00 \times 10^{14}$	16,700	2·06
Green	5,500	550	0·55	$5{\cdot}45 \times 10^{14}$	18,200	2·25
Blue	4,500	450	0·45	$6{\cdot}66 \times 10^{14}$	22,200	2·75
Violet	4,000	400	0·40	$7{\cdot}50 \times 10^{14}$	25,000	3·10
Ultraviolet (lw)	3,660	366	0·366	$8{\cdot}19 \times 10^{14}$	27,300	3·39
Ultraviolet (sw)	2,537	254	0·254	$1{\cdot}18 \times 10^{15}$	39,400	4·89

*Typical values only.

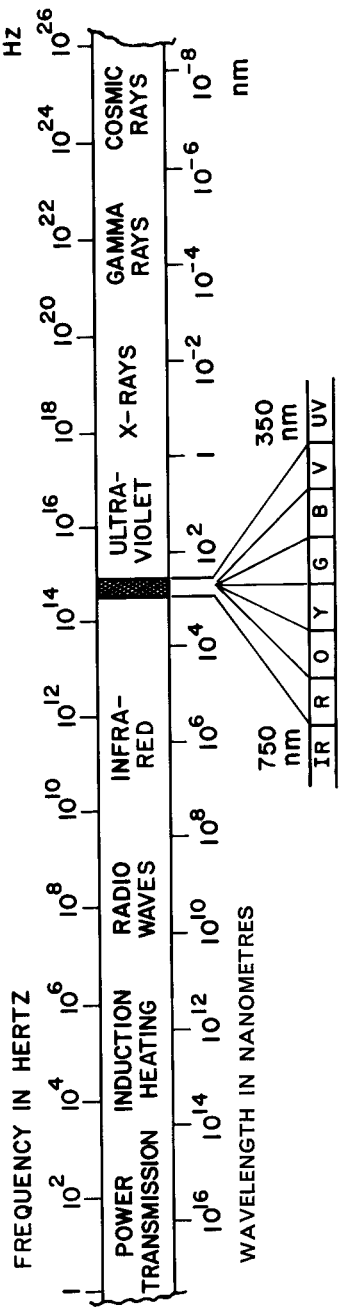
THE ELECTROMAGNETIC SPECTRUM
FREQUENCY IN HERTZ
Hz
1
10^2
10^4
10^6
10^8
10^{10}
10^{12}
10^{14}
10^{16}
10^{18}
10^{20}
10^{22}
10^{24}
10^{26}
POWER TRANSMISSION
INDUCTION HEATING
RADIO WAVES
INFRA-RED
ULTRA-VIOLET
X-RAYS
GAMMA RAYS
COSMIC RAYS
WAVELENGTH IN NANOMETRES
nm
10^6
10^4
10^2
1
10^{-2}
10^{-4}
10^{-6}
10^{-8}
750 nm
350 nm
IR
R
O
Y
G
B
V
UV
VISIBLE LIGHT

Fig. 1.

another may be needed, particularly when consulting the results of physicists who best like additive energy units (such as cm^{-1} for wavenumbers (usually designated $\tilde{\nu}$) and eV (electron volts), both accepted as SI units). The most commonly used units are assembled in Table 3. Of these units only the ångström is not a recommended SI unit; for general use nm is probably most convenient. The whole electromagnetic spectrum is shown in Fig. 1.

The relationships of Table 4 are given to assist in accurate conversions. Also included here are the less frequently encountered energy units cals/mole and ergs, neither of which are SI units.

TABLE 4. SOME DEFINITIONS AND USEFUL RELATIONSHIPS CONNECTED WITH LIGHT

1. Velocity of light $c = 3{\cdot}0 \times 10^{10}$ cm/sec.
2. Wavelength λ is the distance between two repeating parts of the light wave (in cm, micrometres μm, nanometres nm, or ångströms Å).
3. Wavenumber $\tilde{\nu}$ is the number of waves in 1 cm length (in cm^{-1}):

$$\tilde{\nu} = \frac{1}{\lambda(\text{cm})} = \frac{10{,}000}{\lambda(\mu\text{m})} = \frac{10{,}000{,}000}{\lambda(\text{nm})} = \frac{100{,}000{,}000}{\lambda(\text{Å})}$$

4. Frequency ν is the number of waves passing in one second (in $sec^{-1} = Hz$):

$$\nu = \tilde{\nu} \times 3 \times 10^{10} \text{ Hz.}$$

5. Energy $E = \nu \times 1{\cdot}99 \times 10^{-16}$ ergs,
$= \nu \times 1{\cdot}24 \times 10^{-4}$ eV,
$= \tilde{\nu} \times 2{\cdot}86$ cals/mole.

Usage of the SI system of units, with the help of the National Physical Laboratory publication cited, should be encouraged, both at the national as well as at the international level.

THE USE OF THE ELECTRON MICROPROBE IN GEMMOLOGY

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Introduction

Although technology has made much of the older instrumentation in other disciplines obsolete, the tools of the gemmologist have changed but little since the development of the optical refractometer for gems by Smith in 1905. Density balances, refractometers, and microscopes are still the primary tools of the gemmologist and are not likely to be rendered obsolete in the near future.

New advances in electrical engineering have, however, greatly improved the resources available to the research gemmologist in her/his quest for the "reasons why" and the ever-continuing accretion of the tiny bits of knowledge upon which the practising gemmologist makes judgements and decisions. Foremost among these new tools is the electron microprobe. This paper is written to acquaint the gemmologist with this instrument, and the operation, methods, techniques, and special advantages of the electron microprobe in the study of gems.

The Electron Microprobe

The electron microprobe is a relatively recent instrument and was first patented by Hillier in 1947. The further development of the basic concepts which governed its use were proposed by Castaing in 1951 and by 1956 microprobes were being produced commercially (Wilson, 1972).

The microprobe operates on the principle that an element, when bombarded by high-energy electrons, emits x-radiation of specific characteristic wavelengths. The amount of radiation emitted is roughly proportional to the amount of the element in the sample. The microprobe consists of four basic components, together with an impressive array of accessories. These four basic components are: the electron gun, the electromagnetic focusing lenses, the spectrometers and the associated electronic recording system, and a microscope.

The electron gun is located in the topmost conical section of the microprobe (see Fig. 1) and it contains a tungsten filament. With high voltage (15–20kV), electrons leave the filament surface These

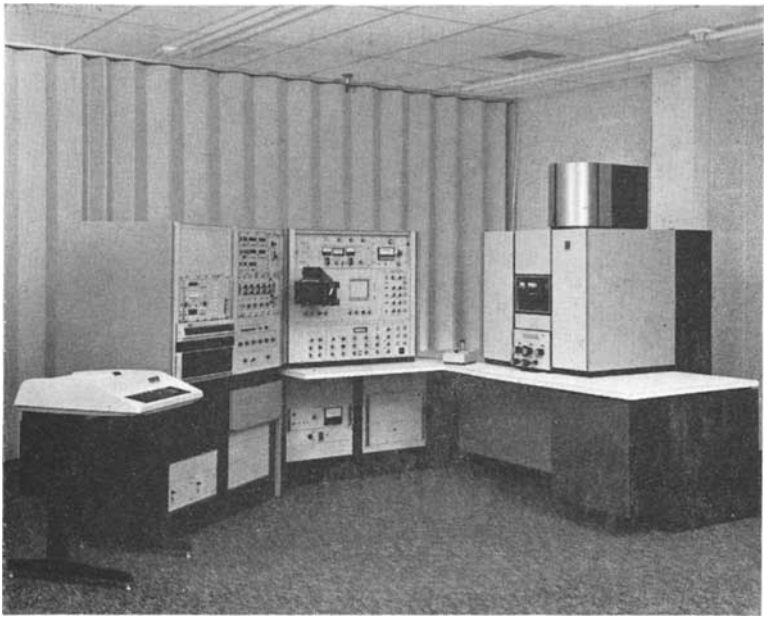

FIG. 1. The ARL-SEMQ electron microprobe. The large rectangular module on the right houses the actual electron gun, lenses, and microscope and sample chamber. The white module to the left is the print-out component of the on-line computer.

electrons are emitted through an aperture and then pass through a series of electromagnetic "lenses" which serve to focus the beam of electrons to whatever beam width is selected by the analyst. With modern microprobes, this beam can be focused to one micrometre (0·001 mm) and inclusions of very small size can be studied in detail.

The gem to be analysed is positioned in this now-focused beam of electrons, using the microscope to observe the sample, and as the electrons bombard the polished surface of the gem, x-radiation is given off, each element within the gem emitting its characteristic radiation. This x-radiation is detected and measured by a counting device and diffracting crystals such as ADP (ammonium dihydrogen phosphate) and LiF (lithium fluoride) whose "d" spacings are well known. These counters and crystals are mounted on spectrometers.

The spectrometers can be set to detect only one element (calcium, for example), or they can be tuned manually or by motors to scan all the x-ray radiation given off by the gem. The elements which are present can be observed by recording the wavelength at

which radiation is detected. The detectors count x-rays and this information is passed as an electronic impulse to a teletype and/or a cardpunch or computer link-up terminal, for further processing.

When scanning the x-rays emitted by an unknown, we make use of Bragg's law $n\lambda = 2d \sin\theta$. Since we know the "d" of the specific crystal in our spectrometer, and know θ which is the angle of incidence at which the x-rays are received by the crystal, we can determine λ, the wavelength at which a given element in our gem is emitting x-rays. Tables of emission spectra lead us to the element known to produce x-radiation in this wavelength. By scanning the full spectrometer range, and recording all the detected radiation, we can perform a qualitative analysis of our sample.

Analysis Procedure

For quantitative analysis, our unanalysed gem is compared with standards which are natural minerals or synthetic compounds whose composition is well-known. The selection of which standard to use in our analysis is a critical one. It is best if the proportion of the element we are analysing for is similar in both our standard and our unknown. In analysing some gems, tourmaline for example, it is also best if the atomic structure of our standard is similar to that of our unknown. If we were analysing an almandine garnet, for example, we would choose a standard for iron which contained about 30% FeO and was a silicate with a structure similar to the garnets. Ideally, we would like to use as a standard another analysed member of the garnet group with an iron content comparable to that noted above.

A sample procedure for analysing a peridot (forsterite) would be as follows. First, we would choose standard(s) for iron, magnesium, and silicon, the primary constituents of peridot. Since peridot has a low-iron and high magnesium content, we would choose an analysed forsterite with comparable constituents. In this laboratory, we would use MARJALAHTI forsterite (named for the Marjahlati meteorite, Viipuri, Finland in which the forsterite occurs), which has a composition very close to that of good, green, gem-quality peridot. Next we would set the spectrometers to analyse for iron, magnesium, and silicon. If we were using a microprobe with more than three spectrometers or an automated microprobe, we would also set others to detect the minor elements found in forsterite, (e.g. calcium, aluminium, chromium, manganese, and

titanium) so as to analyse the gem completely. Next we would have to determine the x-ray intensities for each element on our standard(s) and then determine x-ray intensities emitted from our gems under identical conditions. Such counting periods might range from 10 to 100 seconds on each point on a sample, and 10 or 15 points on our sample or more may be used to insure an accurate analysis. Finally, the intensities on our standards could be read again, and then the spectrometers could be moved off-peak so as to read the ever-present "background" radiation (due to scattered x-rays).

After subtracting these "background" counts from both the standard counts and our sample counts, we could then set up a simple linear ratio, to obtain an approximate estimate of the composition of our gems.

