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and

PROCEEDINGS OF THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

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CHROME DIOPSIDE FROM U.S.S.R.

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A lot of chrome diopside stated to be from an occurrence in the U.S.S.R. was to be investigated. Doubts of the natural origin of these stones arose caused by inclusions, which in their appearance resembled those from synthetic flux crystals (see Figures 1 and 2).

Diopside, $CaMg(Si_2O_6)$, is a member of the pyroxene group and is one end of the continuous crystalline solution of diopside—hedenbergite ($CaFe(Si_2O_6)$) caused by the diadochy of Mg and Fe^{2+}. According to Betechtin (1977) chrome diopside may contain some percentage of chromium oxide. A remarkable green coloration caused by chromium, which is perceptible in thin sections, needs more than 3% Cr_2O_3 (Tröger *et al.,* 1971). The specimens under discussion have a strong emerald-green colour.

Because for diopside the physical data vary, corresponding to the Fe^{2+} content (Tröger *et al.,* 1971), a similar variation should be expected for chrome diopside too. Their densities were measured by hydrostatic weighing and varied between 3.247 and 3.284 (average 3.27), which are in accord with those of reference samples of natural chrome diopsides from U.S.S.R. with 3.168 to 3.323.

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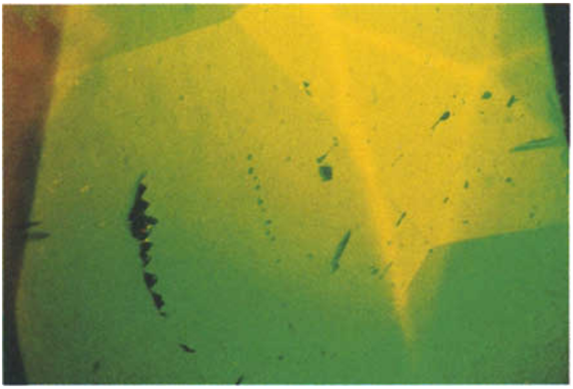

Fig. 1. Strange inclusions in a chrome diopside (30×)

Fig. 2. Inclusion from Figure 1 (140×)

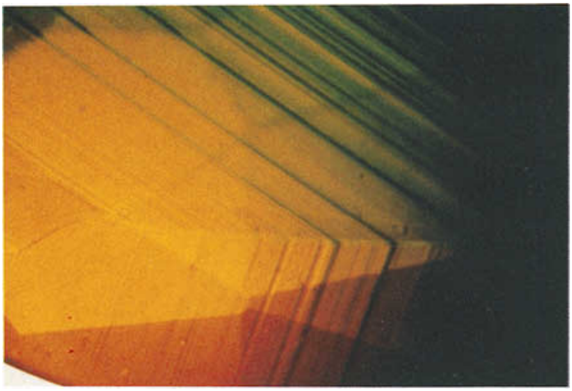

Fig. 3. Angular growth striae (30×)

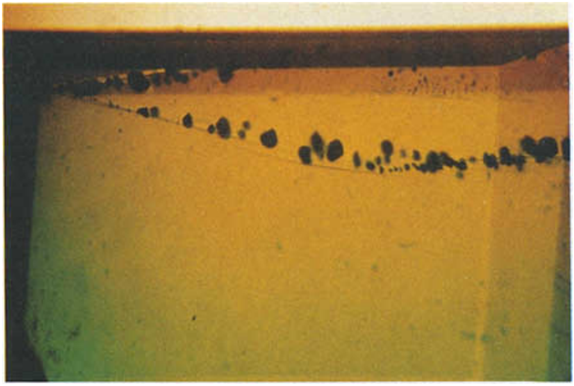

Fig. 4. Crystal inclusions, crystallized at a healing fissure (30×)

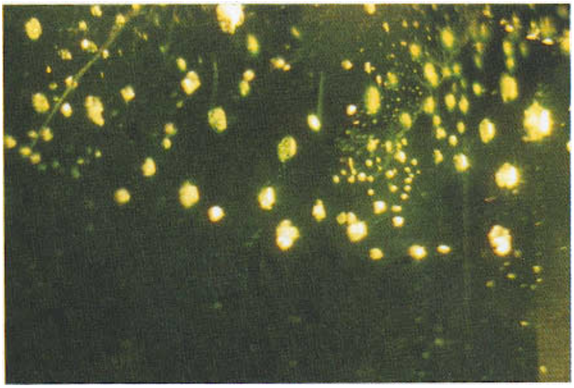

Fig. 5. Crystal inclusions, crystallized at a healing fissure, (see Figure 4, 30×, darkfield)

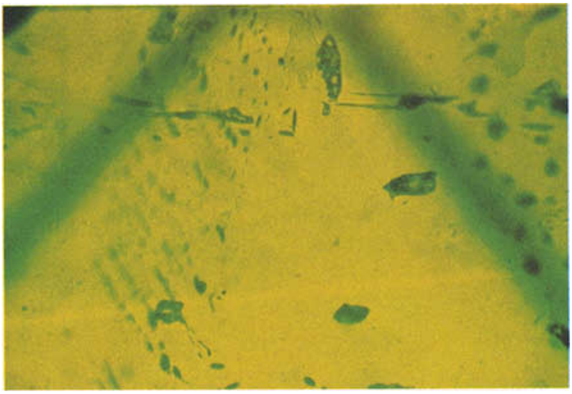

Fig. 6. Two phase inclusions (liquid, gas, 70×)

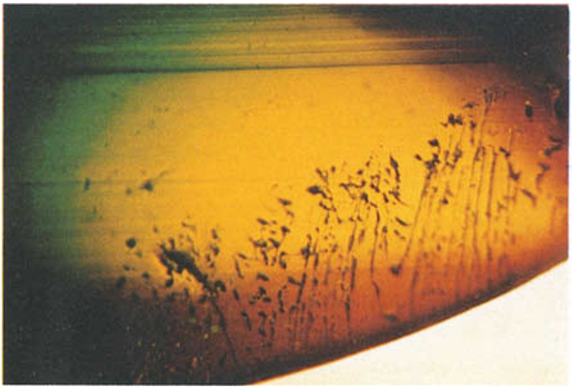

Fig. 7. Dendritic formed liquid inclusion of a healing fissure and growth striae (30×)

Eppler (1973) and Webster (1975) found a density of 3.29 for diopside, Schmetzer & Medenbach (1974) 3.31 for chrome diopside from Kenya, Bank (1976) 3.27 for specimens from Brazil.

The behaviour of the measured refractive indices was very similar, they lay between n_x = 1.670 (± 0.002) and n_z = 1.700 (± 0.002) with a birefringence of 0.030 and only small deviations: they also corresponded to those in the literature.

An investigation of the samples by electron microprobe analysis found an average content as follows:

SiO_2	54.601	wt %
TiO_2	0.070	”
Al_2O_3	0.219	”
V_2O_3	0	”
Cr_2O_3	0.591	”
FeO	1.032	”
CaO	23.528	”
MgO	18.003	”
MnO	0.033	”
Na_2O	0.341	”
K_2O	0.012	”
	98.430	”

These results differ slightly from those found by Schmetzer & Medenbach (1974) in one chrome diopside from Kenya.

Because of the fact that electron microprobe analysis is able to find out only contents of the surface of the sample, an additional method was used for the sample in Figure 1, viz. neutron activation analysis. This method ascertains contents of trace elements of the whole specimen, including those of the inclusions, which can give information as to the origin of the crystal.

The neutron activation analysis revealed:

Fe	8002	ppm
Na	3127	ppm
Sc	49	ppm
Cr	4674	ppm
Mn	354	ppm
Co	15	ppm
Sr	1863	ppm
La	6	ppm
Ce	21	ppm
Nd	13	ppm
Sm	2	ppm
Eu	150	ppb
Lu	111	ppb
Hf	680	ppb

By this method of analysis also no elements were found which could prove a possible synthetic origin. So we have to say that these chrome diopsides from U.S.S.R. are natural.

Further investigations of the inclusions are not yet completed.

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INTENSIVE YELLOW TSILAISITE (MANGANESE TOURMALINE) OF GEM QUALITY FROM ZAMBIA

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ABSTRACT

Transparent gem tourmalines with an intensive yellow coloration from Zambia are described. Chemical and physical properties are given. The tourmalines with manganese contents of 6-7% MnO were proved to be members of the solid solution series elbaite-tsilaisite (manganese tourmaline). The mechanism of coupled substitution in manganese tourmalines and the formula of the end members in the elbaite-tsilaisite solid solution series are discussed.

INTRODUCTION

Most of the transparent tourmaline varieties of gemstone quality are members of the solid solution series elbaite-liddicoatite or members of the series dravite-uvite. In both groups of gem tourmalines small amounts of iron, i.e., small percentages of the schorl molecule, are also present. In general, manganese-containing tourmalines of gem quality were determined as elbaites with only small percentages of MnO < 2%. The rose or rose-red colour of such elbaites is thought to be caused by the small manganese contents of the samples (e.g., Bradley & Bradley, 1953; Slivko, 1959, 1961; Manning, 1969a,b, 1973; Dunn, 1975; Nassau, 1975; Leckebusch, 1978).

A great number of gem tourmalines from different localities with yellow or brown coloration were proved by microprobe analysis to be members of the dravite-uvite series (e.g., Dunn, 1977; Schmetzer *et al.*, 1979; Hänni *et al.*, 1981). Surprisingly, however, when testing some tourmaline specimens of yellow and yellowish-brown colour, which were said to come from a new occurrence near Chipada in Zambia, by microprobe analyses, no magnesium but distinct manganese contents of about 6-7% MnO were found. A more detailed mineralogical investigation (compare Schmetzer & Bank, 1984) showed those tourmalines to be the first tsilaisites (manganese tourmalines) of gem quality known to the authors.

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The name tsilaisite was given by Kunitz (1929) for the hypothetical end member of the series elbaite-manganese tourmaline, who at that time, assumed a formula of $NaMn_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$ for this tourmaline. This formula requires a manganese content of 20.26% MnO. Due to the facts that the highest amount of manganese ever mentioned was a value of 8.21% MnO in an analysis by Kunitz (1929) and that the manganese contents in other Mn-rich tourmalines were found to lie only between 3 and 6% MnO (Scharizer, 1889; Prendel, 1892; Duparc *et al.,* 1913; Agafonova, 1947; Epprecht, 1953), the formula of tsilaisite was changed by Slivko (1959, 1961) to $Na(MnAl_2)Al_6(BO_3)_3(Si_6O_{18})(O,OH)_4$, which corresponds to the manganese contents found in natural samples.

Synthetic tsilaisite was produced by Tomisaka (1968). The synthetic tourmalines of Tomisaka, however, were not analysed chemically, and, therefore, the Mn:Al ratio in the unit cell of the synthetic tsilaisite is unknown. Recently, coupled substitutions in the tourmaline group were examined by statistical methods (Foit & Rosenberg, 1977). Manganese-containing tourmalines, however, were not considered individually. The mechanism of an isomorphic substitution of manganese in the tourmaline structure is not known in detail. Most of the tourmalines with high amounts of manganese contain different percentages of iron. Therefore, the influences of percentages of manganese on the colour of tourmalines and the valence state of this transition metal ion (bi- and/or trivalent) are doubtful.

CHEMICAL AND PHYSICAL PROPERTIES OF TSILAISITE FROM ZAMBIA

The samples available for investigation were mainly cut gemstones (Figure 1), and only some small rough fragments without individual crystal faces were observed. The microprobe analyses show the samples to be very high in their manganese and extremely low in their iron contents. An idealized formula of the tsilaisite from Zambia may be written as $Na(Li_{0\cdot5}Mn_{1\cdot0}Al_{1\cdot5})Al_6(BO_3)_3Si_6O_{18}O(OH,F)_3$. The only difference between this formula and the formula of Slivko (1959, 1961) for the hypothetical tsilaisite end member is the presence of appreciable amounts of Li in the natural sample.

The MnO contents of different crystals from Zambia were found to lie between 6.3 and 6.9% MnO. The refractive indices vary slightly with the manganese contents of the samples, and values of n_e 1.622-1.623, n_o 1.645-1.648, Δ 0.023-0.025 were measured for samples with manganese contents between 6.37 and 6.80% MnO. The refractive indices are closely related to the values given for members of the solid solution series elbaite-tsilaisite with different manganese contents (Duparc *et al.*, 1913; Kunitz, 1929), e.g., the optical properties of tsilaisite with low and high manganese contents were given by Kunitz (1929) as n_e 1.621, n_o 1.642 (2.04% MnO) and n_e 1.630, n_o 1.655 (8.21% MnO), respectively.

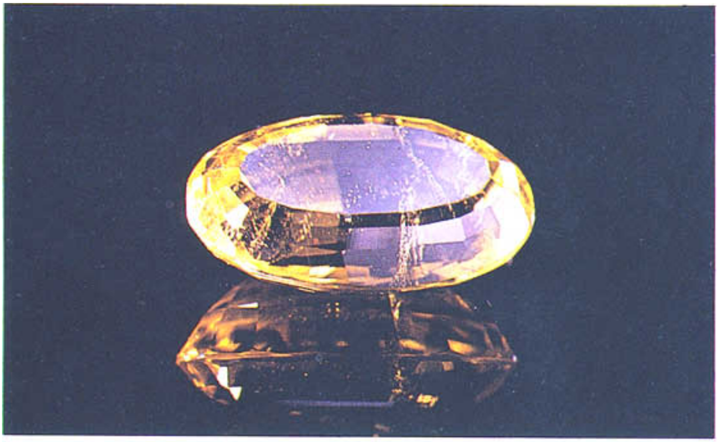

Fig. 1. Yellow tsilaisite (manganese tourmaline) from Zambia; size of the sample approx. 16 × 10 mm. *(Photo. by O. Medenbach Bochum.)*

The strongest lines in the powder diffraction pattern of tsilaisite from Zambia are 4.21 (80), 3.99 (80), 3.45 (60), 2.942 (80), 2.572 (100) and 2.034 Å (60); the powder diffraction patterns of tsilaisite and elbaite do not show any distinct differences (compare Schmetzer & Bank, 1984). The unit cell dimensions (a_o 15.915, c_o 7.123 Å) lie close to the direct line connecting the Mn-free tourmaline end members, elbaite and schorl, as given by different authors (Epprecht, 1953; Slivko & Yorish, 1964; Tomisaka, 1968; Kornetova, 1975; Schmetzer *et al.*, 1979; Sahama *et al.*, 1979).

Therefore, a distinction between members of the solid solution series elbaite-schorl and the series elbaite-tsilaisite or between tsilaisites with different iron contents is thought to be impossible by means of the unit cell dimensions of an individual sample. The density of tsilaisite from Zambia was determined as 3.13 g/cm^3.

The homogeneous colour of tsilaisite specimens from Zambia may be described as intensive yellow, greenish-yellow or yellowish-brown with distinct pleochroism o > e. The absorption spectrum in the visible area consists of a broad absorption band at 15 800 cm^{-1}, an increasing absorption from about 17 000 cm^{-1} to the blue end of the visible area, and a weak shoulder at about 24 100 cm^{-1}. The variation of colours in the Zambian tsilaisite (yellow, brown, or greenish-yellow) is dependent on the ratio of the intensity of the 15 800 cm^{-1} band versus the intensity of the increasing absorption from 17 000 cm^{-1} to the blue end of the visible area. The absorption at 24 000 cm^{-1} is not responsible for the different colours of the samples.

Due to the absence of the strong absorption band at 19 200 cm^{-1}, which is assigned to a Mn^{3+} absorption in rose to rose-red manganese tourmalines (elbaites), manganese in Zambian tsilaisites is assumed to be present in the bivalent state only. The absorption at 24 100 cm^{-1} is due to Mn^{2+} d-d transitions; the assignment of the 15 800 cm^{-1} absorption, however, is difficult. A colour centre, probably in connexion with manganese, or manganese-iron charge-transfer may be the reason for this absorption band (for further details compare Schmetzer & Bank, 1984).

ISOMORPHOUS REPLACEMENT IN THE SERIES ELBAITE-TSILAISITE AND FORMULA OF TSILAISITE END MEMBER

Coupled substitutions in the tourmaline group were described by Foit & Rosenberg (1977). For members of the elbaite-schorl series, three types of an isomorphous replacement were regarded to be present. Though these types of coupled substitution may also be present to a minor extent, the chemical composition of Zambian tsilaisite is not explained by these three types of an isomorphous replacement. From chemical data of Zambian tsilaisite, a new type of coupled substitution was found to be dominant in those samples:

$$Li^+ + (OH)^- \rightarrow Mn^{2+} + O^{2-} \qquad (1)$$

Accepting this type of an isomorphous replacement, the chemical properties of Zambian tsilaisites are clearly understood. The end members of this coupled substitution in the elbaite-tsilaisite series are represented by the formulae $Na(Li_{1\cdot5}Al_{1\cdot5})Al_6(BO_3)_3Si_6O_{18}(OH,F)_4$ for the ideal elbaite, and $Na(Mn_{1\cdot5}Al_{1\cdot5})Al_6(BO_3)_3Si_6O_{18}O_{1\cdot5}(OH,F)_{2\cdot5}$ for the ideal tsilaisite. The tourmaline from Zambia represents a solid solution of 69% of the ideal tsilaisite and 31% of the ideal elbaite end member, the schorl component of the sample is smaller than 1%.

However, the isomorphous replacement in natural manganese tourmalines is thought to be even more complicated. A calculation of the incomplete analysis of manganese tourmaline from Nertschinsk with 8.21% MnO (Kunitz, 1929), on the basis of Si = 6, leads to an approximate formula of

$$(Na_{0\cdot83}Ca_{0\cdot13})(Li_{0\cdot52}Mn_{1\cdot16}Al_{1\cdot38})Al_6(BO_3)_3Si_6O_{18}(O,OH,F)_4.$$

This formula is not completely understood assuming only an isomorphous replacement as given by equation (1). Another type of coupled substitution is thought to be present, too:

$$Al^{3+} + O^{2-} \rightarrow Mn^{2+} + (OH)^- \qquad (2)$$

Both types of isomorphous replacement, which are thought to be present in tsilaisite from Nertschinsk are combined by the following equation:

$$Li^+ + Al^{3+} \rightarrow 2Mn^{2+} \qquad (3)$$

The chemical formula of tsilaisite from this locality is understood by an additional substitution of type (1) and type (3), respectively. In the tourmaline analysed by Kunitz (1929) an isomorphous replacement according to type (1), however, is found to be dominant over a substitution according to type (3). The complete isomorphous replacement by type (3) leads to a formula of $NaMnAl_6(BO_3)_3Si_6O_{18}(OH,F)_4$, as proposed by Kunitz (1929) for the tsilaisite end member with 20.26% MnO. At present, it is unknown to what extent such coupled substitution of type (3) between (Li,Al), and Mn is compatible with the tourmaline structure. A manganese content in tourmaline leading to three Mn atoms in the formula unit was never proved to be present in tourmalines up to now. Therefore, a formula as given by Kunitz (1929), and representing a complete substitution of type (3), is thought to be only hypothetical.

From all those considerations, a dominant substitution of type

$$(1) \qquad Li^+ + (OH)^- \rightarrow Mn^{2+} + O^{2-}$$

is assumed to represent natural manganese tourmalines. A formula with 1.5 Mn atoms in the formula unit

$$Na(Mn_{1\cdot5}Al_{1\cdot5})Al_6(BO_3)_3Si_6O_{18}O_{1\cdot5}(OH,F)_{2\cdot5}$$

is suggested to be used for the tsilaisite end member. Following the reintroduction of uvite by Dunn (1977), tsilaisite is the second new (old) member of the tourmaline group, which is no longer regarded to be a hypothetical end member of this series only.

