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and

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GEMMOLOGICAL
ASSOCIATION
OF GREAT BRITAIN

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OF GREAT BRITAIN
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GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

(*Originally founded in* 1908 *as the Education Committee of the National Association of Goldsmiths; reconstituted in* 1931 *as the Gemmological Association*)

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A NEW TYPE OF SYNTHETIC RUBY

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DURING the summer of 1975 a puzzling ruby, which lacked obvious characteristics for accurate identification, was presented for our examination. This faceted ruby weighed approximately 3 carats, cut in a modified brilliant-cut, with an 8-sided outline, the colour being a saturated violetish red of bright appearance and the dichroic colours showing violetish red and orange.

Other data include:

R.I. 1·772–1·764, birefringence 0·008
Optic axis direction perpendicular to the plane of the table.
S.G. approx. 4·02 (hydrostatic method)
Abs. spectrum: typical Cr spectrum of ruby
Fluorescence under UV 265nm: medium red
Fluorescence under UV 254nm: medium red
Fluorescence under x-rays : strong, red, slightly weaker than that of a Verneuil synthetic ruby of similar size, and as strong as that of a flux-fusion synthetic ruby.
Phosphorescence under x-rays : not noticeable to eyes adapted to the dark.

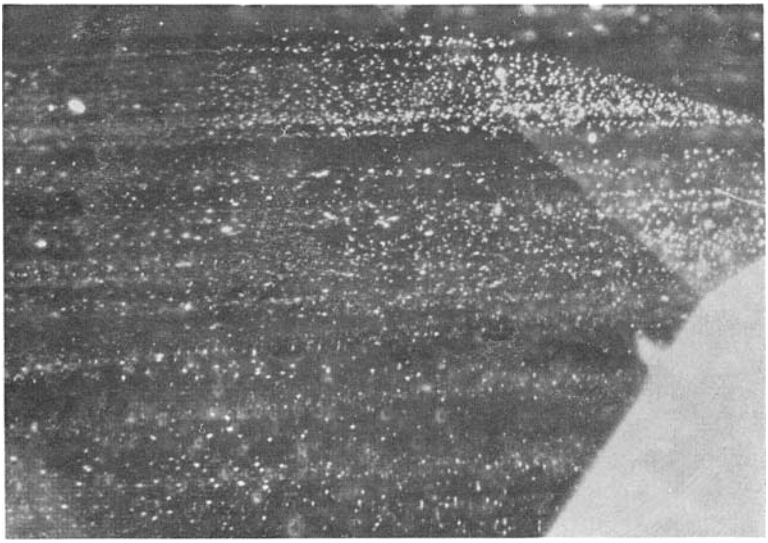

Fig. 1. Synthetic ruby of a new type: dense concentration of tiny particles arranged along roughly parallel-lying planes. Micro. magn. 40 ×, figure magn. approx. 120 ×. *(Photo. C. A. Schiffmann)*

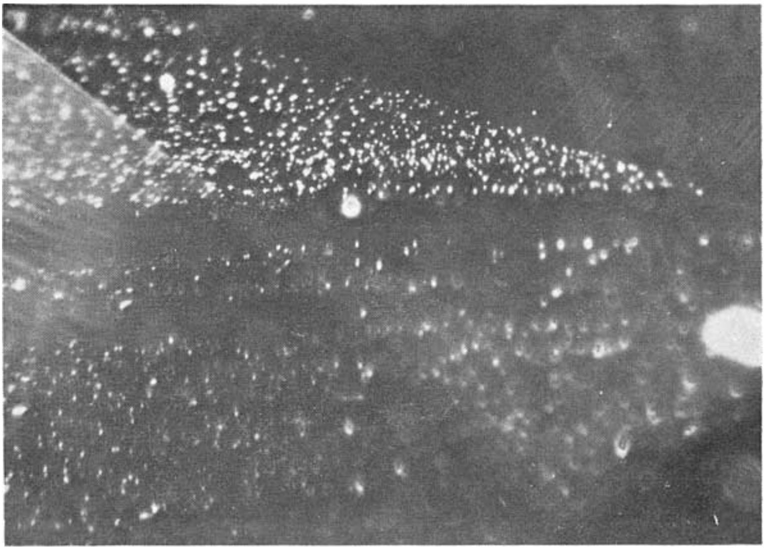

Fig. 2. Synthetic ruby of a new type: same features as in Fig. 1 at a higher micro. magn. of 80 ×, figure magn. approx. 240 ×. *(Photo. C. A. Schiffmann)*

Degree of transparency under UV 254 lamp: intermediate between the degrees of transparency of natural and flux-fusion synthetic rubies. A spectrometric curve was not conclusive about the UV absorption edge, because the strong colour saturation of this cut stone and its improper geometry resulted in too much absorption for the instrument used, to be precisely put forward.

As these data failed to reveal conclusive facts for an identification of the nature of the ruby, the stone was then thoroughly scrutinized under the microscope. At first sight and low power, it appeared to be exceptionally clear. Under higher magnification and special illumination conditions, the following features were discovered:

1. Within the sample tiny particles could be seen, somewhat irregularly distributed along roughly parallel-looking planes—they appear bright under light reflection and are probably minute cavities (Figs. 1 and 2).
2. Some of these cavities were opened during the cutting process and give a dotted aspect of tiny holes to some of the facets. This is best seen under light reflected from the facet's surface (see Fig. 3). The straight, parallel-lying lines on the facet are cutting grooves.

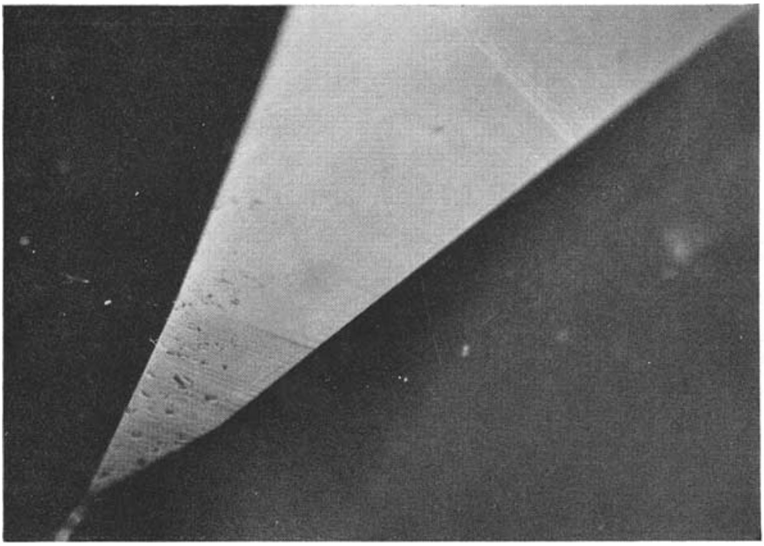

FIG. 3. Synthetic ruby of a new type: surface of a facet seen in reflected light. Dotted effect through tiny cavities. Parallel straight lines across the facet are traces of cutting grooves. Micro. magn. 40 ×, figure magn. approx. 120 ×. (*Photo. C. A. Schiffmann*)

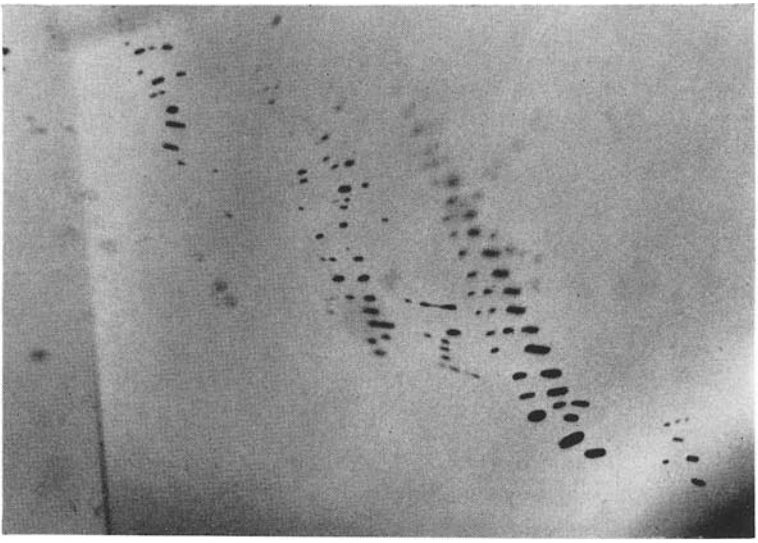

FIG. 4. Synthetic ruby of a new type: coarser type of grouped cavities, having rounded ends, one with dumb-bell shape. Micro. magn. 40 ×, figure magn. approx. 120 ×. (*Photo. C. A. Schiffmann*)

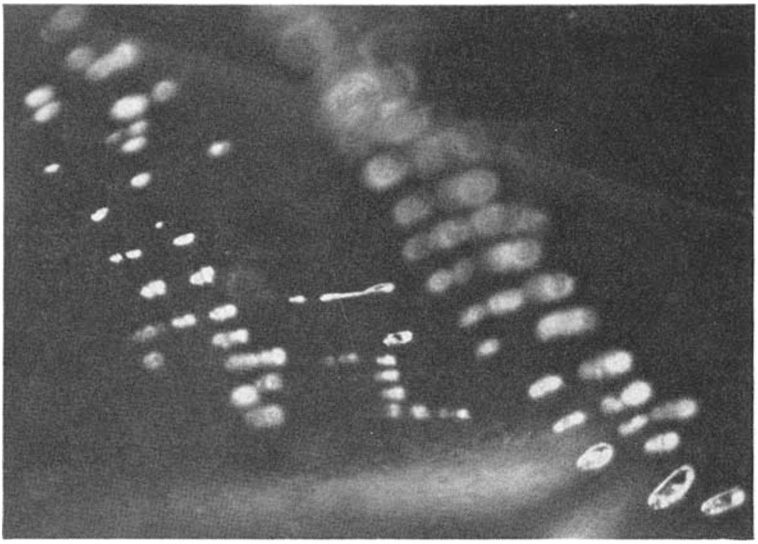

FIG. 5. Synthetic ruby of a new type: same features as in Fig. 4, at higher micro. magn. of 100 ×, figure magn. approx. 300 ×. Dumb-bell like cavity is clearly noticed. (*Photo. C. A. Schiffmann*)

3. Groups of coarser cavities, seeming roughly orientated, having rounded ends, some with a dumb-bell shape (see Figs. 4 and 5).
4. Few isolated cavities, in groups of two, one sometimes larger than its companion, visible at over 100 × magnification.
5. Few, narrow straight needles, one of them ending in a fork shape, observed at over 60 × microscopic magnification.
6. Examination in immersion liquid: seen in a direction perpendicular to that of the optic axis, growth features form a wavy plane of irregular colour saturation, the trace of which appears as a garland in Fig. 6.
7. Traces of parallel-lying growth planes through the whole sample, looking like fine straight lines, only to be seen in immersion, under proper light conditions and sight angle, not to be confused with straight colour in natural rubies.
8. At one place, the tiny particles described under §1 above are concentrated in a comet-like, flowing pattern, the trace of which starts from a rounded head, and expands like diverging arms of irregular concentration. Where the flowing lines join together, they form a hairpin-like pattern. (Fig. 7).

   These features were only observed under a particular sight angle and specially arranged illumination conditions.

The properties described were not in accordance with those of natural or artificial rubies of known sources, and accordingly on the basis of the inclusions described a new artificial product was suspected. Particularly, features mentioned in §8 above are met with only in artificial rubies.

Coming across this for the first time, we considered it necessary to inform the members of the Gemmological Conference of our findings and during the October 1975 meeting in Washington the matter was opened to discussion.* Among our colleagues from other laboratories, Mr Farn, of London, had also met this item but did not issue a final statement due to lack of time for a thorough examination. However, he suspected that the stone might be synthetic. The history of this specimen is worth mentioning: it was sold in Africa as a genuine stone and stated afterwards in a mineralogical examination report to be natural. In the course of discussion during the Gemmological Conference, Messrs Liddicoat and Crowningshield, from the G.I.A., reported having met rubies with

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*see J. Gemm., 1976, XV, 2, 104.—Ed.

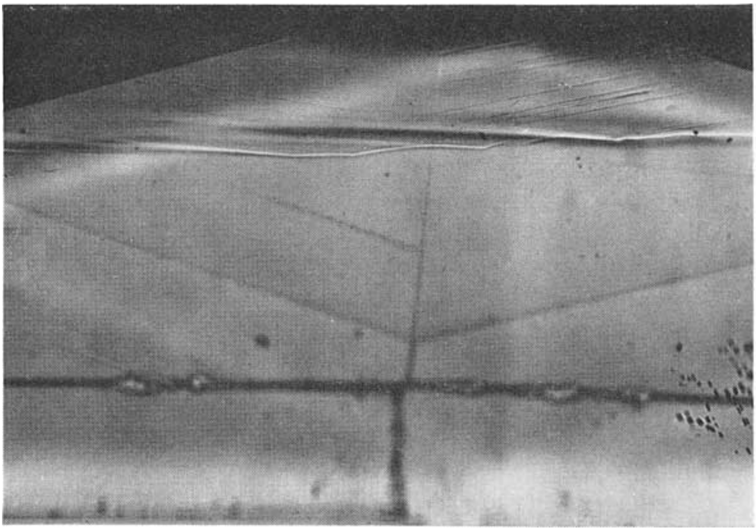

Fig. 6. Synthetic ruby of a new type: view perpendicular to the optic axis direction: wavy trace of irregular growth zone shows as a narrow light garland on the figure. Right lower part: group of cavities as in Fig. 4. Straight, black lines in the lower half of the photograph are facet junctions; narrow, thin black lines in the upper part of the photograph are cutting grooves left by insufficient polishing. Micro. magn. 32 ×, figure magn. approx. 100 ×. (*Photo. C. A. Schiffmann*)

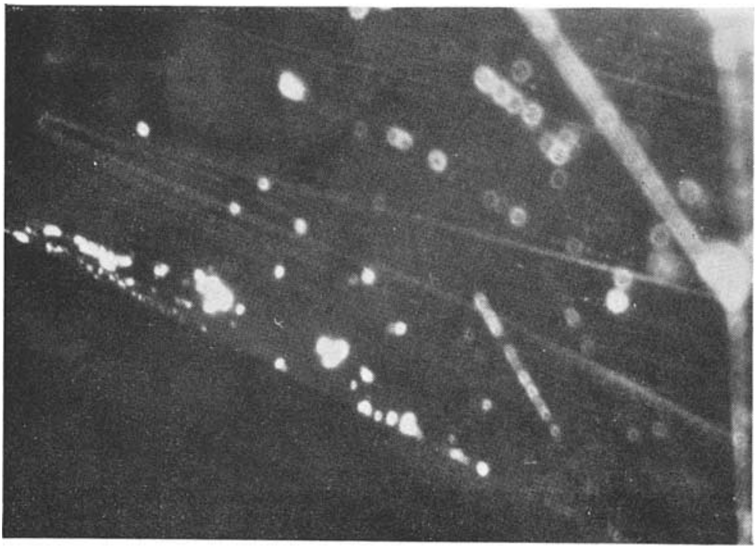

Fig. 7. Synthetic ruby of a new type: comet-like and hairpin-like pattern of diverging flow lines, through irregular concentration of tiny particles. Micro. magn. 40 ×, photog. magn. approx. 120 ×. (*Photo. C. A. Schiffmann*)

similar features and after enquiries Mr Liddicoat was convinced that these are manufactured in the U.S.A.

Summarizing: we have met a new kind of synthetic ruby, gemmologically described here in detail. To avoid inaccurate identification of similar samples in the future, this article is illustrated with clear, large-size photographs of the inclusions for the information of the reader. However, looking at the Figures above does not provide a key to automatically solving identification problems, and, in consideration of the high value of rubies today, and of the commercial consequences involved, we would expressly warn gemmologists not to judge on the grounds of resembling clues only and not to go beyond the limits of their own experience but when in doubt to submit the difficult cases for a reliable laboratory examination.

The author wishes to thank Dr E. Gübelin for his enlightening discussion of this problem and for allowing the release of this information paper, and also Mr G. O. Brunner for registering the absorption spectrum of the sample.