For a precise analysis, it is necessary to submit the rough data to a number of corrections, for example for backscatter, fluorescence, and absorption due to the presence of other elements in the sample. These corrections are complicated and very tedious mathematical procedures and are quite laborious when done by hand. Fortunately, computers can perform these corrections quite quickly and so most microprobe laboratories are equipped with hook-ups for card-punching or direct terminals for computers. Also, microprobes can be set-up with an on-line computer which can calculate final analyses within minutes. Computer data reduction programs are quite varied, and large, flexible ones such as the ones in operation at the Smithsonian Institution can handle a large number of samples, perform all necessary calculations and corrections, and also possess a number of options which allow the analyst to select in what format he would like his analyses.

Figure 1 is a photograph of the new ARL-SEMQ electron microprobe in the Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, D.C. This microprobe, one of the most modern anywhere, is capable of analysing for nine elements simultaneously. Six of the nine spectrometers (all concealed within the instrument) are fixed in position to always analyse for silicon, aluminium, iron, magnesium, calcium, and potassium. The remaining three can be used for scanning and can be set for any three additional elements the analyst wishes to examine.

This microprobe is hooked-up to an on-line computer which performs all corrections and permits the analyst to have a complete,

final analysis within minutes of completing the actual bombardment of the sample gem with electrons!

Limitations of the Microprobe

In spite of its many advantages, the microprobe does have some limiting factors and the gemmologist should be aware of them. The microprobe cannot detect with reliability the presence of elements with an atomic number below 9. Hence we do not analyse for beryllium, boron, lithium and oxygen in our samples. This can be most frustrating since so many of our gem minerals do contain substantial amounts of these elements.

Secondly, the microprobe cannot detect the oxidation state of the elements, and so elements which occur frequently in several oxidation states must be reported as total element content, without a specific designation of the degree of oxidation. Iron, in a garnet or tourmaline, for example, is usually reported as total iron (usually calculated as FeO) without any sure indication from the instrument as to whether it is ferrous or ferric.

When using well-analysed standards, of similar composition and structure to our unknown, and exercising good judgement, the accuracy of the microprobe is about $\pm 2\%$ of the amount present. For example, a peridot with a reported iron content of 10·00% FeO (7·77% Fe) could have an error of $\pm 0{\cdot}15\%$ Fe.

The extremely high cost of a microprobe—a modern one with on-line computation and other advanced features can cost about $150,000—is also an extreme limitation.

Advantages of the Microprobe

The chief advantage of the electron microprobe and a most important one to a gemmologist is that it is completely non-destructive. Hundreds of analyses can be performed on a gem with no trace of mark remaining thereafter. A second advantage is that we can perform complete analyses (partial analyses if elements with atomic number below 9 are present) of minute inclusions only micrometres in width, if they are exposed at the surface of the gem, or can be exposed through the grinding down of rough. A third advantage is the extremely short time required for analysis when compared with classical wet-chemical methods.

When working with gems, the stone is illuminated in vertical incident illumination, which can be polarized. This has advant-

ages in that the gemmologist can observe phase changes in opaque mineral inclusions and twinning and exsolution phenomena in both inclusions and the host gem.

Another notable advantage is that the gemmologist can analyse small portions of gems, or select certain coloured zones for separate analysis to seek clues as to the cause of the coloration where the colour-change is directly related to compositional variation in the gem. It might be noted here that because we are working in vertical, reflected illumination, there are no colours observed. Hence, the analyst must mark such designated colour-areas with paint or ink on the surface of the gem before placing the gem in the microprobe.

At the same time, hardness can be observed. Due to the high magnification (300 ×), one is able to observe subtle differences in hardness between host gems and inclusions. This is evidenced by a differential resistance to polishing, wherein mineral inclusions softer than the host gem show negative relief features (depressions), and inclusions harder than the host appear as positive relief features (small bumps) on the gem surface.

Procedures for Sample Preparation

1. In the study of gem rough, in this laboratory, when chips are available and non-destructive procedures are not required, the samples are usually mounted in a bakelite disc impregnated with epoxy. This task requires consummate skill at polishing and a familiarity with a broad array of techniques and mounting media. Hence the individuals who perform this work are highly trained specialists.

   The usual procedure with gem rough is to drill a number of holes in a 25 mm bakelite disc, and insert each sample into one of these holes. The entire disc is then impregnated with epoxy, and, after curing, the disc is ground down to expose the gem grains. They are then highly polished to a mirror-finish with diamond abrasives. (Fig. 2)

   In the case of inclusion studies, the task is infinitely more time consuming. Each piece of rough is mounted in a separate disc, polished so that the inclusion can be observed, and then laboriously ground down to expose the selected inclusion. This work takes much skill, and more patience.

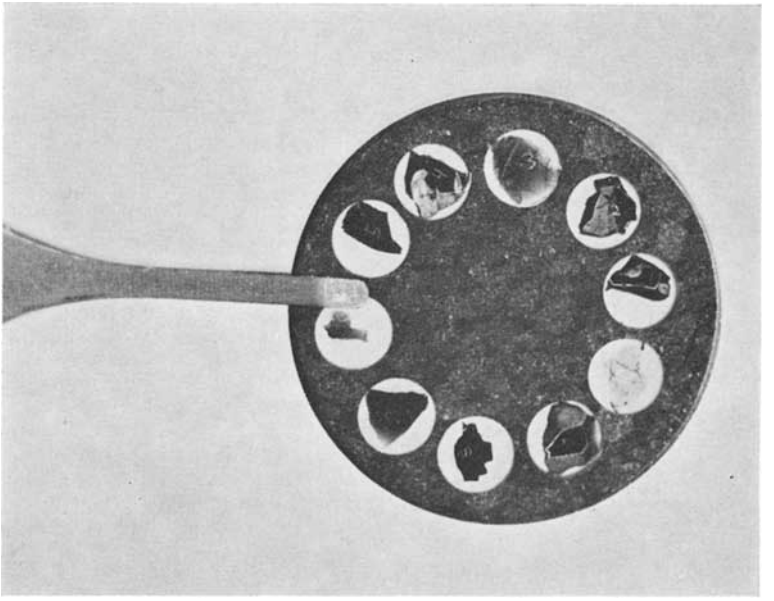

FIG. 2. A sample-disc containing ten fragments of tourmaline. Small numbers scratched on the surface of each grain aid in identifying the specimen within the microprobe.

2. In cases where we desire to analyse a faceted gem, different procedures are followed. The gem is mounted by hand in a sample holder (Fig. 3), using a high-vacuum clay (APIEZON is a good one) to hold the gem rigid in the sample holder. Since it is absolutely necessary that the surface that is to be analysed is horizontal, the gem-in-clay-in-sample-holder is then pressed in a levelling press (Fig. 4) so as to bring the surface to be analysed (usually the table of a gem) into horizontality and flush with the top edge of the sample holder.
3. Whether the sample to be analysed is in the form of a disc of rough fragments or a finished gem, it must then be carbon-coated to give a conducting surface for the removal of electrons, since most gems are non-conductive. For this purpose, the samples are placed in a carbon-coating instrument and a thin layer ($\sim$400 Å thick) of carbon is deposited on the gem. This thin layer is not noticeable on most gems, but it should be wiped off, after the analysis is complete, with a very soft abrasive to ensure maximum brilliance in the gem. Because the carbon-coating is thin, there may be breaks in the conducting surface at

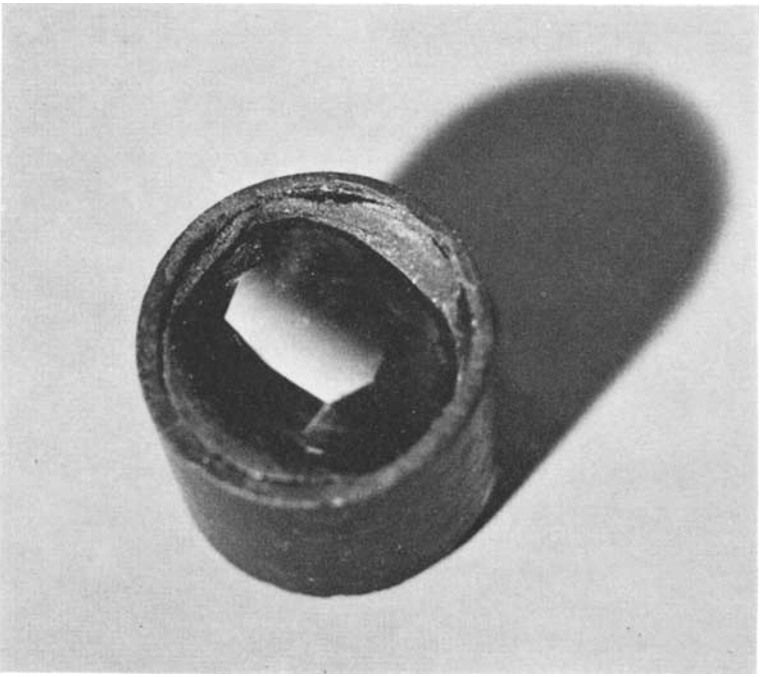

FIG. 3. A faceted amethyst mounted in clay within a sample-holder.

the juncture with the sample holder, and to avoid this break in the conducting surface, the samples are usually daubed with silver or gold paint (Fig. 5), especially at the contact with the sample holder.

4. The gems are now ready for analysis and are placed in the brass module depicted in Fig. 6. This module has five holes (the centre one is reserved for the standard disc) and thus can hold four faceted gems or four discs with up to 19 chips of gem in each disc (Fig. 7).

One additional advantage of the microprobe is that it can accommodate sizeable gems. Figure 8 is a photograph of a 911 carat aquamarine mounted on a module and ready for insertion into the microprobe. Mounted jewellery could also be placed directly in the microprobe, if the need arose.

Due to the essential requirement that the samples have a flat polished surface lying horizontal in the microprobe to insure an

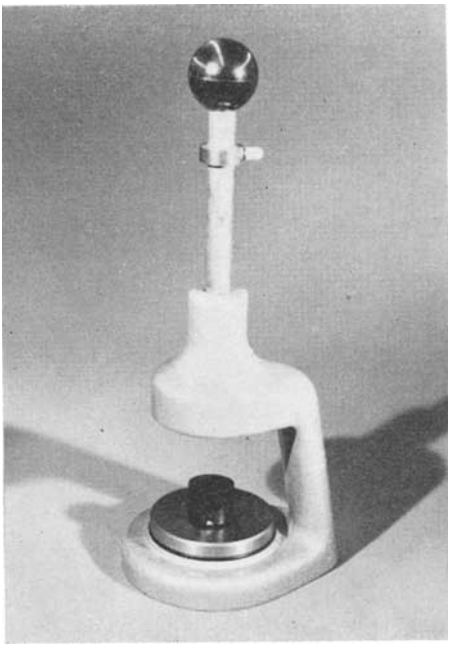

FIG. 4. A levelling press used to obtain horizontality of the surface to be analysed.

FIG. 5. The faceted amethyst of Figure 3, coated with silver paint to ensure electrical conductivity. The gem will be analysed on the clear, non-painted areas.