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MEDICINE NOT MINERALS

By A. E. FARN, F.G.A.

I have never really subscribed to the efficacy of the healing or curative properties of gemstones or gem materials. Neither do I care too much for such stories as Cleopatra's dissolving a fine pearl in wine to impress Mark Antony, even if the wine turned to vinegar. I do not care for the story of Nero watching bloody gladiatorial combats through an emerald slice to cut down glare; at times emerald was termed Neronianus. Some names, however, do have a certain parallel or association with medicine or well-being. In his book, *Pearls,* 1913, W. J. Dakin, D.Sc., F.L.S., Professor of Biology, University of Western Australia, Perth, states: 'We find that many of our common herbs and lowly plants came to be used as medicine and they were used for whatever their shape suggested. So we get the origin of the kidney bean and the liver wort. The pearl seemed so beautiful and pure that the idea arose that it too must have some value in this respect.'

It is not my intention to dwell too much upon the subject of pearls at this juncture except to mention the secondary use of poor quality seed pearls, etc., as aphrodisiacs and the use of the lowest quality non-nucleated cultured pearls as tomb pearls. One function to raise the spirits, the other to appease them?

The reference to the kidney bean reminds me strongly of an interesting item in a lecture given by B. W. Anderson to our diploma class at Northern Polytechnic just after our departure from Chelsea. The lecture was on 'Jade and Similar Materials'. In it Anderson discussed the use of the umbrella-term jade to cover both jadeite-jade and nephrite-jade. Because of the derivation stemming from Le Jade (French) from 'pierre de l'ejade', a direct translation from the Spanish, 'piedra de la yjada', or stone of the kidney or flank, a mix-up occurred.

The interest of authors in those days was so much concentrated on its powers of healing kidney troubles that in the Bibliothéque Nationale de Paris, as late as 1900, books on jade were listed in the section for *medicine,* instead of minerals. Damour, the French chemist, in 1863 separated the two minerals and decided to call the amphibole (nephrite) 'jade néphrétique' and to call the pyroxene 'jadeite', which, as a name, sounds rather 'like-jade' or 'jade-like'.

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But I will not spend more time on jade at present except to mention that gems, gemstones, minerals and gemmology have an interesting aspect other than strictly that of beauty or decoration. Most of us as gemmologists think of gemstones in terms of colour. I never think of diamonds in my ideas on gemmology—perhaps because basically they are *colourless,* and secondly they are cut and polished by diamond cutters and polishers, a race apart, whereas gemstones are cut and polished by lapidaries.

'The first impact of a gemstone is its colour' was the substance of a talk I gave to an international conference at Idar-Oberstein in 1979.* The basis of this idea was that, as a laboratory worker, on seeing a stone, one's reaction is to classify instinctively, i.e. a red stone could be natural/synthetic ruby, garnet, spinel, glass, etc., and the steps to follow would be guided by competent use of the 10× lens, noting double/single refraction, etc., spectroscopic/microscopic examination and so on. The accent is upon the first appearance and impact upon the eye of colour. Nature we know is not prolific in providing richly coloured gemstones whether rubies, sapphires, emeralds, etc. In fact, rubies, sapphires and emeralds are impure samples of corundum and beryl respectively. Ideally corundum and beryl are colourless as are most crystalline varieties of gemstones except the idiochromatic materials such as malachite, peridot, etc.

It seems to me that there is another aspect of gemmology which could be that of the non-gems gemmology but which nevertheless carries the mineral, rock or gemstone name or chemical composition. Such gemmological materials as I have in mind have an important secondary role in commercial markets. I have touched upon the aphrodisiac value of pearls which, according to a well informed Asian source, has indeed some interest. He quotes a case of a Chinese gentleman who has wined and dined well and suffers a little discomfort: it is not uncommon in such cases in Hong Kong to go to a chemist and ask for a draught, which will be made up on the spot by grinding with pestle and mortar seed pearls in distilled water. This is swallowed, followed by a hearty belch, thus proving that the basis of good stomach powder is calcium carbonate (seed pearl). The feeling of well-being engendered does not, I fear, go further than the digestive system!

***Z.Dt.Gemmol.Ges.*, **28**, 4, 188-90.—Ed.

Calcium carbonate (calcite) when burned gives us lime which has considerable use in the building industry and in soil balance—brassicas love it. Another useful gem material in the building industry is gypsum—the subtranslucent type is termed selenite, while satinspar is the name given to a fibrous variety. Gemmologically it is important as number 2 on Mohs's scale of hardness. When burned it forms 'Plaster of Paris', so called from its source in Montmartre (Paris) gypsum quarries.

Slightly softer than gypsum is talc, being number 1 on Mohs's scale: it is known to most gemmologists in its ornamental garb as soapstone. Soapstone has a slippery touch and as a powder provides that smoothness that caresses the body or lubricates the dance floor.

In terms of powders one of the most interesting is haematite, an iron oxide used for carving intaglios and, when crushed, becomes a red powder known as rouge (and a basis for lipstick) or Jewellers' rouge. It is used extensively as a fine polishing agent. Haematite has a red streak when tested. Two other well known polishes and abrasives are derived from synthetic powdered Al_2O_3 (corundum), namely Aloxite and Alundum. Emery or emery paper, suitably graded, can be used wet or dry as a fine finishing agent in metal cleaning and particularly in car body repair work. It is interesting to note that emery consists of corundum, magnetite and haematite, the grain structure of which readily fractures to offer fresh sharp faces for cutting/abrading.

Talking of mixtures in the form of rock material, one of the commonest, interesting and most useful is granite. Granite has occasionally been polished and used in pendants as an ornamental stone, but as a building material and kerb stone it is supreme. I never fail to examine chunks of granite jettisoned by the builders of our local sea-wall. The inclusions of quartz, feldspar and mica reflecting in the sun attract me and usually end up at home on the rockery.

Ornamental stones such as crushed lapis-lazuli were originally used as pigments for artists, ultramarine being the derivation from lapis-lazuli.

In the January 1974 issue of this *Journal* I wrote an article entitled 'An Appetite for Gemmology',* no pun being intended or play upon a similar sounding gem material, apatite. Apatite occupies position number 5 halfway up or halfway down Mohs's

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J. Gemm.*, 1974, **XIV, 1, 16-19.—Ed.

scale. It is a collector's stone, being too soft for real jewellery use. It does, however, have a secondary interest. Despite some enthusiasm in Canadian circles at one of our international conferences where we were presented with useful little samples of 'Trilliumite' (pale green apatite), the broad use of the term 'mineral phosphate' indicates its use as a *fertilizer.* The derivation of the word apatite was from the Greek for 'to deceive', being confused in early days with aquamarine, tourmaline, etc. (fertile imagination?). When one considers such secondary roles of gem minerals, it is not surprising to follow on to differing physical appearances of the same chemical compound, one of the most remarkable, to my way of thinking, being a calcium carbonate which, being basically $CaCO_3$, occurs in oysters and pearls in the labile and stable forms of calcite and aragonite respectively, each having differing hardnesses, densities and crystal formations but both being calcium carbonate. (E. S. Dana does not accept biomineralization products as minerals.)

As an abrasive, diamond is, to all intents and purposes, the hardest known substance and is, almost entirely, carbon; yet in another form known as graphite, carbon is a soft lubricant. Graphite is rhombohedral and occurs as six-sided tabular crystals sometimes showing triangular markings on the basal plane. Although diamond is chemically described as pure carbon, whilst graphite is described as carbon (very often impure), it is interesting to note that some graphite burns more readily than diamond—a somewhat expensive and not absolutely definitive method of differentation.

Most school children are familiar with pencils marked H, HB, etc., which is indicative of the grade of the pencil lead. This lead is graphite (plumbago, black lead) and usually it comes from Sonora, Mexico. Thus we have a fascinating example of the complete range of Mohs's scale of hardness, diamond 10—graphite 1 = carbon; both have the same end result when burned. These differing physical appearances of materials having the same chemical composition are an aspect of gemmology which I find as interesting as I do the other roles of gem materials. I think that these aspects—the senses, the impact and the use of the ten times lens—are of considerable importance and contribute to the enjoyment of the gemmological scene.

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SAPPHIRES FROM KANCHANABURI PROVINCE, THAILAND

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ABSTRACT

An occurrence of sapphires in the Kanchanaburi province, Thailand, is dealt with here. Detailed descriptions of the location and accessibility of the area are given. Recent geological investigations of the Kanchanaburi province are reported and compared with the well-known gemfields to the east, namely, Chanthaburi-Trat. Chemical and physical analyses are presented with gradings of colour according to DIN colour system. The most typical internal scenes of the sapphires found are presented in photomicrographs and carefully analysed.

INTRODUCTION

Thailand—the land of free people, long noted for its collection of gem quality rubies and sapphires—has today become the world's premier ruby centre. The distribution of these rubies is mainly concentrated around the Chanthaburi-Trat area, as reported by Pavitt (1973), Berrangé & Jobbins (1976), Gunawardene & Mertens (1982) and Keller (1982). However, the basaltic distributions extend to the north and the west covering the gemfields in Phrae and Kanchanaburi respectively. During the last 10 to 12 years the Kanchanaburi area has become an interesting sapphire locality and was mentioned by Angkatavanich (1975) in Thai geological reports. Short mentions were made by Findlay (1979) in this *Journal*, and elsewhere (Healy & Yu, 1982).

Kanchanaburi is one of the most beautiful provinces of Thailand. It is famous among war historians and movie buffs as the site of the notorious 'Death Railway' and the 'Bridge over the River Kwai', and among archaeologists for its Neolithic burial grounds. Many other tourist attractions like Kao-Poon cave, located about 1 kilometre away from the 1750 prisoners Chung-Kai war cemetery, and Kao-Phang waterfall are worth mentioning.

The beautifully landscaped gemming area is in Bo Phloi. The mines have yielded an enormous quantity of commercial grade blue sapphire; fine gem material, of course, has also been found.

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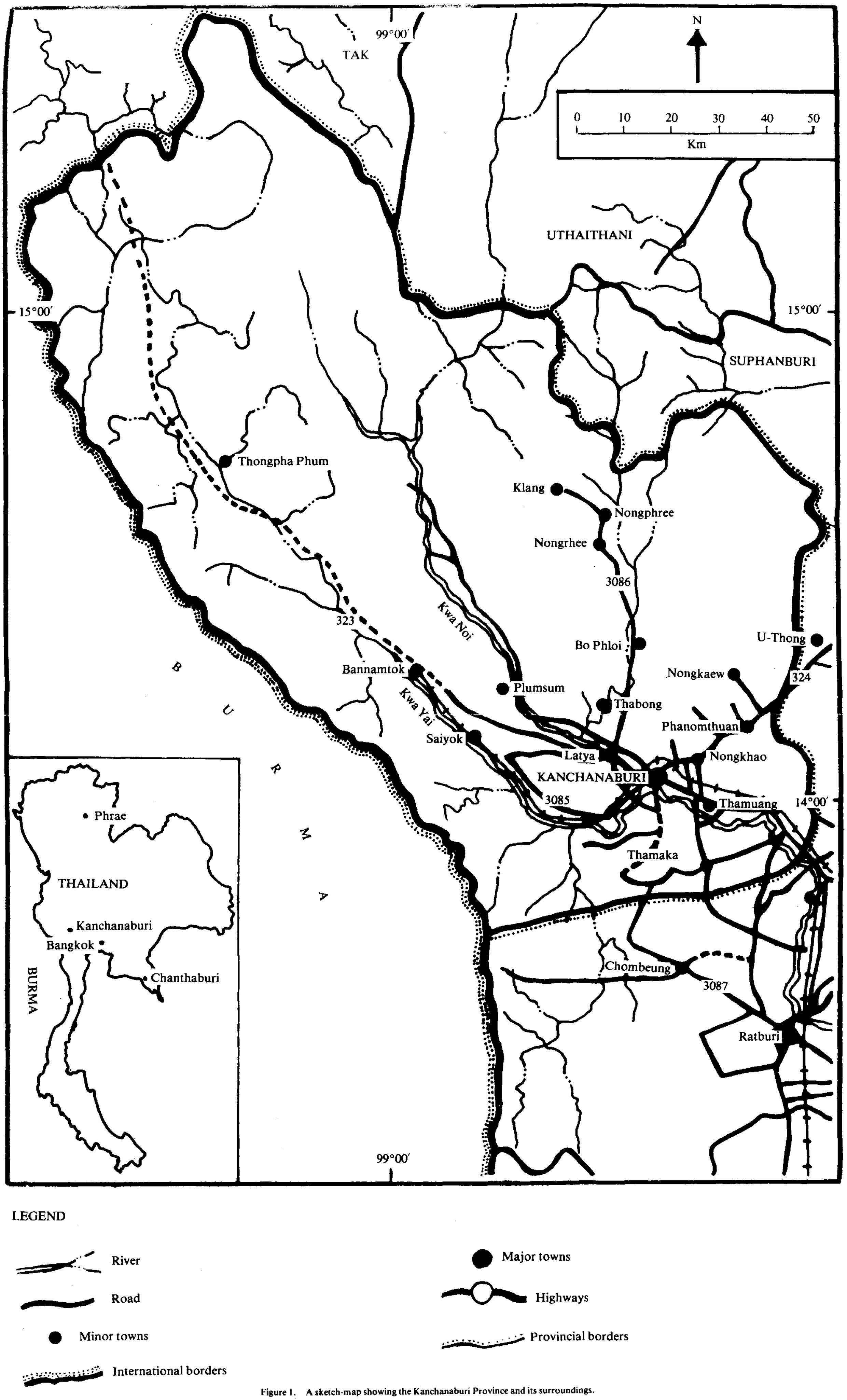

Figure 1. A sketch-map showing the Kanchanaburi Province and its surroundings.

LOCATION AND ACCESSIBILITY

Kanchanaburi is located approximately 129 kilometres west of the capital of Thailand, Bangkok. As shown in Figure 1, the mining centre Bo Phloi (Bo Phloi means 'gem mines' in Thai) is situated 44 kilometres due north from Kanchanaburi town in the Kanchanaburi province. The mining area is centred approximately in the middle part of a large area which extends from approximately 99°00′ to 100°00′ and 13°00′ to 15°00′. Running through the area are two tributaries, the Kwa Noi and Kwa Yai, which meet to form the Mae-Klong river (Mae-Klong means 'mother of rivers' in Thai) near to Kanchanaburi town.

Thanks to the Thai engineers, one can easily reach Kanchanaburi town from Bangkok by super-highway 323; after passing through this town one must turn right to a smaller highway 3086 and continue to Bo Phloi (distance from Bangkok to Bo Phloi is 173 km). The drive can be comfortably accomplished in two and a half hours by car. Bo Phloi is a typical little Thai village, with wooden houses and corrugated tin roofs. The main mode of transportation of the local miner is the motorbicycle, which they use to reach the remote mines and along dirt tracks extended from here to the various gem pits. Yes, indeed, the scene is very picturesque, and all is usually peaceful; the stones are mined, the rice is cultivated and life continues at a gentle pace.

GEOLOGY

Under such tropical climatic conditions the sedimentary and metamorphic rock cycles in the Kanchanaburi area show alluvial, eluvial or residual deposits predominating in the underlying basalt (Vichit *et al.,* 1978; Gunawardene & Mertens, 1982).

The age of the basalt of the area is not yet determined. However, overlies of the tertiary to Permian and carboniferous Devonian aged Kanchanaburi formation are reported (Javanaphet, 1969). The Permian layer consists of light grey limestone interbedded with shale sandstone, conglomerate and volcanic tuff. The deposits are composed of quartz, quartzite, slate and granite. The presence of sapphires in a basaltic outcrop is quite usual when considering the general gem occurrences in Thailand (Berrangé & Jobbins, 1976). The overlie situation in Kanchanaburi was

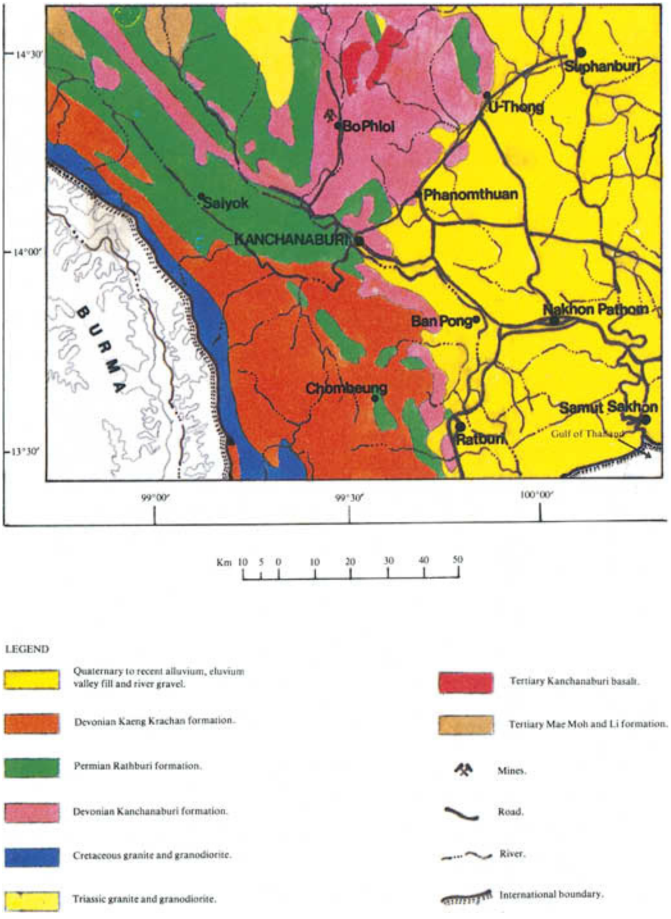

Figure 2. Geological map of the area around Bo Phloi (after Javanaphet, 1969).

mentioned by Javanaphet (1951) and supports the paper published by Berrangé & Jobbins in 1976. Illustrated geological framework of the Kanchanaburi Province is shown in Figure 2.

The famous gem locality of the area is Bo Phloi, where sapphires are extensively mined. Owing to deep chemical weathering and rapid erosion the solid rock is rarely found except occasionally in beds of streams. Apart from the major occurrence of sapphires (mostly blue and partly yellow and colourless) as shown by Vichit (1977), the abundant occurrence of feldspar and fluorite in the hornblende biotite granite was reported by Angkatavanich in 1975. However, information received by the author (M. G.) in this connexion (the Royal Thai Survey department, private communication) revealed the rarity of their gem quality counterparts. Equally possible is that the less durable minerals like fluorite or feldspar may not survive in ideal cuttable sizes under such upheavals of alluvial or eluvial deposits. The corundum would not suffer so much change under such environmental conditions owing to its durability and heaviness. Blue sapphires are the main occurrence in this basalt field, with few yellow and colourless sapphires. Sample examinations at the mines revealed the presence of black spinels embedded in the rocks.

MINING METHODS

As with other corundum mines in Thailand, these fields are worked most primitively. Principally two distinct mining modes are employed—pit mining and open shaft mining.