[*Manuscript received 26th February, 1976.*]

HELVITE AND TOURMALINE ACCOMPANIED BY GRUNERITE IN QUARTZ

By E. J. GÜBELIN, Ph.D., C.G., F.G.A.
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WHEN I read P. J. Dunn's description of helvite as an inclusion in tourmalinated quartz from Governador Valadares, Brazil, in the July 1975 issue of this *Journal**, I remembered having observed this same variety of mineral inclusion in quartz some 20 years ago. However, in those days we gemmologists did not enjoy the convenience of easy access to such

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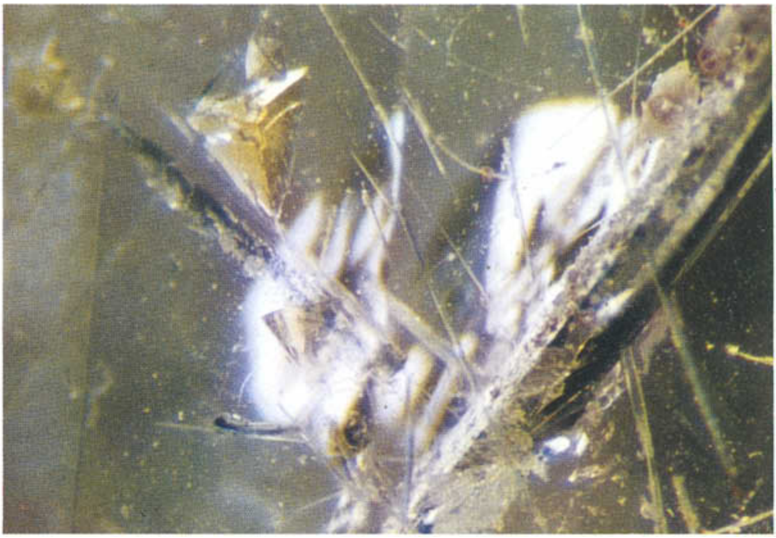
*J. Gemm., 1975, XIV, 7, 335-338.—Ed.



Interesting internal paragenesis of three different minerals in a rock crystal from Governador Valadares, Brazil, consists of yellow tetrahedra of helvite, dark rods of tourmaline and fine fibres of grunerite. (50 ×)

elaborate apparatus as the electron microscope, the electron microprobe or the Gandolfi x-ray camera, let alone to such an excellent reference book as the recently published 'Encyclopaedia of Minerals' by W. L. Roberts *et al.*, which thanks to its marvellous colour illustrations may at least give us valuable information as to the possible appearance of an obscure or rare mineral occurring as a guest in a gemstone. Consequently, and since I could not definitely identify these beautifully shaped greenish-yellow tetrahedra, I stowed away my cut rock crystals containing these attractive inclusions among the unsolved cases in my sample collection. Thus I was delighted to find them there again after their long slumber and a renewed observation under the microscope revealed an exact concurrence with P. J. Dunn's description. Furthermore, it seemed possible that those fine filaments mentioned by P. J. Dunn could be analysed by the microprobe since some of them appeared to be large enough and were exposed in the polished surface of the cut quartzes for such an investigation.

Of the various fibrous or acicular filaments in the four quartz specimens investigated by the electron microprobe *all* revealed the following elements: Fe, Al, Si, (Mg), (Mn), no Ca (which could however substitute Mg and Mn). We know several possibilities amongst the silicates for this combination of elements. A representative of the inosilicates of the amphibole group would just as well agree with the chemical composition as a phyllosilicate of the asbestos group. However, the low content of Mg appears to be rather uncommon for the inosilicate of serpentine-asbestos. This consideration and the presence of traces of manganese lead to the conviction that these needles are grunerite. A certain prolificacy is also attested by the presence of the yellowish helvite tetrahedra which are manganese-rich beryllium nesosilicates.

Grunerite is the almost pure iron-hydroxyl amphibole ($Fe_7[OH\ Si_4O_{11}]_2$) with only little MgO and Al_2O_3, but usually with MnO. It varies from colourless via green to brown with a silky lustre and forms asbestos-like, fibrous and divergent aggregates. Its presence as a guest mineral is not uncommon within rock crystal.

May this short communication act as a further contribution towards the search for knowledge on mineral inclusions in gemstones.

[*Manuscript received 17th February, 1976.*]

GEMMOLOGICAL NOTES

By PETE J. DUNN, M.A., F.G.A.

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CUPRITE

Very large crystals of cuprite (up to 5 cm) have been found at the Onganja mine, near Seeis, Southwest Africa, about 68 miles from Windhoek. The rough crystals, comprised of the octahedron {111}, the dodecahedron {011}, and the cube {001}, are equant and euhedral, and are altered on the surface to a thin coating of malachite.

The cuprite itself is quite gemmy, and can be faceted into fine gems. Due to its low hardness (4) and brittleness, and the semi-metallic lustre produced by the high refractive index (~2·85), and very dark red colour, cuprite is rarely cut as a gem, and then only for collectors and museums. The material is, in some sections, quite flawless, and from these portions dark red gems of surprising clarity have been produced. The largest known cut stone is in the Smithsonian collections and is a round modified brilliant of 172 carats. The stone has a deep dark blood-red colour and is a magnificent brilliant gem.

OPAQUE INCLUSIONS IN ORNAMENTAL SERPENTINES

Opaque inclusions, both euhedral and anhedral, are frequently observed in serpentines used in the carving of ornamental objects and cabochons. These opaque minerals in gem-quality ornamental serpentines from 7 localities were x-rayed utilizing CuKα x-radiation and Gandolfi cameras. The opaque inclusions were found to be magnetite, haematite, and pyrrhotite, and only one phase was present in any given serpentine specimen. The samples, all from the collections of the National Museum of Natural History, Smithsonian Institution, Washington, D.C., are listed in Table 1 with the identity of the opaque inclusions.

TABLE 1

LIST OF SERPENTINES WITH OPAQUE INCLUSIONS

NMNH #	LOCALITY	OPAQUE INCLUSION
94998	Lime Pit Mine, Cecil Co., Maryland, U.S.A.	Magnetite
16049	Tasmania, Australia	Magnetite
114953	Dypingdal, Modum, Norway	Haematite
118473	Devil's Den, Newbury, Massachusetts, U.S.A.	Pyrrhotite
B17970	Snarum, Norway	Haematite
108302	Delight, Maryland, U.S.A.	Magnetite
47167	Musashi Province, Japan	Magnetite

AIKINITE INCLUSIONS IN PHENAKITE

Fine gemmy phenakite crystals, up to several cm, have been found for some years at San Miguel Di Piricicaba, Brazil. Occasionally noted in this gem phenakite are acicular crystals of a black mineral with deeply striated prisms. These crystals were x-rayed utilizing CuKα x-radiation and found to be aikinite, $PbCuBiS_3$, a very rare sulphosalt. The aikinite crystal inclusions are often doubly terminated and frequently adjacent to a gas or vacuum bubble. No epitaxy with the host phenakite was observed. Also noted as inclusions in the phenakite are colourless clear to light green crystals of an unidentified member of the mica group.

ALEXANDRITE FROM TANZANIA

A crystal recently received at the U.S. National Museum is worthy of note. This chrysoberyl, $BeAl_2O_4$, is from the area of Lake Manyara in Tanzania. The crystal is 25 × 20 × 12 mm in size, is pseudohexagonal in habit, elongated on [001] and flattened on [100]. It is a twinned crystal, comprised of three individuals, and the dominant forms are the prism {110} and the pinacoids {100} and {001}.

The alexandrite is opaque. There is a chatoyancy, which is due to a fibrous layer about 0·5 mm below the surface, which is overgrown by a clear zone. The colour-change of this material is quite striking: it is a beautiful blue-green in white fluorescent light, a rich green in daylight, and reddish-violet with bluish overtones in incandescent light.

The crystal fluoresces a deep magenta red in long-wave ultraviolet radiation, but does not respond to short-wave. There was no luminescent response to x-radiation. Optical constants could not be determined, as the crystal is not to be cut but will be for exhibit as gem rough. The x-ray powder pattern of the material matches that of chrysoberyl.

NEW JERSEY NATROLITE

Gem natrolite, $Na_2Al_2Si_3O_{10}.2H_2O$, was discovered in the Bound Brook quarry, at Bound Brook, New Jersey in late 1972. The crystals recovered were notable for their large size, which varied from microscopic to 1·5 × 17 cm megacrystals.

The crystals are orthorhombic with the usual natrolite morphology, are prismatic in habit, and have a square cross-section. Although the crystals occur coated with a micro-crystalline druse of heulandite, this can be easily removed by scraping to expose the gemmy natrolite within. The terminal ends of many of these natrolite crystals are facetable, and some fine stones have been cut, among them two step-cut gems of superb quality weighing 9·31 ct and 7·9 ct. These gems are in the Smithsonian Institution collection (NMNH Gem Numbers 5111 and 5116).

The natrolite is not fluorescent in either long or short-wave ultraviolet radiation, and is transparent to both. No fluorescence was observed in x-radiation. The refractive indices, determined in sodium light with the Rayner Dialdex refractometer are: $\alpha = 1{\cdot}478$, $\beta = 1{\cdot}480$, $\gamma = 1{\cdot}490$, with a distinct birefringence of 0·012. The optic sign is positive.

Inclusions noted in this material consist of thin, parallel, chevron-like zones of tiny white crystals resembling breadcrumbs. These unevenly spaced chevron-like bands of included matter are parallel to the pyramidal termination of the crystals and obviously represent prior growth surfaces.

Natrolite is, due to its low hardness of 5-5½, useful only as a gem for collectors of the unusual and for museum gem collections.

The natrolite was analysed on an ARL Electron Microprobe utilizing an operating voltage of 15 kV and a sample current of 0·15μA with a beam diameter of 50 microns. Standards used were Department of Mineral Sciences microprobe standards of high reliability. The analysis is presented as Table 2. No zoning was noted in the crystals.

The author is indebted to Joseph Nelen for the chemical analysis and to Dr George Switzer for a critical reading of the manuscript.

Table 2

Analysis of Bound Brook Natrolite

		1	2
SiO_2		48·5	47·4
Al_2O_3		27·2	26·8
Fe_2O_3		—	
MgO		< 0·1	
CaO		—	
Na_2O		16·2	16·3
K_2O		< 0·1	
Assumed——H_2O	=	8·0	9·5
	Total		100·0

1. Microprobe analysis of Bound Brook natrolite; H_2O assumed by difference.

2. Theoretical composition of natrolite, $Na_2Al_2Si_30_{10}.2H_2O$.

A SPECIAL GREY GLASS

A light greyish glass was offered for sale as cordierite (iolite) at a mineral sale held recently in Switzerland. Although offered as cordierite, the gem had no pleochroism, the most obvious characteristic of cordierite. One gem, weighing 15·6 carats, was offered for \$100·00.

The gem is poorly cut, with abundant scratches, poor polish, rounded facet-edges, and an over-large coarsely-ground girdle. It is quite soft. It has a refractive index of $n_D = 1{\cdot}516$ (±0·003), a specific gravity of 2·64 (±0·02) and is isotropic, with a weak anomalous birefringence, possibly due to strain. Although quite obviously a glass, the fact that the specific gravity was close to, but slightly higher than that of cordierite, combined with a refractive index close to, but lower than those of cordierite, prompted a more detailed investigation of the material. Powder from the girdle was x-rayed and gave no diffraction pattern, confirming the amorphous nature of the material.

The gem was analysed on an ARL-SEMQ electron microprobe using an operating voltage of 15 kV and a beam current of 0·15 μA. A preliminary analysis indicated a high barium and silicon content, with smaller amounts of aluminium, potassium, and sodium. A more detailed analysis was warranted, and this analysis of the gem is presented as Table 3. The BaO content of 12·67% is quite high and suggests that the barium may have been introduced to raise the density of the glass to near the limits of the density variation of cordierite. The potassium and sodium content may have been

TABLE 3

ANALYSIS OF SPECIAL GREY GLASS

SiO_2	69·99%
Al_2O_3	3·43
FeO	0·11
MgO	0·08
CaO	0·07
K_2O	6·05
Na_2O	6·56
TiO_2	0·09
BaO	12·67
TOTAL	99·05

Accuracy of data ± 2% of the amount present.

selected to adjust the refractive index of the material to be near that of cordierite. The possibility exists that other elements, not detected by the microprobe, are present.

Detection of this glass imitation is quite easy. The complete lack of pleochroism obviates the possibility of cordierite (iolite). The material is isotropic with a weak anomalous birefringence. The glass does respond to ultraviolet radiation, unlike cordierite which does not. Under long-wave it fluoresces an extremely weak light green, and under short-wave it fluoresces a stronger greenish-cream colour and becomes almost opaque in appearance. There is no phosphorescence in either wavelength, and no response to x-radiation. The refractive index of $nD = 1{\cdot}516$ is lower than that of gem cordierite, and the absence of any birefringence confirms the isotropicity of the material. No absorption spectra were observed, using the G.I.A. absorption spectroscope. No inclusions were noted, nor were the schlieren, so common in glasses, seen in this material. The colour was very evenly distributed, with no patches or concentrations. No bubbles were observed.

In summary, this grey glass is a most interesting imitation gem material, but the trained gemmologist should have no difficulty in ascertaining its true identity.

The author is indebted to John Saul for the opportunity to study the gem, and to John S. White, Jr, for bringing it to his attention.

RECENT DEVELOPMENTS IN THE SYNTHESIS OF POSSIBLE GEM MATERIALS

By M. J. O'DONOGHUE, M.A., F.G.S., F.G.A.

(being the substance of a talk given to the Gemmological Association of Great Britain at Goldsmiths' Hall, London, on 8th October, 1975.)

FOR many years scientists have been developing crystalline materials for the furtherance of research in the fields of optics, electronics and communications. Work on the laser alone has led to the creation of many new materials, including, of course, rubies of high quality. Almost all crystalline substances produced for research purposes are useless if flawed or if they show various types of twinning. There is, therefore, a high degree of wastage and this can be seen reflected in the number of such substances which appear on the gem market. Much crystalline material finds its way into the waste basket, and, where there are staff members who have a lapidary interest, we are likely to find some faceted stone which at first defies identification. These stones may be unusual in colour or behave in ways not previously described in the gem literature when subjected to ultraviolet light or x-rays. So far many substances which from their colour and hardness would seem to have possible gem applications have been manufactured in small sizes only, but there is no reason why one or a number of them should not suddenly appear in larger and faceted forms.

Blue β-spodumene has been synthesized and resembles a pale aquamarine or blue topaz in colour. Both flux-melt and hydrothermal methods have been successfully employed and the temperatures needed are not particularly high. The α-form does not easily yield to synthesis, but an iron-bearing type has been obtained at temperatures between 550°–600°C and using pressures of 2,000 – 3,000 atmospheres. A chromium-bearing green spodumene (cf. hiddenite) has been made, and various other colours can be obtained by the addition of suitable dopants. The lithium compounds were synthesized in solutions of LiCl or LiOH using a combination of the oxides Al_2O_3 and SiO_2. Alkalinity of the solutions was varied by adding HCl to the original LiCl or LiOH. Results obtained by Kuznetsov(1) indicated that in pure solutions of LiCl and at temperatures of 400°–700°C and pressures of 750–3,000 atmospheres α-eucryptite, β-spodumene and petalite can be obtained. The β-spodumene is found as bipyramids and also as concretions. During the experimental production of the green chromium-bearing spodumene an overgrowth of colour formed on the natural crystal at 3,000 atmospheres and at 700°C. This occurred when Al_2O_3 was partly replaced by Cr_2O_3.

Dr D. J. Drysdale, of the University of Queensland, tells me(2, 3) that he has made $LiCr_3Si_2O_6$ using silica gel, LiOH solution and $Cr(NO_3)_3$ and Li_2CO_3—this crystallizes at around 500°C under 2 bars pH20 to produce a very fine-grained powder of chrome spodumene. Dr Drysdale states that the synthesis of a true hiddenite (i.e. with a few per cent Cr_2O_3 replacing Al_2O_3) would be more difficult and would need much higher pressures, up to 6kb. He suggests that part of the difficulty in synthesizing the α-spodumene lies in the dense hexagonal structure with Al in 6-fold co-ordination. The β-spodumenes have lower density phases with Al in 4-fold co-ordination. Dr Drysdale has synthesized spodumenes with iron, vanadium, indium and scandium substituting for aluminium as well as chromium.

Sodalite cannot be grown from a melt, since this method invariably produces a glass with the sodalite composition. Hydrothermal methods produce single crystals using a solvent of an aqueous solution of NaOH and a charge of the sulphur-bearing sodalite, hackmanite. Seeds have been obtained by growing artificial material on natural hackmanite. Weights up to 70g have been manufactured and the colour is a fine dark blue. Sodalite crystals are grown for their interesting optical properties, and although the period of growth may be as long as six months some crystals could very well appear on the gem scene.

Lithium tantalate is $LiTaO_3$, has a S.G. of 7·3 and quite a high degree of hardness. It is optically positive and uniaxial, with R.I. 2·175 and 2·180. The birefringence is 0·006. It is similar to lithium niobate in its optical transmission, since it transmits from 0·3 to 6 microns. It is grown by the flux-melt method and also with the Czochralski technique. It is insoluble in dilute acids and with a fairly high dispersion could make a diamond simulant.