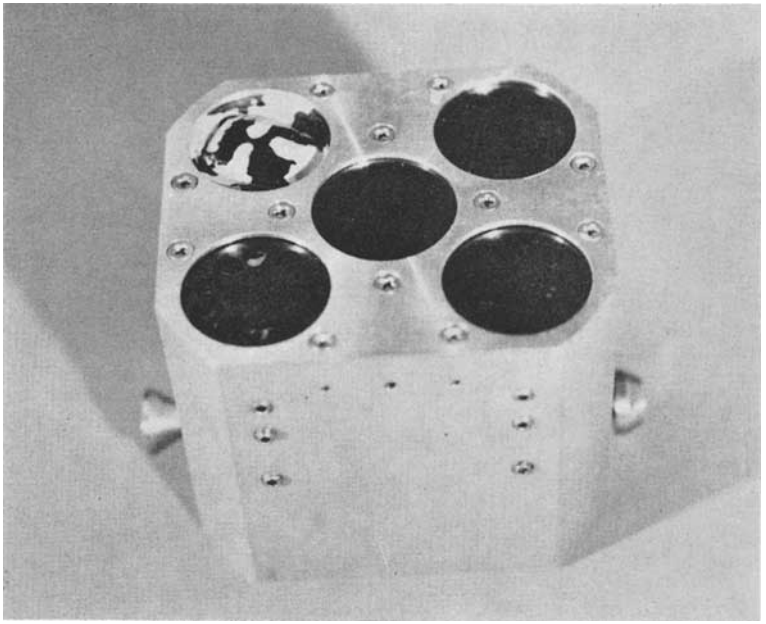

FIG. 6. A module for holding sample discs and gems.

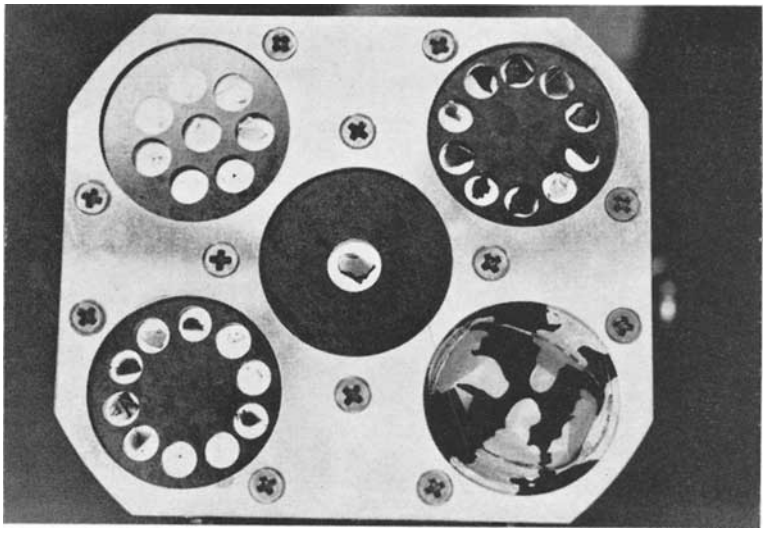

FIG. 7. Top-view of the module of Figure 6. The single fragment mounted in the centre is for analysis of an exposed inclusion of apatite. The amethyst shown in Figures 3 and 5 is mounted in the lower right position.

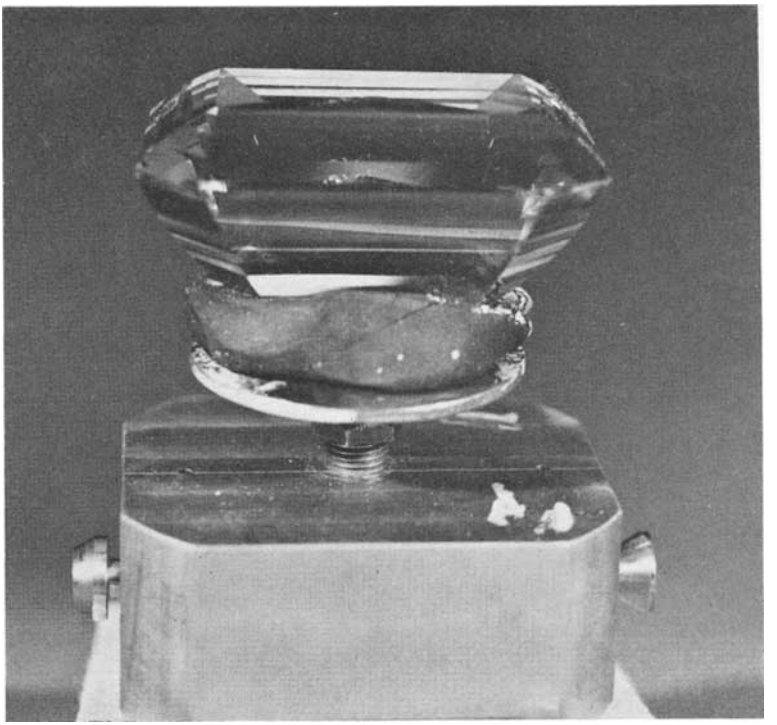

FIG. 8. A 911 carat aquamarine mounted on a module for insertion into the microprobe.

accurate analysis, cabochons cannot be analysed easily in the probe. To analyse a cabochon, it would be necessary to polish a flat on the bottom of the stone. Qualitative results could be obtained without this flat facet, but a really accurate analysis would necessitate it.

In summary, the electron microprobe is a most useful tool to the research gemmologist or mineralogist, and its full potential in gemmology might not yet be realized. More so than any other instrument, it has allowed us to omit the over-qualified "maybe" from the identification of gemstone inclusions and allowed us to define and characterize such inclusions with certainty.

The author is indebted to Mr Eugene Jarosewich, Supervisor of the chemical laboratory in the Department of Mineral Sciences, Smithsonian Institution, for a critical reading of the manuscript and helpful suggestions for improvement.

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Recent studies in this area include some on aventurine feldspars but no cause for the origin of hematite in the feldspar has yet been discovered. Flakes of hematite in labradorite from Labrador, which are arranged in straight lines, may be following dislocation lines in the host. Chatoyancy and asterism are also discussed. M.O'D.

BANK (H.). *Gemmologische Kurznachrichten.* (Gemmological short notes). Z.Dt. Gemmol. Ges., 1976, 25, 2, 106-112.

Six short notes by the author. (1) Cuttable villiaumite from Los Island (Guinea). This cut reddish stone has n=1·328, density 2·79, hardness only 2. (2) Natural colourless beryls covered with synthetic emerald after Lechleitner; constants are given, as also of (3) colourless topaz covered with synthetic emerald according to Lechleitner: the "kernel" of topaz has been determined by x-ray diffraction. (4) In this case a reputed synthetic emerald with beryl kernel was shown to be a doublet using topaz. (5) A case is described where zoisite was mistaken for vesuvianite and lastly (6) a reputed synthetic spinel was shown to be a pale green grossularite from Kenya. E.S.

BANK (H.) and OKRUSCH (M.). *Über Rubin Vorkommen in Marmoren von Hunza-Pakistan.* (About occurrences of rubies in the marbles of Hunza, in Pakistan.) Z.Dt.Gemmol.Ges., 1976, 25, 2, 67-85. 12 illus., bibl.

Gem quality, cuttable rubies and well coloured spinels which were not of cuttable quality have been found in the marbles in the Hunza valley in Pakistan, north-west of the Karakoram mountains of Kashmir. The marble forms concordant intercalations within sillimanite-bearing garnet-biotite-plagioclase gneisses and mica schists. The metamorphic sequence is cut by discordant aplite and pegmatite dykes. Details are given of the micro-analysis showing quantities of chromium and iron contents in the rubies and in three colour varieties of spinel. The Hunza rubies have the same purity, transparency and colour as those from Burma, while the spinels found so far are not of gem quality. The formation of corundum in the Hunza marbles was caused by an enrichment of alumina in the parent material. The uncommon rock chemistry is best explained by lateritic weathering of impure limestone. Metamorphic conditions are estimated from experimental data as about 600-620°C at a total fluid pressure of 7 kilobars. The CO_2/H_2O ratio in the fluid phase should have been roughly 20:80. E.S.

BOATWRIGHT (C.). *Unusual jade-like quartz from Georgia.* Rocks & Min., 1976, 51, 20-21. 1 fig.

Green quartz, of lapidary quality, occurs in veins east of Marietta, Cobb County, Georgia. The colour is caused by unidentified green inclusions. R.S.M.

BOSCARDIN (M.), DE MICHELE (V.) and MATTIOLI (V.). *Lo smeraldo della Val Vigezzo (Ossola).* (Emerald from Val Vigezzo, Ossola). La Gemmologia, 1976 II, 1, 21-26.

Emerald from this locality in Ticino, Italy, was discovered as recently as 1974. It occurs with albite and is semi-transparent, with inclusions which may be bertrandite, chlorite or cookeite. Accessory minerals include a blue tourmaline, zircon and clinochlore. Chromium content was estimated at up to 0·05%. Specific gravity was between 2·69 and 2·72, the latter value being for a crystal of good colour. The R.I. for the ordinary ray was measured as 1·5905 and for the extraordinary ray as 1·5834. This gives a birefringence of 0·0071. Pleochroism was distinct but no absorption spectrum was seen. However, the infrared spectrum closely resembled that of stones from Muzo, Colombia. M.O'D.

BROWN (G.), MOULE (A. J.) and O'NEAL (R. L.). *The radiopacity of some common gem minerals.* Australian Gemmologist, 12, 8, 241-247. 5 illus.

An attempt to use the varying opacity of different gems to x-rays as a testing factor. An x-ray source and a densitometer are needed and it is evident that the method is slow and demonstrably vague unless one is authenticating diamond. No mention is made of colour changes, temporary or otherwise, produced in some species (e.g. corundum) when exposed to x-rays. The authors come to conclusions which are already well established. R.K.M.

DIEHL (R.) and BANK (H.). *Einige neuere Synthesen und künstliche Produkte in durchsichtigschleifwurdiger Form.* (Some new syntheses and artificial products in transparent and cuttable form). Z.Dt.Gemmol.Ges., 1976, 25, 2, 104-106.

The article deals with six products which are usable as gems. (1) Zinc blende and wurtzite, ZnS, both colourless imitations of diamond: R.I. 1·81 (thus higher R.I. than normal refractometer reading); very soft, Mohs scale 3–4; zinc blende is cubic, wurtzite hexagonal; both can be coloured green with cobalt, yellow with nickel and pale green with copper. (2) $RbMnF_3$, rubidium manganese fluoride, is a synthetic product which can be produced in long pink single crystals with a diameter of 10·15 mm by drawing out of the melt, hardness 4; S.G. 4·31; R.I. $1{\cdot}428 \pm 0{\cdot}001$. (3) LiF, cubic lithium fluoride, used in the optical industry because of its low R.I., colourless but can be coloured yellow with chromium. (4) MnF_2: this manganese fluoride is brown/pink, tetragonal; D.R. 0·030; hardness 4; density 3·93. (5) $YA10_3$, yttrium aluminium garnet (YAG), orthorhombic; density 5·36; R.I. $1{\cdot}90 \pm 0{\cdot}05$; hardness $8\frac{1}{2}$; colourless, but can easily be coloured; of importance to gemmology and for laser work. (6) Greenockite, CdS: crystallization hexagonal, similar to wurtzite; density 4·79; hardness 3–4; doubly refractive, $n=2{\cdot}50$; used for its photoelectric properties. E.S.

DITCBURN (R. W.), TABOR (D.), FRANK (F. C.), MITCHELL (E. W. J.), EVANS (T.), LOUBSER (J. H. N.) and ROSENBERG (H. M.). *The future of diamond research.* Diamond Research 1976 (Industr. Diamond Inform. Bur.), 4-6.

Each of these authors offers individual thoughts on what results future research may bring. In addition to work giving a better understanding of present results or which represents extension or completion of work now in progress, new and unexpected discoveries may be concerned with studies of the phases of carbon

at very high P and T, the behaviour of diamond under very high densities of UV or x-radiation, the electrical properties of He-doped diamond, the petrogenesis of diamond-bearing rocks, the solubility and diffusion of nitrogen at very high P and T, bonding at diamond surfaces, the surface chemistry of diamond, the production of synthetic diamonds for maser use, and the high velocity of sound waves in diamond. R.A.H.