Hundreds of pits ranging in depths from 5 to 15 metres have been sunk (some pits being only 2 metres apart). The walls of the pits have been reinforced with bamboo canes, and workers lower themselves by means of 'bamboo ladders' as shown in Figure 3, where they dig out and collect the gem-bearing gravels into the buckets. The buckets are hoisted up by means of crude pulley-type mechanism (Figure 4).

In other areas of the mining region, large open shaft mines are used. A large amount of overburden (or top soil) is removed, creating craters about 20 metres across. The gem-bearing gravel is collected and washed, using various schemes which have been

Figure 3. Pit mining of sapphires in Bo Phloi. The walls of the pit are reinforced with bamboo canes and the 'bamboo ladder' used to climb down to the pit.

Figure 4. Hoisting the buckets containing the gem gravel by means of crude pulley-type mechanism.

developed to facilitate the excavation and cleaning of gem gravels. Artificial pools are created by diverting water from a nearby river (a tributary of the Kwa Noi).

This water flow is passed through wooden gravel-containing crates (which are termed 'Thraka Mai' by the natives), so that the clays in which the sapphires are imbedded loosen and crumble. The decomposed material then travels downwards into the pool, the sapphires and other larger rock types being collected by sieves which are fixed in crates.

Figure 5. Use of strong jets of water to clean the remaining clay at the final stage of cleaning. Later, the workers sit on these large wooden crates and pick out the sapphire crystals by hand.

The rocks and sapphires are then transported to a separate series of large, wooden crates with fine-meshed bottoms. Again strong jets of water are used to clean the remaining clays as shown in Figure 5. As the last step the workers sit in these crates and carefully pick out the sapphire crystals by hand.

TABLE 1. Colour grading of Kanchanaburi sapphires according to DIN colour system.

No. of stones used	Colour system after DIN 6164	Standard X_c	colour Y_c	estimation Z_c	Comments on colour	Other remarks
4	16:4:4	9.0	7.5	20.5	Dark blue resembling somewhat the Australian blue with a greenish hue.	Oval mixed cut. Strong zoning of dark blue.
2	16:5:4	7.8	6.2	20.5	Deep inky blue similar to darker Pailin blue and slightly visible greenish hue.	Oval mixed cut. Zoning running through the stones.
3	16:3:5	6.9	6.2	20.5	Inky blue with a greenish-yellow hue.	Antique mixed cut. Zoning and many fractured feathers.
1	16:4:5	5.8	4.9	13.4	Blue colour resembling fine Sri Lanka stones.	Round mixed cut. Even colour concentration. Fine silk.
5	17:2:2	28.9	28.7	46.1	Blue colour with zoning.	Many shapes of mixed cut stones. Fine zoning.
8	17:1:3	24.1	24.1	31.0	Slightly inky blue with whitish-green hue.	Many shapes of mixed cut stones. Zoning with lighter coloured gaps in between.
4	17:2:3	19.4	19.3	31.0	Light blue colour with greyish hue.	Oval mixed cut. Strong zoning.
5	17:3:3	16.0	15.9	31.0	Light blue.	Many shapes of mixed cut stones. Zoning.
4	17:2:4	12.9	12.8	20.6	Very light blue.	Flat antique mixed cut. Zoning.
3	17:3:4	10.6	10.5	20.6	Very light milky blue.	Many shapes of mixed cut. Strong milky zoning.

GEMMOLOGICAL CHARACTERISTICS

The sapphires found in Kanchanaburi can readily be distinguished from the sapphires found in alluvial deposits of Sri Lanka or Australia by the study of various properties mentioned below, including the internal characteristics.

Besides the main chemical component of Al in the sample stones analysed a Cl percentage was recorded by the microprobe. Since the analysis was qualitative, the exact percentage of this unusual Cl content as well as the usual Fe and Ti percentages were not calculated in this determination.

Thirty-nine well cut Kanchanaburi sapphires of different blue tones and hues were used in the colour-grading according to the DIN 6164 system. The darker-coloured blue sapphires were in the 16:4:4 to 16:4:5 range and the lighter-coloured stones ranged between 17:2:2 and 17:3:4. The graded stones and their colour numbers are given in Table 1. Most of the stones examined revealed a greenish to greyish hue in directional observations. Most of the cabochon cut commercial grade are of the lighter colour grade.

The refractive indices and specific gravity values are slightly variable in these sapphires from Kanchanaburi (RI $1.761 \, ^{+0.008}_{-0.001}$ — $1.769 \, ^{+0.008}_{-0.001}$, DR – 0.008, SG 4.00 ± 0.001 at 4°C); however, a distinct difference from sapphires from other localities was not found. Those with higher Fe content often showed the typical blue sapphire spectrum with distinct lines at 450 and 460 nm. All the stones exposed to both short- and long-wave ultraviolet radiations remained inert.

The growth conditions in such an environment of basaltic terrain have left readable evidence presented in the form of mineral inclusions in these sapphires. Such an eloquently informative preformed feldspar crystal is shown in Figure 6. Equally characteristic mineral paragenesis is a dominant primary sulphide in an iron-rich basalt, namely pyrrhotite, which may alter to goethite with attendant metallic appearance (Figure 7). Qualitative microprobe analysis proved the presence of Na, Al, Mg with Si confirming hornblende in the form of crystals as in Figure 8. Fractured feathers, often filled with the remaining iron oxide can be taken as a common inclusion in Kanchanaburi sapphires (Figure 9). Frequent dislocations in the form of needle-like structures were often seen within the sapphires from this locality (Figure 10), but

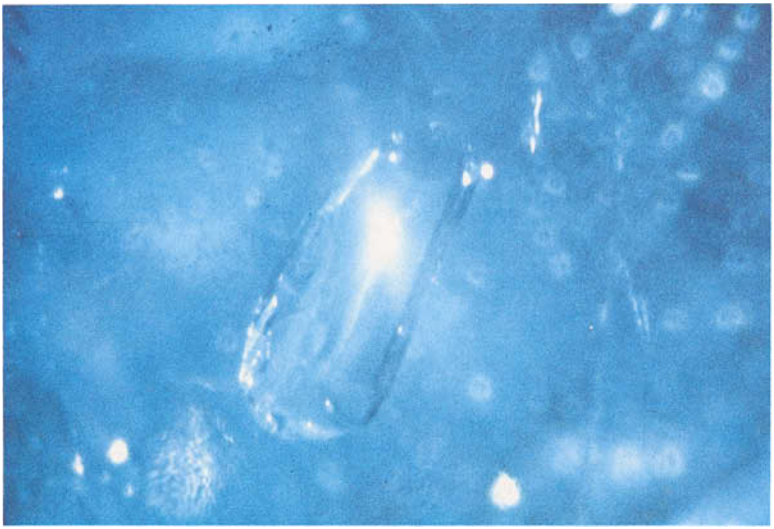

Figure 6. Moderately transparent, abundant occurrence of feldspar ($KAlSi_3O_8$) crystals. 60 × .
(photo: M. Gunawardene)

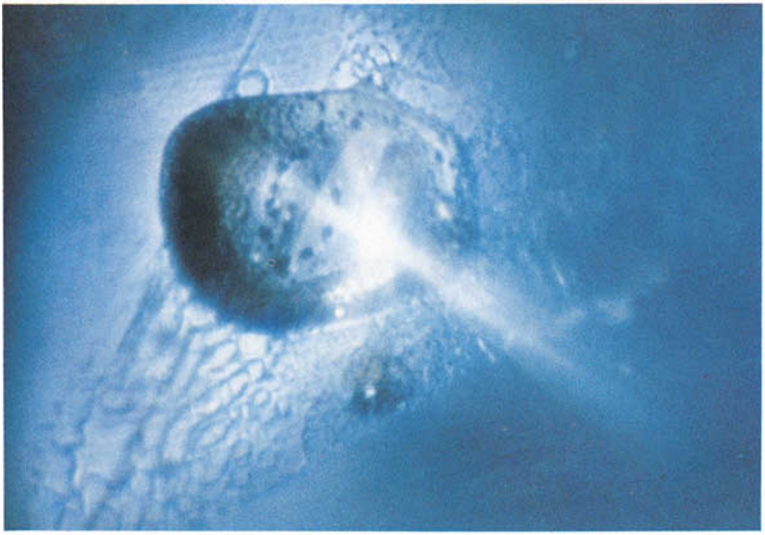

Figure 7. Intruded submetallic appearance of pyrrhotite ($Fe_{1-n}S$) crystals. 80 × .
(photo: M. Gunawardene)

Figure 8. Typical prisms of hornblende seem to be a common mineral inclusion in these sapphires. 40 × . *(photo: M. Gunawardene)*

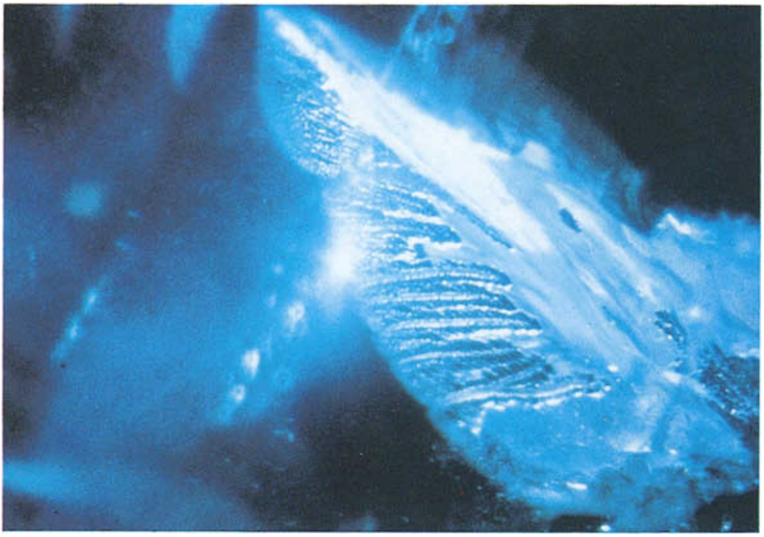

Figure 9. Naturally formed leaf-like healed feather in Kanchanaburi sapphire. 20 × . *(photo: M. Gunawardene)*

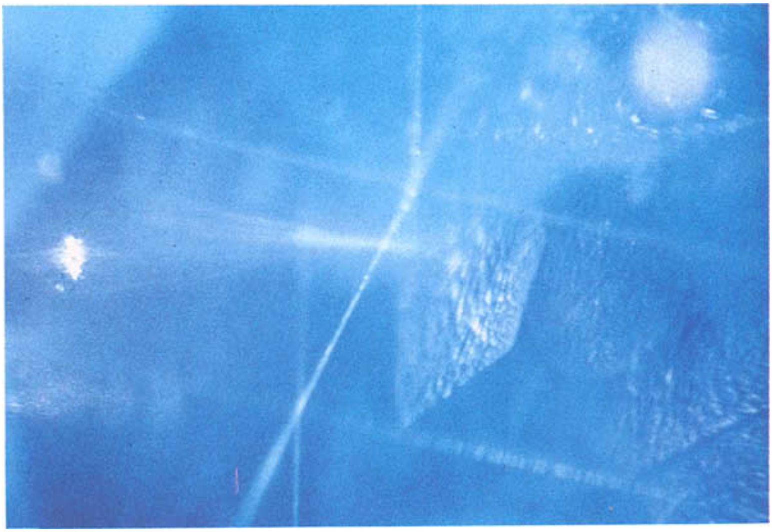

Figure 10. Needle-like structures of dislocation directions are frequently seen in sapphires from this locality. 25 × . (*photo: M. Gunawardene*)

without the typical rutile orientation as in sapphires from Sri Lanka. The stones studied indicated the presence of fine stubby rutiles similar to those seen in blue sapphires from Burma as described by Gübelin (1974). The characteristic polysynthetic twin planes, which are usually present in corundums from Thailand (other than Kanchanaburi), Cambodia, Australia and E. Africa, were observed also in this investigation of sapphires from Kanchanaburi.

CONCLUSION

The past military activities in Cambodia reduced the production of blue sapphires in the famous gemfield Pailin. This stimulated the mines in the Kanchanaburi area to market their gemmy material in the Thai gem trade. However, the decrease of the military forces in Cambodia has effected the blue sapphire market of this region during the last few years: and the small basaltic rock area comprises only a limited number of gem quality sapphire deposits and fruitful production has become less in the trade now than before.

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HYDROTHERMAL GROWTH: THE FIRST HISTORICAL ACHIEVEMENT BY GIORGIO SPEZIA ON QUARTZ

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ABSTRACT

One of the two original bombs devised and employed by Giorgio Spezia, at the beginning of this century, is kept at the Museum of the Mineralogy Institute of Turin University. It is here described and illustrated with several photographs. An account is given of the technique, with comments on the first results by Spezia. The conclusions are contained, in practice, in an interesting letter dated in 1948, from the United States of America, reproduced at the end of the article.

INTRODUCTION

Several methods for growing artificial crystals are named after their inventors. A typical example, well known in gemmology, is that of the Verneuil corundums, which are in fact obtained using the special furnace invented by Professor Auguste Verneuil at the end of the last century and reported for the first time in 1902.(1) A similar origin can be traced for the names of other methods: Czochralski (1918), Bridgman (1925), Kyropoulos (1926), etc.(2)

Nonetheless, one of the growth methods most widely employed, not only for jewellery but chiefly for electronics, is not named after the inventor, but after the growth process on which it is founded. Actually, the reason why the *hydrothermal method* is not known as the *Spezia method* may be confidently attributed to the fact that it is not alternative to and different from the natural process, like many others, but just the result of the laboratory reproduction of natural genetic conditions.

Nowadays we increasingly hear about gems grown by hydrothermal synthesis. Although the working principle of the method is generally known, I think a short illustration of it to be worthwhile as an introduction to the main subject of this paper.

The principle is that of increasing the solubility in aqueous solutions of substances nearly insoluble under room conditions by an adequate increase of temperature and pressure.

The vessel for the hydrothermal synthesis is a sort of autoclave (Figure 1), nicknamed 'bomb', which consists essentially of a long

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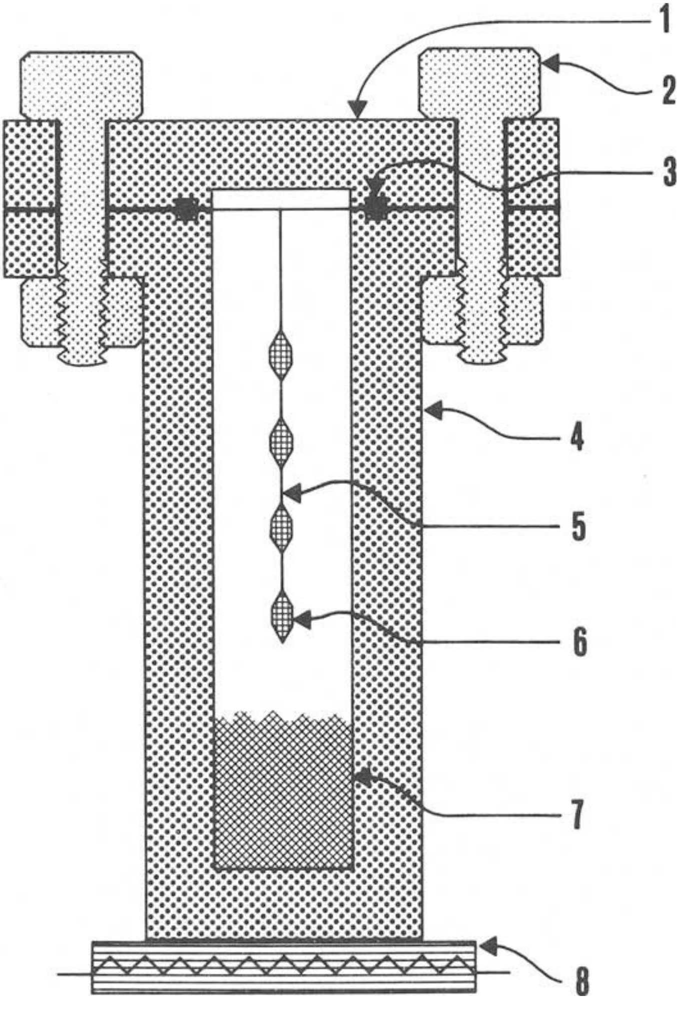


Fig. 1. Scheme of the apparatus for hydrothermal growth: 1, lid; 2, bolt; 3, gasket; 4, vessel body; 5, noble metal wire; 6, seed; 7, nutrient; 8, heating element.

cylindrical steel body, thick walled, provided with a hermetical sealing resistant to the high pressures and relatively high temperatures. The bomb is externally heated by an electric resistance. It is charged with an amount of fragments or powder of the substance to be crystallized (or of reagents to yield the wanted crystals) called *nutrient,* plus a water solution of other compounds easily soluble under room conditions. Such compounds, e.g. potassium hydroxide, sodium carbonate, sodium or lithium chloride, etc., facilitate the dissolution of the nutrient, and therefore they are called *mineralizers* according to their function.

The solution expands during the bomb heating (approaching the vapour phase): a hydrostatic pressure is generated in this way; the higher the temperature and the initial per cent volume taken by the solution, the higher the final pressure.

With the heating element in the lower part of the vessel (Figure 1), as is now common practice, the working scheme is as follows:

(1) because of the temperature and pressure generated by the heating (according to the choice and needs of the operator) part of the nutrient dissolves and, therefore, a *solution* originates inside the bomb;

(2) the temperature difference between the lower zone (hotter, since nearer to the heater) and the upper one originates *convective streams* in the solution (movements from the bottom to the top of the hotter and less dense solution and, counterwise, movements from the top to the bottom of the colder and denser solution).

The solution can keep a certain amount of nutrient as solute which depends on the fixed values of temperature and pressure (*equilibrium values* corresponding to the *saturation*). By lowering the temperature and maintaining the initial pressure, this equilibrium no longer holds: the solution cannot retain the previous amount of solute (this new condition corresponds to a *supersaturated* solution). A well determined quantity of solute must necessarily be released (it *precipitates*) in order to obtain a new equilibrium.

In the common practice, as mentioned before, the solution moves up from the bottom side of the vessel; by cooling in the upper side it becomes supersaturated.

Owing to the simultaneous action of the two effects quoted above at (1) and (2), a steady flow takes place: the ascending solution separates some *precipitate* in the upper part of the bomb, whilst when descending to the bottom it does 'reload' with solute so that the cycle can be continued. The solute fraction precipitating from the solution during the ascension, deposits upon small crystal *seeds* hung inside the bomb at preselected heights. The seed size increases so generating the artificial crystals.

Corrosive effects by the solution at high temperature and pressure are avoided either by lining the inner walls of the bomb with inert materials (e.g. silver, gold, platinum), or by making a sealed capsule into which crystals grow and by filling the interspace between the capsule and inner walls of the bomb with distilled (virtually inert) water.