Bismuth germanium oxide (BGO): two stoichiometric compositions of this material are known, $Bi_{12}GeO_{20}$ with a molar ratio of $6Bi_2O_3{:}1GeO$, and $Bi_4Ge_3O_{12}$ with a ratio of $2Bi_2O_3{:}3GeO_2$.

The material crystallizes in the cubic system and is used for electro-optic research. It is manufactured using the Czochralski technique, and, since its melting point is relatively low, it is quite easy to obtain crystals with a high degree of mechanical soundness. $Bi_{12}GeO_{20}$ has a S.G. of 9·23, a R.I. of 2·55 and a hardness of 4·5. The colour is bright yellow to orange. $Bi_4Ge_3O_{12}$ has a S.G. of 7·12, a R.I. of 2·07 and a hardness of about 4. Both materials are transparent, and $Bi_{12}GeO_{20}$ shows photoluminescence spectra at 6358Å and 9537Å; on doping with various elements the peaks of the luminescence can be shifted further into the infrared.

Spinel has been grown by flux evaporation; crystals of spinel have been grown from solution in PbF_2 and have reached quite large sizes. Green colours have been obtained by doping with cobalt, yellow from the addition of iron (or nickel?) and red from the addition of chromium. The octahedral form is prominent and shows triangular trigonal pyramids on well-formed faces. Crystals doped with Ni and Co show a highly coloured central region with a colourless periphery. Crystals in which Zn replaces Mg and Ga replaces Al have also been grown: colours include red (from chromium) and other colours from other dopants, as in the Mg spinels. Only $\{111\}$ faces are present; there is a uniform growth rate and no preferential absorption of dopant on different faces. In the red crystals there is a strong emission line in the red part of the spectrum but no group of emission lines as shown by some natural red stones.

Nickel-olivine was synthesized by Grigoriev in 1937, using a fusion of NiO and SiO_2 with 3% CaF_2. Ringwood(4) in 1956 showed that Mg_2SiO_4 and Ni_2SiO_4 form a complete series of solid solutions. It may be that the nickel enters the olivine structure in excess of the magmatic Mg:Ni ratio because iron in the natural material lowers the thermal stability. Stones made by Ito at the University of Chicago are coloured a fine bright green. The S.G. has been calculated at 4·09. Another reported method combines $NiCO_3$ with $Mg(OH)_2$ and H_2SiO_4 with a flux of $NaWO_4.2H_2O$. The process runs for 72 hours at 1280°C to produce $NiMgSiO_4$.

Phenakite doped with vanadium is an interesting bright blue-green. The natural mineral has a hardness of 7½, R.I. of 1·670 and 1·654, with no pronounced cleavage. The crystals examined were made at the University of Chicago: a larger crystal made at Bell Laboratories shows the typical crystalline characteristics of phenakite.

Recent progress in the synthesis of corundum has led to the production of a red corundum that is not ruby since it contains no chromium (using the analogy of emerald). The colour, from doping with manganese, is an orange-red and the flattened plate-like crystals have a brown edge, due to the presence of magnesium. There is no noticeably prominent band in the absorption spectrum. These stones were manufactured by White, of Imperial College, London.

Yttrium ortho-aluminate, $YAlO_3$, was developed by the Raytheon Co. in about 1969 for use as a possible laser material, for which purpose it was doped with neodymium. Apparently it was not completely successful in this role and may now be on the market as a diamond simulant. It has a S.G. of 5·35, and R.I. of 1·97. The dispersion is 0·033 and the hardness $8\frac{3}{4}$. The melting point is 1875°C and it is made by the Czochralski technique.(5)

Rare-earth silicate apatites have been made in a wide variety of colours. Vasilieva (1958)(6) showed that the intensity of the colour obtained was due to the amount of Mn in the mineral but that the nature of the colour depended on the degree of oxidation of the Mn. Mn^{2+} gives pale pink and blue, Mn^{3+} blue and Mn^{7+} violet. The combination of ferrous and ferric iron gives green. Ito, of the University of Chicago, has synthesized some apatite-like minerals(7), including Na-Nd-F silicate, coloured purple; $NaLa_8Si_6O_{24}F_2$, colourless; Na-Pr silicate, bright green; and Na-Sm silicate, yellow. Cobalt and nickel produce violet and pale green colours respectively. RE^{3+}, RE^{3+}:Si^{4+} and RE^{3+}:O^{2-} charge-coupled substitutions and defects are quite easily incorporated into the apatite structure.(8)

Investigations of the possibilities of the use of Nd-doped fluorapatite for laser work has shown that $\sim$1wt% Nd doping of FAp crystals by adding Nd_2O_3 to the melt makes a laser body with more than twice the efficiency of yttrium aluminium garnet, since the emission is concentrated in a narrow line, due to the occurrence of nearly all the active Nd in a single site. Doping with NdF_3 produced larger crystals of high optical quality but with impaired laser characteristics. Work in this field shows that Nd substitutes at both Ca(1) and Ca(2) sites in approximately equal atomic fractions in the NdF_3-doped material and that Nd substitutes only at the Ca(2) site in the Nd_2O_3-doped material.(9)

Professor E. Kostiner, of the Institute of Materials Science of the University of Connecticut, has recently published an account of the synthesis of azurite and malachite. Small crystals of azurite that I have examined show well-developed crystal form and are of a fine dark blue. So far they are of approximately 2mm size only; I have not yet seen the synthetic malachite.

Gadolinite has the chemical composition $Be_2FeY_2Si_2O_{10}$. A form with the composition $CuPr_2Be_2Si_2O_{10}$ has been synthesized (Ito, University of Chicago) and is a very bright green. The natural mineral has a hardness of 6½–7, a S.G. of 4·0–4·6 and R.I. 1·7–1·8. In nature the colour is dark green to black; the synthesis is probably hydrothermal.

Lithium niobate has been known as a diamond simulant for some time, although it does not often seem to occur. Through the kindness of Dr R. Diehl(10) I have recently examined a set of coloured crystals. These include one undoped crystal which is virtually colourless; one coloured brown (due, it is thought, to a reduction in the amount of niobium); one, doped with 0·1 mole% Co_2O_3, which is a dark blue colour and which gives a clear cobalt absorption spectrum; one doped with 0·05 mole % NiO which is yellowish; and one doped with 0·05 mole % CuO which is golden brown to yellow. None of these, other than the cobalt-doped crystal, shows an absorption spectrum and none shows any luminescence under ultraviolet radiations. Interesting surface dendrites have been observed by Singh and Deshmukh in lithium niobate crystals grown perpendicularly to the c-axis. This phenomenon only seems to occur when there is a fairly large amount of the melt in the crucible and when there is a slow rate of cooling.(11)

Zincite, the zinc oxide, is only known from one locality in its natural state (Franklin, New Jersey). It takes its attractive orange-red colour from manganese, and this can now be repeated in the laboratory since the mineral has been grown hydrothermally. It is formed in aqueous solutions of NaOH or KOH and the temperature of the dissolution zone has been reported as 380°–410°C and that of the growth zone as 350°–380°C. The initial charge is a zinc oxide chemical reagent or a fine crystalline charge of previously crystallized ZnO. Growth is improved by the addition of mineralizers usually LiOH or LiF. The crystals obtained are hexagonal prisms, hexagonal pyramids and monohedra. The rate of growth of the {0001} face is about 8–10 times greater than that of the prism and pyramid faces. Red is obtained by the addition of manganese, green by the addition of nickel.

We are by now quite familiar with the diamond simulant gadolinium gallium garnet (GGG). A little less well-known are the coloured forms, red coloured by manganese and green by cobalt. Even more interesting are the crystals, which (in the examples in my collection) take on forms typical of the cubic crystal system, dodecahedra combined with icositetrahedra. The red crystal shows some form of two-phase inclusion and it will be interesting to see whether cut stones appear on the market.

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NOTES FROM THE LABORATORY

By A. E. FARN, F.G.A.
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IN this trade, and certainly as a trade gemmologist in a laboratory serving commerce, one never stops learning. A very large baroque pearl of about 50/60 grain size in a brooch (set with baguette and brilliant-cut diamonds) of quite reasonable importance proved very interesting and to me unusual. A radiograph of the brooch with pearl still mounted showed a mabe effect in a very strong and striking manner. In fact the centre of the mabe looked remarkably opaque, much more than is usual, and the exterior much more transparent (to x-rays) than usual. I decided to unset the "pearl". I found it very simply pegged and secured by pearl cement and removed it quite easily. The base had a cap of mother-of-pearl in the manner of a mabe, and the sides had been worked as is usual with a large baroque to fit snugly into a mount. The heft seemed very great and to my surprise it scaled 142 grains, whereas it looked about 50/60 grains. In print this may sound rather tame, but in fact it was quite interesting. The texture was now very thoroughly examined. I found it, to my surprise, to be fine matt glass of an exceptionally fine orient. I took a density and found it to be 4·21—much too heavy for pearl! The customer, a well-known F.G.A., was equally interested, having intended to purchase it (subject to test). He described a firm who, pre-War, made "pearls" to order to match a pearl in a suite, etc. These he said were usually filled glass beads and were termed "de meisner pearls".

* * *

Heft is a useful rough and ready guide, or at least indication, to preliminary testing of a gemstone. If an apparent aquamarine of reasonable size—say above 7 carats—is handed in for testing, one can sometimes tell in the hand by heft that it is too heavy for aquamarine. Reasonable chances are it is a blue topaz or synthetic blue spinel.

Thus very recently when Harry Wheeler, Secretary of the Gemmological Association, sent to me for my interest and observation a golden coral, I was surprised at its extreme lightness in the hand. In fact it felt like a thin piece of plastic. I read of golden coral in *Gems and Gemology*, 1974/5, 14, 12, 369–370, which contains photographs showing good examples of the peculiar surface structure. At best it can be described as resinous or lacquered (treacly perhaps), which when examined by reasonably high-power magnification (50 × upwards) shows some signs of overlapping or tears, as seen when too much paint is applied to a vertical panel. The most striking feature, however, structurewise is the dotted or circular pattern which—to coin a phrase—is regularly irregular. Since heft was my first impact and impression, I took a density of the stone and found it to be 1·27, and a distant vision method refractive index of 1·54. I am continually impressed by the number of items often tested by this method which show a mean figure of 1·54, without counting the quartz family. We have reported earlier on the characteristics of black coral. I must confess that I had never really liked the term black coral, neither did I feel happy with golden coral. To my shame I had always thought of coral as being, to quote Webster,* "almost wholly calcium carbonate ($CaCo_3$) . . ." [with] "a density of between 2·6 and 2·7". Here I was faced with a non-calcareous substance with a density of 1·27.

Resorting to Chambers's Encyclopaedia, I found that coral belongs to the Madreporaria, an order of marine animals which form the true or stony corals, but the hydrocorallines, the horny corals, are also embraced under the general title of coral. I feel at least relieved that, when I did report recently on a black coral hoop ring as such, I did not either upset the Trade Descriptions Act or impinge upon the already overstretched nomenclature division of gemmological references. Incidentally, the golden coral examined came from Maui divers in Hawaii. Since our first testing of golden coral we have had a further piece of black coral in to test, brought to us by a local jeweller's daughter. She had the pendant sent to her by her boy-friend who is diving for black coral in Hawaii. Father, the jeweller, condemned it as plastic because he said it was "too light for coral": which proves that heft is a *rough* guide, not to be used lightly.

I have re-examined a large specimen of black coral, previously and amply reported upon by Robert Webster in this *Journal*, 1954, IV, 5, 197–199. One quick density gave a figure of 1·33. Webster quotes 1·32 and 1·35. I felt pleased to be not only in the target area but well bracketed by Webster. One characteristic of black coral—having immersed it and dried it by placing it on top of a convector, I noted that whilst warm it bends. Black coral is probably a form of conchiolin, a horny substance.

* * *

Synthetic gemstone manufacturers seldom produce inferior looking goods as does nature. Since there is no logical reason to perpetuate mediocrity, it follows that most synthetics seen in jewellery are good in size, sometimes well cut, if a modern hydrothermal or flux-fusion product, and exhibiting colours which to the trained eye *look* wrong. These strong colours, particularly in Verneuil flame-fusion products, are usually due to random cutting, as opposed to correct cutting from a crystal for a natural stone.

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*"Gems", 3rd edn, 1975, p.502.—Ed.

Gemmologically one can admire the knowledge, expertise and research required to arrive at a new synthetic. Sometimes one wonders on reading of the new synthetics or of the synthesis of yet another gemstone if it is really worthwhile. We have had recent information of synthetic sodalite, and it doesn't seem too far removed to hear of synthetic lapis lazuli, synthetic turquoise, synthetic opal and synthetic quartz. Gemmologically this is fascinating if one only has to read the journals, attend classes or give talks. Equally, if one is in doubt as a dealer or merchant, one can opt out of a purchase and deal only in goods one is familiar with, or those which already bear a certificate. After all, if stones are bought and sold "subject to test", a merchant is fairly well covered. This of course presumes he is buying in the market.

Recently we have been given two samples of "synthetic lapis lazuli", the product of that master of synthesis, Pierre Gilson. I wrote to him to thank him for his gesture and generosity and asked him if it were a bonded product by plastic or other cementation. I was told that *no* plastic bonding occurred in his opal, turquoise or lapis lazuli. The chief ingredient in his lapis he states is lazurite, which can be checked by x-ray powder diffraction method. One of the constituents of natural lapis lazuli is of course lazurite, which cancels out lazurite as a test for a synthetic! However, the pieces I received were of sufficient size to afford a density-test, and I found it to be extremely low for such apparently pure material, namely 2·33 to 2·35 plain and 2·36 with some pyrites. On doing a second check of specific gravity I found my weights were wrong, or so it at first appeared. Further checking proved that the discrepancy was due to porous material soaking up water.

I decided to crush a portion and burn a sample. I would not do this to jewellery set with lapis lazuli in a routine test. Just simply crushing a small piece of synthetic lapis lazuli gave off a smell of fireworks similar to sulphurous smoke. The porous synthetic lapis lazuli, when placed against or with known natural lapis lazuli, is inert when viewed through the Chelsea filter, whereas most natural lapis lazuli appears a brown red to dull liver-red colour. The test is best conducted with side by side comparison. Checking lapis lazuli and its imitations in Robert Webster's third edition, I found that the test he gives† for natural lapis lazuli as against

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†"Gems", 3rd edn, 1975, p.222.—Ed.

imitations is that a drop of dilute hydrochloric acid upon natural lapis lazuli gives off a smell of hydrogen sulphide. I tried a drop of hydrochloric on the Gilson synthetic lapis lazuli which produced a fierce reaction of foaming effervescence. I tried the same acid test on various specimens of known natural lapis lazuli with no effervescence and no smell.

To sum up: to check lapis lazuli one should be suspicious (always) of fine superb colours, including finely disseminated pyrites. If possible, a check density should be taken, or, failing this, a very careful weight in air to three places of decimals, followed by a soak in water (which can do no harm) for ten minutes and a further weighing to note any increase in weight. Follow on by observation (with comparison piece) with a Chelsea filter and a discreet touch on the back of the piece using a glass dipstick, so that only a microscopic dot of acid is dropped. Viewing with a watchmaker's glass in the eye, one can see the positive reaction leap from the stone. This has a bleaching effect and leaves a dull somewhat faded mark, which won't matter on the back of a stone. With the stone suspended in a wire cage and the balance freely poised, I was able to watch the illuminated scale of the balance move as water was absorbed and weight gained in well under a minute.

Since the S.G. is so low and the material so porous, one wonders whether the term "synthetic" is incorrectly applied. In this case it should be *imitation.* The modern tendency is to apply the word "synthetic" broadly to almost any man-made product. Doubtless there will be further debate in the future about the use of the word "synthetic", which I previously discussed in April 1960 in this *Journal* (VII, 6, 209–210).

STUDIES OF NUCLEATION AND PROPAGATION OF CRACKS IN NATURAL QUARTZ

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ABSTRACT

Evidence is given for existence of pile-up of dislocations against some impurities on rhombohedral cleavages. Nucleation of cracks due to pile-up of dislocations on rhombohedral cleavages is dealt with. Initiation of cracks due to intersection of glide bands with a grain boundary on basal cleavages are illustrated and discussed. Also described are the intergranular cracks, viz. wedge-type (w) and round-type (r). Their formation and growth are discussed and interpreted.

INTRODUCTION

Plastic deformation and nucleation of cracks are two closely related phenomena. Influence of plastic deformation on nucleation of cracks has been investigated by several workers both in metallic and nonmetallic crystals (1-4).

Dislocation etching experiments carried out on fracture surfaces of natural quartz crystals gave evidence for the nucleation of cracks due to pile-up of dislocations and also due to intersection of glide bands with a grain boundary. Cracks are found to be nucleated also at grain corners as well as along grain boundaries on subjecting the crystals to thermal stresses. The authors contribute evidences of such cavitation fracture.