DOLENC (M.). *Das Tansanitvorkommen Merelani in Tansanien.* (The Merelani deposit of tanzanite in Tanzania). Z.Dt.Gemmol.Ges., 1976, 25, 2, 86-95. 5 illus. bibl.

The tanzanite deposit at Merelani, south-west of Moshi, is connected to the marble and gneiss complex of the Usagaran system of Late Archaean. Zoisite appears as a fissure-filling mineral in the graphite gneiss, amongst quartz boudins. Quartz and gneiss must relate in such a manner that conditions are right for the formation of fissure-filling material. A part of the zoisite is formed as tanzanite. Amongst accompanying minerals are green tourmaline and vanadian grossularite. E.S.

FAYAZ (H.) and FORGHANI (A.-H.). *The turquoise of Iran.* Rocks & Min., 1975, 50, 526-528. 3 figs.

Blue, bluish-green, and green cryptocrystalline turquoise occurs in nodules and veinlets in volcanic rocks near Neishabur, Khorassan Province, north-eastern Iran. The mine has a 1,000 year history. The petrography of the associated trachyte is given. R.S.M.

GLOBOVITCH (B. A.). *Les richesses de Leningrad.* (The riches of Leningrad). Revue de Gemmologie, 1976, 47, 14-15.

A short account of the gem materials displayed in the museums of the city and in particular that of the School of Mines. M.O'D.

GRAMACCIOLI (C. M.). *Lo zircone: una pietra interessante.* (Zircon: an interesting stone). La Gemmologia, 1976, II, 1, 16-20.

An account of the types and occurrences of zircon, some of which are illustrated in colour. M.O'D.

GÜBELIN (E.). *Zum Problem des Farbwechsels im Alexandrit.* (The problem of colour-change in alexandrite). Z.Dt.Gemmol.Ges., 1976, 25, 2, 96-102. 3 illus., bibl.

The colour-change in alexandrites seems to be brought about by chromophore chrome-atoms taking the place of Cr^{3+}ions in the octahedric co-ordination which is usually taken up by Al^{3+}ions: this replacement takes place twice, once in the normally-sized lattice and once in the "small" lattice. In order to push sufficient numbers of Cr^{3+}ions into the small lattice either high temperature/low pressure or extremely high pressure/low temperature is necessary. These rare conditions occur very infrequently in the formation process of chrysoberyls, so that specimens with good colour-change are very rare. E.S.

HUDSON (P.R.W.). *A review of the thermal properties of natural gem diamond.* Australian Gemmologist, 1975, 12, 9, 286-290. 3 figs.

A résumé of papers on this essentially industrial attribute of diamond. Heat conductivity is five times that of pure copper, and diamond, apart from the very rare type IIb, is an electrical insulator. Presence of nitrogen, and unidentified "platelets" parallel to the cube form, in type Ia, and nitrogen in type Ib, reduce the thermal conductivity. Type II diamonds, the purest material, are the best thermal conductors but IIb is electrically a semi-conductor. Because of these facts diamond is an excellent abrasive not only because of its extreme hardness but also because it conducts heat away from the point of friction with sufficient speed to avoid graphitization. More importantly diamond, apart from type IIb, is extremely useful as an electrically insulated heat-sink in present day miniaturized electronics. Although only a precis of available information this is a highly technical paper and is not easily understood in detail. Such expressions as "10^4W m^{-1} c^{-1}" are meaningless to the average gemmologist and need explanation. Some of the data refer to the performance at -173°C, the optimum temperature for thermal conductivity. Generally, the facts given are either of purely scientific or of industrial importance rather than gemmological. The Editor attempts to simplify one definition but in so doing reduces its accuracy. R.K.M.

JONES (D. A.). *Stockbarger crystal growth, optical assessment and laser performance of holmium-doped yttrium erbium lithium fluoride.* Journal of Crystal Growth, 1975, 30, 21-26.

Single crystals of this material have previously been grown by the top-seeded solution growth method. Growth by the Stockbarger technique has been shown to produce crystals with an improved laser performance and with a high degree of optical homogeneity. No light scattering centres occur in the visible region of the electromagnetic spectrum. The method cannot, however, produce crystals oriented along a definite crystallographic direction. M.O'D.

KOSEL (G. E.). *The prairie agate—Nebraska's state rock.* Rocks & Min., 1975, 50, 613-614.

The "prairie agate" described is a banded chert of red, yellow, tan, blue, and grey colour. It occurs in the north-western and central western parts of the state, although its original source is Wyoming. Colourful chalcedony also occurs in Dawes and Sioux Counties, Nebraska. R.S.M.

LAPWORTH (P.). *Jet.* Australian Gemmologist, 1975, 12, 8, 248-250.

An account of jet and jet mining particularly from a historical viewpoint. R.K.M.

MOORE (P. B.) and ARAKI (T.). *Painite, $CaZrB[Al_9O_{18}]$: its crystal structure and relation to jeremejevite $B_5[\square_3Al_6(OH)_3O_{15}]$ and fluoborite, $B_3(Mg_9(F,OH)_9O_9)$.* Amer. Min., 1976, 61, 1/2, 88-94.

Painite was found to possess a rigid and dense octahedral framework topologically identical to that of jeremejevite and fluoborite. The chemical composition, obtained from electron probe analysis, is proposed as $CaZrBAl_9O_{18}$. M.O'D.

NICHOL (D.). *Nephrite jade deposits.* Australian Gemmologist, 1975, 12, 7, 220-221.

An account of nephrite deposits at Cowell, S. Australia. Material is said to be similar to that found in New Zealand and other places. An estimated 45,000 tonnes is thought to be available. R.K.M.

ONOTAKE (H.). *Historical development of cultured pearl industry in Japan.* Journal of the Gemmological Society of Japan, 1976, 3, 1, 14–16. (In Japanese).

A chronological review of the cultured pearl industry in Japan begins with this article. M.O'D.

OUGHTON (J. H.). *New synthetic gems set a problem.* Australian Gemmologist, 1975, 12, 7, 222-226.

A general account of synthetics which have appeared in recent years, including synthetic alexandrite, opal, YAG "garnet" imitations of diamond, hydrothermal and flux-fusion rubies and emeralds, synthetic turquoise, synthetic quartz and a synthetic purple zircon (not available commercially). Laser drilling and irradiation of natural diamond to improve clarity and colour, and various doublets are also discussed although outside the subject of the paper. R.K.M.

POULLEN (J.-F.). *Un gisement exceptionnel : le grenat demantoide de Sferlun, Val Malenco, Italie.* (An exceptional location: demantoid garnet from Sferlun, Val Malenco, Italy). Revue de Gemmologie, 1976, 40, 2-6.

Val Malenco lies about 130 km north of Milan and has long been known for its fine demantoid garnets. Artinite and perovskite are found in association, and melanite is also found. Chemical analyses and comparative absorption spectra are given. M.O'D.

POVARENNYKH (A. S.), PLATONOV (A. N.), TARASHCHAN (A. N.) and BELICHENKO (V. P.). *The colour and luminescence of tugtupite (beryllosodalite) from Ilímaussaq, South Greenland. (Contributions to the mineralogy of Ilímaussaq, no. 21)* Grønlands Geologiske Undersøgelse, 1971, Bulletin no. 95 (II).

The cause of the luminescence of tugtupite was established as S_2^- molecular ions taking up the position of Cl ions in the structure. These ions may also be the cause of the colour, together with other radiation centres of lower thermal stability. M.O'D.

SØRENSEN (H.), DANØ (M.) and PETERSEN (D.). *On the mineralogy and paragenesis of tugtupite. (Contributions to the mineralogy of Ilímaussaq, no. 20).* Grønlands Geologiske Undersøgelse, 1971, Bulletin no. 95 (1).

Tugtupite is $Na_8Al_2Be_2Si_8O_{24}(Cl,S)_2$ and is a member of the tetragonal crystal system. It forms triplet twins on {101}. Data on the mineral include c:a $1{\cdot}0269 \pm 0{\cdot}0003$, d = 2·33 gm/cm^3, $n_e 1{\cdot}499 \pm 0{\cdot}001$, n_w $1{\cdot}495 \pm 0{\cdot}001$, $a_o = 8{\cdot}637$–$8{\cdot}643$, $c_o = 8{\cdot}867$–$8{\cdot}870$, $V_o = 662A^3$. It occurs in hydrothermal veins in the Ilímaussaq alkaline intrusion, South Greenland, and in the Lovozero alkaline intrusion, Kola Peninsula. It is associated with albite, analcime and lithium mica. M.O'D.

SUTTON (J. & P.). *Crystallography is fun.* Australian Gemmologist, 1975, 12, 7, 210-220. 16 figs.

A detailed account of the method of making a model of the atomic structure of the diamond unit cell and of methods of producing cubic crystal models from cubes of expanded polystyrene. Deals with cubic system only and, by implication, erroneously includes the icositetrahedral form among those of diamond. The double unit-cell model illustrated would be better if the atom bonds were differentiated from the cubic framework by colouring them differently. Ideally the cube outline should not be included in the model. Diagrams relating the eight basic forms to the cube and to each other are well drawn and helpful in identifying Miller indices. R.K.M.

TAKENOUCHI (S.). *Basic knowledge on studies of fluid inclusions in minerals: part 5.* Journal of the Gemmological Society of Japan, 1976, 3, 1, 25–31. (In Japanese).

Inclusions typical of pegmatite minerals, especially quartz and beryl, are studied; they are compared with inclusions from hydrothermal minerals. Gases from diamond crystals have been analysed. M.O'D.

TROSSARELLI (C.). *Il rifrattometro.* (The refractometer). La Gemmologia, 1976, II, 1, 5-13.

A summary of the use of the refractometer and the various types available. The principle of total internal reflection is described. M.O'D.

VANDENBERGE (G.). *Blauw Zoisiet of Tanzaniet.* (Blue zoisite of Tanzania). Bulletin, Société Belge de Gemmologie, 1976, 2, 1-4.

A summary account, with two photographs, of the blue variety of zoisite found in Tanzania. M.O'D.

VAN DE WALLE (P.). *Le filtre à émeraude.* (The emerald filter). Bulletin, Société Belge de Gemmologie, 1976, 1, 2-3.

A list of the uses of the Chelsea colour-filter with a number of stones and their appearance specified. M.O'D.

WANKLYN (B. M.), GARRARD (B. J.) and WONDLE (F.). *Flux growth of some fluoride crystals under reducing conditions (VF_2,$K_5V_3F_{14}$,$KTiF_4$): pt 3.* Journal of Crystal Growth, 1976, 33, 165-8.

Crystals of some fluorides were grown in strongly reducing conditions with a vertical tube furnace. An atmosphere of hydrogen and nitrogen gave the required reduction. M.O'D.

WATANABE (J.), YOSHINO (F.) and HASEGAWA (T.). *Structure of etch pits and light figures developed on diamond surfaces.* Journal of the Gemmological Society of Japan, 1976, 3, 2, 57-63. (In Japanese, summary in English).

Two methods of etching are described. The {111} surface is covered with etch pits of triangular pyramidal shape surrounded by side faces inclined at 11·5°

against the {111} plane. The {100} surface etched by one of the methods shows tetragonal-pyramidal etch pits with side faces at an angle of 28·5° against the {100} plane. M.O'D.

YOSHIMURA (J.) and KOHRA (K.). *Studies on growth defects in synthetic quartz by x-ray topography.* Journal of Crystal Growth, 1975, 33, 311-23.

Characteristic patterns of lattice disturbance due to 2-dimensional impurity distributions showed in Z-growth sectors. M.O'D.

ZAPATERO (L.). *Inclusiones fluorescentes en cuarzo.* (Fluorescent inclusions in quartz). Boletin del Instituto Gemologico Español, 1976, 13, 15–21. Illus. in colour.