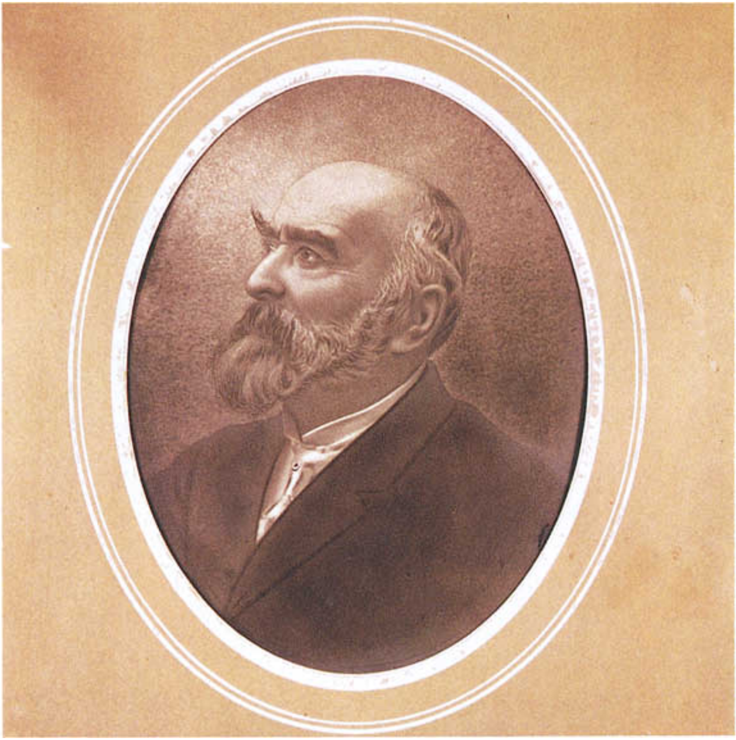


Fig. 2. Giorgio Spezia (1842-1912).

DESCRIPTION OF SPEZIA'S APPARATUS

Whilst many people know the fundamentals of the hydrothermal method for growing crystals, only a few know that it was devised, as mentioned above, by Professor Giorgio Spezia (1842-1912) (Figure 2) at the beginning of this century (1905), when he was the head of the Istituto di Mineralogia dell' Università di

Fig. 3. One of the two original apparatuses devised and used by Giorgio Spezia.
(Overall height: 500 mm).

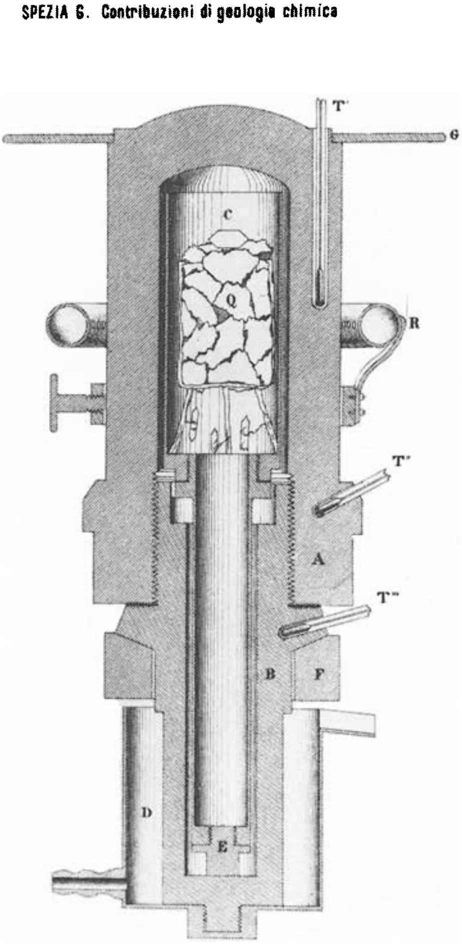
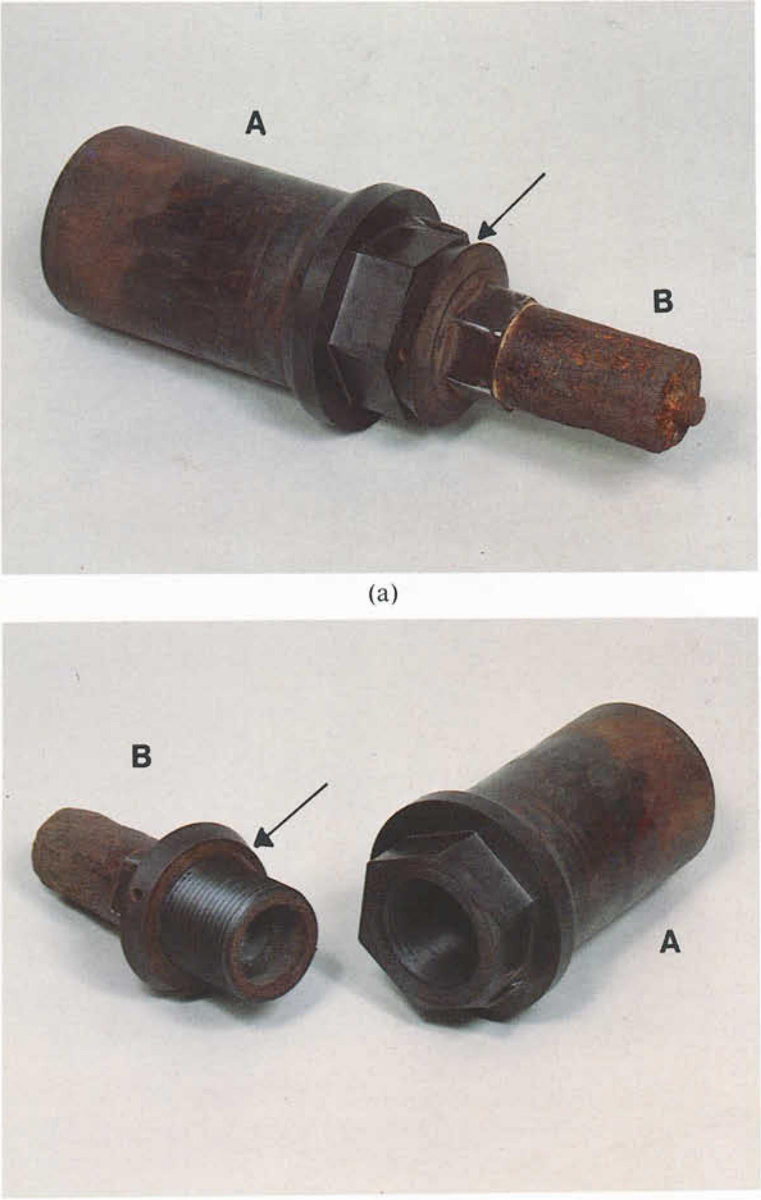


Fig. 4. Diagram of Spezia's apparatus (reproduced from the original paper (Spezia, 1905)).

Torino (Italy), which now bears his name. Finally, very few know that one of the two instruments he used personally has been preserved in its original assemblage in the Museum annexed to the Istituto (Figure 3).

Spezia's bomb (he never used this nickname) was not built by a cylinder and tight cover as today's bombs, but by two steel halves



(b)

Fig. 5. The two halves of Spezia's apparatus body. The arrow points at the silver gasket. (a) Halves screwed together. Note part (B) corroded and made rusty by the cooling water circulation. (Length: 380 mm; ext. diam. of the upper part: 107 mm). (b) Halves unscrewed.

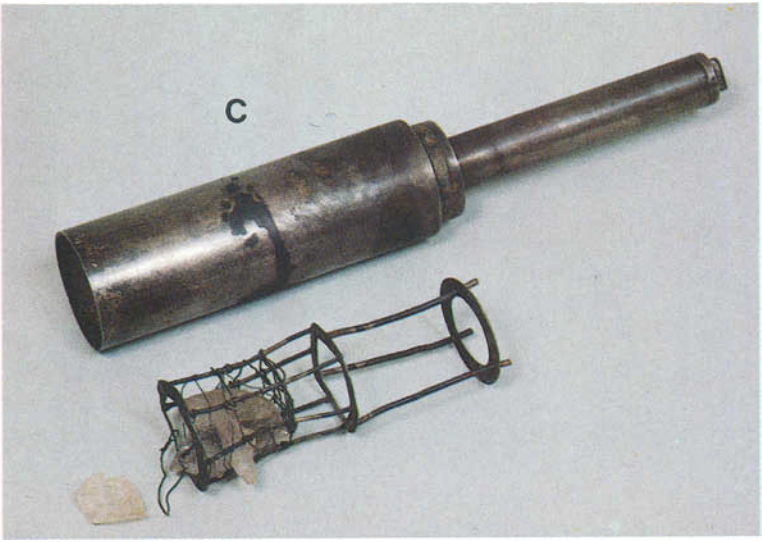


Fig. 6. Top. The silvered copper container (C). (Length 313 mm; external larger diameter 54 mm). Bottom. The silver basket, to be placed inside (C), containing quartz fragments used as nutrient. (Length 141 mm; diameter 48.5 mm).

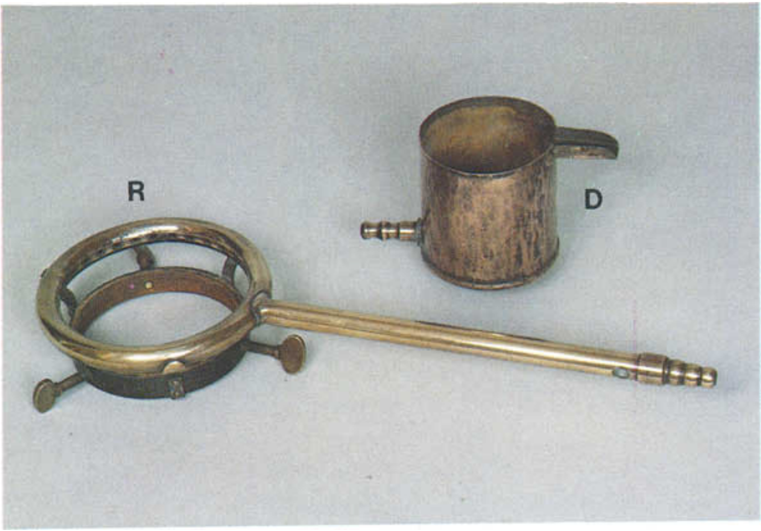


Fig. 7. Top. The muff (D) (to be screwed at the lower end of the bomb body) for the circulation of the cooling water. (Height 110 mm; diameter 92 mm).
Bottom. Gas annular burner (R) mounted on crown locking with three wing-screws. Note the holes for the flame outlet in the inner surface of the ring. (Length 453 mm; external diameter 155 mm).

(A) and (B) screwed one into the other, as shown in Figures 4 and 5, the first of them taken from Spezia's paper.(3)

Inside both halves the long container (C) was placed (Figures 4, 6), made with silvered copper. Apropos of this container (that, oddly enough, was left *open* at the upper end) Spezia wrote: '. . . I employed silvered copper because from a different experiment, having placed in a copper container vitreous sodium silicate plus distilled water, keeping the whole at high temperature for a few days, I obtained crystalline quartz aggregations with copper inclusions . . .'. (3, pp.256-7)

Spezia used, as heater, an annular gas burner (R) (Figures 3, 4, 7) with small holes in the inner surface of the ring, placed at about half the height of the upper half of the bomb. The lower part of the assemblage was cooled by water circulating in the muff (D) (Figures 3, 4, 7); T', T'', T''' (Figures 3, 4) are mercury thermometers to check the temperature during the experiments.

A tight closing between parts (A) and (B) was secured by a silver gasket placed just above T''' (Figures 4, 5); the two parts show an external hexagonal section to allow locking with appropriate spanners. Thermometer T' was thermally insulated from (R) with an asbestos circular sector placed at (G) (Figures 3, 4).

Spezia himself complains that screwing of the two halves of the bomb 'presents the drawback of large resistance when having to open the apparatus when it works for a long time: therefore it would be better that the two parts were tied together by some projecting tongues screw tightened'. (3, p.258) A kind of closure (by means of many screws) similar to that here suggested is now adopted for a certain kind of bomb of large size.

Spezia had two identical instruments manufactured: (4, p.159) both were supported by a ring (F) at the level of the hexagonal section (B); in one case the ring (F) was linked to a walled bar, in the other case it rested on a four-legged support. The second apparatus is that still kept in the Mineralogical Museum of Turin University (Figure 3).

For the growth runs Spezia placed in the upper part of the cylinder (C), astride the zone in contact with the flame, a silver basket (Q) (Figure 6b) filled with fragments of natural quartz; the seeds destined to capture the solute fraction from supersaturated solution were placed in a lower place.

From the above description a peculiarity results, both of scientific and historical interest. Spezia, for the 'transport' of the solute from the dissolution to the crystallization zone, did not exploit the convection effect as it is commonly done nowadays.

In point of fact in Spezia's apparatus dissolution and deposition zones were *reversed* because of the placement in the upper part of the heating element and in the lower part of the cooling element.

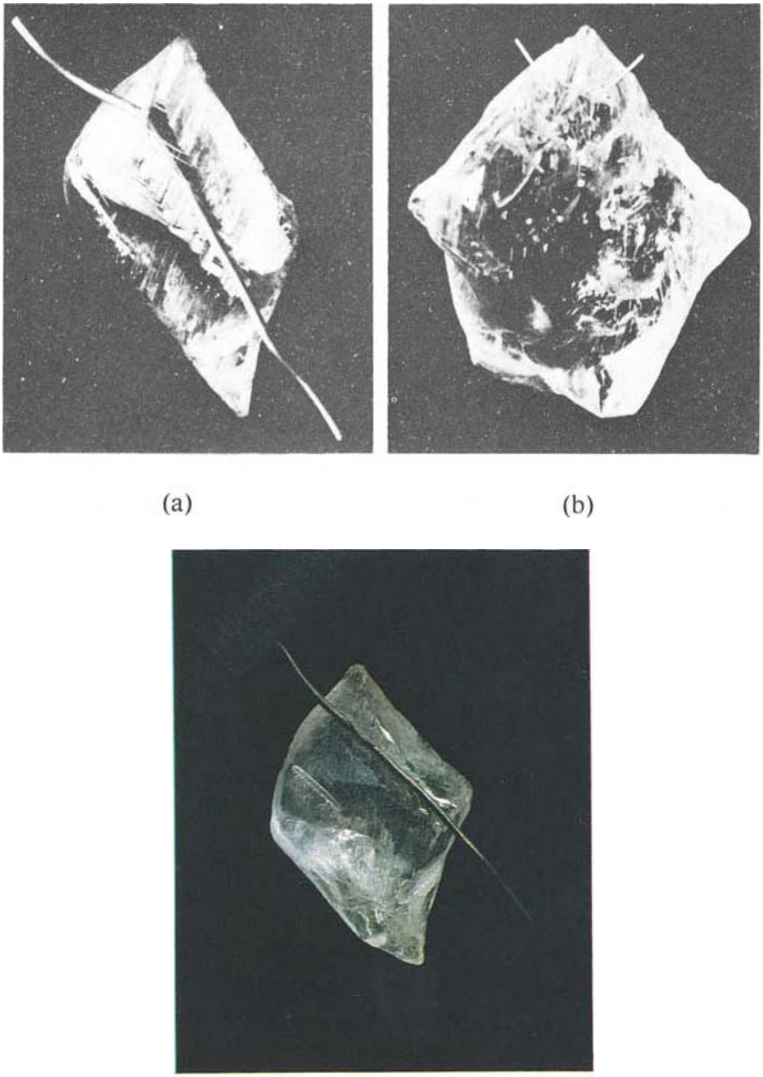
In this device natural convection of solute does not occur. Nevertheless, the crystallization does. This can be done by solute diffusion only. In fact, when in a given volume of solution the solute concentration is not homogeneous, the solute particles propagate from the higher concentration zones to the lower ones. With this method the growth rate of the crystals is much lower but more regular.

FIRST RESULTS BY SPEZIA

For his first run, that lasted six months, Spezia employed a solution of sodium metasilicate octahydrate ($Na_2SiO_3.8H_2O$) dissolved in water so as to obtain a 2% solution of Na_2SiO_3. The average temperatures over the whole run time were: 338 °C at T′, 221 °C at T″, 164 °C at T‴: '. . . Therefore, assuming that 338 °C was the maximum temperature, a uniform pressure of 150 atmospheres must have taken place in the whole apparatus afforded by the water vapour pressure of the aqueous solution at this temperature . . .'. (3, p.259)

Spezia could note first of all a deep corrosion of the quartz fragments placed as nutrient strictly astride the heated zone, whilst the fragments below appeared cemented one to the other and crystal faces developed only where the deposition was not hindered.

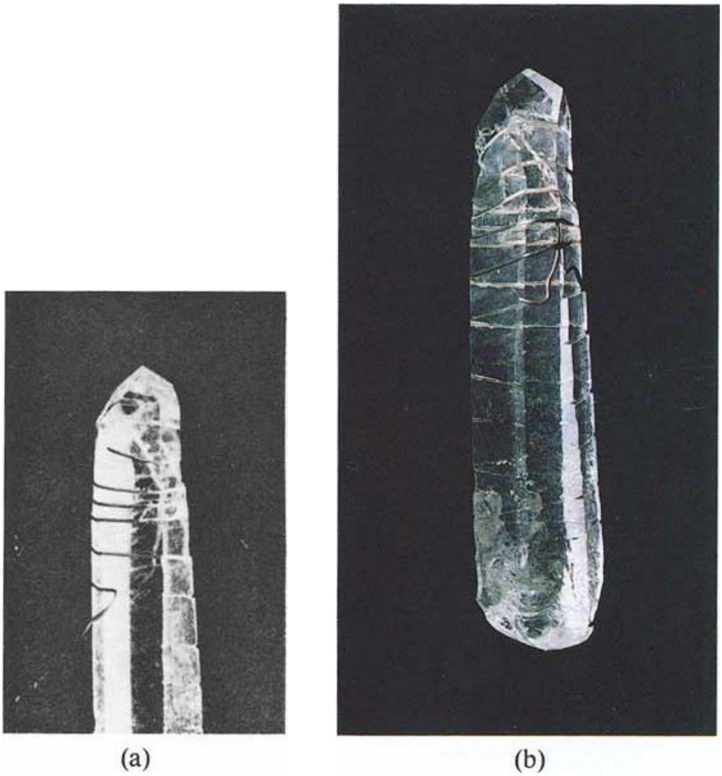
In his first paper, Spezia describes, reproducing the two photographs (Figure 8), 'two fragments removed from the little basket after cutting the silver thread imprisoned by them'. (3, p.260) Unfortunately, only one of two samples has been recovered up to now; it is shown in Figure 8c.



(a) (b)

(c)

Fig. 8. Fragments removed by Spezia from the basket after the first run.
(a) & (b) The silver threads of the basket imprisoned during artificial growth are clearly visible (reproduced from Spezia's original paper (Spezia, 1905)).
(c) Colour picture of the fragment shown in (a). Note the thread groove visible with difficulty in (a). (Diagonal 24.1 mm).



(a) (b)

Fig. 9. Quartz crystal with a thin synthetic layer at the top.
(a) Picture reproduced from Spezia's original paper (Spezia, 1906).
(b) Whole crystal in colour. Note the base partially dissolved and the silver thread caught by synthetic layer, near the sound upper apex. (Length 47 mm).

One of the three crystals placed as seeds below the basket '. . . showed a growth of quartz with partial inclusion of the wire . . . ' (3, p.260)

With regard to this point, Spezia is probably right in deeming that the distance of the seeds from the dissolution zone was not very appropriate in order to have a large deposit.

Better results were obtained from a new series of runs.(4) A quartz crystal from Dauphiné (France) with hexagonal habit, about 4.5 cm long and 1.1 cm in section, broken at one end, was placed in the bomb with the broken end in the 'dissolution milieu' (to report Spezia's expression) and the sound apex inside the 'deposition milieu'. After 100 days, employing the same kind of solution and under conditions similar to those of the first experiment, the crystal appeared as in Figure 9. Three other squat prisms cut from different crystals had grown as shown in Figure 11. On illustrating his results, Spezia reports: '. . . I also looked for inclusions and noticed them in the long crystal subjected to growth. They are in the thin growth layer of the prism faces; they are liquid inclusions with gas bubble, and are large; . . .'. (4, p.162) The inclusions are in fact shown in Figure 10.