OBSERVATIONS

Cracks at the head of dislocation pile-ups

A noteworthy observation on a rhombohedral cleavage $\{10\bar{1}1\}$ after etching the cleavage in steam in an autoclave at 280°C for 12 hours is illustrated in Fig. 1. The row of triangular etch pits represents a pile-up of dislocations in a direction parallel to the r-m edge. This is one of the possible directions of glide in quartz, the glide plane being $\{0001\}$. No visible boundary is observed at the tip of the pile-up. Therefore it would be reasonable to assume that the pile-up had taken place against some obstacle such as an impurity. It may also be noted that the direction of propagation of crack coincides with the r-z and r-m edges of the crystal.

Nucleation of cracks at the intersection of glide bands with a grain boundary

There are two general types of crack nucleation sites:

(i) at the intersection of glide bands;

(ii) at the intersection of glide bands with a boundary.

A large number of fracture surfaces were examined, but no evidence for the first type of nucleation mechanism was obtained. Nucleation of microcracks at the intersection of glide bands with a grain boundary has been observed on the $\{10\bar{1}1\}$ cleavages of quartz. A typical example is illustrated in Fig. 2. It was obtained after etching the cleavage in fused KOH (6 gm of KOH + 3 cc of distilled water) for 1 hour at 250°C. The two sets of rows of pits are oriented along r-m and r-z edges of the crystal. This means that the two sets of glide bands are formed as a result of glide on $\{0001\}$ and $\{01\bar{1}1\}$ planes along r-m and r-z directions respectively. As observed earlier, here also the microcrack P is found to be oriented along one of the glide directions (r-z edge direction).

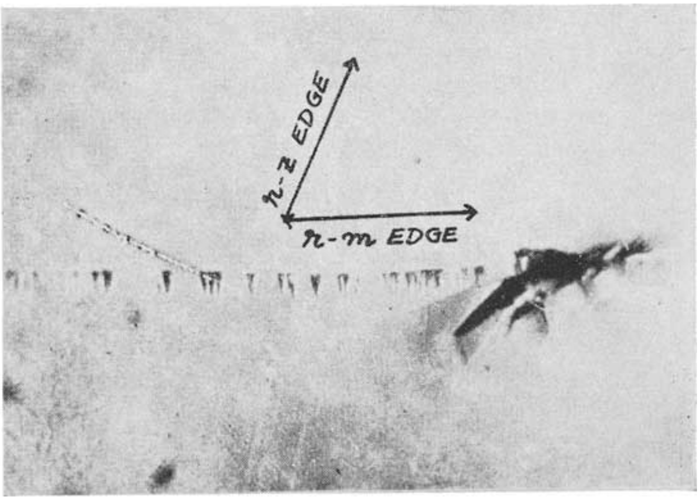

Fig. 1. Nucleation of cracks at the tip of dislocation pile-up; direction of pile-up along r—m edge; crack propagation along r—z and r—m edge directions. (×90)

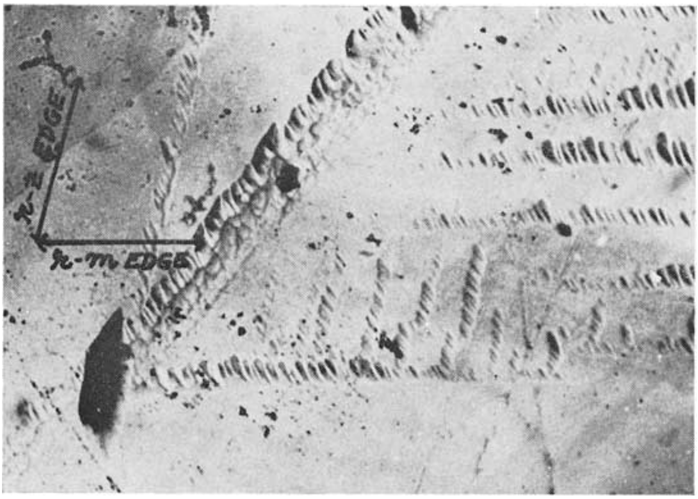

FIG. 2. Nucleation of microcrack at the intersection of glide bands with a grain boundary. Major axis of the crack along r—m edge direction. (× 170)

Intergranular cracks

During the microscopic investigations of heated fracture surfaces, the authors obtained two varieties of cavities associated with grain boundaries:

(i) wedge type cavities (w-type);

(ii) round type cavities (r-type).

The wedge cracks are formed at grain corners, whereas the spherical cavities are distributed all along grain boundaries. It was also noted that the above types of cavities appear only on the fracture surfaces of annealed samples of quartz. A typical example of a w-type crack observed at a corner of an s-bend grain boundary on a {0001} fracture surface is illustrated in Fig. 3. This observation was obtained on a fracture surface subjected to air-annealing at 500°C for about 2 hours.

One case of the second variety of cavities distributed along a grain boundary on a {0001} fracture surface is shown in Fig. 4. The cavities are almost spherical in shape and well isolated (the heat-treatment is the same as before). In order to understand whether a further heating has any effect on the growth of these spherical cavities, successive annealing treatments were given to the

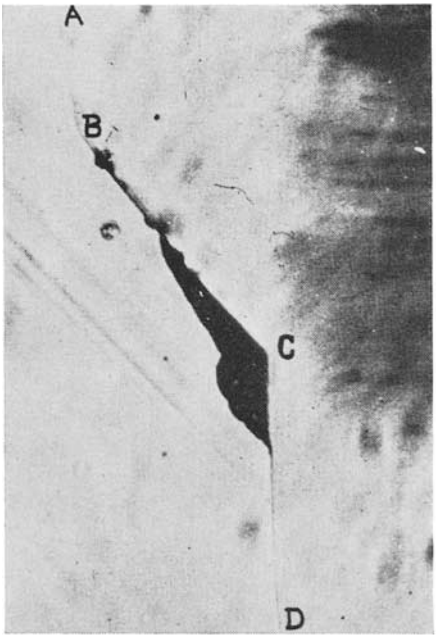

Fig. 3. An example of wedge (w) type crack at the corner of an s-bend grain boundary observed on a {0001} fracture surface after heating the specimen for 2 hours at 500°C. (×360)

specimen of Fig. 4. Figure 5 illustrates the region of Fig. 4 resulting from a further annealing for a period of three hours at the same temperature. Evidently the heat-treatment resulted in the growth and linking of the spherical cavities along the boundary leading to a continuous grain boundary crack. (Fig. 5).

Discussion and Conclusions

Observations presented in this paper suggest that plastic deformation assists the nucleation of cracks in brittle materials like quartz. The string of piled up dislocations terminated by obstructions forms a macroscopic stress concentration and the relaxation of this stress concentration takes place by the coalescence of the leading dislocations to nucleate a crack. Theoretical possibilities of such coalescence due to such piled up dislocations have been suggested

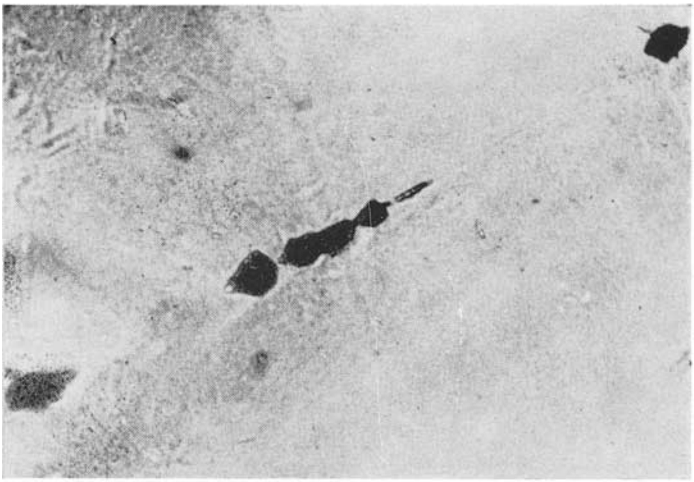

FIG. 4. Example of cavitation fracture along a grain boundary; heat treatment the same as that given to the specimen of Fig. 3. (× 90)

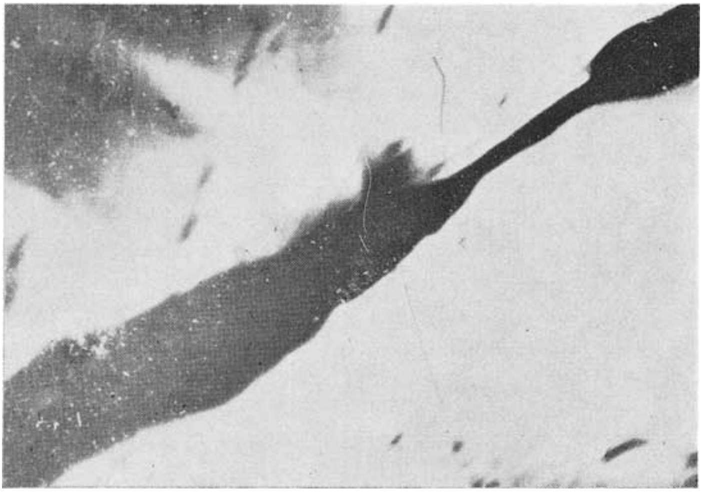

FIG. 5. Same region as Fig. 4 after heating for another 3 hours at the same temperature; this region was also etched in KOH afterwards. (× 90)

by Stroh(5). An interesting fact observed is the tendency of the crack to propagate along glide directions. Taking into consideration the observation of Fig. 1, it may be noted that the cracks begin to propagate exactly in the r-z and r-m edge directions, which are two possible directions of glide in quartz with gliding on $\{01\bar{1}1\}$ and $\{0001\}$ planes.

A number of instances of intersecting glide bands were obtained in the present investigation but without any evidence of crack nucleation at such points. However, the presence of grain boundaries alters this condition. Grain boundaries are effective barriers to slip. Nucleation of cracks is to be expected to occur in polycrystalline materials when slip is hindered by grain boundaries as observed in the present study (Fig. 2). The cause of the nucleation of such microcracks is the superimposition of the stress concentration of the two glide bands on each side of the boundary as suggested by Westwood(6) and due to subsequent coalescence of dislocations. The stress concentration occurs by blockage of dislocations at the boundary so that dislocation motion will be highly difficult. As observed earlier, here also the major axis of the microcrack is oriented in one of the glide directions (r-z edge). The above observations strongly suggest an anisotropic propagation of cracks along easy directions of glide in brittle materials like quartz.

Intergranular cracks (both w- and r-types) have hitherto been reported only in metals and alloys. This is the first report of such cracks in brittle crystals like quartz. These types of cracks are often associated with grain boundary sliding (7) which is a consequence of slip(8). The thermal stresses resulting from the annealing treatments are responsible for plastic deformation in this crystal at such high temperatures. Since grain boundary sliding is a result of slip, plastic deformation occurring at such high temperatures should be responsible for grain boundary sliding and hence for the formation of cracks at grain boundaries. When such sliding gets blocked at grain boundary junctions, a crack nucleated thereby leads to the formation of w-type cracks.

Several suggestions to nucleate cavities (of the second type) in grain boundaries have been made. The essence of each was that sliding should take place in a grain boundary containing a jog or ledge. On the other hand, Greenwood *et al.* (9, 10) suggested that it is possible to form cavities by the condensation of vacancies at the grain boundary. Since in the present investigation no evidence of such a ledge or jog is obtained at the boundary it would be reasonable to rule out the first possibility. Vacancies may be originally present in these crystals or may be created at high temperatures due to lattice expansion and annihilation of dislocations. These vacancies can be supplied to the boundary by diffusion along the dislocations(11). It is therefore suggested that voids at elevated temperatures are produced due to the agglomeration of diffused vacancies at the boundary.

ACKNOWLEDGEMENT

The second author gratefully acknowledges CSIR Govt of India's financial assistance.

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BRIEF NOTE ON A NEW SPECTROSCOPE ASSEMBLY

By M. J. O'DONOGHUE, M.A., F.G.S., F.G.A.

THE Eickhorst "Kaltlicht" spectroscope assembly forms part of the series of gemmological instruments manufactured by the firm of Eickhorst & Co., Hans-Henny-Jahnn Weg, Hamburg, West Germany. The light, both transmitted and reflected, is brought from its source by fibre-optic guides, one of which is movable so that the specimen can be viewed to the greatest advantage. The specimen stands on a rotatable mount and the spectroscope is arranged to move in an arc above it. So far the spectroscope used is that made by Zeiss of Jena, East Germany; it has a built-in wavelength scale and this is separately illuminated on the assembled instrument. Both the main light and the scale illumination are adjustable for brightness and a fan cools the light source. Trials on the two-day course for F.G.A.s last September and on subsequent courses elicited widespread satisfaction, and the instrument also was most useful for showing spectra to students who had never seen them before. Altogether a first-class instrument.

Gemmological Abstracts

AKIZUKI (M.). *Gemstones with optical effect.* (In Japanese). Journal of the Gemmological Society of Japan, 1975, 2, 4, 150-164.

Explanations are given on lustre, reflection and refraction, diffraction and dispersion.

M.O'D.

ANDERSEN (H.). *Synthetischer Lapis lazuli aus der Herstellung Gilson.* (Synthetic Gilson lapis lazuli). Z.Dt.Gemmol.Ges., 1976, 25, 1, 42-43.

Hints for recognizing the Gilson product include very good violet-blue colour comparable with the finest lapis lazuli, a better lustre than the natural stone, more like sodalite; the pyritic inclusions can be scratched with a needle; density of 2·38 is also nearer to sodalite; the white inclusions are like longish clouds, not comparable to the natural stone inclusions; the streak is dark blue instead of light blue; and the x-ray shows as amorphous substance.

E.S.

ARBUNIÉS-ANDREU (M.), BOSCH-FIGUEROA (J. M.), FONT-ALTABA (M.), and TRAVERIA-CROS (A.). *Physical and optical properties of garnets of gem quqlity.* Fortschr. Min., 1975, 52 (Spec. Vol.; Papers & Proc. 9th Gen. Meeting I.M.A., Berlin (West)—Regensburg, 1974) 531-538. 6 figs.

Values of *n*, S.G. and microhardness have been measured for gem-quality purple-red almandines, light green grossulars, and yellow hessonites. The dispersion curves of transmittance are given, but no data on the chemical compositions of the specimens.

R.A.H.

ASMUS (B.). *Buying emeralds in Colombia.* Lapidary Journal, 1976, 29, 12, 2288-9.

A large rough crystal purporting to be emerald proved to be colourless beryl sawn into five sections and recemented with a green cement. It was then dipped at the ends into a molten slag to give the appearance of natural matrix.

M.O'D.

CAVENEY (R. J.). *The hardness of diamond and gem diamond "substitutes".* Industr. Diamond Rev., 1976, 45-47. 2 figs.

The use of Mohs's scale to compare the hardness of diamond with that of the various simulants, several of which are currently marketed under different trade names, can be very misleading. Yttrium aluminium garnet (YAG), one such material, has H. 8-8½ but will wear 3000 times more readily. Using the pentagonal indenter developed by Brookes and Moxley [Journ. Phys. E., Sci. Instr., 1975, 8, 456*], diamond has an indentation hardness of 10000 kg/mm^2; equivalent values are sapphire 1200, spinel 1730, YAG 1600, strontium titanate 500.

R.A.H.

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*Abstracted in J.Gemm., 1976, XV, 1, 31.—Ed.

Chikayama (A.). *New localities of gemstones in Eastern Africa.* (In Japanese). Journal of the Gemmological Society of Japan, 1975, 2, 4, 147-158.

Countries covered include Kenya, Tanzania and Uganda; the gem materials are described and illustrated.

M.O'D.

Collins (A. T.). *The Hannay Diamonds.* Industrial Diamond Review, December 1975, 434-437.

This fair, well-reasoned and informative paper should provide a fitting conclusion to the long series of investigations undertaken by physicists on the famous Hannay diamonds with the modern knowledge and techniques at their command. Dr Collins has re-examined nine of the original diamond fragments which were found in the residues of the three possibly successful attempts by J. B. Hannay to manufacture diamonds by heating in a furnace mixtures of bone oil, paraffin and lithium in iron tubes four inches thick.

Originally there were 12 such fragments, mounted on a slide and labelled "Hannay's artificial diamonds" in the collections of the Mineral Department of the British Museum, and the specimens accorded well with the description of those examined by the mineralogist Story-Maskelyne in 1880, and accepted by him as diamond. In 1943 the matter was re-opened when the pieces were re-examined by F. A. Bannister and Kathleen Lonsdale using x-ray crystal analysis, who found that 11 of the 12 pieces were indubitably diamond.