These include negative crystals, two-phase inclusions, polyphase inclusions with bituminous solid matter and liquid and gas; some liquid inclusions are paraffin, which may fluoresce. M.O'D.

ZEITNER (J. C.). *The southwest: a mineral rich land.* Lapidary Journal, 1976, 30, 1, 50–62. Illus. in colour.

A review by state of the ornamental minerals of the area. M.O'D.

ZEITNER (J.). *False names, real names, trade names.* Lapidary Journal, 1976, 30, 4, 1070-75.

A list of undesirable names applied to minerals and gemstones. M.O'D.

NOTE.—*Bulletin, Société Belge de Gemmologie* (Belgische Vereniging voor Edelseenkunde) is a new journal, reproduced from typewriting but containing some interesting articles. It is published from 118, rue du Midi, Brussels, and the annual subscription is B fr 400.

Revue de Gemmologie is the new title of the former *Bulletin de l'Association Française de Gemmologie;* the numeration continues without a break. M.O'D.

BOOK REVIEWS

CAVENAGO-BIGNAMI (S.). *Manuale di gemmologia.* Ulrico Hoepli, Milan, 1973. pp. xix, 193. Illus. in colour. L 4000.

A beautifully-illustrated small guide to the commoner gemstones, this book is well worth obtaining for the photographs alone. Preceded by a short section on basic gemmology, most of the book consists of short descriptions of gems in rough order of accepted value. An illustration of an elephant carved from Tanzanian ruby is particularly impressive—that of ruby in zoisite from the same country is out-of-focus. Crystal system, chemical composition, hardness, specific gravity and refractive index are given for each species. M.O'D.

MACINTOSH (E. K.). *A guide to the rocks, minerals and gemstones of Southern Africa.* C. Struik, Cape Town, 1976. pp. 96. Illus. in colour. £4·00.

This book is presumably intended for the amateur collector and deals almost exclusively with the Republic of South Africa and with South-West Africa. A short introduction to the crystal systems is followed by a descriptive section making up most of the remainder of the book and arranged by major and minor rock-forming minerals, the major rock groups, minerals of economic importance; despite the title gem materials are fitted into appropriate sections and are not awarded a section on their own. Specific gravity is perversely abbreviated as relative density; there are some misconceptions on the colouring of quartz varieties which are attributed to the hexagonal system although the trigonal system is separately treated in the introduction; none of the representations of water-melon tourmaline actually depict this species; the section on garnet is useless as an introduction. No doubt the rest of the book is equally rich in errors and slack writing; like many other works aimed at the amateur, this book shows up the insufficient critical apparatus possessed by the author, who must seek the aid of a guide to his sources before he writes another book. M.O'D.

PEARL (Richard M.). *Garnet, gem and mineral.* Earth Science Publishing Co., Colorado Springs, Colorado, U.S.A., 1975. pp. 24. Illus. $1·00.

A general introduction to the garnet group of minerals with notes on their crystallization and other relevant data. Some undesirable names are included in the glossary but marked by quotes. M.O'D.

PEARL (Richard M.). *Turquoise.* Earth Science Publishing Co., Colorado Springs, Colorado, U.S.A., 1976. pp. 32. Illus. $1·35.

A well-written short guide with special reference to North American deposits and fashioning of turquoise. The material was and is of great importance to the North American Indians and some references to their superstitions are included. M.O'D.

SINKANKAS (John). *Gemstones of North America in two volumes. Vol. 2.* Van Nostrand Reinhold Co., New York, 1976. pp. xv, 494. Illus. in black-and white and in colour. $30·00.

Volume one of this standard work was first published in 1959*; in this second volume some earlier material is included where the author felt it was needed, but in the main all the information here is new. As in the earlier volume the materials are listed in general order of importance and within this category by area of deposit. A large number of quoted personal communications are especially valuable and when taken with the superb bibliography (by far the most exhaustive to appear on the subject and an enticing forerunner of the same author's projected general gemstone bibliography) make this book as authoritative as it is possible to be. This reviewer laments the paucity of information given in most gemmological texts (do most authors merely read books similar to their own?) and wishes that the general standard of writing on the subject was improved by a greater familiarity with material in other languages and from sources other than monographs which have the same readership. However this state of affairs may change in the future, this book shows the way that a country guide should be written. Each mine is briefly described with notes on its origin and ownership, with records of finds of particular importance and mention of their destination and present location. Information is as up-to-date as January 1975: the Tourmaline Queen mine at Pala, California, is now in operation once more—at least it was in December, 1975, when the author and the present reviewer were present and a fine crystal-bearing pocket was opened. The tourmalines from Newry, Maine, are given 13 pages of description, which is proportional to their importance. It is interesting to learn that the manganese-bearing red beryl from the Wah Wah Mountains in Utah has yielded some small cut stones: this material has the varietal name of bixbite. With regard to one of the minerals peculiar to the U.S.A., benitoite, it appears that the supply may be exhausted, since no accessory minerals are found in the lowest glaucophane schists and their altered phases. Willemite from Franklin is also exhausted and the mine flooded. A great deal of information is given on nephrite jade deposits (unfortunately the running head "Nephrite jade production in British Columbia" is allowed to run over into sections dealing with other areas) and these have been greatly developed since publication of the earlier volume. Alaska has alone produced some fine-quality nephrite.

As in the earlier volume, North America includes Mexico, Canada, parts of Central America and, by geographical convention, Greenland, so that some notes on tugtupite are included. The last chapter covers the history of North American gemmological literature—the only place where this information can be found. The bibliography itself is exhaustive; dates are given before volume and page numbers so that the reader can see quickly how current the information is.

This book is a model for a country guide and is quite essential for anyone with an interest in North American materials, indeed for anyone with any gemmological interests in any country. The price is quite reasonable for these days.

M.O'D.

*Reviewed in J. Gemm., 1960, VII, 5, 197–8.—*Ed.*

UEDA (R.) and MULLIN (J. B.). *Crystal growth and characterization. Proceedings of the ISSCG2 Spring School, Japan, 1974.* North-Holland Publishing Co., Amsterdam, 1975. pp. vii, 419. £16·15.

The second International Spring School on Crystal Growth was organized by the committees associated with the International Organization of Crystal Growth and the International Union of Crystallography; it was linked to the 4th International Conference on Crystal Growth held one week later in 1974. Proceedings of the first International Spring School (Hartman, ed.) dealt with nucleation theory and experimental techniques; this volume covers crystal growth and characterization. Early chapters include material on the practical growth of device-quality crystals and the basic science associated with the techniques used. Vapour phase, melt and solution growth are considered. A large number of illustrations in the text include excellent-quality reproductions of crystal dislocation effects. Each chapter includes its own bibliography, and there are subject and author indexes. M.O'D.

WENK (H.-R.). *Electron microscopy in mineralogy.* Spring-Verlag, Berlin, 1976. pp. xiv, 564. U.S. $39·40.

This book consists of a series of papers by various authorities on the uses of electron microscopy as applied to mineralogical topics. Many of the subjects treated are most interesting to the gemmologist with mineralogical leanings, and there are many excellent photographs. Each chapter includes its own bibliography and there is a general subject index. M.O'D.

Guidebook I to mineral collecting in the Maine pegmatite belt. Federation of Maine Mineral and Gem Clubs, 1974. pp. vi, 22. Price on application.

Complete directions and maps are given for a number of the classic localities, including Mt Mica and Newry. Owners are mentioned where appropriate. M.O'D.

Jahrbuch der Edelsteinkunde, 1976. (Gemstone Yearbook, 1976). Verlag Edelsteinlabor Dieter Pschichholz, 87 Würzburg, Domstrasse 13, West Germany. Price on application.

An excellent new venture containing accounts of new developments in gemmology over the year. Included are articles on inclusions in the new Lechleitner synthetic emerald, reviews of new instruments, including the Eickhorst Gemmodul-Kaltlichtspektroskop* and the Diamant-Photometer by the same manufacturer. The theme of diamond grading is prominent in the book, reflecting present interest throughout the trade. Other articles cover a variety of minerals and phenomena with a note on some synthetic materials by the present reviewer. M.O'D.

Treasures of the U.S.S.R. Diamond Fund. The Diamond Fund, Moscow, 1975. Unpaginated. Illus. in colour. Price about £11·50.

Each piece of jewellery is given brief captions in English and French, but the main descriptions are in Russian. The standard of reproduction of the photographs is fairly high, though not up to modern Western standards. The pieces illustrated are a selection only from the great wealth of the Fund. M.O'D.

*See J. Gemm., 1976, XV, 3, 136.—Ed.

ASSOCIATION NOTICES

OBITUARY

Professor Dr KARL F. CHUDOBA—A TRIBUTE

Professor Dr Karl F. Chudoba, whose death on 14th March last was briefly recorded in the October *Journal*, was one of a formidable series of German mineralogists who have given to our science a solidity and academic prestige it might have lacked without their aid. Bauer, Brauns, Schlossmacher, and Eppler, each in turn became so fascinated by gemmology that it is by their work in this special aspect of mineralogy that they will be chiefly remembered. Karl Chudoba, retired Professor of Mineralogy at the University of Göttingen, may be included in the same category, though mineralogists may reasonably maintain that his most important contribution to science lay in his continued scholarly series of additions to that most complete of all descriptive texts on minerals—Hintze's "Handbuch der Mineralogie", which first appeared in the eighteen eighties, and has since spread like some coral reef along the shelves of our largest libraries.

Chudoba's first impact on gemmology resulted from research work carried out with M. von Stackelberg in 1936—just forty years ago—in which for the first time a satisfactory explanation was discovered for the great variations in the density and refractive index of gem zircons from the Ceylon gravels, which had puzzled two generations of scientists. I had been able to lend him for this investigation a green zircon of exceptionally low density (3·97), in which x-ray analysis showed that the tetragonal lattice had broken down, leaving amorphous silica and zirconium oxide, partly crystallized in the cubic modification.

This important disclosure of what we now refer to as the metamict state (later fully exemplified in the radioactive gem mineral, ekanite) was presented by Chudoba in a simplified form in an article which appeared in the *Gemmologist* for November 1937.

This was followed by another article on the low hardness of metamict zircon. Soon the advent of war imposed a gap of about ten years before the work of German scientists became once more known to us in this country. But from 1952 onwards many of Chudoba's papers (chiefly on the causes of colour in gemstones) became available, being published either as abstracts or in full in this *Journal*. Already the author of a textbook of mineralogy, Prof. Chudoba, in collaboration with Dr E. Gübelin, also published two useful gemmological books, "Echt oder synthetisch?" and "Edelsteinkundliches Handbuch", the latter rather in the style

of Webster's "Compendium". The third edition of this appeared as recently as 1974. Professor Chudoba joined Professor Eppler in representing Germany in meetings of the International Gemmological Conferences held in many of the capital cities of Europe, and he and his wife Lotte were popular figures at these gatherings, until his health became too precarious for such activities. But his bibliographical work continued to the end, particularly as an Editor of "Hintze". In this field it seems unlikely that his thoroughness and assiduity will ever be matched. Those who knew him will remember with gratitude his gift for warm-hearted friendship. B.W.A.

GIFTS TO THE ASSOCIATION

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

Mr D. M. Arandara, Seven Kings, Ilford, for 90 ct of rough Sri Lankan gem materials, including some crystals.

Dr Donald L. Marchbanks, Salina, Kansas, U.S.A., for specimens of Gilson synthetic lapis lazuli and Gilson synthetic turquoise with matrix streaks.

Mr J. M. Marshall, F.G.A., South Bend, Indiana, U.S.A., for a collection of coloured slides of inclusions in diamonds and other gemstones suitable for use for study purposes.