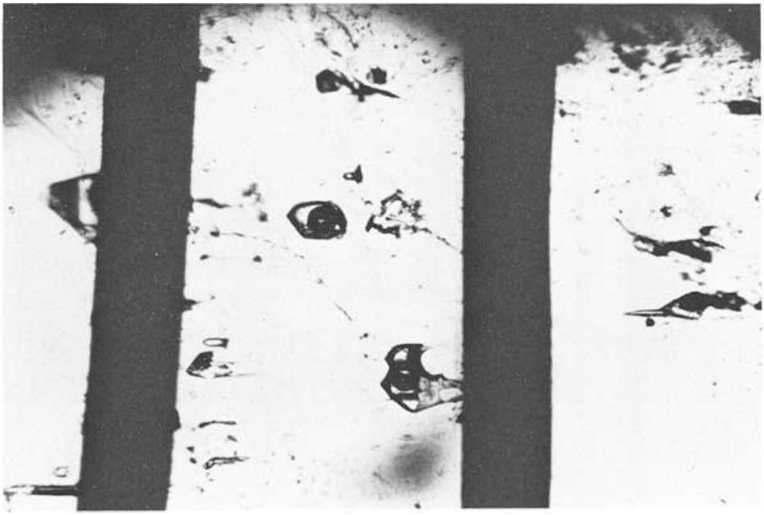


Fig. 10. Two-phase inclusions in the synthetic layer of the crystal in Figure 9. The two nearly parallel dark bands are the silver thread shadows. (Transmitted light, 40 ×).

LAST REPORTED RESULTS

In the last paper[5] on the hydrothermal growth of quartz, Spezia (1909) gave the results about further experiments carried out with his devices. For one of the runs he employed a different water solution: 12.7% in NaCl and 1.9% in Na_2SiO_3.

'The quartz preparation placed in the deposition milieu consisted of hexagonal prisms made by cuts normal to the principal symmetry axis of elongated quartz crystals as can be understood from figure' (5, p.96) (see Figure 12a).

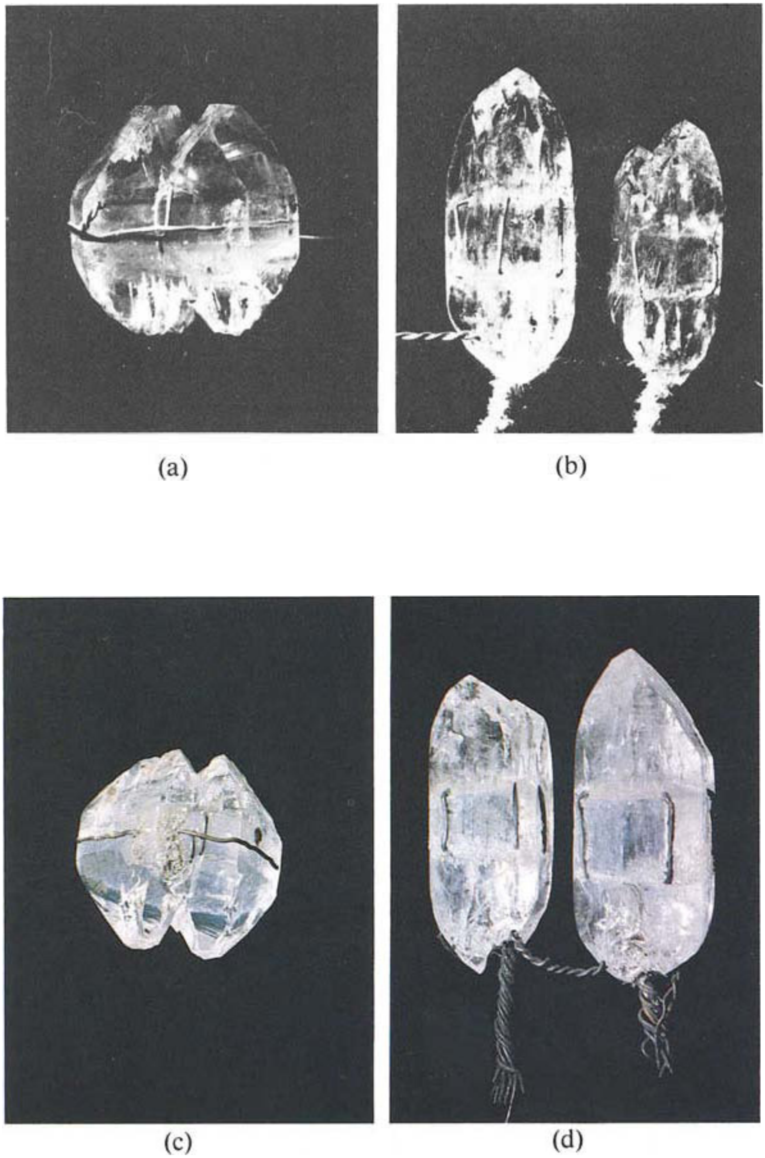


Fig. 11. Hydrothermal growth on hexagonal prisms of quartz cut before the run. (a) Print from original glass plate negative used by Spezia (Spezia, 1906). (Height 16.2 mm). (b) Picture reproduced from Spezia's original paper (Spezia, 1906). (Left: Length 25.4 mm. Right: Length 22.8 mm). (c) & (d) Colour pictures of crystals in (a) and (b). (Note: in crystals of (a) and (c) the silver thread stimulated parallel growth with doubling of both apexes).

This experiment was carried on for five months and at the end Spezia obtained the crystals of Figure 12b.

By another experiment, (5, pp.98-9) again five months long, employing a water solution 11.33% in NaCl and 1.24% in Na_2SiO_3, Spezia was able to show that the growth rate was greater on those surfaces perpendicular to the flow of the SiO_2 bearing solution. In fact he cut two nearly equal seeds from the same natural crystal: the one placed with the artificial basal faces orthogonal to the flow, showed a gain of 96.88% in weight, the one with the basal planes parallel to the flow, during the same experiment and placed at the same height as the former one, increased only by 78.65%. Besides, with this experiment, Spezia obtained further evidence of an effect already noticed: quartz grows more rapidly along its triad axis than along other directions, at least under the experimental conditions used by him.

From this experiment Spezia also obtained an impressive growth of two broken terminations of a crystal from Traversella Mine (near Turin), twinned according to the Japan law. Figure 13 shows the crystal before and after the run. The more impressive aspect of this growth is that the artificially grown sectors appear clearer and finer than the seed. Spezia maintains: 'From these experiments it follows that on adding sodium chloride to the sodium silicate solution, one obtains much clearer crystals'. (5, p.101)

In this experiment Spezia had also placed in the deposition zone a small specimen of ferruginous quartz (probably from Compostella, Spain) '. . . with a perfect hexagonal bipyramid . . .'. (5, p.102) After the run the crystal showed a growth of three faces of only one of the rhombohedra, whilst the transparent deposit of artificially grown quartz allowed one to see the whole of the two rhombohedra (six faces) simulating one end of the 'bipyramid'. Unfortunately, this crystal was not preserved till now; nonetheless Figure 14 shows another ferruginous quartz specimen with one apex of the 'bipyramid' intact, whilst the opposite one was purposely cut. The deposition took place on both ends. This result was one of several not published by Spezia.

Actually, at Turin Museum there is other material left by Spezia that bears witness to the large amount of research carried out by him (Figure 15).

Unfortunately, nobody in Italy after his death (1912) continued his pioneering work. It was only during World War II

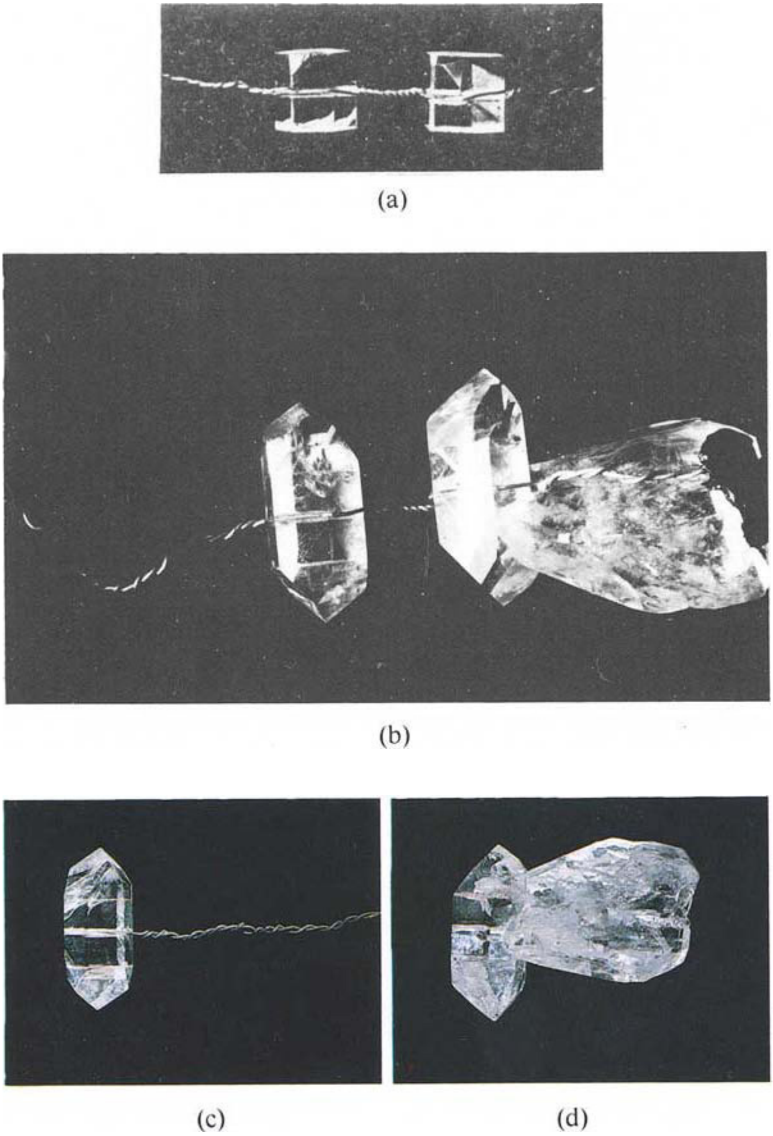


Fig. 12. (a) Small hexagonal prismatic seeds obtained by cutting quartz crystals (reproduced from Spezia's original paper (Spezia, 1909)). (b) Artificial quartz growth on seeds shown in (a). A nutrient fragment was dropped from dissolution milieu and joined to the crystal on the right; its surface was being covered by many small face planes. (Print from original glass plate negative used by Spezia (Spezia, 1909)). (Left: 15.8 mm in length. Right: 17.4 mm in length). (c) & (d) Colour pictures of crystals shown in (b). The silver thread had been broken in the course of time.

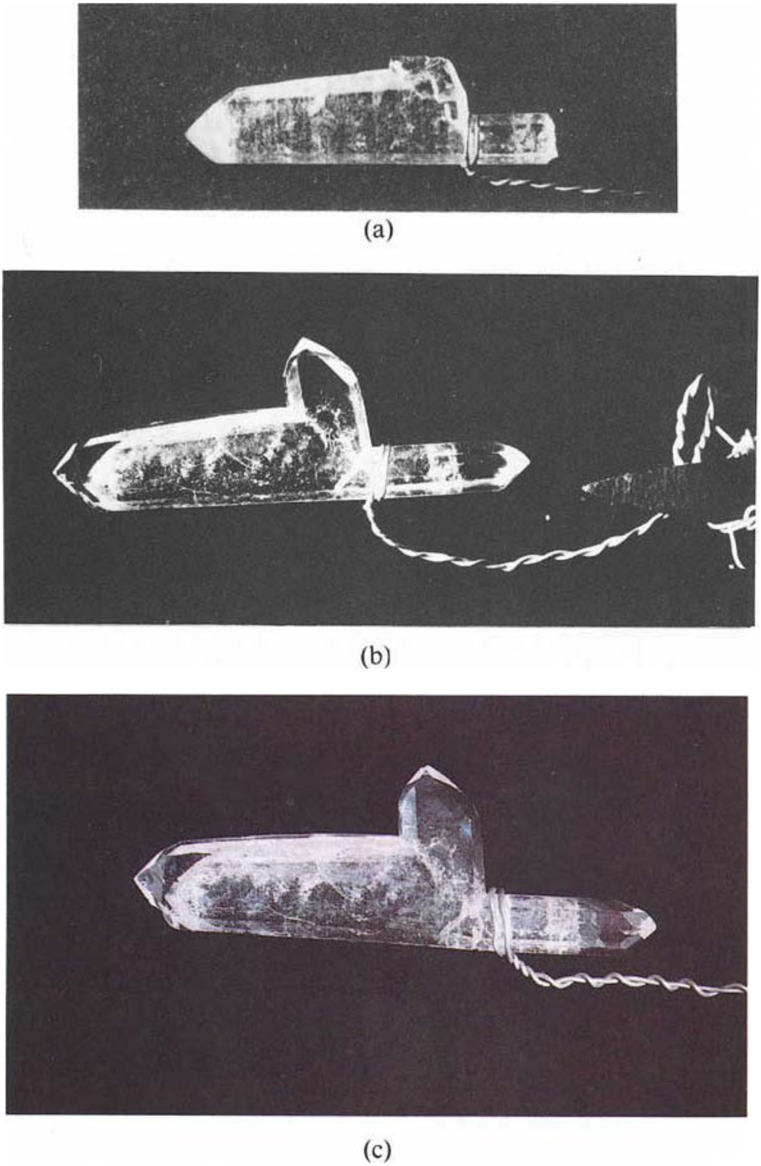


Fig. 13. (a) Quartz crystal twinned after Japan law (from Traversella Mine) before the hydrothermal growth. (Picture reproduced from Spezia's original paper (Spezia, 1909)). (b) The same as in (a) after the run. Note the artificial growth clearer than the seed, and more developed along the main symmetry axis. (Print from original glass plate negative used by Spezia (Spezia, 1909)). (c) Colour picture of the crystal shown in (b). (Length 38.7 mm).

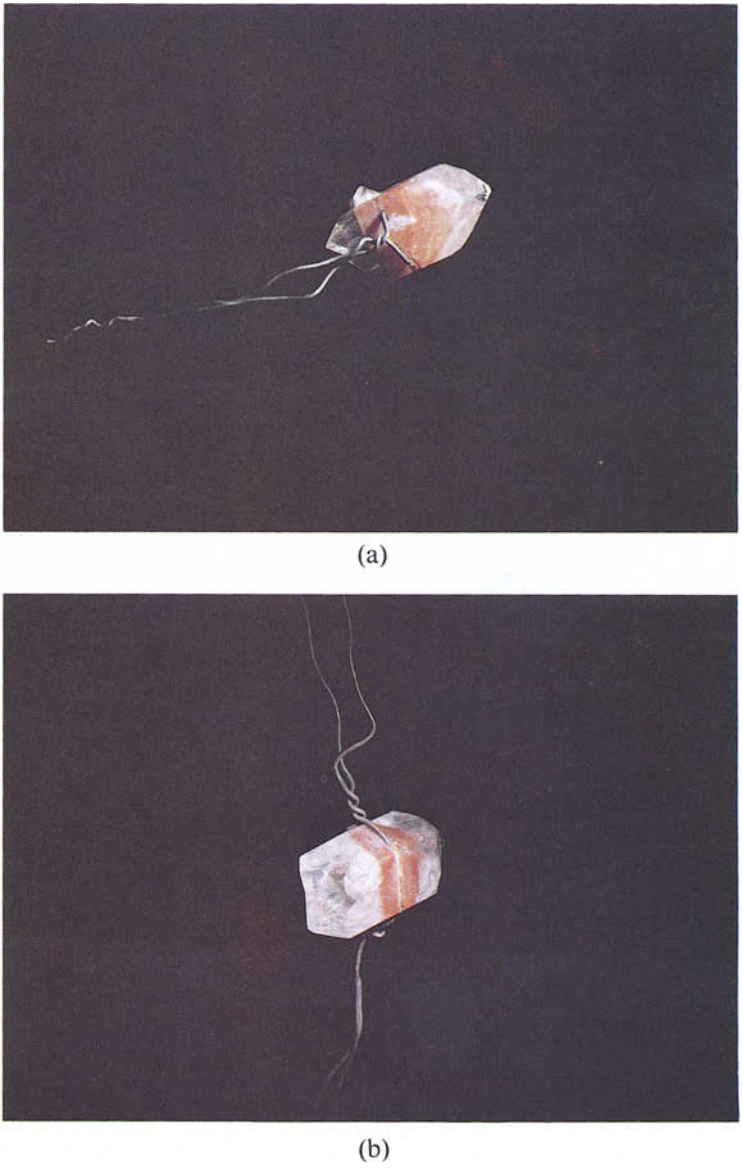


Fig. 14. (a) Hydrothermal growth of colourless quartz on ferruginous seed.
(b) The parallel growth on the artificial face made by sawing is clearly visible. (Length 13.7 mm).

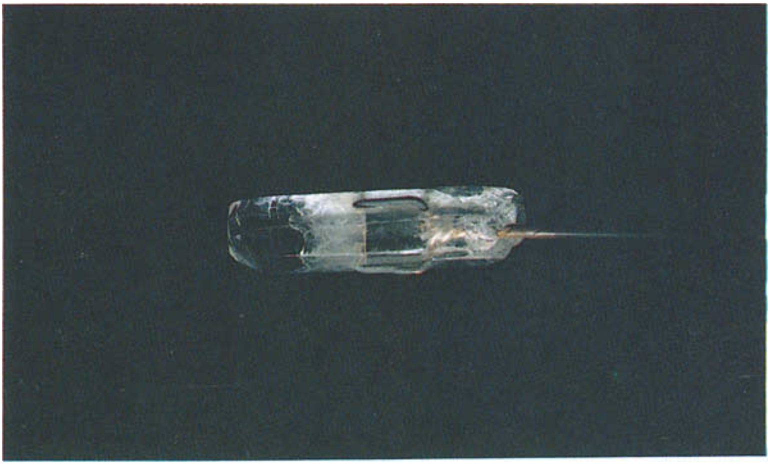


Fig. 15. One of the several results not published by Spezia. Note: the wire is made of copper, and the synthetic growth is clearer than the seed and much more developed along the main symmetry axis of the crystal. (Length 24 mm).