In 1955, when for the first time the conditions necessary for the synthesis of diamond were firmly established, it seemed certain that the necessary enormous pressures and temperatures just could not have been attained in Hannay's experiments. In 1959 and in 1962 the Hannay specimens were again examined by x-ray methods by Professor Lonsdale and her colleagues, and they now became convinced that the fragments consisted of *natural* diamond. Dr M. Seal, on the basis of electron microscope studies, is the only modern worker who has expressed belief that the diamonds recovered from Hannay's apparatus could have been formed by his process.

For the present investigation, Dr Collins examined the cathodoluminescence of the fragments, and compared this with the luminescence produced by synthetic and by natural diamonds under these conditions. Electrons from a heated tungsten filament were accelerated by a voltage of 50 kV and focused into a tiny spot which impinged on the diamond in question, and the luminescence was analysed by a Hilger Monospec spectrometer. The results were highly characteristic of natural diamond in which the blue glow is apparently due to donor-acceptor pair recombination of boron and nitrogen impurities which have aggregated together. Such aggregates have not been found to occur in any synthetic diamond.

These latest results thus reinforce the generally held judgement that Hannay's diamond fragments could not have been synthesised as the results of his experiments. It is good to have Dr Collins's opinion that despite these conclusions Hannay's scientific integrity is no longer impugned. The most probable explanation of the mystery seems to be that the starting materials were accidentally contaminated with particles of diamond dust.

B.W.A.

Diehl (R.). *Herstellung und Laseranwendung von Rubineinkristallen.* (Production of ruby single crystals and their application as lasers). Z.Dt.Gemmol.Ges., 1975, 24, 3, 148-152.

Since the first synthesis of rubies by the Verneuil methods, a whole series of alternative crystal production methods have been used to produce homogeneous and stress-free ruby crystals for use as lasers. The more economic methods start with an Al_2O_3 melt with a chrome oxide content of 0·035 mol %. Various methods are described and the laser application explained. In medicine it is used mainly for optical and tumour treatments. Laser treatment of the retina can save complicated eye operations, while, in the treatment of cancer, especially skin cancer can be thus treated. In dentistry, the ruby laser can be applied to fight caries.

E.S.

Diehl (R.) and Bank (H.). *Eigenschaften, Herstellung und Charakterisierung von Lithiumniobat-Einkristallen und ihre mögliche gemmologische Verwendung.* (The properties, production and characteristics of lithiumniobate single crystals and their possible use in gemmology). Z.Dt.Gemmol.Ges., 1975, 24, 3, 118-129. 9 illustrations, bibl.

Lithiumniobate, $LiNbO_3$ has many interesting properties and because of its possible technical application many laboratories work on this substance. It crystallizes in the trigonal class, is piezo-, pyro- and ferro- electric and can be used as an optical store. The production of large single crystals with these properties is of great importance in technology. The authors suggest the application of this material in gemmology mainly because of its optical storing capacity.

E.S.

De Michele (V.). *Réné Just d'Haüy e l'inizio della gemmologia scientifica.* (Réné Just Haüy and the beginning of scientific gemmology). La Gemmologia, 1975, 1, 2, 20-21.

Quotations from "Trattato dei caratteri fisici delle pietre preziose per determinarle quando siano lavorate", published as a translation from the French in Milan, 1819.

M.O'D.

Eppler (W. F.). *Totalreflexion an Rissen in Edelsteinen.* (Total reflection of fissures in gems). Z.Dt.Gemmol.Ges., 1975, 24, 4, 237-9. 3 photomicrographs.

Professor Eppler discusses Professor Schlossmacher's statement in his book that air-filled fissures in gems appear as dark areas due to the total light reflection. This seems to depend on the angle of the fissure, which has to be fairly vertical to appear dark.

E.S.

Eppler (W. F.). *Wachstumsröhren im Kunzit.* (Growth tubes in kunzite.) Z.Dt.Gemmol.Ges., 1975, 24, 3, 115-117.

Article with four photomicrographs showing long thin needle-like inclusions in kunzite, most probably from Brazil. These hollow needles or tubes contain snake-like lines, which proved to be growth phenomena and not inclusions. They are parallel to the c-axis and seem to have been formed by the alternative growth of two neighbouring vertical planes.

E.S.

Fontana (M.). *Zoisite blu (varietà "tanzanite").* (Blue zoisite—variety "tanzanite"). La Gemmologia, 1975, 1, 2, 17-19.

A review of the occurrence and properties of blue zoisite with diagrams of the crystals.

M.O'D.

Glazunov (O. M.), Suturin (A. N.) and Zamaletdinov (R.S.). *(Gem-type chrysolite from ultrabasic rocks of eastern Sayan.)* Nemet. Polezn. Iskop. Giperbazitov, 1973, 248-254 (in Russian). (Edited by Yu K. Andreev and V. P. Petrov, "Nauka", Moscow.)

This chrysolite (olivine) has a composition Fo_{93} and is similar to that from kimberlite pipes. EPR spectra show that Mn^{2+} ions are present replacing some of the Mg^{2+}. The chrysolite occurs in asbestos-like, chrysolite-sepiolite shells and as crystalline inclusions in talc veins intersecting serpentinized, carbonaceous peridotites of Cambrian age.

R.A.H.

Gramaccioli (C. M.). *Una gemma insolita: la benitoite.* (An unusual gem: benitoite). La Gemmologia, 1975, 1, 2, 14-16.

A review of the occurrence and properties of benitoite with the additional comment that pabstite, $BaSnSi_3O_9$, is also only found in California.

M.O'D.

Gübelin (E. J.). *Where gemstone research stands today.* Fortschr. Min., 1975, 52, (Spec. Vol.: Papers & Proc. 9th Gen. Meeting I.M.A., Berlin (West)—Regensburg, 1974), 501-513.

New gemstones discovered during the last 30 years include taaffeite, sinhalite, painite, ekanite, and brazilianite, as well as gem varieties of long-established species such as amblygonite and zoisite. In gem testing, absorption spectroscopy and microscopy have become important and the study of infrared absorption spectra of polarized radiation appears to be becoming important for distinguishing between certain simulants or treated stones and their natural counterparts. The study of inclusions in gemstones by x-ray fluorescence and electron microprobe also helps in this distinction and in recognizing diagnostic features typical of certain sources. Gemmology is now being commercially applied to give more accurate grading methods of gemstones.

R.A.H.

Gübelin (E.). *Die neuen Katzenaugen-Schmucksteine von Taiwan.* (The new cat's-eye gems from Taiwan). Z.Dt.Gemmol.Ges., 1975, 24, 4, 234-236.

The author refers to H. Bank's note in Z.Dt.Gemmol.Ges., 1975, 24, 3, 167 (see Short Gemmological Notes *infra*). These stones are marketed under the name of nephrite cat's-eye, have a very strong chatoyancy and have been shown to be actinolite. The difference between actinolite and tremolite can be decided by the colour, the former being the iron-rich variety, the latter poor in iron and nearly colourless.

E.S.

GÜBELIN (E.) and WEIBEL (M.). *Neue Untersuchungen am blauen Zoisit (Tansanit).* (New examinations of blue zoisite (tanzanite)). Z.Dt.Gemmol.Ges., 1976, 25, 1, 23-31. Bibl.

The natural colour of this mineral is usually yellow-brown and trichroic (violet-red, dark blue, yellow-green), rarely blue. This colour is usually produced by firing (about 400°C?). By the heating process the trichroism is converted into dichroism (violet-red, dark blue, dark blue) and the colour becomes more intense. The colour seems to be caused by vanadium. The authors mention work done on the colour change by various people and give details of chemical composition and trace elements. The fired stones were re-heated and were unchanged at 900°, but at 1000° gave off some water and became dirty-yellow in colour. Details of mineral inclusions are given; there are five black-and-white photomicrographs and three coloured ones, the latter showing actinolite inclusions, an included graphite table and two staurolite prisms, the brown colour of which can be easily seen against the blue tanzanite.

E.S.

GÜBELIN (E.). *Skorodit-ein neuer Edelstein aus Tsumeb, S.W. Afrika.* (Scorodite—a new gem from Tsumeb in South-West Africa). Z.Dt.Gemmol.Ges., 1976, 25, 1, 33-39. Bibl., 5 photomicrographs.

Scorodite is an iron-containing arsenate, is orthorhombic and has a density of 3·29. It can be nearly colourless to grey-green, green, yellow, blue to violet. It is strongly pleochroic (violet blue and blue-green, similar to the fired tanzanite). R.I. and birefringence vary according to Fe and Al content between 1·785 and 1·812. Tsumeb in S.W. Africa yielded a few single crystals up to 25mm length and some very good geodes with many larger and smaller crystals. The stone will be of interest to collectors but not suitable for jewellery purposes, as the hardness is only 3½-4 and too rare.

E.S.

HOCKLEY (J. J.). *Nephrite (jade) occurrence in the Great Serpentine Belt of New South Wales, Australia.* Nature, 1974, 247, 364. 1 fig.

A lensoid-shaped occurrence 24 km SE. of Tamworth yielding gem quality material is reported. Its size, overall grade, and economic potential are under investigation.

F.B.A.

JAIN (S. K.). *Tourmaline, a gemstone packed with many peculiarities.* Gem World, 1975, 2, 9, 31-36.

A summary of the properties of tourmaline.

M.O'D.

Jones (R. W.). *Arizona's green gem, peridot.* Gem World, 1975, 2, 9, 33-35. (Reprinted from Alaska Highways).

In the San Carlos Indian reservation peridot is collected and much is sold to the Peridot Mining and Marketing Project, who cut and sell the stones. Some peridot is also fashioned and made into jewellery on the reservation by trained Indian workers.

M.O'D.

Lang (A. R.) and Woods (G. S.). *Fingerprinting diamonds by x-ray topography.* Industr. Diamond Rev., 1976, 96-103. 4 figs.

Successful tests have demonstrated the effectiveness of x-ray topographic maps of internal crystal lattice defects as "fingerprints" which unambiguously identify a given cut gem with its parent rough stone, or identify the gem even though it may have been recut. The technique could be used with other gemstones, such as ruby, sapphire or emerald.

R.A.H.

Lehmann (G.). *Bemerkungen zu der Arbeit "Thermolumineszenz als Untersuchungsmethode der Farbursach von Topasen".* (Notes to the article on thermoluminescence as method for examining causes of the colour in topazes). Z.Dt. Gemmol.Ges., 1975, 24, 4, 242-244.

Lehmann discusses an article* by I. Petrov and W. Berdesinski in Z.Dt.Gemmol. Ges., 1975, 24, 2, 73, about thermoluminescence as testing method of the cause of colour in topaz. He maintains that the article is not detailed enough and the authors answer shortly that it was only designed as an introduction.

E.S.

Manutchehr-Danai (M.). *Zur Geologie und Mineralogie der Türkis Lagerstätte Baghu.* (On the geology and mineralogy of the Baghu turquoise deposit). Z.Dt.Gemmol.Ges., 1976, 25, 1, 15-22. Bibl., maps.

Baghu lies in north Iran: the deposits are historically known. The turquoise deposit is connected with an eocene intermediate magmatic rock formation in which granodiorite can be found. The clay minerals as weathering products of the feldspars react with copper-bearing aqueous solutions and form turquoise. The area also yields gold, copper and lead.

E.S.

Mathur (S. M.). *Exploration for diamonds in India.* Gem World, 1975, 2, 9, 21-28.

Most of the current Indian production of about 20,000ct per year comes from the Panna area of Madhya Pradesh. Since over Rs 600 million was spent on importing diamonds in 1973 more effort is needed to be devoted to prospecting in India; a reserve of about 1·2 million ct is estimated for the Majhgawan mine in the Panna district. No diamonds are mined at present in southern India, the historically important area.

M.O'D.

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*Abstracted in J.Gemm., 1975, XIV, 8, 392—Ed.

MERTENS (R.). *Peridot von beachtilicher Grösse aus der Eifel.* (Sizeable peridots from the Eifel). Z.Dt.Gemmol.Ges., 1975, 24, 4, 240-241.

Olivine pebbles up to the size of a head have always been found in the Eifel (German mountain range on the left side of the middle Mosel), but the material was mostly not of cuttable quality. Now some material has been cut—some peridots of good gem quality, some over 1 ct. The mineral haüyne in good blue colour has also been found.

E.S.

MONÉS-ROBERDEAU (L.), BOSCH-FIGUEROA (J. M.), and FONT-ALTABA (M.). *Quantitative study of fluorescence of brilliant-cut diamonds.* Fortschr. Min., 1975, 52 (Spec. Vol.; Papers & Proc. 9th Gen. Meeting I.M.A., Berlin (West)—Regensburg, 1974), 521-529. 9 figs.

The fluorescence of 52 specimens of commercial white and top silver Cape diamonds, weighing 0·35–0·75 carats, in UV light at 365 nm was measured using a specially designed camera with photomultiplier and a running interference filter monochromator. A practical classification of the colour can be established from the intensity of the fluorescence. The dispersion curves of the relative intensity of fluorescence are given.

R.A.H.

NASSAU (K.). *Radiation-induced colors in gem materials.* Guilds, (published by the American Gem Society), 1975, 6-7, 15-16.

A survey of the effects of various types of radiation on gemstones.

M.O'D.

NASSAU (K.) and PRESCOTT (B. E.). *A reinterpretation of smoky quartz.* Phys. Stat. Sol. (a), 1975, 29, 659.

In some specimens of quartz optical absorption bands A_1 and A_2 which are characteristic of smoky quartz have been found, although the colour of the specimens does not show this type of coloration. If these specimens are further irradiated the smoky colour becomes apparent, a new absorption band appears at 2.9eV (designated A_3) and an EPR signal develops due to the substitutional Al centre. The smoky colour is therefore due to this A_3 band.

M.O'D.

NASSAU (K.), PRESCOTT (B. E.) and WOOD (D. L.). *The deep blue Maxixe-type color center in beryl.* Amer. Mineral., 1976, 61, 1 & 2, 100-107.

A deep blue colour is produced in beryl by a variety of penetrating radiations. If the original beryl is yellow or green, the resulting colour can be green or blue-green, though this colour centre cannot be produced in just any beryl. Both light and heat can cause fading of the blue component of the colour, and it can be restored by γ-ray, x-ray or neutron irradiation in the Maxixe-type material. In the case of the original blue material found about 1917 in the Maxixe mine, Brazil, irradiation of bleached material produces a green colour, indicating that the Maxixe colour was not due to irradiation.

R.A.H.

Rösch (S.). *Versuch einer Geschichte der Reflektographie.* (Sketch of the history of reflectography). Z.Dt.Gemmol.Ges., 1976, 25, 1, 1-14.

This article, which has a bibliography of 35 items, tries to construct the story of the reflectograph. The idea of a reflex picture is explained, and it is seen how this is applied in photography. The first work done in this subject was published around the turn of the century and about 20 years later a reflectograph was built The author concludes with details of its non-crystallographic applications and of its importance to gemmology by providing a "passport" for each stone.

E.S.

Sanders (J. V.). *Microstructure and crystallinity of gem opals.* Amer. Min., 1975, 60, 749-757. 8 figs.

Gem opals from various volcanic host rocks have been examined by electron microscopy and diffraction. They are generally a mixture of amorphous and crystalline silica, the extent of crystallinity varying between samples from different sources. Tridymite has been identified in some samples. The microstructures are compared with those of gem opals from sedimentary rocks and with specimens heated in the laboratory. Changes in morphology produced by sintering occur at around 400°C and crystallization at around 1100°C. Both tridymite and cristobalite were identified in material crystallized by heating.

A.P.

Sanders (J. V.). *Star opal from Idaho.* Lapidary Journal, 1976, 29, 11, 1986-2010.

Opal from the Spencer mine in Idaho is brilliantly coloured, commercially valuable and may show a star. The stones are sold as triplets capped by quartz. One type of star resembles a cat's-eye in that a single streak of dispersed colours moves across the surface at a given angle; other types show three rays and six points. Some stars were examined with the aid of an optical diffractometer and the patterns obtained differed from those seen in Australian stones. These usually give a set of six parallel streaks and two spots, the layers of silica particles being arranged on a hexagonal net but arranged in a random order, being neither face-centred cubic nor hexagonal in sequence. The star opals on the other hand show the layers parallel to the base to have a face-centred cubic stacking sequence. In addition there are stacking faults and twins on the three $\{111\}$ planes inclined to the base and it is diffraction from these faults which gives rise to the star effect. It is thought that the opal showing the star was laid down in bands of particles separated by an interfacial layer of silica which gave a smooth surface on to which the particles in the next band could settle. The opal occurs in a volcanic rock.

M.O'D.

Santos Munsuri (A.). *Tabaqueras de rapé chinas.* (Chinese snuff-bottles). Boletin del Instituto Gemológico Español, 1975, 12, 17-23. Coloured illustrations.

The second part of a survey of Chinese snuff-bottles dealing mainly with those fashioned from quartz-family minerals.

M.O'D.