Mr E. A. Thomson, London, for a very dark, almost black, small round iron-rich cut spinel having a R.I. of about 1·78 with S.G. in the region of 3·90 from Thailand.

During the early part of 1975 Mr Joseph Best, F.G.A., Santa Barbara, California, U.S.A., presented the Association with a comprehensive collection of synthetic materials. Since then Mr F. G. French, F.G.A., Purley, Surrey, has very kindly produced cut and polished specimens from most of that synthetic material, so that the Association now has an excellent collection of rough and cut specimens of less common synthetic materials.

MEMBERS' MEETINGS

London

A talk was given at Goldsmiths' Hall, London, on 11th October, 1976, by Mr P. G. Read, C.Eng., M.I.E.E., M.I.E.R.E., F.G.A., Technical Manager for the Diamond Trading Co. Ltd., entitled "Automation in sorting of rough diamonds". The substance of his talk will be given in a future issue of the *Journal*.

Midlands Branch

On the 30th September, 1976, at the Royal Institution of Chartered Surveyors, Birmingham, a talk was given by Mr R. Huddlestone entitled "An approach to diamond colour-grading".

Mr P. G. Read gave a repeat of his London lecture, "Automation in sorting of rough diamonds", on the 17th November, 1976, at the Royal Institution of Chartered Surveyors, Birmingham.

North-West Branch

The Annual General Meeting of the Branch was held on the 14th October, 1976, at Church House, Liverpool. Mr J. G. Roach and Mrs D. M. Brook were

re-elected Chairman and Secretary respectively. During the evening Mr J. L. Pyke, F.G.A., gave an illustrated talk on his visits to the emerald mines of Colombia and various Far Eastern gem mining deposits.

Scottish Branch

On the 24th November, 1976, at the Royal British Hotel, Edinburgh, Mr Alastair Cairncross, F.G.A., gave a talk entitled "Scottish pearls", accompanied by two films on the same subject. Members were also able to examine specimens.

GEM DIAMOND EXAMINATION 1976

Thirty-four candidates entered for the Association's 1976 Gem Diamond Examination, of whom twenty-eight qualified, three with distinction. The following is a list of successful candidates arranged alphabetically.

QUALIFIED WITH DISTINCTION

Benjamin, John C., Wembley Park.
Garcia Abril, Ana, Valencia, Spain.
Gomez Perez, Pila, Valencia, Spain.

QUALIFIED

Alvarado Moro, Odorico, Barcelona, Spain.
Cartwright, Donald R., Little Bookham.
Carrera Poblet, Jaime, Barcelona, Spain.
Cidoncha Garcia, Miguel, Valencia, Spain.
Clarkson, Roland N., Chessington.
Harding, J. L., London.
Hewson, Robin J., Crowthorne.
Horder, Heather A., Windsor.
Iwahori, Mitsuo, London.
James, Alan R., Walsall.
Jones, Alison R., Woking.
Lewis, Sheila J., Kenton.
Marsal Astort, Montserrat, Barcelona, Spain.
Maurer, Robert J., Brentwood.
Mayor Giner, Enrique, Vinaroz, Castellon, Spain.
Morrill, Christine, Cambridge.
Padro Tortajada, Angeles, Barcelona, Spain.
Read, Peter G., London.
Sanchez Almer, Javier, Castellon, Spain.
Sanchez Garcia, Paloma, Valencia, Spain.
Thomas, Geoffrey A., Hertford.
Tolmie, Andrea J., Lynn Stonnall.
Wharton, Stuart, St. Albans.
Wisdom, Terence R., Chorleywood.

EXAMINATIONS IN GEMMOLOGY 1976

In the 1976 examinations in gemmology, organized by the Gemmological Association of Great Britain, 755 candidates sat for the preliminary examination and 413 for the diploma examination. Overseas centres were established again in many parts of the world.

Upon the recommendation of the Examiners, the Tully Memorial Medal has been awarded to Dr Joel E. Arem, of New Carrollton, Maryland, U.S.A.

Mme Genevieve Bourdon Destrem, of Paris, France, was commended by the Examiners for her excellent work.

The Rayner Prize, in the preliminary examination, has been awarded to Mr Aarne Alhonen, of Salpakangas, Finland.

The following is a list of successful candidates, arranged alphabetically.

DIPLOMA EXAMINATION

TULLY MEMORIAL MEDAL

Arem, Joel E., New Carrollton, Md, U.S.A.

QUALIFIED WITH DISTINCTION

Arem, Joel E., New Carrollton, Md, U.S.A.
Baker, Elaine C., Lihue, Hawaii, U.S.A.
Bourdon Destrem, Genevieve M. C., Paris, France.
Fenoll Hachi-Ali, P., Barcelona, Spain.

QUALIFIED

Abraham, Robert, Amsterdam, Holland.
Alabaster, Stephen P., Birmingham.
Aloy, Richard N., Allhallows.
Alvarado Moro, Odorico, Barcelona, Spain.
Ambjornsen, Truls P., Fredrikstad, Norway.
Anandavadivel, Kumarasamy, Ratmalana, Sri Lanka.
Asano, Yoshio, Kyoto, Japan.
Baird, Donald D., London
Baldock, Lynette, Weston.
Beck Kaiser, Margrit, Barcelona, Spain.
Blackley, Robert, London.
Bolli, Bruno, St Gallen, Switzerland.
Borscho, Shirley J., Plymouth.
Bratton, Timothy J., Sidcup.
Byfleet, Anne P., Doncaster.
Callaghan, Christopher C., Port Elizabeth, S. Africa.
Chapellier, Dominique M. B., Lausanne, Switzerland.
Collier, John M. B., Fordingbridge.
Comin Vilajosana, Luis, Barcelona, Spain.
Cook, Judith A., Northwood.
Elliott, Douglas H., Nairobi, Kenya.
Eldridge, Maurice W., Sheffield.
Engelbrecht, Johann P., Pretoria, S. Africa.
Engineer, Thrity P., Bombay, India.
Evans, Mark, London.
Fabregas Guardiola, Virginia, Barcelona, Spain.
Falomir Penarrocha, Amadeo, Valencia, Spain.
Ferrandis Recatala, Juan V., Valencia, Spain.
Ferrando Lario, Salvador, Valencia, Spain.
Flewelling, Arthur G., Arthur, Ont., Canada.
Furuya, Masashi, Tokyo, Japan.
Gaarder, Kierstin, Voyenenga, Norway.
Garcia Pilan, Alfonso, Valencia, Spain.
Giereke, Nicolaus, Hamburg, Germany.
Goh, Kong B., Petaling Jaya, W. Malaysia.
Goto, Midori London.
Gulliksen, Gunnar B., Gol, Norway.
Hanni, Henry A., Basel, Switzerland.
Hayes, Elizabeth A., Ossett.
Heckman, Hayo W., The Hague, Holland.
Hendrickson, James E., Los Altos, Cal., U.S.A.
Holdroyd, Donna J., Oslo, Norway.
Hornytzkyj, Seppo, Helsinki, Finland.
Hudspith, James W., Leatherhead.

Jayakody, Don F., Ja-Ela, Sri Lanka.
Jefferson, Barbara J., London.
Judez Martinez, Gregorio, Valencia, Spain.
Junquero Abellan, Ramon, Valencia, Spain.
Koivula, John I., Seattle, Wash., U.S.A.
Kurata, Yukiko, Tokyo, Japan.
Leach, Jane, London.
Lewis, Ian R. M., Sheffield.
Lo, Louis Y., Hong Kong.
Maeda, Kikuko, Tokyo, Japan.
Mahendrarajah, Maureen, Colombo, Sri Lanka.
Matsui, Reiko, Tokyo, Japan.
Miller, Duncan E., Cape Town, S. Africa
Mills-Owens, Paul, London.
Moline Sala, Agustin, Barcelona, Spain.
Moller, Peter J., Tully, N. Qld, Australia.
Mollfulleda Buesa, Antonio, Barcelona, Spain.
Monche Maristany, Alicia, Barcelona, Spain.
Montserrat Nebot, Alfredo, Barcelona, Spain.
Mora Carbonell, Antonio R., Valencia, Spain.
Moses, Heather, London.
Need, Mary, Lelant Downs.
Oclee, Caroline H., Hythe.
Oliver, Peter J., Wellington, New Zealand.
Oria Albero, Isabel J., Valencia, Spain.
Oria Albero, Maria P., Valencia, Spain.
Pandithakoralege, Don R. M., Nugegoda, Sri Lanka,
Pender, Harold, Kenilworth.
Piech, Olwen, Bushey Heath.
Pinder, William R., Cairne, Qld, Australia.
Poel, Melvin C., Solihull.
Pons Gomez Joaquin, Barcelona, Spain.
Prat Moya, Sagrado C., Barcelona, Spain.
Pratt, John C., Toronto, Ont., Canada.
Ralston, Jonathan B., London.
Ranasinghe, Mahesha, Yogiyana, Sri Lanka.
Read, John V., Randburg, Transvaal, S. Africa.
Ribes Cudinach, Emilio, Barcelona, Spain.
Richards, Nancy A., Fredericton, N.Br., Canada.
Richards, Patsy-Ruth, Brisbane, Australia.
Rider, Stephen G., Leatherhead.
Ruiz Roca, Jose V., Valencia, Spain.
San Juan Ribes, Antonio, Valencia, Spain.
Sant' Angelo, Louis, London.
Sieders, Margaretha E. Den Haag, Hollan d
Sigl, Berta, Sargans, Switzerland.
Simonin, Daniel, St Gallen, Switzerland.
Snow, John J., Brisbane, Australia.
Speekenbrink, Wilhelmus A. M., Den Haag, Holland.
Staver, John, Virginia, Minn., U.S.A.
Storr, Jonathan, Lincoln.
Stromnaes, Bjorn, Oslo, Norway.
Suzuki, Yusaku, Tokyo, Japan.
Tanner, Eileen M., Amersham.
Tilling, Julian G., Dunstable.
Tomita, Koichi, Tokyo, Japan.
Tschudin, Francoise F., Lausanne, Switzerland.
van den Hoven, Alexander N., Ede, Holland.
van Iwaarden-Bender, Maria M.A., Delft, Holland.
van der Meer, Bastiaan, Schiedam, Holland.
Verkerk, Ruud, Stolwyk, Holland.

Vilá Perales, Vicente, Barcelona, Spain.
Vivo Ibanez, Jose, Valencia, Spain.
Vleeschhouwer, Willy A., Schoonhoven, Holland.
Vuorijarvi, Terhikki, Leppakoski, Finland.
Wilson, Anthony A., Bromborough.
Winstone, Harry, Durban, S. Africa.
Wennell, Susan D., Hazel Grove.
Yamada, Masahiro, Tokyo, Japan.
Zaveri, Rupesh P., Bombay, India.

PRELIMINARY EXAMINATION

RAYNER PRIZE

Alhonen, Aarne, Salpakangas, Finland.