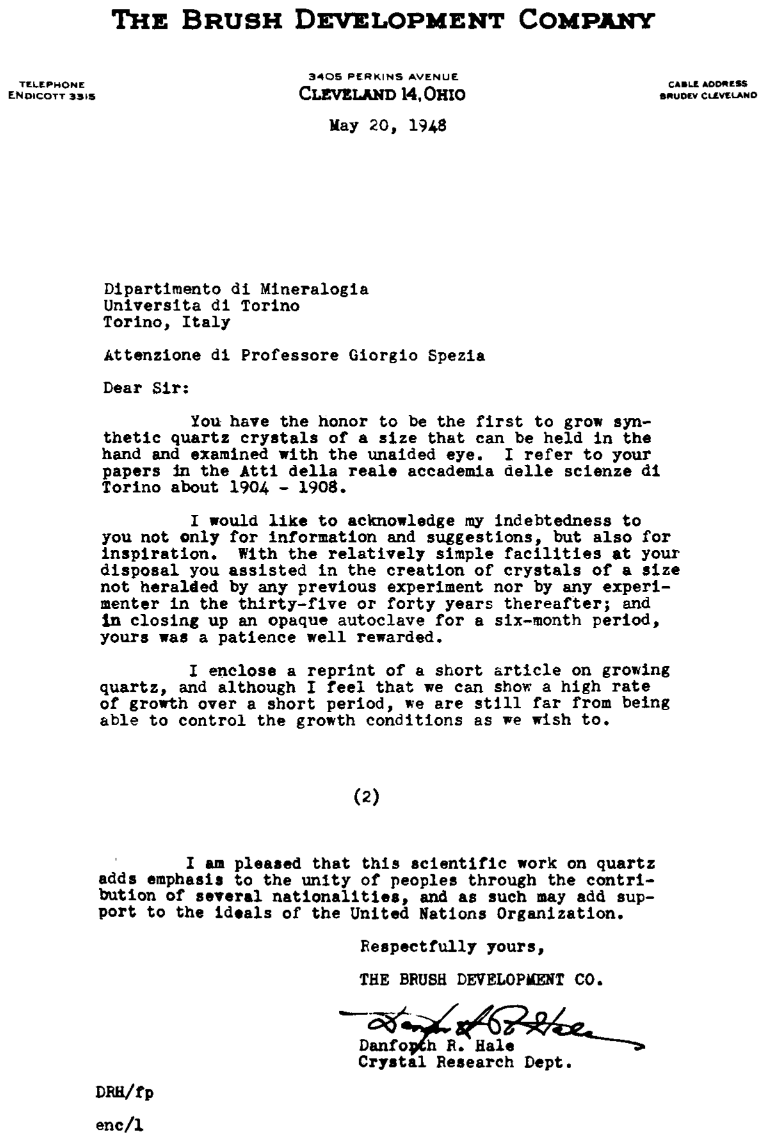
(1943) that Richard Nacken in Germany restarted the investigation on the hydrothermal growth of quartz, which was a raw material of vital importance for the production of oscillator devices employed in the field of radio-communications, since the traditional Brazilian sources were then barred to Germany. (6, p.393) It seems that Nacken had not time enough to start a large scale production, but he succeeded in having a pilot plant working before the end of the War.

N. and W. A. Wooster (7, p.791) in 1946, using an apparatus quite similar to Spezia's demonstrated the reproducibility of his results, thus confirming the scientific and practical validity of his method.

In 1948 Danforth R. Hale, of Brush Development Company, Cleveland (Ohio), carried out new experiments on the hydrothermal growth of quartz exploiting Spezia's and Wooster & Wooster's experiences. (6, p.393-4)

CONCLUSIONS

In 1948 the letter reproduced in Figure 16 was received at the Istituto di Mineralogia, Turin University.



THE BRUSH DEVELOPMENT COMPANY

TELEPHONE
ENDICOTT 3315

3405 PERKINS AVENUE
CLEVELAND 14, OHIO

CABLE ADDRESS
BRUDEV CLEVELAND

May 20, 1948

Dipartimento di Mineralogia
Universita di Torino
Torino, Italy

Attenzione di Professore Giorgio Spezia

Dear Sir:

You have the honor to be the first to grow synthetic quartz crystals of a size that can be held in the hand and examined with the unaided eye. I refer to your papers in the Atti della reale accademia delle scienze di Torino about 1904 - 1908.

I would like to acknowledge my indebtedness to you not only for information and suggestions, but also for inspiration. With the relatively simple facilities at your disposal you assisted in the creation of crystals of a size not heralded by any previous experiment nor by any experimenter in the thirty-five or forty years thereafter; and in closing up an opaque autoclave for a six-month period, yours was a patience well rewarded.

I enclose a reprint of a short article on growing quartz, and although I feel that we can show a high rate of growth over a short period, we are still far from being able to control the growth conditions as we wish to.

(2)

I am pleased that this scientific work on quartz adds emphasis to the unity of peoples through the contribution of several nationalities, and as such may add support to the ideals of the United Nations Organization.

Respectfully yours,

THE BRUSH DEVELOPMENT CO.

Danforth R. Hale
Crystal Research Dept.

DRH/fp

enc/1

Fig.16. Letter of 20th May 1948 from Danforth R. Hale.

ACKNOWLEDGEMENTS

The author is greatly indebted to Dino Aquilano (Professor at Mineralogy Institute of the University, Turin) for helpful discussions and valuable criticisms, and to Mariano Calleri (Professor at Mineralogy Institute of the University, Turin) for the careful translation.

Note: this article is a new and partly rewritten version of a previous paper, 'Giorgio Spezia, il padre della sintesi idrotermale'* (*La Gemmologia,* 1975, **1**, 1, 9-24).

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[*Manuscript received 27th July, 1983.*]

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*'Giorgio Spezia, the father of hydrothermal synthesis.'

THE ALPHA-TEST GEMSTONE IDENTIFIER—A TEST REPORT

By PETER READ, C.Eng., F.G.A.

The first thermal conductivity gem tester developed specifically to identify not only diamond and its simulants but also a range of other gemstones was the Gemtek Gemmologist. This instrument, like the simpler thermal testers for diamond identification, employed a heated probe tip whose temperature was monitored by the associated control box electronics. In the case of the Gemtek Gemmologist, however, a more sophisticated measuring technique was necessary to detect the much smaller differences in thermal conductivities (or thermal inertias(1)) between other materials such as corundum (at 40 W/m/°C, the next highest in thermal conductivity to diamond's 1000-2600 W/m/°C) and glass (around 1.0 W/m/°C). This technique uses two pre-set temperature sensing levels. When the heated tip of the probe is applied to the surface of the gem, its temperature begins to fall. When it reaches the first predetermined level, the output of an oscillator is fed into a digital counter/display unit. As the temperature of the probe tip continues to fall, it reaches the second predetermined level and this switches off the output of the oscillator.

The number displayed on the digital display unit is a measure of the time taken for the probe tip to fall between these two predetermined temperature levels, and is used as a direct indicator of the thermal conductivity of the stone under test (the lower the reading, the greater the gem's ability to conduct heat away from the probe).

Because of the very small differences in thermal conductivities between the non-diamond gems (1.0 to 40.0 for the complete range), it is necessary to impose several operating constraints in order to produce repeatable results. The instrument has to be used in a draught-free environment having an ambient temperature between 18 and 25 °C (64 and 77 °F), the gem under test has first to

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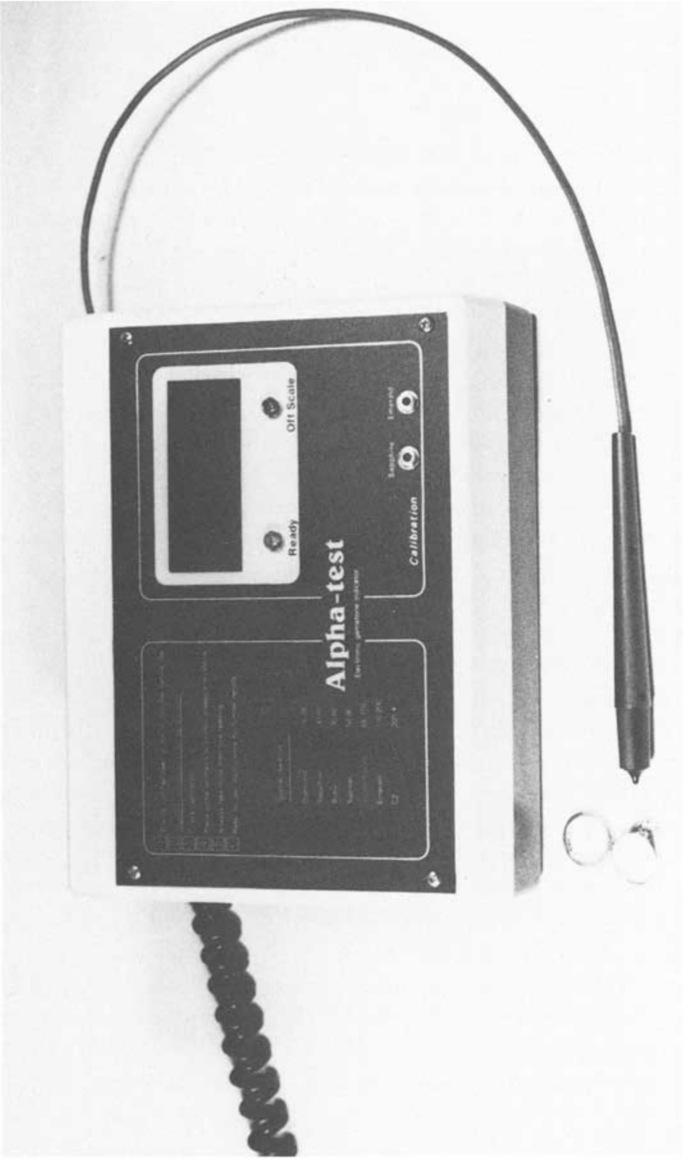

FIG. 1. The Alpha-test electronic gemstone identifier

be warmed up to body temperature, and the probe tip must be applied at right-angles to the test surface with a reasonably precise pressure. Even then, the usefulness of the instrument is limited to those gemstones whose thermal conductivity is not overlapped by that of other gems.

Following the introduction of the Gemmologist, a new instrument has been developed which is also able to identify a range of gemstones in addition to diamond and its simulants. This instrument is called the Alpha-test (see Figure 1), and uses a similar measuring technique to that employed in the Gemmologist. It also has the same operating constraints, but unlike the Gemmologist is relatively simple to use. With the Gemmologist it was necessary to press a 'Reset' button before each test in order to zero the display, and if a 'Too Hot' lamp was illuminated the probe tip had to be manually cooled before use.

The Alpha-test automatically resets its counter display as soon as the probe is applied to a stone, and the temperature of its probe tip is thermostatically regulated. As with the Gemmologist, a 'Ready' lamp indicates that the probe tip temperature has reached its operating temperature. Rather than use a 4-digit display to indicate very low thermal conductivities, the Alpha-test's top reading is limited to 999, and an 'Off Scale' lamp lights when this figure is exceeded.

Two calibration pre-sets are provided on the instrument's front panel, one enabling sapphire to be used as a calibration reference, and the other for calibration against emerald. This method of two-point calibration ensures reasonable accuracy across the measuring range.

One disadvantage which the Alpha-test has in comparison with the Gemmologist is that its probe is permanently connected to the control box instead of via a connecting plug. This could present a problem if the probe is damaged, as the complete unit would have to be returned for service.

During tests on the new instrument, a range of gemstone specimens were checked after first calibrating the unit on a sapphire and a natural emerald. Each stone was tested ten times, and the table below gives the average of these readings. The listed spread between each set of ten readings was quite small for high thermal conductivity stones (e.g. 4 to 10 for diamond, corundum, high zircon, topaz and spinel). The spread became progressively larger for stones of lower thermal conductivities (e.g. 15 and 100 for emerald and low zircon). This spread of readings is simply an indication of the repeatability of measurement using the same stone. Different stones of the same species would give a wider range of average readings as indicated on the instrument's panel and in the operating manual.

TABLE OF TEST READINGS

GEM	Diamond	Corundum	Topaz	High Zircon	Natural Spinel	Synthetic Spinel
Average of 10 readings	15.2	40.5	49.3	51.9	54.2	64.6
Spread of readings	4	5	9	9	10	10

GEM	Gilson Emerald	Andalusite	Natural Emerald	Garnet	Zoisite	Low Zircon	Cubic Zirconia
Average of 10 readings	75.8	84.4	150.5	161.0	207.4	427.0	200 to off scale
Spread of readings	15	20	30	80	60	100	—

As was mentioned in the test report on the Gemtek Gemmologist,(2) this type of instument is mainly of use for the identification of diamonds, diamond simulants, and very small non-diamond gems (particularly those which are mounted in such a way as to make it impossible to use either a refractometer or a reflectivity meter). With care, positive separation is possible between ruby and garnet; aquamarine, spinel and topaz; sapphire and tourmaline, and between natural and some flux-melt synthetic emeralds. Andalusite and zoisite also have quite distinctive readings. The readings for natural spinel are significantly different from those for synthetic spinel, and low zircon is dramatically different to high zircon. Readings for topaz, high zircon and natural spinel are too close, however, to provide positive differentiation by this method.

The Alpha-test is distributed by Mann-Marketing (U.K.) Ltd., Goldfly House Annexe, Sarum Road, Winchester, Hants SO22 5QH.

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[*Manuscript received 17th March, 1984*]

GEMMOLOGICAL ABSTRACTS

ANDERSON (B. W.). *The fluid and the filter.* Lapidary J., **37**, 11, 1590-4, 1984.

Notes on the development and use of the liquids used in gem testing with reminiscences of early days at the Laboratory of the Diamond, Pearl and Precious Stone Trade Section of the London Chamber of Commerce. The piece concludes with some notes on the Chelsea colour filter. M.O'D.

BALDWIN (J. R.), VON KNORRING (O.). *Compositional range of Mn-garnet in zoned granitic pegmatites.* Canadian Mineralogist, **21**, 4, 683-8, 4 figs, 1983.

A correlation between the composition of some garnets and their occurrence in zones in large complex granitic pegmatites has been established. Mn-rich garnet is found in the inner and replacement zones, garnet with Mn and Fe in intermediate mineral assemblies and garnet with a greater iron than manganese content in the wall and contact zones. Pure spessartine is most likely to be found in replacement and quartz-rich core zones of pegmatites containing lithium minerals. M.O'D.

BANK (H.). (a) *Durchsichtiger Analcim aus Australien.* (Transparent analcime from Australia.) Z.Dt.Gemmol.Gess., **32**, 4, 204-5, 1983; (b) *Gelber und gelbbrauner Klinohumit aus Russland.* (Yellow and yellow-brown clinohumite from U.S.S.R.) Id., 206, 1983; (c) *Neue synthetische Rubine nach Lechleitner als Überzug auf natürlichen und synthetischen Rubinen sowie farblosen Korunden der Verneuilsynthese.* (New synthetic ruby with Lechleitner skin over natural and synthetic ruby, also over Verneuil synthetic corundum.) Id., 207, 1983.

(a) Transparent colourless analcime from Australia with RI of ε 1.486, ω 1.487. (b) Rough and cut yellow-brown stones from Russia were found to be clinohumite, RI 1.625-1.636, DR 0.024, SG 3.18. (c) New synthetic rubies with a Lechleitner skin-layer over natural and synthetic rubies, as well as over Veneuil colourless corundums. E.S.

BOSSHART (G.). *Ramaura—eine neue Rubinsynthese (erste Untersuchungsergebnisse).* (Ramaura—a new synthetic ruby (first test results).) Z.Dt.Gemmol.Ges., **32**, 4, 164-71, 7 figs (6 in colour), bibl., 1983.

The synthetic rubies are produced by Overland Gems, Ramaura Division, Los Angeles. Seven specimens were examined and found to be chromium-rich, intensely red; and there was also a chromium-poor, paler violet-red version. The first type shows flux veils and has the characteristic UV absorption behaviour of synthetic rubies. The second type has few inclusions, contains no platinum crystal platelets and absorbs UV radiation like a natural ruby. For the time being, this synthetic version can only be recognized by growth features consisting of acute, wedge-shaped colour zones and spindle shaped growth inhomogeneities. These new synthetics are not cloudy and show no unusual colours or dichroism. E.S.

BOSSHART (G.). *Cobalt glass as a lapis lazuli imitation.* Gems & Gemology, **XIX**, 4, 228-31, 4 figs (2 in colour), 1983.

A moulded bead necklace offered as "blue quartz from India" resembled fine lapis lazuli but was proved by absorption spectra and other tests to be a non-transparent cobalt glass. White inclusions of low-cristoballite gave necessary colour irregularities. Dendritic and radial inclusions were seen, completely different from lapis lazuli structure. No pyrite inclusions or bubbles or swirls were present. Macroscopic appearance was confusing. R.K.M.

BRACEWELL (H.), BROWN (G.). *Turquoise or chrysocolla from Jervois area, Northern Territory.* Aust. Gemmol., **15**, 6, 189-95, 10 figs in colour, 3 maps, 1984.

Turquoise (?) from Plenty River mine was investigated in detail and found to be chrysocolla-rich quartz. Colours blue to greenish-blue. Some cabochons examined were found to be reconstituted material bonded with plastic. Natural material resembles Eilat stone in appearance. R.K.M.

BREITER (K.), PASAVA (J.). *Agate from Horni Halze, Czechoslovakia.* Lapidary J., **37**, 11, 1556-7, 7 figs (6 in colour), 1984.

Horni Halze is north-west of Prague and close to the border with East Germany. Blue, red and ribbon agates are found. M.O'D.

BROWN (G.). *Fairfield variscite.* Wahroongai News, **18**, 3, 16-18, 1984.

A mineralogical and geological description of this little known gem, based on material from its classic location described in an American Mineralogist paper by Larsen (E. S.) in 1942. R.K.M.

BROWN (G.). *Inclusions in synthetic corundum by Chatham.* Aust. Gemmol., **15**, 5, 149-54, 8 figs in colour, 1984.

A careful study of inclusions to be found in Chatham flux-grown synthetic rubies and sapphires, with a list of those reported by other observers. R.K.M.

BROWN (G.). *Korite—a unique organic gem.* Aust Gemmol., **15**, 6, 206-8. 6 figs (4 in colour), 1984.

The iridescent ammonite material [now properly called 'ammolite'—see J.Gemm., 1983, XVIII, 6, 551] from south Alberta, Canada, is described and illustrated. R.K.M.

BROWN (G.). *Notes on the cause of colour in labradorite and moonstone.* Wahroongai News, **18**, 2, 19-23, 1984.

Writer disagrees with conventional explanation quoted by Webster and others. Suggests that paper by Ribbe (P. H.) on 'Exsolution textures and interference colours in feldspar' shows that iridescence in labradorite is due to relative thickness of stacked paired lamellae of alternating albite and anorthite, and that sheen in moonstone is due to Tyndall-scattering of incident light at albite crystallites, and not to interference. Reflections are blue when crystallites are smaller than the wavelength of incident light. [I question the statement that 'schiller is always bluish within an opaque whitish background'. Most gem 'blue' moonstones are in almost transparent material.] R.K.M.

BROWN (G.). *The Seward gemmological microscope.* Aust. Gemmol., **15,** 6, 196, 1 fig., 1984.

A description of a 1930 hand-held microscope. R.K.M.

BROWN (G.)., MENDIS (H.). *An unusual cultured pearl necklace.* Aust. Gemmol., **15,** 5, 155-7, 4 figs (1 in colour), 1984.

A large very baroque cultured pearl necklace x-rayed to reveal an exceptional collection of oddities. Largest pearl had a pear-shaped MOP bead centre which had been loosely wrapped in metal wire before thinly culturing. Some others contained more than one bead, or a bead and a large conchiolin-filled cavity. An interesting investigation. R.K.M.

BROWN (G.), SNOW (J.). *Bits and pieces.* Aust. Gemmol., **15,** 5, 158-9, 162-3, 10 figs, 1984

A report from the Instrument Evaluation Committee of the G.A.A. covering the Mark 2 Portalab, the Diamond and White Gem Constants Comparator (a rotating data disc), the Snow Pocket Polariscope, and the Gemtek Diamond Detector.

R.K.M.