Schmetzer (K.), Berdesinski (W.) and Traub (I.). *Vanadiumhaltiger Grossular aus Kenya.* (Vanadium-containing grossularites from Kenya). Z.Dt. Gemmol.Ges., 1975, 24, 4, 230-233. Bibl.

The chemical and physical properties of grossular-spessartite are described. This stone is light green in colour and coloured by V^{3+} vanadium.

E.S.

Schmetzer (K.) and Gärtner (H. R.). *Über Kurnakovit und Inderit, zwei wasserhaltige Magnesiumborate gleicher chemischer Zusammensetzung.* (About kurnakovite and inderite, two water-containing magnesium borates of the same chemical composition). Z.Dt.Gemmol.Ges., 1975, 24, 3, 130-137. Bibl. of 28 items.

Kurnakovite occurs in colourless and perfectly transparent crystals of up to 2 cm long, density 1·833, R.I. 1·488-1·520. Kurnakovite and inderite are two (respectively triclinic and monoclinic) modifications of $(B_3O_3(OH)_5).5H_2O$. In several cases the two types have been mixed up and various physical properties of both crystals are described.

E.S.

Sinkankas (J.). *Beryl in Brazil: Part I.* Lapidary Journal, 1975, 28, 324-332, 1 sketch-map: *Part II.* Ibid., 1975, 506-515, 1 sketch-map: *Part III.* Ibid., 1975, 646-655, 2 sketch-maps.

Details are given of Brazilian beryl and emerald production figures followed by locality details of beryl-bearing pegmatites in the states of Ceará, Rio Grande do Norte, Paraiba, Bahia, Minas Gerais, and Espirito Santo.

R.A.H.

Strack (E.). *Die Diamantvorkommen der Elfenbeinküste.* (The diamond occurrences in the Ivory Coast). Z.Dt.Gemmol.Ges., 1975, 24, 4, 199-229. Bibl.

A very detailed report on two diamond occurrences, in Tortiya and in Séguela. The geographical situation and its geology is described and the production compared to world production. The sorting and separating is explained. The occurrences seem to produce some colourless or slightly coloured crystals for gem purposes (55-65%), some industrials (34-45%) and boart (1-2%). Purity is good (clean to VS) and average size seems to be 8-12 stones per carat. The two occurrences are compared and the other occurrences in West Africa are described.

E.S.

Strübel (G.). *Neue Methoden der Hydrothermalsynthese.* (New methods of hydrothermal synthesis). Z.Dt.Gemmol.Ges., 1975, 24, 3, 138-147.

Various new methods are discussed, the apparatus used schematically illustrated. There are photographs of recrystallized gold crystals and of some silver crystals produced from an alkaline hydrothermal solution.

E.S.

SUNAGAWA (I.). *Surface microtopography as a tool of distinguishing natural and synthetic emeralds.* Fortschr. Min., 1975, 52 (Spec. Vol.: Papers & Proc. 9th Gen. Meeting I.M.A., Berlin (West)–Regensburg, 1974), 515-520, 4 figs.

Surface microtopographs of crystal faces reflect very sensitively the differences in growth conditions and in growth seeds and thus can be used as a tool to distinguish natural from synthetic crystals or even to identify different localities or manufacturers. Examples are given of natural, flux and hydrothermal synthesized emeralds to show the marked differences in the surface microtopographs of their crystal faces.

R.A.H.

SUZUKI (S.). *Further comments on the double dispersion design.* Australian Gemmologist, 1974, 12, 95-97.

A revised description is given of the Suzuki brilliant cut designed to give enhanced dispersion, without loss of brilliance, in stones of medium to low refractive index.

D.R.H.

TAKENOUCHI (S.). *Basic knowledge on studies of fluid inclusions in minerals.* (In Japanese). Journal of the Gemmological Society of Japan, 1975, 2, 4, 165-172.

Destructive methods of analysis are considered. Contamination is a problem when such small amounts are to be studied and apparatus needs to be carefully checked in this regard. Notes are given on the mixing of waters in the earth's crust.

M.O'D.

TOMBS (G.). *Synthetic-like fluorescence in a natural sapphire.* Australian Gemmologist, 1974, 12, 94.

A cut Ceylon sapphire with strong colour zonation from colourless to blue has fluorescence similar to Verneuil synthetic blue corundum. The colourless portion fluoresces apricot pink in long wavelength UV and weak red under short UV, and the blue portion is inert under long UV and fluoresces pale bluish under short UV.

D.R.H.

WILSON (A. C.). *An occurrence of sapphire in the Land's End granite, Cornwall.* Bull. Geol. Surv. Gr. Britain, 1975, 52, 61-63. 1 coloured plate.

Clusters of mid-blue sapphires are distributed over an area of one square metre in megacrystic coarse granite at Trencrom Hill, in the north-eastern part of the Land's End pluton about 0·5 km from the margin of the intrusion. The sapphire is associated with coarse-grained pink andalusite, and it is considered that this association represents digested, highly aluminous inclusions derived from the surrounding pelitic rocks. There are no replacement textures between the sapphires and the quartz andalusite.

R.A.H.

ZANCAMELLA (R.). *Considerazioni sul taglio delle gemme, in particolare, del diamente.* (Considerations on the fashioning of gemstones, especially of diamond). La Gemmologia, 1975, 1, 2, 6-13.

A summary of ideas on proportion postulated at various times with particular attention to those of Tolkowsky.

M.O'D.

ZOIS (A.). *Extract from a letter to Dr E. Gübelin dated 22.1.1976.* Z.Dt.Gemmol. Ges., 1976, 25, 1, 32.

This letter explains the history of the Zois family, which originated in Crete and then came via Spain and Italy to Egg (Switzerland), where they worked an iron mine. Amongst the minerals found there was one called locally "saualpite" but later re-named zoisite. The title Freiherr Zois von Edelstein (Baron Zois of Gemstone) was granted by the Empress Maria Theresa.

E.S.

SHORT GEMMOLOGICAL NOTES. Z.Dt.Gemmol.Ges., 1975, 24, 3, 154-172.

Various short articles of gemmological interest. Firstly, H. Bank talks about the importance of publishing as quickly as possible characteristics of new synthetics. The two examples he mentions are synthetic ruby and synthetic alexandrite. In the case of the first, new production methods show that straight growth lines also can occur in synthetic rubies: in the second case, the synthesis of actual alexandrites is fairly new. H. Bank and W. Berdesinski report on translucent, nearly transparent antigorite (serpentine) from Pakistan. The faceted green-yellowish stones had an R.I. of 1·559-1·561, with a double refraction of 0·001-0·002. H. Bank discusses low refractive indices and double refraction of nearly transparent rhodochrosite from Argentina. The stones came from Las Capillitas and the R.I. was as low as 1·6 and 1·8. H. Krupp and K. Schmetzer researched into scapolite from Tanzania with very high R.I. (1·579-1·553; 0·026). A. Frere warns against aventurine quartz (slightly transparent, faceted, dark green to emerald green, porous surface) which is being marketed as emerald and jade. H. Dern talks about the artificial colour-effect of originally colourless gems. According to a U.S. patent, the stone is given a small hollow at the bottom of the culet, which is filled with colour which is then reflected to the table. The last three notes are by H. Bank. The first deals with light brown and yellow as well as green tourmalines with low R.I. and medium double refraction from Kenya, which are of cuttable quality. The second discusses cat's-eyes of tremolite, actinolite and nephrite; the third deals with ortho-pyroxide cat's-eyes; these are offered commercially as enstatite cat's-eyes but have been shown to be ortho-pyroxide.

E.S.

SHORT GEMMOLOGICAL NOTES. Z.Dt.Gemmol.Ges., 1975, 24, 4, 245-256.

K. Schmetzer and H. Bank describe cut grossularite-chlorite-epidote hornfels from Pakistan. H. Bank talks about precious green apatite from Canada, with relatively low R.I. and occurring in large pieces. H. Bank also writes about transparent violet stones shown to be tremolite according to R.I., birefringence, S.G. and x-ray powder diagram. A blue gemmy willemite from Mount St Hilaire near Montreal in Canada is described also by H. Bank. The same author also contributes a small article dealing with nomenclature, suggesting the use of tsavorite instead of tsavolith for transparent emerald-green grossularite. He also deals with treated yellow topazes: these stones were originally white with low R.I. (1·61-1·62) and are now commercially available as heat-treated yellow topazes with high R.I. (1·63-1·64). H. Dern contributes a note on a synthetic gem with chatoyancy. These are produced by a patented process by the Queensbury Opal Co. Ltd in Cleveland, Ohio, from a molten block of light-conducting fibres of boron silicate glass, hardness 6·5, S.G. 3·25-3·93. The effects of a star-stone can also be produced. The material is also used in doublets together with amethysts, rose quartz, garnet, topaz, opals, etc. to produce the chatoyancy effect. The last two notes deal with observations from the laboratory. One is a short article by H. Bank and W. Berdesinski on the possibility of mistaking paste ($CaSO_4.2H_2O$) cat's-eyes for ulexite cat's-eyes. H. Bank, K. G. Leyser and J. Maes mention a case where amblygonite was thought to be tourmaline.

E.S.

SHORT GEMMOLOGICAL NOTES. Z.Dt.Gemmol.Ges., 1976, 25, 1, 40-57.

H. Bank describes an apatite cat's-eye which can be mistaken for a yellow-green tourmaline cat's-eye or a yellow or green beryl cat's-eye. He also describes pink transparent topazes from Pakistan; they come from the Mardan district, have a R.I. of 1·632-1·641, double refraction 0·009 or 0·011, density 3·53. H. Bank also examined several cut apatites of various colours from various localities, recording their R.I. and birefringence. These vary according to their F and OH content between 1·628 and 1·642 for the extraordinary and 1·632 and 1·649 for the ordinary ray. Birefringence varies between 0·003 and 0·007. Bibl. The same author deals also with cuttable epidotes with low R.I. and birefringence from Minas Gerais in Brazil, density 3·3 to 3·5. The crystals had been offered as tourmalines, but were suspicious because of their trichroism and were shown to be epidotes. Poor in Fe-content, their low R.I. was 1·724 ± 0·002 and 1·745 ± 0·002. H. Bank also describes some cut vivianites; these are of interest only to collectors—their hardness is 2 and because of their perfect cleavage they are difficult to cut. Another short article by H. Bank deals with the R.I. and birefringence of cuttable datolite, which is a monoclinic prismatic tecto-silicate.

E.S.

BOOK REVIEWS

ANDERSON (B. W.). Trans. SCHIFFMANN (C. A.). *Identification des Pierres Précieuses.* Hugo Buchser S. A., Geneva, 1975. pp. XXV, 422. Illustrated in black-and-white and in colour. Sw. fr 120.

This is a fatter volume than my latest English "Gem Testing", due not so much to the slightly different format (with longer lines of print and one less line to a page) as to added matter. Indeed at first glance I thought it must be a translation of the yet unpublished 9th edition: but on further reading—beginning at the beginning—I found it to be a translation *and adaptation* of the 8th edition. The main changes are the addition of descriptions of the Dialdex refractometer and of a number of recently introduced man-made gem materials: some of the original black-and-white illustrations have been changed and some have been added. The original colour-plates are omitted and instead the book is "enriched" (the publisher's word) by 176 colour-photographs taken by Mr Schiffmann of different gem materials: these are perhaps more suitable to a work titled as in the French version than in one strictly confined to gem *testing*, but with some exceptions—for instance, I am not happy about the alexandrite (shown green in artificial light, mauvish in daylight) or the notably different pinks of the rhodonite and the rhodochrosite—they give a fair indication of the appearance of the stones illustrated.

Misprints are not only to be found in English publications. They do not catch the eye of this reviewer so painfully in French as in English, but a number were observed: to mention a few, "sciure de bois" on p.5 should surely be ". . de buis": chrysoberyl is printed instead of orthoclase in a sub-heading on p.167, and Eric Bruton appears as Burton (twice): also, surprisingly, the "Erratum" only succeeds in replacing one error by another. They are, however, of little consequence.

Mr Schiffmann has done his work well. This book will be an invaluable aid to French-speaking gemmologists, and for those English-speakers with sufficient French will bridge the gap between the 8th edition of "Gem Testing" and the eagerly awaited 9th edition.

J.R.H.C.

COURT (A.) and CAMPBELL (I.). *Minerals: nature's fabulous jewels.* Harry N. Abrams, Inc., New York, 1974. pp. 318. Illustrated in black-and-white and in colour. Price on application.

Although there is a short introduction, the bulk of this book is given over to high-quality illustrations of mineral specimens, most of these emanating from North and Central America. Some of the statements in the opening chapters are incorrect; the R.I. of water is 1·33, not 1·00; quartz crystals are said to be terminated by pyramids, not rhombohedra. In the caption to the orthorhombic crystal illustrated the name of the system is misspelt. In general the authors seem unhappy with the crystal systems and the text is not lucid at these points. Elsewhere they seem to be uncertain about the type of audience they are addressing. However, the illustrations are good, some very good. The bibliography includes some out-dated and worthless works; the name Sinkankas is misspelt. The index is far too short and does not cover the introductory chapters.

M.O'D.

De Michele (V.). *Guida mineralogica d'Italia.* (Mineral guide of Italy). Istituto Geografico de Agostini, Novara, Italy. 2 volumes. pp. 216 and 192. Illustrated in colour. Price on application.

One hopes that this superb production might be a forerunner of similar guides to other well-mineralized countries; arranged by location, each entry covers at least two facing pages and includes a map, general photograph of the working area and photographs of one or more of the mineral species found there. Descriptions include general geology, specific details of the minerals encountered and details of associated minerals. One might perhaps cavil at the publicity given to classic sites, but this is a world-wide problem.

M.O'D.

Gill (J. O.). *Origins of gemology in pictures.* J. & S. S. De Young, Inc., Boston, Mass., 1976. pp. 50. Illustrated in black-and-white. Price on application.

Illustrations and title-pages from early books are reproduced with captions almost long enough to serve as a separate text. The books are chosen from the author's large private library of books on gemmology.

M.O'D.

Poirot (J. P.). *Éléments de Gemmologie.* (Elements of Gemmology). Institut National de Gemmologie, Paris. pp. 350 (in two loose-leaf volumes). Fr 165.

In the international literature of gemmology, which is by now quite extensive, we have had surprisingly few contributions from French authors. This new publication, written by no less an authority than the Director of the Precious Stone Laboratory in Paris, should therefore be of special interest to serious gemmologists, since it provides for the first time a clear insight into recent French thought and teaching on the subject.

It seems more appropriate to refer to "Éléments de Gemmologie" as a "publication" rather than as a "book", since it is issued in the shape of two slim loose-leaf volumes in plain red covers, each containing some 170 foolscap pages. There are diagrams in great abundance and some drawings, but no other concessions in the form of photographic illustrations or coloured plates. The work can in fact be fairly described as notes for a course in gemmology, but a course more thorough and notes more detailed than any previously attempted.

It is in two sections: "General gemmology" and "Descriptive gemmology". There are a few concluding pages on legislation in connexion with gemstones, a table of contents and an index which, in the reviewer's copy, was added as a typed sheet, but will presumably be incorporated into the text. To level up the contents of each folder, the first 42 pages of Section II are included in the first volume.

The first chapter, as might be expected, deals with crystals, with diagrams of the unit cells appropriate to the seven systems and of the common habits of some of the gem minerals. One surprise comes in an illustration of "sceptre quartz", which shows crystals in parallel growth in place of the more usually accepted form of a crystal head on a more slender prismatic "stem". Next follow chapters on light and its behaviour in gemstones, on refractive index and its measurement, and lustre. A short discussion on the influence of the proportions of a cut stone on its reflecting power is followed by a chapter giving a very detailed treatment of dispersion and fire, where, not content with the determination of dispersion as n_G—n_B (here given as n_B—n_G, which would be a minus quantity), there is a table where figures are given for "fire", "dispersive power" and "constringence", which will mean little to the practising gemmologist. "Fire" is defined as n_G—n_B/ $n_D \times 1000$, which leads to a figure of 20 for zircon which is higher than the 18 calculated for diamond.

It would take too long to comment on, or even enumerate, each one of the chapters in Section I, but a few points may usefully be mentioned. The importance of the "doubling" of the back facet edges of a cut birefringent stone as observed with a lens is well understood by any practising gemmologist, but it is seldom accorded more than passing reference in text-books. In M. Poirot's work, however, an entire chapter is devoted to this effect, and the important observation is made (and explained mathematically) that the doubling effect for stones of comparable birefringence is less for stones of high index than for those of low, so that the effect in rutile, for example, is less than that to be seen in calcite. A complete table is given showing the birefringence and a figure for the actual "doubling" effect, based on the formula birefringence/$(R.I.)^2$ for every gem species.