QUALIFIED

Abraham Robert, Amsterdam Netherlands.
Abril Sirvent, Inmaculada, Barcelona, Spain.
Alabaster, Stephen P., Birmingham.
Allen, Darold C., Santa Monica, Cal., U.S.A.
Almirall Elizalde, Marta, Barcelona, Spain.
Alvarez Bringas, Jose A., Oviedo, Spain.
Amendra, Don H., Maharagama, Sri Lanka.
Andersen, Brit N., Horten, Norway.
Andersen, Oddvar F., Horten, Norway.
Anderson, Martin G., Fort Monmouth, N.J., U.S.A.
Anderson, Neil, Dover.
Antony, Mary R. R., Negombo, Sri Lanka.
Anttila, Kristiina, Helsinki, Finland.
Arandara, Don M., Ilford.
Arem, Joel E., New Carrollton, Md, U.S.A.
Arla Peris, Francisco, Barcelona, Spain.
Arla Pont, Enrique, Barcelona, Spain.
Arnold, Alan P., Metairie, La, U.S.A.
Aron, Mass K. Mass, Nugegoda, Sri Lanka.
Asquith, Lynn C., Bradford.
Attanayake, Walter, Ratnapura, Sri Lanka.
Ayuso Estanol, Juan, Barcelona, Spain.
Ayling, John C., Portsmouth.
Bailey, Paul S., Corsham.
Badenas Perez, Jorge, Barcelona, Spain.
Balachandran, Kanagaratham, Los Angeles, Cal., U.S.A.
Baldock, Edward J., Neston.
Banfill, Paul D. T., Sutton.
Barker, William G., Sutton Coldfield.
Barnatt, Robert W., Northampton.
Barnett, Paul A., Johannesburg, S. Africa.
Barrella, Lydia, Sea Point, S. Africa.
Basnayake, Gerard S., Colombo, Sri Lanka.
Bastiampillai, Mary N., Colombo, Sri Lanka.
Beard, Paul, Nottingham.
Beeks, Johannes F. M., Valkenswaard, Netherlands.
Bennett, Russell K., Aylesbury.
Berger Eva, London.
Bienert Albaladejo, Rosario, Barcelona, Spain.
Blackman, Margit C., Port Elizabeth, S. Africa.
Bloom, Leon K., Walsall.
Bolin, Anita M. H., Stockholm, Sweden.
Bolin, J. M. J., Stockholm, Sweden.

Bourdon Destrem, Genevieve M. C., Paris, France.
Bowskill, Alan P., Mansfield.
Brady, Michael F., Salisbury.
Brenton-Coward, Richard I., Otford.
Bressel, Heinz L., Milwaukee, Wis., U.S.A.
Briant, Richard A. C., Fleet.
Bromley, Ivy M., London.
Brookhuis, Harry, Schoonhoven, Netherlands.
Brown, Harold G., Glasgow.
Buckner, Richard A., Clinton, Tenn., U.S.A.
Buhary, Tuan D., Colombo, Sri Lanka.
Burford, Murray L., Ottawa, Ont., Canada.
Burlage, Ingeborg C., Schoonhoven, Netherlands.
Buxeda Corbera, Pilar, Barcelona, Spain.
Bylander. Liliane D., Bangkok, Thailand.
Cabrera Lagunilla, Pilar, Madrid, Spain.
Campbell, Susan H., Hong Kong.
Campo de Quevedo, Juan, Madrid, Spain.
Caparros Reyes, Victor, Barcelona, Spain.
Carry, Peter D., Aberdeen.
Cassidy, David F. F., Worcester.
Cassidy, John, Birmingham.
Castanera Rodriguez, Luis, Barcelona, Spain.
Cavey, Christopher R., London.
Cawdron, Margaret A. F., Aberdeen.
Chadderton, Yvonne E., Royton.
Chambers, Gareth, Harrow.
Chan, Sow C., Penang, Malaysia.
Chandrasena, Sooriya H. M., Colombo, Sri Lanka.
Chang, He O., Rio de Janeiro, Brazil.
Chapellier, Dominique M. B., Lausanne, Switzerland.
Clarke, Donald H. Johannesburg S. Africa.
Clarke, Elizabeth A., Barking.
Clarke, Tristan R., Wendover.
Close, Keith J., Liverpool.
Cobbald, Catherine J., Islington, Ont., Canada.
Coebergh, Henricus M. A., Montfoort, Netherlands.
Coleman, Kevin J., Huntingdon.
Collier, John M. B., Fordingbridge.
Conrad, Donald B., East Islip, N. Y., U.S.A.
Consolacion Montseny, Alredo, Barcelona, Spain.
Cooper, Dorothy A., Stockport.
Cooper, John D., Manchester.
Cooray, Harindra T., Moratuwa, Sri Lanka.
Cotes Mediavilla, Eusebio, Barcelona, Spain.
Crawford, Hugh B., Kirkcudbright.
Crossley, Anne D.. Oldham.
Croydon, Charles, Ipswich.
Cullman, Peter, Johannesburg, S. Africa.
Curran, Wilma, Weston-Super-Mare.
Daniel, Janice B., Plymouth.
Davies, Mark A. P., Hereford.
Davies, Robert I., Coventry.
Davis, Howard A., Toronto, Ont., Canada.
de Boer, K. J., Schoonhoven, Netherlands.
de Knecht, Petrus-Bernardus, Strijen, Netherlands.
Denton, Gillian M., Clacton-on-Sea.
de Silva, Denise M., Colombo, Sri Lanka.
de Silva, Nirmali Priyani, Ambalangoda, Sri Lanka.
de Silva, Pandigamage D. A., Colombo, Sri Lanka.
de Tong, Ype P., Krimpen a/d Issel, Netherlands.
Devereux, Maureen, Hong Kong.
Devji, Praful G., London.

de Waele, Carine-Ghislaine, Gent, Belgium.
Dewendra, Rekha, Panadura, Sri Lanka.
Dharmadasa, Sooriya H. M. S. P., Colombo, Sri Lanka.
Dick, Brigitte M., Great Billing.
Dissanayake, Akuranawattage B., Colombo, Sri Lanka.
Domenech Plo, Juan, Valencia, Spain.
Drummond, John R., London.
Dunlop, Helen R., Maybole.
Duroc-Danner, Jean-Marie, Geneva, Switzerland.
Edwards, Peter M., Aberystwyth.
Elkington, Mary, Solihull.
Ellis, Paul A., Colchester.
Elms, Kenneth G., London.
Elizinga, Vivienne, Durbanville, S. Africa.
Emmanuel, Michael R., St. Helier, Jersey, C.I.
Enger, Antoinette C. A., Voorburg, Netherlands.
Enrique Aranda, Laura, Barcelona, Spain.
Essery, Martin H., Feltham.
Etchen, Elsie J., Toronto, Ont., Canada.
Farnham, Julian R., Haslemere.
Farweez, Shabdeen M., Nawalapitiya, Sri Lanka.
Feingold, Sidney D., Manchester.
Feldman, Trevor M., London.
Fernando, Dilrutshi Y., Colombo, Sri Lanka.
Fernando, Joseph S. B., Toronto, Ont., Canada.
Fernando, Rambukkanage A. N., Colombo, Sri Lanka.
Fernando, Regina T. B., Colombo, Sri Lanka.
Fillmore, Robert W., Bromley.
Fonseka, Rita J., Colombo, Sri Lanka.
Fonseka, Ruwan K. M., Colombo, Sri Lanka.
Fonseka, Wanniachchige A., Dehiwala, Sri Lanka.
Fookes, Mark H., Brentwood
Fores Domper, Nieves, Barcelona, Spain
Funaro, Stella B., Livorno, Italy.
Gadot, Arnona, Tel-Aviv, Israel.
Galasko, Gail T. F. Johannesburg, S. Africa.
Gamage, Deegodagamage S. de S., Sri Lanka.
Gammidge Michael G., Sheffield.
Ganesen, Ganga-Devi, Colombo, Sri Lanka.
Garcia Blasco, Jose, Barcelona, Spain.
Garland, David J., Sheerness.
Gerard, Anthonypillai, Kayts, Sri Lanka.
Gianforte, Carmen A., Ellicott City, Md, U.S.A.
Gill, Stephen H., East Horsley.
Gion, Hirotaka, Toyohira-ku, Sapporo, Japan.
Girbes Faba, Adolfo, Valencia, Spain.
Gleeson, Derek B., East Leake.
Goicoechea Utrillo. Luisa, Barcelona, Spain.
Goldsmith, Philip E., Preston.
Goldwyn, Peter G., London.
Gotoh Takeshi, Amsterdam, Netherlands.
Gower, Wendy, Brisbane, Australia.
Grater, Jane, Fordingbridge.
Gray, Peter J. G., Plymouth.
Gray, Philip, Hessle.
Green, James E. W., Albrighton.
Green, Kenneth Farnham.
Grigg, Andrew J., Norwich.
Groves, Jane M., Bulawayo, Rhodesia.
Grunberg, Emanuel, Hertzlia, Israel.
Gulwer, Mats K., Karlstad, Sweden.
Gunaratna, Don L., Ratnapura, Sri Lanka.
Gunaratna, Mapatunage S., Colombo, Sri Lanka.

Gunasakara, Sirimevan P., Ratmalana, Sri Lanka.
Gunasekera, Ajit I., Colombo, Sri Lanka.
Gunathilake, Kenneth D., Nugegoda, Sri Lanka.
Gunatilaka, Hemamala, Kandy. Sri Lanka.
Gunawardena, Manel S., Colombo, Sri Lanka.
Gunawardene, Mahinda, Colombo, Sri Lanka.
Hailey, Robert J., London.
Hamilton, Sheilah E., Hong Kong.
Harper, Ian R., Sutton Coldfield.
Harre, Hendrik, Schoten, Belgium.
Harris, Philip, Bradford.
Haseyama, Hiroyuki, Tsurumi-Ku, Yokohama, Japan.
Haugh, Breda, London.
Havlik, Jan C. London.
Hebratski, Kazimierz F., Boston.
Hellman, Knut, Asker, Norway.
Hemaratne, Suraweera A., Colombo, Sri Lanka.
Hemphill, Craig L., Pacific Grove, Cal., U.S.A.
Hemphill, Sheri T., Pacific Grove, Cal.. U.S.A.
Henrich Francis J., Lower Hutt, New Zealand.
Herbert, Janet E., Northampton.
Hewitt, Nigel F. Amersham.
Hibberd, Nigel J., Ipswich.
Higuma, Teruo, Tokyo, Japan.
Hirotsune, Masanori, London.
Hiscox, Peter C., Solihull.
Hitchen, Alan, Walsall.
Ho, Kennedy, Bangkok, Thailand.
Hodges, Caroline F., Lowdham.
Hodges, Cherryl A., Bridgend.
Hoskins, Robert C., Mobile, Ala, U.S.A.
Hoskins, Tonja R., Mobile, Ala, U.S.A.
Houghton, John Manchester.
Hoyle, Elizabeth M., Huddersfield.
Huang, Hsing Y., Singapore.
Huddart, Alastair C. D., London.
Hudson, Robert J., Bradford.
Hughes, Steven B., Manchester.
Hurst, Adam K., Solihull.
Iborra Garcia, Juan C., Valencia,
Ilukkumbure, Parakrama M. J., Nuwara Eliya, Sri Lanka
Innala, Harri, Hameenlinna, Finland.
Irving, Antony J., Bradford.
Ismail, Mohamed H., Colombo, Sri Lanka.
Jackson, Christopher P., Gosport.
Jackson, Paula R., London.
Jacobs, Marie F. T., Colombo, Sri Lanka.
Jaliwala, Firoz A., Bombay, India.
Jayasingha, William H., Nugegoda, Sri Lanka.
Jayasuriya, Ranjit L., Colombo, Sri Lanka.
Jayawardena, Dennis A., Dehiwela, Sri Lanka.
Jimenez-Diaz Jorrin, Teresa, Madrid, Spain.
Jimenez Montoya, Angel, Bogota, Colombia.
Jinadasa, Sybil T., Colombo, Sri Lanka.
Jobin, Marc P. B., Beaconsfield.
Joel, Thomas, Waterloo, Belgium.
Johansen, Kare M., Lillehammer, Norway.
Johns, Alan T., Exeter.
Johnson, David S., Stoke-on-Trent.
Jothimani, Rajanawamani, Badulla, Sri Lanka.
Kallioniemi, Erkki, Helsinki, Finland.
Kan, Neville Y. C., Kew.
Kandasamy, Srimathi, Colombo, Sri Lanka.
Kangasvuori, Matti, Hameenlinna, Finland.
Kannangara, Vishwakanthie W., Colombo, Sri Lanka.
Kapukotuwa, Senerath L. B., Rajagiriya, Sri Lanka.