BROWN (G.), SNOW (J.). *Inclusions in Biron synthetic emeralds.* Aust. Gemmol., **15,** 5, 167-71, 9 figs (1 in colour), 1984.

A study club report on the new Australian hydrothermal synthetic emerald from Perth, which examines production rejects to find identifying inclusions which seem to be eliminated from the cut stones. A patchy red fluorescence may be seen in cut specimens under strong lighting. R.K.M.

BROWN (G.), SNOW (J.), TAYLOR (B.). *National FF-393E Light Scope.* Aust. Gemmol., **15,** 6, 197-9, 4 figs, 1984.

A report on a modern pocket microscope with built-in light source. Magnification ×30. Found to be useful for flat surfaces but not for inclusions.

R.K.M.

BROWN (G.), WAINWRIGHT-SMITH (N.). *Experimental pearl radiography.* Aust Gemmol., **15,** 6, 182-8, 9 figs, 1984.

Macroradiography (×2) was achieved by distancing the pearl from the recording film. Since x-rays diverge from the point source an enlarged image was obtained and yielded greater detail than the normal pearl/film contact radiograph.

Another technique called tomography, using oblique x-ray beams, is said to eliminate obscuring factors and enhance detail. Explanation is confused by the wrong numbering of a diagram, but writers conclude that this complex technique does not greatly assist diagnosis of pearls. R.K.M.

CASSEDANNE (J. P.), SAUER (D. A.). *The Santa Terezinha de Goiás emerald deposit.* Gems & Gemology, **XX,** 1, 4-13, 10 figs in colour, 1984.

A well-illustrated account of new mines which are producing good quality emeralds in small sizes, SG 2.70, RI 1.580-1.588, DR 0.008, emerald filter—inert to pink, absorption normal, inclusions pyrite, chromite, talc and calcite. 'Average yield is 11 carats of emerald per cubic meter.' 'It is accepted that 6 cubic meters yield about 1 kilogram.' One or other of these statements must be wrong. R.K.M.

Cassinelli (C.). *Le pagina dei micromounts.* (Micromounts page.) Rivista Mineralogica Italiana, **7**, 4, 134-6, 6 figs in colour, 1983.

Among the minerals described is elbaite from Elba. M.O'D.

Chikayama(A.). (New gemstones.) J. Mineralog. Soc. Japan, **15**, 3, 163-8, 1981. (Japanese with English abstract.)

Gemmological properties and keys for identification of the new natural gemstones, which have been discovered or appeared in the gem market from 1945, are described briefly together with their histories of discovery. The minerals described are brazilianite, taaffeite, sinhalite, amblygonite, greened amethyst, ekanite, painite, tugtupite, trapiche emerald, jade-albite, grossular garnet, blue zoisite, red tourmaline, jeremejevite, transparent sodalite, bixbite, treated blue beryl, herderite, prosopite, ceruleite, charoite, transparent rhodochrosite, palygorskite, ammolite and sodalite. T.Y.

Clare (S.). *What to facet—5.* Gems, **16**, 1, 12-13, 1984.

The technique of sawing pebbles is described. M.O'D.

Collins (A. T.). *Pitfalls in colour grading diamonds by machine.* Gems & Gemology, **XX**, 1, 14-21, 8 figs (1 in colour), 1984.

An expert assessment of colour grading by spectrophotometer which shows that these can give unreliable results because of fluorescence and of scattered reflections. This necessitates recourse to comparison with master stones by eye. Author shows that DGL method of assessing intensity of the 415 nm absorption line and the Eickhorst diamond photometer can both give false grades for brightly fluorescent diamonds. An important paper. R.K.M.

Fryer (C. W.), ed., Crowningshield (R.), Hurwit (K. N.), Kane (R. E.). *Gem Trade Lab Notes.* Gems & Gemology, **XX**, 1, 45-50, 22 figs in colour, 1984.

Iridescent coatings on aquamarine and synthetic emerald; coral stained blue and plastic coated; diamond with large conical laser drillings and another with 'stepped' laser hole are illustrated and reported upon. An emerald showed white dendritic deposits of oil dried out by heat; haematite proved to be magnetic, possibly as a result of heating; jadeite offered as dyed in Japan proved to be natural in colour; a small dyed nephrite and several examples of hollow natural pearls are described and illustrated. A ruby 'crystal' fashioned from a flame-fusion synthetic had the 'habit' of beryl, and a new reddish-brown scapolite cat's-eye from Kenya is depicted and described. R.K.M

Fryer (C.), ed., Crowningshield (R.), Hurwit (K. N.), Kane (R. E.). *Gem Trade Lab Notes.* Gems & Gemology, **XIX**, 4, 232-7, 22 figs in colour, 1983.

Sapphire with thin colour zone on one surface was thought to be heat-treated, not diffusion coloured; a 2.55 carat fine ruby had been badly fractured by heat treatment; C-Ox is trade name for green and blue forms of cubic zirconia, both stones having strong and characteristic absorption spectra; all diamonds in a brooch fluoresced under long UV; a 4 carat diamond had pronounced fern-like white dendritic inclusions; a carved yellow/black grey/green jade-like ornament was found to be mainly serpentine; a sawn jade boulder was maw-sit-sit on one side and chloromelanite on the other; new Inamori synthetics are described; three-quarter blister pearls were found with bead completely enclosed but visible through the thin back; a ring pearl showed very marked erosion by body acids around each claw of the setting.

Reddish-brown quartz is thought to be heat-treated natural stone; an early 'Geneva' synthetic ruby is described; recently most yellow sapphires tested in New York Lab owed colour to Thai heat-treatment; a group of natural yellows are also discussed; rare cat's-eye zircon is also described. All are illustrated. R.K.M.

GIANNINI (W. F.), PENICK (D. A., Jr.). *Large gem topaz crystal discovery.* Virginia Minerals, **29**, 1, 1-3, 6 figs, 1 map, 1983.

A large, colourless, gem-quality topaz crystal was discovered in the dump of the Herbb no. 2 pegmatite in Powhatan County, Virginia. The virtually flawless crystal weighs 8.9 pounds and measures 10.9 × 3.5 inches. It is terminated by crystal faces at one end and by a cleavage plane at the other. Two small liquid inclusions are present. The deposit, explored and briefly worked in 1944, is approximately 40′ thick and 240′ long. Other minerals occurring there include quartz, beryl (crystals up to 300 pounds), albite (cleavelandite), tantalite-columbite, muscovite, spessartine, microcline (amazonite) and kaolinite (from altered feldspars). R.S.M.

GRANDIN DE L'EPREVIER (A.), ITO (J.). *Flux grown orthoenstatite by a multiple slow-cooling technique.* J. Crystal Growth, **64**, 411-12, 1983.

Large gem-quality enstatite $MgSiO_3$ has been grown with a lithium vanado-molybdate flux. Crystals up to 13 × 6 × 4 mm have been obtained. M.O'D.

GRAY (F. L.). *Engraved gems: a historical perspective.* Gems & Gemology, **XIX**, 4, 191-201, 12 figs (8 in colour), 1983.

An account of engraved gems from Egyptian times to the present day, when ultrasonic drills are being used to mass-produce cameos and intaglios, thus removing skill from this ancient art. R.K.M.

GUNAWARDENE (M.). *Über die synthetischen blauen und orangefarbenen Sapphire von Chatham.* (About the synthetic Chatham blue and orange-coloured sapphires.) Z.Dt.Gemmol.Ges., **32**, 4, 196-203, 8 figs (6 in colour), bibl., 1983.

The author discusses the fact that it becomes increasingly difficult to distinguish between natural and the new synthetic stones. Only photomicroscopy seems to be a reliable method. The blue and orange Chatham sapphires show remains of the melt, platinum inclusions, the growth marks being similar to those of the natural stone, although there are some slight variations. E.S.

HAGEMANN (C.). *Insitut für Edelsteinforschung.* Lapidary J., **37**, 11, 1550-2, 2 figs, 1984.

The institut is located at the University of Mainz and is engaged upon the testing of gemstones with particular reference to the exploration of gem deposits.

M.O'D.

HASSAN (I.), GRUNDY (H. D.). *The crystal structures of sodalite-group minerals.* Acta Crystallographica, B, **40**, 6-13, 6 figs, 1984.

Sodalite, hauyne and nosean have significance in gemmology. Their crystal structure is discussed and illustrated. M.O'D.

HEFLIK (W.). (Turquoise.) Mineralogia Polonica, **12**, 2, 105-8, 1981. (In Polish).

This is the first of a series of articles in Polish dealing with minerals and gems of Poland, written specifically to stimulate co-operation between mineralogists (amateur and professional) and gemmologists. The occurrence of turquoise at Wroclaw is described. R.A.H.

HOSAKA (M.), TAKI (S.). *Hydrothermal growth of amethyst and citrine in NaCl and KCl solutions.* J. Crystal Growth, **64**, 572-6, 6 figs, 1983.

Since natural quartz grows from solutions containing mainly Na^+, K^+ and Cl^- ions, growth of synthetic quartz was attempted using NaCl and KCl solutions. Quartz cut from r-cut and R-cut plate seeds with iron added was colourless, but a purple colour was produced by gamma-irradiation. Quartz grown from X-cut plate and Y-bar seeds was yellow. This colour deepened with increase in iron. M.O'D.

KELLER (P. C.). *The rubies of Mogok: a review of the Mogok stone tract.* Gems & Gemology, **XIX**, 4, 209-19, 11 figs in colour, 1983.

An excellent account of the geology and mining methods of the tract, and of the gemmology of its stones. R.K.M.

KOIVULA (J. I.), ed. *Gems News.* Gems & Gemology, **XIX**, 4, 246-7, 1983.

Australian Ashton Joint Venture has sold its first 200 000 carats of rough diamonds for about US$9.50 per carat; C.S.O. starts quarterly journal; improvement in diamond market expected; Japan cancels duty on diamonds. In 1982 Laurence Graff bought a 278 triangular diamond in West Africa; it cut three stones, including one of 70.03 carats, claimed to be the world's largest heart-shaped diamond. India is banning export of rough gems; opal production in Australia fell by estimated 60% last year, driving prices on all grades up; Yogo Gulch sapphire deposit, Montana, plans to go into full production; in Sri Lanka, Swedish gemmologist, Olle Fjordgren, has found a first blue zoisite in Rakwana material; information on C-Ox is given. Scientists at Marwell,* Oxon, said to have grown diamond on diamond, using high-energy particle accelerator; carbon atoms fired into diamond crystal and incorporated in structure by annealing at 800 °C; theoretically claimed to be possible growth method for large synthetic diamonds.

R.K.M.

KOIVULA (J. I.), ed. *Gem News.* Gems & Gemology, **XX**, 1, 58-60, 1984.

Diamonds; there is news of exploration in Guinea, Swaziland, off coast of Namaqualand and in or near the Argyle locality in W. Australia. The first diamonds from the latter locality are sold in Antwerp. Andhra Pradesh, India, yields steady supply of gem diamond rough; exploratory drilling in Panna diamond belt in

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*Sic—obviously meaning Harwell.—Ed.

Madhya Pradesh. The 10.73 Eureka diamond (claimed the first discovered in S. Africa) is on permanent loan to De Beers Mine Museum, Kimberley, which also received a gift of over 1000 technically important diamonds purchased by S.A. Diamond Producers' Association from the estate of A. F. Williams, author of *The Genesis of the Diamond* (1932).

Coloured stones: three new gem tracts identified and other areas explored in South India's state of Karnataka; Sri Lanka forms state company to heat treat geuda quality sapphires there rather than allow export to Thailand; Korean amethyst of 'very attractive colour' is reported; various reports on gold production.

Synthetics: Seiko are growing synthetic gems by floating zone method; a sintered rod is rotated while a small region near the top is brought to melt temperature by convergent reflection, heat is slowly lowered down the rod, producing a high quality single crystal. Method, originally used to make high quality silicon crystals, refractory metals and other semi-conductors, is now employed to make ruby, sapphires,and alexandrite. Constants are normal, inclusions swirled and curved, with gas bubbles. Marketed under name of Bijoreve; a flux emerald also made. R.K.M.

KOIVULA (J. I.). *Induced fingerprints.* Gems & Gemology, **XIX**, 4, 220-7, 11 figs in colour, 1983.

Since 1980 heat-induced healed-crack fingerprints have been found in some Verneuil synthetic corundums. The author has sucessfully reproduced such clean synthetic material. The formation of fingerprints is explained in detail. It is suggested that they are induced to up-grade cheap Verneuil stones to look like the more expensive flux synthetics. Synthetic corundum slabs were quench-crackled and then placed in a Chatham flux-growth environment for 42 days causing cracks to heal to give fingerprint-type inclusions. Other stones were subjected to heat alone, but did not heal in this way. A further attempt to induce chemical dendrites was successful, but the fingerprints were not natural looking. It is thought that such healed cracks occur accidentally when the Thais heat the stones to reduce the visible curved zoning.

Recognition is a problem and depends on basic clues of curved zoning, bubbles, UV transparency beneath the false appearance conferred by the fingerprints. Czochralski pulled crystals can be essentially flawless, so fingerprint inclusions in any otherwise flawless stone must be treated with suspicion. Straight and sharply angled growth or colour zoning, and recognized natural included crystals will be further important clues to the natural stone. Induced fingerprints *must* be disclosed. However, Koivula envisages a time when it may be possible to repair a cracked or broken natural stone using one of the techniques described. An important paper!

R.K.M.

KOIVULA (J. I.), FRYER (C. W.). *Lepidolite with simulated matrix.* Gems & Gemology, **XX**, 1, 42-4, 4 figs in colour, 1984.

A fine pink crystal of lepidolite mica was found to have had 'matrix' glued onto it. Bubbles found in adhesive, which fluoresced yellow under UV. Lepidolite proved by x-ray powder diffraction pattern. R.K.M.

KUHLMANN (H.). *Emissionsspektralanalyse von natürlichen und synthetischen Rubinen, Sapphiren, Smaragden und Alexandriten.* (Emission spectrum analysis of natural and synthetic rubies, sapphires, emeralds and alexandrites.) Z.Dt.Gemmol. Ges., **32**, 4, 179-95, 8 figs, 1 table, bibl., 1983.

Using a grating spectrograph, 207 samples of natural ruby, sapphire, emerald and alexandrite, and 61 synthetic samples were investigated for eleven trace elements. The analytical data show characteristic trace elements for natural samples of different localities which are different from the trace element patterns of synthetic samples. The method is shown to be helpful in the determination of the natural or synthetic origin of the stone. E.S.

LAYTON (N. A.), BROWN (G.), SNOW (J.). *A scrimshaw imitation.* Aust. Gemmol., **15**, 6, 201-5, 8 figs, 1984.

An account of the scrimshaw art and of a polystyrene 'walrus tusk' imitation which was betrayed by presence of round bubbles. Material soluble in acetone, insoluble in nitric acid, melted readily in flame. RI 1.56, SG 1.85, (very high due to calcite mixed with the core filler). R.K.M.

LOWTHER (J. E.). *The form of the different charge states of the vacancy in diamond.* J.Phys.Chem.Solids, **45**, 2, 127-31, 12 figs, 1984.

A number of different centres are formed in diamond and many of them display similar optical features including a sharp zero phonon line and phonon sidebands. The paper analyses the electronic structure and behaviour of some of the defects using an intrinsic lattice vacancy model. A comparison of stress matrix elements for the GR1 ND1, H3 and 1.945 eV centres is made, and it is concluded that the main behaviours of these defects can be attributed to the charged states V^0, V^-, V^{2-} and V^{3-}. Nitrogen lowers the symmetry about the vacancy. M.O'D.

MOREL (B.). *La veritable histoire du 'Sancy'.* (The true history of the Sancy.) Revue de Gemmologie, **78**, 13-15, 2 figs in colour, 1984.

A short history of the sancy diamond. M.O'D.

NAMIKA (M.). (The state of the art in gem testing.) J. Mineralog. Soc. Japan, **15**, 3, 151-62, 7 figs, 1981. (Japanese with English abstract.)

In recent years, because of technical progress in making synthetic or man-made stones and diversification of making such stones, it has become extremely difficult to distinguish between natural stones and imitations. The introduction of new instruments and testing methods for the identification of gemstones in the jewellery trade has been discussed, and new techniques such as XRF, UF, IR, etc., are employed. These instruments are, however, expensive and are not as effective as one would expect. It is most important in the jewellery trade to become proficient in gem-testing with the unaided eye and the simple methods based on gemmology.

T.Y.

NASSAU (K.). *The early history of gemstone treatments.* Gems & Gemology, **XX**, 1, 22-33, 9 figs (6 in colour), 1984.

Dr Nassau takes us back into classical times to trace the origins of foiling, crackle staining, heating, painting and doublets, and shows that, although never accepted, the majority of such practices survive in more sophisticated form to this day. There are some quaint recipes for 'improving' gems. R.K.M.

O'DONOGUE (M.). *The dealer looks at gemstones—13.* Gems, **16,** 1, 51-2, 1984.

Mostly concerned with the wording of opal advertisements, the article also discusses clinohumite, lepidolite, deep blue aquamarine and Kashan ruby identification kits. (Author's abstract.) M.O'D.

O'DONOGUE (M.). *Man-made gemstones.* Gems, **16,** 1, 37-8, 1984.

A cobalt glass imitating lapis lazuli, a new synthetic opal and the material C-OX (cubic zirconia) are described. (Author's abstract.) M.O'D.

O'DONOGHUE (M.). *Some beryl minerals—2.* Gems, **16,** 1, 38-9, 1984.

The emerald deposit of Muzo, Colombia, that of Bom Jesus dos Meiras, Brazil, and the occurrence of phenakite and euclase are described.
(Author's abstract.) M.O'D.

O'DONOGHUE (M.). *Spessartine from Amelia Court House, Virginia.* Gems, **16,** 1, 7-8, 1984.

A cut stone recently added to the author's collection is described, with some history of the mines in the area. (Author's abstract.) M.O'D.

OHTOMO (J.), TAKAHASHI (M.) (Coloration of Synthetic quartz.) J. Mineralog. Soc. Japan, **15,** 3, 169-75, 9 figs, 1981. (Japanese with English abstract.)

Coloured crystals of quartz of gemstone grade (citrine, amethyst and blue quartz) have been synthesized under hydrothermal conditions ranging 320-330 °C and 1000-1550 kg/cm^2. Conditions for coloration were Fe impurity, K_2CO_3 mineralizer, Ag-lined autoclave for citrine and amethyst; and Co and Al impurities, NaOH mineralizer for blue quartz. These impurities were added in the forms of metals or metallic oxides. Gamma irradiation was necessary for the final coloration of amethyst. IR examination of natural and synthetic quartz crystals were made in the spectral range 2000-4000 cm^{-1}. T.Y.

ORLANDI (P.). *Minerali delle pegmatiti Elbane cinque nuove segnalazioni.* (Minerals of the Elba pegmatite with five new reports.) Rivista Mineralogica Italiana, **7,** 4, 97-112, 23 figs (17 in colour), 1983.

The Elba pegmatite is reviewed with particular reference to tourmaline and beryl. Five new reports (of minerals not of gem quality) are given. M.O'D.

RAMSEY (J. L.). *Brazilian rare and beautiful.* Lapidary J., **37,** 11, 1566-77, 5 figs in colour, 1984.

The present state of gemstone production in Brazil is reviewed. M.O'D.