Chapter 12, on absorption spectra, was naturally of particular interest to the reviewer. A clear account of the techniques for observing the spectra is given, but the reader is left with the impression that the chief value of the method lies in its providing a means of identifying trace elements in gemstones, rather than being, as it is, an indispensable means for the identification of numerous species regardless of whether the elements causing the absorption bands are known or not. Diagrams indicating the positions of all the important absorption bands in gemstones are given, as seen through a prism spectroscope in which the red end of the spectrum is on the observer's right. In the drawing of the spectrum for Cape diamond the 4780Å absorption band is strongly delineated, while the more powerful and fundamental band at 4155Å is omitted.

Chapters 22 and 23, dealing with the principal counterfeits of natural gems and on inclusions seen in natural and synthetic stones are, from a practical point of view, the most valuable in the whole work. Clear descriptions of glass, porcelain and plastics of various kinds are provided and also some of the many unpleasantly clever doublets which may nowadays be encountered.

In the descriptive part of the work, a great deal of emphasis is laid on the atomic structure of the gem minerals as revealed by x-ray crystal analysis, and to enable the student to understand the nature of the covalent and electrovalent forces by which the atoms in a crystal are bound together a good deal of general discussion and explanation has been undertaken in an introductory section before proceeding with a description of diamond—the only gemstone whose atoms are held together by covalent forces. Once launched on actual description, the author gives diamond the full treatment in 13 (admittedly short) chapters. The remaining gemstones (all classed as essentially electrovalent in structure) are naturally described far more briefly. In the accounts given of all the more important species there are diagrams showing the internal crystal structure, common habit and (on a sketched Mercator projection) the world distribution of their major sources.

There is a special section on pearl and other gems of organic origin, and the book concludes with a brief summary of legislation in connexion with the terminology of gems—a matter which concerns the author in his official capacity.

Despite its austerity, M. Poirot's text should prove fascinating and rewarding reading for the serious student of the subject. There is much therein which is not to be found elsewhere. The amount of work which has gone into the preparation of the innumerable diagrams and tables is truly formidable, and the author is to be congratulated on having provided a major contribution to our science.

B.W.A.

SCHIFFMANN (C. A.). See ANDERSON (B. W.) above.

SHAUB (B. M.). *Treasures from the earth: the world of rocks and minerals.* Crown Publishers, New York, 1975. pp. 223. Illustrated in colour. Price on application.

A guide to minerals directed at the general public, this book deals in the main with and illustrates almost totally the minerals from the North American continent. It is welcome on that score and for the quite good quality of the illustrations. Appendices list museums of mineralogical interest, confined to the U.S.A. and Canada, a glossary, bibliography (in which Dana's Textbook of Mineralogy is listed as an advanced work), mineral habits and simple chemical tests. A useful book for those living in North America and also of interest to those interested in minerals from that area.

M.O'D.

The International Turquoise Annual, Vol. 2. Impart Corporation, Reno, Nevada, U.S.A., 1976. pp. 112. $2·95.

This issue, as well illustrated as its predecessor, contains articles on turquoise from Australia, various chapters on the manufacture of turquoise jewellery and a special feature on tourmaline. The general standard is high.

M.O'D.

Queensland's gem fields. (Leaflet). Queensland Government Tourist Bureau, Brisbane. Undated. Free of charge.

A list of locations with a map and general information on mining.

M.O'D.

ASSOCIATION NOTICES

OBITUARY

ROBERT WEBSTER

An Appreciation by B. W. Anderson

So manifold and varied were the activities of Robert Webster in the field of gemmology that the gap left in our ranks by his death can never adequately be filled—not, at least, by any one person. It is but natural that we who were his friends should mourn his loss, but there is much to be said for the practice followed by Quakers who, following the death of one belonging to their group, gather together not so much to lament his passing as to give thanks for his life and work—spontaneous tributes being paid by several speakers covering different aspects of their lost Friend. In the case of Robert Webster I feel that we should indeed be grateful that he was able to exercise his activities as teacher, writer, and consultant until quite a short time before the end of his long and busy life. To him idleness was misery: work at a chosen task, a pleasure. And he was able, some months before he left us, to hold in his hands and to distribute with his accustomed generosity the third enlarged edition of his 900-page book, "Gems", and to receive the acclamations of many gemmologists at home and abroad for his achievement in completing this massive contribution to our science.

Robert Webster was born on 29th September, 1899, and his formal education was interrupted at the age of fifteen by the necessity to earn a living to support his widowed mother. His father had been a master pawnbroker and it was natural for young Robert to follow the same calling. This branch of the trade, at least to one so intelligent and eager to learn as Webster, provided a rough but valuable training ground for a practical gemmologist, since success in the business must depend so largely on the ability to assess the nature and value of both metal and gems in pieces of jewellery of all kinds.

In the First World War Robert was just old enough to serve in the Army: his courage in carrying messages under fire was recognized by the award of the Military Medal.

I first came to know him when, newly appointed as evening lecturer in gemmology at Chelsea Polytechnic, I had the good fortune to number him amongst my second-year students. He had already received a good grounding in the elements of gemmology under Mr I. G. Jardine, to whom the organization of these classes had up till then been due. This was in the autumn of 1933 and came at a period when gemmology was advancing on all fronts. The Paris Laboratory, the

German Gemmological Association and the Gemological Institute of America were all just getting into their stride, while here in Britain the Gemmological Association had become independent of its parent, the National Association of Goldsmiths, of which it had been the Educational branch. Moreover, an important stimulus for the keen students of that time was the *Gemmologist,* which was launched in August 1931 by Mr Arthur Tremayne, director of the N.A.G. Press. This little monthly journal was devoted entirely to gemmology, and was the first of its kind in the world. It served admirably as a vehicle for the exchange of news and ideas, and encouraged young gemmologists to contribute accounts of any original work on which they were engaged. An added attraction, especially to those like Robert Webster, who had a wife and family to support, was the fact that fees were paid for any contributions published. He soon became one of Arthur Tremayne's "stable", and found plenty to write about, as, after obtaining his Diploma with distinction in 1934, he continued to attend Chelsea, together with a few other gifted students, and was able to carry out some useful research work.

A year or two later he compiled the collection of gemmological tables, data, and glossary, originally known as "The Gemmologist's Pocket Compendium", which was published by Tremayne and soon became the constant companion of most students and of gemmologically-minded jewellers. Enlarged and revised editions of this work have continued to be published to the present day. In 1941, Webster's second book, "Practical Gemmology", made its appearance. This was a useful and easily comprehended course on the subject which has also been revised from time to time.

Although still earning his living in the pawnbroking trade, Webster was now definitely marked for a gemmological career. In 1942, Thorold Jones, who had been an assistant lecturer at Chelsea, was called to take up a special war-time job in Wales; Robert succeeded him in teaching the first-year students, and he continued to lecture when the powers that framed the policy of the L.C.C. decided to banish gemmology from its long-established home in Chelsea Poly. and we were shifted first to Northern Polytechnic, and later to the Sir John Cass School of Art. Throughout the Second World War R.W. served with enthusiasm and efficiency in the Home Guard, and eventually took a Commission. Fortunately he, together with a few others of us who were home-based, kept skeleton classes in gemmology going, despite interruptions and alarms by Goering's bombers.

Quite soon after the war, we in the Precious Stone Laboratory of the London Chamber of Commerce were faced with a formidable problem—that of preventing the infiltration of calibré synthetic rubies and sapphires, which were being imported into the country from hitherto reliable sources, each parcel of the native stones containing five or even up to ten per cent of Verneuil synthetics. The need became urgent to test each and every imported stone: an impossible task in a Laboratory with a staff of only two scientists, a lack of good microscopes, and already fully occupied in testing pearls. More staff and new microscopes were urgently needed. The most experienced gemmologist then available was clearly Robert Webster, and I persuaded him to join us: A. E. Farn (another fortunate choice) completing a team which was to endure for the next quarter century.

After a year in which no fewer than 105,000 stones were tested, the flow of calibré corundums subsided somewhat, as, for political and other reasons, London ceased to be the chief world centre for marketing these goods, and we in the

Laboratory settled to a routine of more varied tasks. Without definitely planning a demarcation of our respective labours, it became convenient for each of us to undertake the main responsibility for testing in one particular field. Robert Webster became interested in the radiography of pearls, for which a specially designed x-ray set had recently been installed, and he quickly acquired a particular skill in producing good negatives and a flair for their interpretation. He also assumed responsibility for the burdensome task of bookkeeping, which he carried on for many years with great efficiency. His powers of concentration in this and in all the tasks he undertook were formidable, and one of the prime reasons why he could get through so much work.

He explored so many fields in gemmology—in particular those neglected by other workers—that it is difficult even to enumerate them. While still a student he had investigated the properties and structure of Corozo nuts—the source of "vegetable ivory", and was able to continue in this line of country while assembling a paper on Ivory and its Substitutes, which was to earn him the coveted Research Diploma of the Gemmological Association. One consequence of thus drawing attention to ivory as a suitable subject for gemmological study was rather amusing to the onlooker. Dr Herbert Smith, who had not considered the substance worthy of inclusion in the 1940 edition of his classic "Gemstones", over-reacted to Webster's work by incorporating no fewer than sixteen pages on the subject in the text of his next (1949) edition—not to mention a plate illustrating the ivory-bearing animals.

Possibly the most useful of all Webster's long-term and completed researches lay in the field of luminescence. Over the years he investigated with characteristic patience and thoroughness the luminescent responses of all gem materials to long and short ultraviolet light and to x-rays, and recorded his results in systematic alphabetic sequence in a series of papers published in the *Gemmologist.* Other noteworthy investigations included those on turquoise and its substitutes, on the serpentines, and on different types of imitation pearl. Though his results were fully published in the appropriate journals, they might be difficult of access to gemmologists of to-day had they not been eventually included in his all-embracing book, "Gems", which first made its appearance as a two-volume work in 1962, and which also incorporated the accurate determinations on stones of special interest which had been tested by C. J. Payne and myself throughout years of work in the Laboratory.

Though he relied largely upon others for niceties of optics, Webster, with his relish for hard work, probably carried out a greater number of hydrostatic density determinations on "fringe" gem materials than any other worker. In establishing the range shown, shall we say, by the massive grossular (hydrogrossular) garnets, where most investigators would be content with half-a-dozen S.G. measurements, Robert would carry out fifty to ensure covering the complete range!

As time progressed, Robert Webster's techniques began to include some very effective micro-chemical tests, which held for him a special fascination. In this trend he was greatly helped and influenced by his close friendship with an exceptionally gifted industrial chemist, the late Mr Harold Lee, who lived a bachelor existence near Robert's home in Wimbledon, and whom he initially met as a fellow-member of the local Conservative Club.

Another growing interest in his life became the work of the police in its detective branches, and in the Courts of law, where so often gemmology played a leading role in the correct identification of goods which had been stolen or which were the subjects of some kind of fraud. Witnesses who could properly be termed "expert" in this field were few and hard to find, in police experience. The busy jeweller who really knew his job was naturally reluctant to sacrifice his time and risk being the butt of clever Counsel in matters which did not concern him personally. Where the Lab. was in some degree involved, or when our aid was sought by the police, R.W. was less unwilling than the rest of us to undertake the job of acting as an expert witness—in fact he usually thoroughly enjoyed himself in the witness box. He gradually became "known to the police" in a favourable sense, and over a period of nine years was an honorary visiting lecturer to the Detective Training School in London. The lectures were very popular, being copiously illustrated by lantern slides, not all of which were strictly technical. Eventually Webster was to become a member of the British Academy of Forensic Sciences, and then of the Forensic Science Society, serving on the Committee of the former body. He also recently completed a term on the Committee of the Mineralogical Society, of which he had been a member for many years in common with several others of Britain's more serious gemmologists.

Although not a "collector" in the field of either rough or cut gemstones in the usually accepted sense, where showmanship and detailed cataloguing play a major rôle in the hobby, Webster accumulated throughout his life a vast and valuable assemblage of (chiefly uncut) gem materials from well authenticated sources, which were of enormous value in his teaching work, in his researches, and also to the Gemmological Association, and to his friends on appropriate occasions.

His kindness to those who sought his help was quite exceptional, and he was almost absurdly lavish with his time and trouble, tending sometimes to embarrass the recipient. When monitoring students or protégés by correspondence, for instance, he was very liable to write several pages in long-hand in the form of a "model answer", if he felt it would help the student.

He had a useful working knowledge of electrical circuits, and rigged up many effective and robust (if crudely finished) pieces of electrical equipment for use in the laboratory or in Poly. classes in gemmology. As an invigilator in the practical examinations held by the Gemmological Association he was without peer and will here be particularly missed—this because he knew so well how the testing equipment could best be laid out in the appointed room, and could vet the equipment to ensure that it was working properly. Moreover he was generally capable of putting right the minor breakdowns which are always apt to occur during the course of an exam., and which can have a devastating effect on the students' morale.

In 1968 Webster was invited by the Canadian G.A. and the Gemological Institute of America to cross the Atlantic and give a series of lectures, in Toronto, New York, and Los Angeles, where he spent some days in the G.I.A. headquarters. And on another occasion he was able to visit the main diamond mines and other gem localities of South Africa by acting as assistant courier and gemmologist to a group of people on a tour organized and financed by the *Illustrated London News*.

Though I have written only of Robert Webster's public life and work, before concluding it should be put on record that he was fortunate and happy in his family life. He and his wife Margaret had three daughters, all of them now married. Though his wife has had the misfortune for many years of being unable to move more than a few paces, her grave disability has been borne with amazing cheerfulness and courage. Only the fact that she was well cared for by their daughter Jean and her husband, who shared their household, enabled Robert to spend such long hours away from home on his manifold gemmological activities.

Mr J. D. S. Wade, F.G.A., Tully Medallist 1951, died in January 1976.

GIFTS TO THE ASSOCIATION

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

Mr J. R. Briggs, F.G.A., Cromer, for a nodule of amber picked up on the Norfolk coast (eastern England).

Mr H. B. Crawford, F.G.A., Borgue, Scotland, for a 34 ct blue synthetic quartz, together with a piece of original material from which it was cut.

Mr Yoshio Nemoto, F.G.A., Japan, for a donation to the funds of the Association, in appreciation of help received.

Professor Jose C. Precklet, Brazil, for six golden topaz crystals.

Mr E. A. Thomson, London, for an oval, faceted, rare purple colour scapolite weighing 0·60 ct.

ANNUAL GENERAL MEETING

The 46th Annual General Meeting of the Association was held at Saint Dunstan's House, Carey Lane, London E.C.2. on the 28th April 1976.

The Chairman, Mr Norman Harper, welcomed members and commented: "I should first of all like to mention the honour given to our President and express our thanks that despite all of his other commitments he has agreed to continue as our President.

"The Association suffered a sad loss in the sudden death of Mr Robert Webster earlier this year and I would like to thank all of those interested in gemmology both at home and overseas who wrote and expressed their condolences.

"During the year, through Mrs Jill Rutland (widow of Dr Ernest Rutland), the Association was able to acquire some very useful crystal specimens and cut stones to supplement its collection which is constantly in use for teaching purposes and for illustrating talks given by members.

"I would like to thank those members who during the year donated specimens and books. Members may remember the G.A. of Australia donated a large collection of Australian mineral specimens in 1974 and during a recent visit to Sydney, Australia, Mr D. J. Ewing attended a meeting of the Australian G.A. Council and personally expressed our thanks for their very kind gesture. I would like to mention the very useful work done by Mr John Chisholm as Editor of the *Journal of Gemmology* and the way that he continues to maintain such a high standard. I would also like to thank the many contributors to the *Journal*, in particular those who do book reviews and abstracts."

The Chairman then proposed the adoption of the Annual Report and Accounts which was seconded by the Rev. Nikon Cooper and duly carried.

Sir Frank Claringbull was re-elected President, Mr N. A. Harper re-elected

Chairman, Mr D. King re-elected Vice-Chairman and Mr F. E. Lawson Clarke re-elected Treasurer.

The Secretary then read the nomination of the Council putting forward Mr Basil W. Anderson for election as Vice-President. The Chairman said that the Council had never lightly made nominations for Vice-Presidents, but the work that Mr Anderson had done for so many years for gemmology certainly warranted his election and it was a great pity that he was not present to hear the well deserved remarks that had been made. Mr Anderson had done a great deal of pioneering work in establishing gemmology as the important subject that it is today; his work as an examiner is of untold benefit and we still continue to have his excellent services in this respect; and his books, which are published in more than one language, are known and respected world-wide.

In declaring Mr Anderson elected as Vice-President Mr Harper said that this gave him a great deal of pleasure.

Miss I. Hopkins and Mr P. Riley were re-elected and Messrs M. Carr, N. Deeks, D. Frampton and C. Winter were elected to the Council. The Chairman thanked Mr T. H. Bevis-Smith, who did not seek re-election, for all the hard work he had done in the past.