Kat, Amanda, Hadley Wood.
Kattan, Jacob, London.
Kawecki, Julian M., Maidstone.
Kaye, Ian D., London.
Kearney Garrett D. A , Manchester
Keenan, James, Glasgow.
Keller, Joseph R., Concord, Cal., U.S.A.
Kennedy, Padraic J. T., North Vancouver, B.C., Canada.
Kim, Young C., Seoul, Korea.
Kimura, Tokao, Kodaira-City, Japan.
Kinch, John C., Morden.
King, Marie C., Seattle, Wash., U.S.A.
Kinsey, John D., Cape Town, S. Africa.
Kipps, Maurice J. D., Cape Town, S. Africa.
Kizawa, Masakatsu, Ibaraki-Ken, Japan.
Kleibrink Marion Amsterdam, Holland.
Knedler, Karin E., Lower Hutt, New Zealand.
Knight, David J. R. E. A., London.
Knight, Ronald C., Stockton-on-Tees.
Koetter, Marthlina H. M., Cape Town, S. Africa.
Kortenaar, Francois L. Schagen, Holland.
Kossick, Martin, Enfield.
Kotagama, Leslie S., Harlow.
Krishnarajah, Dev R., Colombo, Sri Lanka.
Krogfoss, Odd R., Tarnasen, Norway.
Kropman, Caroline A., Schoonhoven, Netherlands.
Kubica, Jack, Vaxjo, Sweden.
Kulanayagam, Karthigesu K., Point Pedro, Sri Lanka.
Kumburagedera, Wijeratne, Nugegoda, Sri Lanka.
Laking, Brian G., Newlands, S. Africa.
Lame, Elizabeth H. G., Schoonhoven, Netherlands.
Lammi, Lauri, Hameenlinna, Finland.
Lander, Charmian E. M., London.
Lea, Thomas, Maidenhead.
Leppanen, Virpi, Helsinki, Finland.
Leslie, Phyllis Sylvia, Bournemouth.
Leslie, Steven C., London.
Lewis, Keith, Liverpool.
Lind, Rolf, Raisio, Finland.
London, Phil, Melrose Park, Pa, U.S.A.
Ludlow, Lynda J., Orpington.
Lyly, Anne, Hameenlinna, Finland.
Mack, Jerrold F., Los Angeles, Cal., U.S.A.
Mackie, Mohamed I. S., Colombo, Sri Lanka.
Magudia, Ratilal H., Ilford.
Malkamaki, Hilkka, Helsinki, Finland.
Manthri, Anthony P., Colombo, Sri Lanka.
Margetts, William J., Sherborne.
Marti Calvo, Victoria, Valencia, Spain.
Martin, Denham D., Wellington, New Zealand.
Mastenbroek, Caroline H., Breda, Netherlands.
Mathieson, Cynthia J. G., Hong Kong.
Matugama, Don C. J. Migoda, Sri Lanka.
Mead, Valerie S., Leicester.
Mendis, Harold G. S., Panawala, Sri Lanka.
Mendis, Sarath D. A., Devinuwara, Sri Lanka.
Mennie, Ruth, Wallasey.
Mercado, Brian R., Braamfontein, Transvaal, S. Africa.
Mewes, Richard R., Salisbury.
Micheli Bellera, Francisco, Barcelona, Spain.
Micilotta, Francesco, Port Elizabeth, S. Africa.

Middleton, Michael S., Swansea.
Miles, Patricia A. J., Barton-on-Sea.
Miller, Duncan E., Cape Town, S. Africa.
Mills-Owens, Paul, London.
Mitchell, Ann V., Nairobi, Kenya.
Miyokawa, Yoshinori, Kodaira-City, Tokyo, Japan.
Mohideen, Mohamed F., Kelaniya, Sri Lanka.
Molamure, Atma H., Colombo, Sri Lanka.
Monras Montells, Jorge, Barcelona, Spain.
Moor, David, London.
Moriuchi, Masana, Niigata City, Japan.
Morris, Jane D., London.
Moser, Martin I., Edgware.
Mott, Junko, Strood.
Muhsin, Aftab R., Mount Lavinia, Sri Lanka.
Muije, Cornelius S., Louisville, Ky, U.S.A.
Muije, Lilian E., Louisville, Ky, U.S.A.
Muller, Jennifer A., Mt Gravatt, Brisbane, Australia.
Mundin, Kenneth W., Leicester.
Muraishi, Kunio, Ohta-Ku, Tokyo, Japan.
Murray, Gillian M. S., London.
Murray, Graeme D., Perth.
Muthulingam, Yaithianathan, Colombo, Sri Lanka.
Myer, Richard D., Auckland, New Zealand.
Mylius, Maren-Ann, Alle, Norway.
Nachimson-Palacci, Rosy, Geneva, Switzerland.
Nakazato, Tetuo, Taito-Ku, Tokyo, Japan.
Nanayakkara, Vajira, Nugegoda, Sri Lanka.
Narros Martin, Gabriel, Madrid, Spain.
Nation, Peter L., St. Helier, Jersey, C.I.
Nelson, James B., London.
Nessim, Barry, London.
Ng, Edward B. G., Singapore.
Ng, Kevin K., Singapore.
Nilsen, Tore, Oslo, Norway.
Nimalasuria, Lakshmie S., Colombo, Sri Lanka.
Nithiyananthasothy, Vallipuram, Ratmalana, Sri Lanka.
Noakes, David E., Chelmsford.
Odaka, Etsuko, Inba-Gun, Chiba-Pref., Japan.
O'Donoghue, Mary E., Brooklyn, N.Y., U.S.A.
Ogawa, Kenji, Nerima-Ku, Tokyo, Japan.
Oliver, Peter J., Wellington, New Zealand.
Onnink, Jannie A. P., Barendrecht, Netherlands.
Oono, Kunihiro, Shinagama-Ku, Tokyo, Japan.
Opsal, Kjell A., Oslo, Norway.
Paillard, Eva E., Paris, France.
Pandya, Praful J., Welwyn Garden City.
Pardo Marques, Jorge, La Bisbal-Gerona, Spain.
Pares Vinals, Candelaria, Barcelona, Spain.
Patel, Natvarlal, Bradford.
Pathirana, Hetti P. D. P., Ratnapura, Sri Lanka.
Patterson, Mark S., Merion Station, Pa, U.S.A.
Pattni, Ashok, Luton.
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Yamato, Kenzo, Setagaya-Ku, Tokyo, Japan.
Yamaya, Sachiko, Funchu-Shi, Tokyo, Japan.
Zdanowicz, Stanislaw J., Warsaw, Poland.

COUNCIL MEETING

At a meeting of the Council held on Monday, 1st November, 1976, the appointment of Mr F. A. Fryer, F.G.A., Mrs S. J. Lewis, F.G.A. and Mrs H. Muller, F.G.A., as course instructors was approved.

At the same meeting the following were elected to membership:

Fellowship

Alabaster, Stephen P., Birmingham. D. 1976
Aloy, Richard N., Allhallows. D. 1976
Ambjornsen, Truls P., Fredrikstad, Norway. D. 1976
Arem, Joel E., New Carrollton, Md, U.S.A. D. 1976
Baird, Donald D., East Sheen. D. 1976
Borscho, Shirley J., Plymouth. D. 1976
Bratton, Timothy J., Sidcup. D. 1976
Byfleet, Anne P., Doncaster. D. 1976
Collier, John M. B., Fordingbridge. D. 1976
Eldridge, Maurice W., Sheffield. D. 1976
Evans, Mark, London. D. 1976
Goto, Midori, Kitayusyu-City, Japan. D. 1976
Gulliksen, Gunnar B., Gol, Norway. D. 1976
Hanni, Henry A., Basel, Switzerland. D. 1976
Hayes, Elizabeth A., Ossett. D. 1976
Holdroyd, Donna J., Oslo, Norway. D. 1976
Leach, Jane, London. D. 1976
Monche Maristany, Alicia, Barcelona, Spain. D. 1976
Oclee, Caroline H., Hythe. D. 1976
Piech, Olwen, Bushey Heath. D. 1976
Poel, Melvin C., Solihull. D. 1976
Sieders, Margaretha E., Den Haag, Holland. D. 1976
Sigl, Berta, Sargans, Switzerland. D. 1976
Snow, John J., Brisbane, Australia. D. 1976
Storr, Jonathan, Lincoln. D. 1976
Stromnaes, Bjorn, Oslo, Norway. D. 1976
van der Meer, Bastiaan, Schiedam, Holland. D. 1976
van Iwaarden-Bender, Maria M. A., Delft, Holland. D. 1976
Vuorijarvi, Terhikki, Leppakoski, Finland. D. 1976

Transfers from Ordinary Membership to Fellowship

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Asano, Yoshio, Kyoto, Japan.
Baker, Elaine, Lihue, Hawaii, U.S.A.
Blackley, Robert, London.
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Bourdon Destrem, Genevieve, Paris, France.
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Mahendrarajah, Maureen, Colombo, Sri Lanka.
Matsui, Reiko, Tokyo, Japan.
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Younghusband, John R., Salisbury, Rhodesia.
Zerbe, Charles J., Colorado Springs, Colo, U.S.A.
Zullu, Alli S., Dar es Salaam, Tanzania.

Research Diploma

The Council upon the recommendation of the Examiners awarded a Research Diploma to Pete J. Dunn, M.A., F.G.A., for his work on gem tourmaline: his thesis entitled "Uvite: A Newly Classified Gem Tourmaline" will be published in a future issue of the *Journal*.

LETTER TO THE EDITOR

From Dr E. Gübelin, C.G., F.G.A.

Dear Sir,

A recent opportunity to acquire several small hessonites from Ceylon, all excelling in that well-known granular look caused by a dense dissemination of minute guest minerals, offered the welcome chance of carrying out a more careful and accurate examination of these mineral inclusions. Several of the guest minerals in each hessonite were subjected to an electron microprobe analysis, and in each case the mineral inclusions were identified as being *apatite*. This result causes an amendment to be necessary in my book, "Internal World of Gemstones", and I wish to invite readers to alter the caption of the *centre right* illustration on *page 166* so that it reads: "Hessonites from Ceylon are recognizable by their 'granular' appearance which is provided by grains of apatite" (instead of "diopside or zircon" as thought previously).

Yours sincerely,

13th September, 1976. E. Gübelin

GIA's NEW HEADQUARTERS

After twenty years in San Vicente Boulevard, Los Angeles, the Gemological Institute of America has recently completed its move to new headquarters at 1660, Stewart Street, Santa Monica, California, which were built specifically for GIA needs and incorporate the most modern equipment and teaching aids available.

The new training centre is more than twice the size of the old one and contains more than 50,000 square feet of space situated on a $3\frac{1}{2}$ acre campus-like setting: the building also includes the Gem Trade Laboratory, Instrument Manufacturing Division and Publishing Division, of which the Laboratory offers the services of a fully equipped laboratory and a staff of highly skilled professional gemmologists, while the Instrument Manufacturing Division is engaged in the research, design and manufacture of gem-testing and grading instruments, and the publications for which the Institute is responsible include dictionaries, texts, pamphlets and other articles of interest to gemmologists and jewellers: it also, of course, publishes the quarterly *Gems & Gemology*.

The address of the new GIA Headquarters for correspondence is Post Office Box 2110, Santa Monica, CA 90406, U.S.A.

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