The Chairman announced that Messrs Hard Howdy, Watson Collin & Co., Chartered Accountants, had signified their willingness to continue as Auditors.

Finally the Chairman expressed the Association's thanks both to the N.A.G. and also to the Goldsmiths' Company for the ready willingness of the Wardens to place various rooms at the Goldsmiths' Hall at its disposal for meetings whenever convenient: "the Association is greatly indebted to them".

MEMBERS' MEETINGS

London

A talk was given at Goldsmiths' Hall, London, on 12th April, 1976, by Mr J. D. C. Wood, Manager of the Crystal Growth Laboratory, Imperial College of Science and Technology, entitled "Methods of Crystal Growth". The substance of his talk will be given in a future issue of the *Journal.*

Midlands Branch

On the 6th May, 1976, at the Royal Institution of Chartered Surveyors, Birmingham, Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., gave a talk on synthetics.

North-West Branch

A meeting of the Branch was held at Church House, Liverpool, on the 6th May, 1976, when a selection of gemstones and crystals, together with synthetics, were available for examination.

On the 12th June, 1976, a party visited the Museum in Liverpool, where they were shown the Museum's collection of gemstones and crystals by Dr Trezise.

Scottish Branch

A meeting was held on the 24th March, 1976, in the North British Hotel, Glasgow, when films entitled "Aurum" and "The Island of Gems—Sri Lanka" were shown.

The Annual General Meeting of the Branch was held on the 5th May, 1976, at the North British Hotel, Glasgow. Mr M. Turner and Mr A. W. Tait were elected Chairman and Secretary respectively, and Messrs B. Jackson, H. Whitehead, C. Wade, A. Armstrong, I. McKenzie, A. McRae and Mrs C. Kilpatrick, elected to serve on the Committee.

The Summer Outing was held on the 13th June when members of the Branch visited the Leadhills area. A demonstration of gold panning was given in one of the local burns and a visit to a lead mine was arranged.

GEMMOLOGISTS' VISIT TO IDAR OBERSTEIN

A second trip for jewellers and gemmologists was organized by the *Watchmaker, Jeweller and Silversmith* in collaboration with the Gemmological Association and the National Association of Goldsmiths, and a group of members of the G.A. and of the N.A.G. visited Idar Oberstein from 5th to 8th October, 1975.

On the first morning the party was welcomed to the Diamond and Precious Stone Exchange by Julius Petsch, Jr, F.G.A., who recounted some of the history of Idar Oberstein and of the Diamond Exchange Building—finished three years previously and functioning as a Diamond Exchange since October 1973, with 123 offices occupied by people dealing in stones from 23 different countries: there are also 500 members who, having no offices in the building, are entitled to show their stones and carry on business in the hall. The Exchange also houses a museum, which Mr Petsch claimed is rivalled only by the Smithsonian Institution in Washington, D.C., and on the second floor there is a permanent samples exhibition open to trade buyers only, where 200 show-cases display the ranges of 130 local companies.

Mr H. Wheeler, F.G.A., Secretary of the Association, thanked Mr Petsch on behalf of the group and emphasized that they would be seeing a remarkable collection of gemstones and mineral specimens which the ordinary visitor would not have the opportunity to see.

Later in the tour Mr Petsch gave a talk, and began by pointing out the reasons behind the new fashion in gemstones, and the reasons why the cutters in Idar Oberstein were now cutting such a wide variety of gem minerals.

"Before the war we, in Idar Oberstein," he said, "were mainly faceting gemstones. Now, though we are still faceting many fine stones, rubies, tourmalines, aquamarines and so on, we are also cutting a great many cabochons from many types of material—rhodonite, rhodochrosite, onyx, jade, chrysoprase, sodalite, lapis, and of course, agates. We discovered long ago that one can dye agate to produce many different colours, every shade of green, blue, red and black, producing stones with or without striations. Besides agates, we are cutting those other chalcedonies, the jaspers. We get a wonderful variety of these from India in shades from green to yellow and red. Then we get jaspers from Australia in brownish, rose and orange colours as well as those from Africa. Indeed we get jaspers from all over the world today. Every cabochon cut today from the jaspers and the other decorative gem minerals is a work of art in itself. Each stone is a unique single piece cut from natural stones, for of course nature never repeats herself. The reason why we are cutting all these stones in such quantities today is that people do not just wear jewellery set with stones to go to special celebrations. Young people wear jeans and want to wear jewellery with them, not jewellery set with diamonds or aquamarines, but something which also looks nice but is not so expensive.

"The cutters in Idar Oberstein all have big orders to cut this cheaper material and do not foresee any decrease in the demand. Good companies, which previously made only diamond-set jewellery are now starting to make the new everyday jewellery. They are forced to do this. I know the stone trade from the mining aspect in particular, and today when you visit the mines in Africa or Brazil you meet a lot of competition. The Japanese and people from Hong Kong and India are going to the mines wanting to buy good stones. As a result there is insufficient fine material suitable for faceting any more. It is for this reason that we have to use other materials in order to fulfil the wishes of our customers. It is also a question of price. Five years ago, a good aquamarine in Idar Oberstein cost approximately 300 marks a carat. Today the same stone costs 650 to 700 marks a carat. If you look at the price of cheap stones, five years ago a cheap aquamarine cost 8, 10 or 12 marks a carat while today the same stone costs 24 to 36 marks a carat. Prices are going up, so fewer and fewer people can afford a fine faceted stone or even a medium quality one. So more and more of the non-transparent stones are being cut.

"As well as facing a lot of competition from people who buy the rough directly from the mines and distribute it throughout the world, a lot of nationalization has been going on in Africa. The African nations seem to think that the Europeans who come to buy are stealing their national wealth and so they nationalize the mines. The governments try to run the mines themselves and the end result is usually that no further supplies are available. This happened in Tanzania. The mines there were nationalized and then the stones were no longer available on the market in any quantity. At the present time we are facing the same problem in Mozambique. I have just come back from Mozambique, and it is now very difficult to get an export licence for any kind of stones. Then a lot of infighting is going on in Kenya concerning the nationalization of the mines and the same thing is going on in Madagascar. My firm unfortunately has a mine there, and the latest news is that the government of Madagascar are also thinking of nationalizing the mines, and this means again that no more stones are coming onto the market. Many years will pass before these people start producing systematically. All this explains why fine material is increasing so much in value, and why bulk materials from Australia and other countries which allow free export are now being used increasingly."

Mr Petsch then referred to the increasing amount of treated stones coming on the market, mentioning particularly topaz, tourmaline, aquamarine and citrine, and continued: "The agate which comes from Brazil or Madagascar is almost always a grey colour. By processing this and dying it they can produce blue, green, red or black agate. Black agate simulating onyx is very easy to make. The stone slabs are put into sugar-water and left for three or four weeks, and then the slab is treated with sulphuric acid, causing oxidation. As a result the sugar carbonizes, producing the fashionable black onyx. Making a cornelian out of a grey agate is a similar process. The stone is left in the liquid and heat-treated, cooked in certain acids and turned into red cornelian colour. Agates can be dyed green or blue in a similar way.

"Most of the tanzanite crystals found in Tanzania are a brownish colour, as I have seen myself at the mines. Once the brown crystals are heat-treated, however, they take on an attractive mauve blue colour. If these stones were not treated, only ten per cent of tanzanites would in fact be blue. As I have said before, far fewer tanzanites are coming out of Africa since the nationalization of the mines. Also the Tanzanian government are asking very high prices for what they do release, more than 1,000 marks a carat. It is possible to buy medium-colour sapphires for this price.

"New rubies are coming out of Kenya from the Tsavo area between Mombasa and Nairobi. The Tsavo park is situated by a little place called Voi, and here very good quality rubies are found, which are the colour of Burmese rubies. Quite a lot of these have come onto the market in the last few years, but now the Kenyan government has prohibited the mining there.

"Not far from the area where the rubies have been found, they have also found blue sapphires which are better than the Australian stones, which usually have a greenish colour on one side. The sapphires from Kenya are blue on both sides and are very fine. In the next three or four months a lot of these stones should be coming on the market, but I hope that the dealers will regulate the price so that nobody makes a loss on his sapphires."

Mr Petsch then showed a number of slides he had taken himself during his regular visits to the Brazilian gem mines, and talked about the mining methods employed there. The biggest discovery of emeralds ever made, he said, had been made, not in Colombia or Russia, but in Brazil in 1965. Thanks to this discovery the price of emeralds had been kept down to half or a third of what they would otherwise cost by this time. Ninety per cent of these emeralds coming out of Brazil were only of cabochon quality but the ten per cent of facetable stones were enough to keep down the price.

Up to the present time Brazil was still the biggest producer of gemstones. What tended to come out of Africa were new stones like tanzanite or stones which were now coming into fashion such as scapolite. Of the traditional stones such as tourmalines, aquamarine, amethyst, topaz, agate and the jaspers, the bulk were still mined in Brazil. And because of nationalization in Africa, the Brazilian deliveries of stones were becoming even more interesting than they had been in the past. "Stones mostly come", he said, "from three areas in Brazil, the south, the state of Minas Gerais and Bahía. Stones are also mined in the north of Brazil. Opals and aquamarines are both found in Rio Grande do Norte for instance. From Rio Grande do Sul, a hilly mountainous area twice the size of West Germany, come agates and amethysts which can be heat-treated and turned into citrine. Five hundred miles into the interior is the harbour of Porto Leigo in the Palmeria area, where the biggest finds are made. The small stone-diggers and miners bring their goods to the local restaurants to sell them to the buyers and dealers. You can do business in the back yards of these small restaurants. The miners bring along citrine. They have already burned the amethyst by putting it on the ground, covering it with sand and lighting a big fire over it. They know instinctively how long to leave the fire until the stones have become a reddish yellow colour.

"Most of the agate dealers in this area are poor farmers and they often have twenty to fifty tons of agate in their yards, which they find in their fields. The buyer can either pick out individual stones or buy in bulk. As I mentioned before, these Brazilian agates are ninety-eight per cent grey coloured with a white skin outside.

"Rio do Sul in the south of Brazil is interesting only for amethysts and agates. Going north of Rio de Janeiro one comes to the little town of Teofilo Otoni, which is the centre of mining in the state of Minas Gerais. Here one finds German and Japanese buyers from São Paolo and exporters from Rio de Janeiro and Bahía, who either live in the town or go there every four or five weeks to buy their stones.

"Going from Teofilo Otoni into the mining area of Marambaía one notices that all the hills contain pegmatites in which tourmalines, aquamarines and kunzites are found. At the side of every road you can see where the miners have staked their claims and dug for stones. The mine of Machadão, in this area, is a very famous one with feldspar outcrops in which tourmalines and aquamarines are found. Mining is done by tunnelling ,and the mines are very primitive and very dangerous. Inside the mine, pockets of tourmalines of various colours are found in mica, and in one pocket the colour of the stones can vary from black to a fine green.

"A mine such as this is owned by several miners. The normal system in Brazil is that one man discovers a claim, another man registers it, and together they form a company of five or six partners. They do not draw up any written agreements. The group who own the mine also work it. One man is appointed to sell the stones that they find, and once they have been sold in the nearest town or city the partners divide the profits amongst themselves. The mines are worked not with machines but entirely by hand.

"At this mine, one can see large and well crystallized white non-transparent quartz crystals containing tourmalines outside the manager's house. Tourmalines are found every day, but not in large quantities. Half a kilo or three hundred grams a day add up to ten or fifteen kilos by the end of a month, which may have a value of anything between £10,000 and £100,000 depending on the quality of the stones. Today really fine rough tourmaline is sold in Brazil for between £20,000 and £22,000 a kilo.

"A lot of kunzites and aquamarines are found at the mine of Galileia, together with rutilated quartz. Most of the mining here is done in underground tunnels and caves. Where traces of a pegmatite are found the miners follow this into the hill. Miners continue working even in the rainy season when the tunnels are full of water. The stones coming out of this mine are very good and much in demand. The typical Brazilian buyer lives at the mine and carries a suitcase of money with him, as the miners always want cash and do not trust cheques. A few years ago a lot of very large aquamarines were found in mines like this weighing about 14 or 15 kilos apiece. Each stone was sold for about £50,000 or £60,000. When a stone such as this is found, some of the miners who divide the profits buy land and farm, but most of them run through their money in a matter of weeks. Then they return to the mines and try their luck once more.

"It is in the area of Carnaíba that the largest known deposits of emeralds in Brazil have been found. In fact these are probably the largest emerald deposits anywhere in the world. Along a stretch of ten kilometres there are claims every two or three kilometres. There are thousands of small miners digging there because the Brazilian government has declared this area a free mining area. Anyone who goes there can start working a claim. The main centre is in Campo Formoso. Here the miners work on the hillside erecting small huts over their claims. In the rainy season the huts are often swept into the valley and the miners have to rebuild them again. The claims here have been worked for the past ten years, and large areas of the hillside have been removed. The miners are now working in holes they have dug reaching down for twenty or thirty metres, which lead into underground caves where emeralds are found.

"Brazil exports rough and cut emeralds to the value of several million dollars, some say $80 million worth a year, whereas others believe the gems are exported to the value of only $10 million. My feeling is that the export of rough and cut emeralds must average out at between $60 to $70 million, all the stones being mined in this one area completely by hand.

"With ten thousand miners living close together, as they do in this area, it's every man for himself. Every man carries a gun, and law and order are established by the miners in their own fashion. They are proud people and expect to be treated with respect. A well-known Indian buyer from Bombay, who bought millions of American dollars' worth of rough material, recently had an account to settle with a local miner for only £40. He told the man that he would have to wait for his money until next week. To a small miner £40 is a lot of money, however. So the miner said, 'I'll show you how I get my money', drew his gun and shot the buyer dead. Four or five times a year a man is killed because of a minor dispute of this kind.

"When the miners have found the mica which contains the emeralds, they throw it in a small river bed at the end of the mine to wash the stones free of mica and mud. The buyers and miners then cluster round to see the stones being washed in the hope of finding perhaps a large stone of 50 carats, though so far no stone of that size had been discovered.

"Even in the abandoned parts of an emerald mine, one can sometimes see a lone miner searching through the tailings the others have abandoned looking for stones. In a week such a man might find one or two stones. This is just enough to keep him going. It is only the few among all the miners who are lucky enough to find big deposits of stones. The majority spend their whole life digging, often ruining their health, and when they are old they have nothing to show for it. Even the few who do make a good find think the money will go on forever, spend it and end up perhaps searching for small overlooked stones in an old tip at the mouth of an abandoned mine shaft."

Mr R. W. Yeo thanked Mr Petsch on behalf of the party for his fascinating talk.

The party visited the gem-testing laboratory, which is affiliated to the University of Mainz. From there they passed into the exchange hall, where local stone-dealers offer their merchandise for sale. Here they saw not only a wide range of familiar faceted and cabochon stones, but also stones from the new finds in Kenya and Tanzania—the newly discovered Kenyan rubies and the beautiful green chrome garnets from Kenya and Tanzania. Most of these green garnets are small, from 0·3 to 1 carat. Larger stones are rare and expensive—for example, Albert Ruppenthal had a very fine 2 carat stone, for which the firm was asking £400. Besides the natural material, a wide range of synthetics were being offered for sale. One firm had a box of Gilson synthetic opals, the white synthetic opals in this collection being the most convincing. There was also reconstituted material on display. Besides powdered and compressed turquoise both clean and veined, there was compressed lapis lazuli complete with specks of iron pyrites, and also compressed coral. Those who inspected these reconstituted stones felt they would be very difficult to detect when mounted. The group also visited the museum and the permanent sample exhibition.

A visit was arranged to the firm of Julius Petsch where the party saw how rough minerals and gemstones arrived in crates, sacks and drums from all parts of the world. Mr Petsch conducted the group round his showrooms, describing the gems on display and indicating the price of the rough. Among the many unusual specimens on show was one enormous aquamarine crystal of gem quality from one of his mines. The next morning the group was conducted by Albert Ruppenthal round the Ruppenthal showrooms, perhaps the largest and most diverse collection of gems and minerals in the world.

The final morning of the trip was left open for private visits to firms. Some of the group, however, participated in a visit to the factory of Johann Wild and saw the automated gem-cutting controlled by computer. Another party visited a small gem-engraving workshop and had the opportunity to talk to two of the last practitioners of this disappearing craft.

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The Editor wishes to call the attention of readers and contributors to *Quantities, Units and Symbols*, published by the Royal Society last year. This is a report of the Symbols Committee and was approved by the Council of the Royal Society on 6th March, 1975. It aims at providing "an authoritative and convenient statement of the best up-to-date practice for the use of procedures, symbols and units by scientists in general." It will be editorial policy to bring the usages of the *Journal* in respect of matters covered by this Report (including the printing of numbers and symbols) into line with the Royal Society's recommendations as soon as reasonably practicable.

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