ROBERTSON (A. D.). *Negative inclusions in zircon from Anakie, Queensland.* Aust. Gemmol., **15,** 5, 164-6, 2 figs, 1984.

Describes rod-like inclusions which are occasionally found in zircons from this sapphire area. They are similar to those in Anakie sapphires. R.K.M.

ROUX (J. E.). *The diamond industry.* Aust. Gemmol., **15,** 5, 143-8, 1984.

Reviews the diamond industry with brief details of various mines selling through the Central Selling Organization of the Diamond Corporation. Explains the complex classification of diamond rough into 'several thousand categories'. The future of the Kimberley pipe mines in Western Australia is discussed. R.K.M.

SAUL (J.), POIROT (J.-P.). *Le premier cristal de taaféite gemme?* (The first gem-quality taffeite crystal?) Revue de Gemmologie, **78,** 28, 4 figs, 1984.

A taffeite crystal from the neighbourhood of Ratnapura, Sri Lanka, shows crystal faces and is of gem quality. Drawings of the crystal and of its absorption spectrum are given. M.O'D.

SCHÄFER (W.). *Die kolumbianischer Smaragdlagerstätten Muzo und Chivor.* (The Colombian emerald locations of Muzo and Chivor.) Lapis, **9,** 4, 9-23, 22 figs (15 in colour), 1984.

An exhaustive and beautifully-illustrated account of the mining of emerald in the two main Colombian sites. M.O'D.

SCHMETZER (K.). *Zur Natur der lapis Lazuli-Imitation von Gilson.* (About the nature of the lapis lazuli imitation of Gilson.) Z.Dt.Gemmol.Ges., **32,** 4, 172-8, 4 figs (1 in colour), 1 table, bibl., 1983.

The author accuses the producer of giving misleading information. The product is manufactured by Gilson, sold as synthetic lapis lazuli and consists of ultramarine and hydrous zinc-phosphates as main constituents with small pyrite crystals added. It is therefore not a synthetic but an imitation. E.S.

SCHMETZER (K.), BANK (H.). *Intensiv gelb gefärbter Tsilaisit (Manganturmalin) von Edelsteinqualität aus Sambia.* (Intensive yellow tsilaisite (manganese tourmaline) of gem quality from Zambia.) Z.Dt.Gemmol. Ges., **32,** 4, 159-63, 1 fig. in colour, bibl., 1983.

An English version of this article is published on pp. 218-23 above. E.S.

SECHOS (B.) *Kashan synthetic ruby.* Wahroongai News, **18,** 2, 10-13, 1984.

A reprint of a paper in N.S.W. Gemmological Review—December 1983, which outlined the difficulties in distinguishing these synthetics from natural rubies and indicated that distinction may depend on several factors, chief of which must be recognition of one of the number of characteristic inclusions, many of which are solid, or filled with flux material. R.K.M.

SHIGLEY (J. E.), STOCKTON (C. M.). *'Cobalt-blue' gem spinels.* Gems & Gemology, **XX,** 1, 34-41, 13 figs (11 in colour), 1984.

An examination of intensely blue spinel of exceptional colour, strongly reminiscent of synthetic spinels coloured by cobalt, which had cobalt related spectra despite high iron content which also showed their absorption. RIs were around 1.717, indicating natural spinel, and many contained natural crystal inclusions. [These stones also give a strong red through the emerald filter. Abstracter was first to report this rare type of spinel in 1977* and has been taken to task for assuming empirically that the colour was due to cobalt. Present paper seems to vindicate that 'shot in the dark'.] R.K.M.

SHINDO (I.). (Growth of chatoyant single crystals.) J. Mineralog. Soc. Japan, **15**, 3, 136-41, 4 figs, 1981. (Japanese with English abstract.)

It was found for the first time that single crystals of $MgTiO_3$ solid solutions showed chatoyancy and that they could be used as a new imitation cat's-eye gemstone. The crystal growth experiment was made by the travelling solvent float zone method using a halogen lamp image furnace. The crystals tended to grow mostly along the [1010] axis. Boules were dark, when first grown, but became transparent and colourless after annealing at 1300 °C for 24 hours in an oxygen atmosphere and showed distinct chatoyancy along the (0001) plane. T.Y.

SREBRODOL'SKIY (B. I.). *Accumulation of amber.* Doklady, Academy of Sciences of the USSR, Earth Science Sections, **253**, 184-6, 1982. (Translated from Doklady Akademii Nauk SSSR.)

Amber from the Baltic region is fossilized resin that accumulated in 'blue earth', a dark-green glauconite-quartz rock with grit-size quartz particles and phosphorite concretions. The highest amber concentrations are either at the upper or lower parts of the 'blue earth' unit, especially in clayey sediments that indicate a quiescent environment in Palaeogene and Neogene times. S.R.

STACEY (G.). *Mineral of the month. Uvarovite.* Wahroongai News, **18**, 2, 9-10,1984.

Summary of facts on rarest of the garnet sub-species. Crystals usually too small for cutting; larger ones when found, are very dark green, opaque and unsuitable for cutting. Tsavorite [now renamed tsavolite] is also dealt with—a fine green grossular garnet. R.K.M.

STACEY (G.). *Mineral of the month. Andradite.* Wahroongai News, **18**, 3, 21-2, 1984.

A summary of the facts relating to this garnet subspecies which gives us the valuable and rare demantoid, and the less appreciated topazolite, which is probably even rarer. R.K.M.

STOCKTON (C. M.), MANSON (D. V.). *Gem andradite garnets.* Gems & Gemology, **XIX**, 4, 202-8, 7 figs (2 in colour), 1983.

A careful study of the garnet subspecies generally known as demantoid.A range of twenty-one stones was tested and RII 1.880 to 1.883, SGG 3.80 to 3.88 were recorded.These did not include the highly prized rare vivid green. Detailed electron-microprobe chemical analyses underlined the unusually constant composition of the variety. Colour did not directly relate to the small amount of Cr_2O_3 that was found. Manganese and titanium, also in minute amounts, may influence colour. Authors suggest that cutters deliberately orient stones to include characteristic byssolite

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*J. Gemm., 1977, XV (7), 356-7.—Ed.

fibres under the table facet. From observation of rough I would say that these usually radiate from the centre of the crystal and the cutter has little choice if size and colour are to be maintained. R.K.M.

THOMPSON (H. M.). *Argyle, De Beers and the international diamond market.* Raw Materials Report, **2**, 3, 25-41, 10 figs, 1983.

A wide ranging view of the prospects of the world diamond market, taking into account new sources of diamond and the production of synthetic material. M.O'D.

VOIGT (S.). *Chrysoberyll-Kristalle aus Niederösterreich.* (Chrysoberyl crystals from Lower Austria.) Lapis, **9**, 4, 26-9, 10 figs (4 in colour), 1984.

Trillings of chrysoberyl are reported from Spitz, between Melk and Krems in Lower Austria. M.O'D.

WADA (K.) (Colour and fine structure of pearls.) J. Mineralog. Soc. Japan, **15**, 3, 143-50, 2 figs, 1981. (Japanese with English abstract.)

It is evident on the base of studies that the colour of pearls is the sum of iridescence and body colour. The iridescence occurs by the interference of light reflected from the superficial and internal laminar structure of nacre, which consists of the accumulation of a crystal layer and a thinner organic sheet parallel to the surface of pearls. The crystal layer is 0.3-0.8 mm thick and consists of a definite aggregate of many small tabular crystals of aragonite in a row. On the other hand, the body colour is due to the absorption of light by pigment, nacreous matter and other material. T.Y.

BOOK REVIEWS

AHRENS (J. R.), MALLOY (R. L.). *Gems and jewellery in Hong Kong: a buyer's guide.* South China Morning Post, Hong Kong, 1984. pp.158. $45.

For those wishing to visit Hong Kong this pocket-sized guide is a most entertaining companion; it is useful as well, since the information given is reliable and sensible. Hints on how to buy are given, as well as details of all the important gemstones, so that the gemmologist will find the book valuable. Few readers will know how to buy ivory in an Oriental country, so if this experience is likely to come your way get the book. M.O'D.

DA CUNHA (C.), DA CUNHA (A.). *Des pierres précieuses aux pierres fines.* (From precious stones to gemstones.) Plon, Paris, 1984. pp.93. Illus. in colour. Fr 135.00.

This is a beautifully produced gemmological textbook since the subject matter is introduced with gem testing in mind. A large portion of the book comes under the section 'how to know as much as the professionals', and it must be admitted that the first stage in learning, the stimulus of the imagination, is successfully accomplished. Preceding this section are descriptions and illustrations of inclusions, all superbly shown. There is a separate chapter on the recognition of synthetic material and an identification table. On the end-paper is a short bibliography and a most useful list of addresses, including those of some of the producers of synthetics. For the student the omission of any discussion or illustration of crystals would be a drawback, but the book is well worth getting if only to remind ourselves that all aspects of gemstones are perennially beautiful. M.O'D.

HENTSCHEL (G.). *Die Mineralien der Eifelvulkane.* (The minerals of the Eifel volcanic region.) Christian Weise Verlag, Munich, 1983. pp.152. Illus. in black and white and in colour. Price on application.

This forms part of the series *Lapis Monographie.* Presumably each part will deal with a particular region or topic, and the standard set by this first issue is very high. It is likely to be of interest to gemmologists, since in the Eifel region are important occurrences of sanidine, peridot and some of the very rare gem materials such as hauyne. Minerals are extensively described, following traditional chemical order and with drawings of many of the crystals. Following this major section come descriptions of the more important localities, a bibliography and an index, both well constructed. M.O'D.

O'DONOGHUE (M.). *Identifying man-made gems.* N.A.G. Press Ltd., London. pp.223. Illus. in black and white, with 61 figs in colour by Edward Gübelin. £14.95.

The basic concept of a book on this aspect of gemmology is a good one, and the publishers have produced a good-looking volume with excellent illustrations accurately captioned in bold type. These are elaborately numbered, although there is little attempt to use these numbers in the text.

The first part of the book deals with 'Methods of Growth'. Here the writer deals mainly with gem crystal production but includes some detail which relates to the much broader aspects of the crystal growth industry concerned with laser crystals, semi-conductors and other non-gem uses. A very short chapter on 'Testing Man-made Gems' and a longer one on 'Photographing Gem Inclusions' seem out of place in this section. The first of these devotes half its length to describing cathodoluminescence, a laboratory research technique which is known to turn some diamonds brown and to cause damage to some other stones, and is a long way out of reach for the ordinary gemmologist.

The second part deals with 'Identification' and covers most methods adequately, although detail seems to be lacking on reflectivity and diamond probe tests, both of which need to be used with some care if errors are to be avoided. Emphasis could have been given to the precautions needed.

Meanings are sometimes rather obscured by using advanced terminology which might confuse rather than enlighten, e.g. on p.107, [GGG crystals] 'are used for magnetic bubble devices which . . . operate by the movements of magnetic domains through a thin epitaxial magnetic layer grown on a non-magnetic, rare-earth, single crystal, garnet substrate.' Apart from the problem of comprehension, this seems to have little to do with gem identification.

There are occasional ambiguities, e.g. on p.191, 'no trace of the "umbrella" marking . . . could be seen, as is common in stones treated by cyclotron.' In some other cases the facts are at variance with those in the source articles, e.g., Knischka rubies on p.126, 'strong phosphorescence . . . long lasting.' The Gübelin report upon which is was apparently based says 'x-ray phosphorescence . . . is neither strong nor of long duration.'

On p.137 RIs are quoted which make Linde emeralds optically positive. The error was in the original GIA paper but was corrected in a note sent out with their next issue. All beryl is optically negative. On p.140 we read of 'A man-made emerald coloured by vanadium *then by* chromium'. That read '*without* chromium' in Dr A. M. Taylor's original paper. The RI of GGG is quoted as 7, which is its SG. Some absorption spectra wavelengths are jumbled and should have been corrected in proof reading.

I have quoted a few examples only and am left with an impression of haste and a feeling that greater care in writing would have produced a more reliable textbook.

R.K.M.

ASSOCIATION NOTICES

OBITUARY

TOINI MIKKOLA

28.3.1907 — 4.2.1984

Mrs Toini Mikkola died in Helsinki on 4th February 1984.

She had graduated as geologist and mineralogist in 1943 and became L.Phil. in 1967. She devoted all her professional life to the Petrological Department of the Geological Survey of Finland, beginning her career as assistant researcher and continuing as a full-time geologist. She specialized in optic mineralogy and published numerous papers on the subject.

In 1960 she passed the Diploma Examination and was elected to the Fellowship of the Gemmological Association of Great Britain, and in the same year she joined the Board of its Finnish counterpart and the team of teachers and instructors at the courses in Finland.

In 1970 she was appointed to be one of the Association's Examiners in Gemmology in respect of the Finnish Candidates, and her comments on the translations of Finnish answer-papers and her lucid explanations of what the candidates were intending to say, when, as sometimes occurred, the meaning of their actual words as literally translated into English was obscure, were of the greatest assistance to her English colleagues in assessing the correct marking of the papers.

Mrs Mikkola was equally well known in the international geological and mineralogical circles, as well as in the International Federation of University Women.

She was widowed in 1940, when her husband (also a geologist) fell in the Finnish Defence War of 1939-40. Her closest surviving relatives are two small grandchildren and their widowed mother.

H.T.
J.R.H.C.

FIG. 1. Mrs Toini Mikkola, L.Phil., F.G.A.

Dr MAX H. HEY
Mineralogist and Microchemical Analyst Extraordinary

Dr Max Hey died peacefully in his sleep, in the early hours of Tuesday, 24th January, 1984. In his 80th year, he had undergone surgery at Reading in November, and was convalescing at the home of his son in Newcastle-upon-Tyne. He is survived by his widow.

Max Hutchinson Hey was born on 11th March, 1904, at Leyland, Lancashire. His father worked with dyestuffs, and from him Max and two of his brothers acquired their interest in chemistry. His schooldays were spent at Leyland Grammar School, and later at Manchester Grammar School. In 1921 he went to Magdalen College, Oxford, graduating in 1925 with first class honours in chemistry and crystallography.

The middle years of the 1920s were not good for employment but, after two years in the Government Chemist's Laboratory and in the Patent Office, he was appointed Assistant Keeper (Second Class) in the Mineral Department of the British Museum (Natural History), with sole responsibility for the running of the chemical laboratory.

His first major task, set for him by the Keeper of Minerals, Dr L. J. Spencer, was to examine and catalogue the many zeolite specimens in the collection. In those days, work on the catalogue was an urgent priority, and all newly-appointed Assistant Keepers in the Department were expected to devote part of their time to a selected group of specimens. Aided on the x-ray side by F. A. Bannister, Max published a now classic series of papers on the zeolites; the new light shed on this complex group earned him both a D.Sc. and an international reputation.

The analysis of small amounts of material was an early challenge, and for qualitative work he enjoyed using reactions that produced characteristic products on a microscope slide. Quantitative analyses were also required, for such minerals as gemstones or the individual grains in a platinum concentrate from the Transvaal. Mineral analyses had previously been made on about 1/10 gram, rarely less, and the purchase of the Department's first microbalance enabled him to get down to the 10 mg scale; he regarded his first true microchemical analyses to have been those on magnesium-zinc-spinels, in 1937.(1) He was also innovative, deviethods for the analysis of the metallic phases of meteorites by chlorination and for the direct determination of ferrous iron in resistant silicates (for kornerupine, 1941).(2)

After the war, he continued his occasional collaboration with B. W. Anderson and C. J. Payne, of the Gem Testing Laboratory, and in the 1950s became known to many of the present generation of gemmologists by the microchemical analyses that he contributed to the descriptions of the newly-discovered gem minerals taaffeite(3), sinhalite(4), and painite(5).

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1. 1937: Magnesium-zinc-spinels from Ceylon, by B. W. Anderson and C. J. Payne; with a chemical analysis by M. H. Hey. *Mineral. Mag.*, **24**, 547-54.
2. 1941: Some new data concerning kornerupine and its chemistry, by M. H. Hey, B. W. Anderson and C. J. Payne. *Mineral. Mag.*, **26**, 119-30.
3. 1951: Taaffeite, a new beryllium mineral, found as a cut gemstone, by B. W. Anderson, C. J. Payne and G. F. Claringbull; with microchemical analysis by M. H. Hey. *Mineral. Mag.*, **29**, 765-72.
4. 1952: Sinhalite ($MgAlBO_4$), a new mineral, by G. F. Claringbull and M. H. Hey. *Mineral. Mag.*, **29**, 841-9.
5. 1957: Painite, a new mineral from Mogok, Burma, by G. F. Claringbull, M. H. Hey and C. J. Payne. *Mineral. Mag.*, **31**, 420-5.

Perhaps his best-known work is the 'Chemical Index of Minerals', which grew almost by chance from a wartime request for a listing of all the silicates of magnesium known in nature. He was preparing a third, expanded edition at the time of his last illness. Although he had officially retired in 1969, he remained as busy as ever, working at home and in the Museum as often as the demands of his large garden would permit.

It is impossible here to do more than mention his vast output of about one hundred and fifty publications, since he was master of an amazing range of subjects in both theory and practice: chemistry in its various aspects; crystallography and crystal optics; systematic, topographic, curatorial, and nomenclatural mineralogy; meteoritics; computational and statistical mathematics; and to all of these he made significant and lasting contributions. Yet this is by no means the sum of his professional achievement, since he was never too busy to help others, both in the Museum and in his capacity as Editor of the Mineralogical Magazine. Such was the growth of the subject, that in twenty-five years, from 1956 to 1980, he edited more papers than the redoubtable L. J. Spencer had in fifty-five; there can have been few of their authors who did not benefit from his advice. There is no secret to his success, which was founded in a unique blend of native genius, sound teaching, an ever-inquiring mind and retentive memory, hard work, and above all the ability to keep several problems progressing simultaneously and commit them to paper.

P.G.E.
E.A.J.

* * *

Mr J. A. Fleming, F.G.A. (D.1962), Auckland, New Zealand, died on 3rd May 1984.

MEMORIAL SERVICE FOR B. W. ANDERSON

A Service of Thanksgiving for the life of Basil William Anderson, B.Sc., F.G.A., F.K.C., was held on Tuesday, 24th April, 1984, in the Chapel of King's College London.

The Bidding was delivered by the Dean of King's College, followed by the singing of Charles Wesley's 'Rejoice, the Lord is King' to the music of Handel. The Lesson read by the Secretary of the Gemmological Association, Mr Con Lenan, F.G.A., was from Revelation 21:10-26, followed by Psalm 121, and the Address was delivered by Mr David Callaghan, F.G.A., the Chairman of the Gemmological Association. Two other hymns were sung, 'The King of love my Shepherd is' and 'O praise ye the Lord', and the prayers were led and the Blessing pronounced by the Dean of the College.

Those present included Mrs (Barbara) Anderson (widow), family friends and more than a hundred gemmologists from the United Kingdom and overseas and members of the trade.

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to the late Mr John A. Fleming, F.G.A., of Auckland, New Zealand, for a specially made carving in New Zealand nephrite.

NEWS OF FELLOWS

Miss Judith Bannister, F.G.A., who was granted the freedom of the Worshipful Company of Goldsmiths in 1977, was recently elected to the Livery.

Mr Robert Croydon, F.G.A., has recently been granted the freedom of the Worshipful Company of Goldsmiths.

Mr E. A. Jobbins, B.Sc., F.I.M.M., F.G.A., has been elected to the Committee of the Society of Jewellery Historians.

Dr David B. Michaels, LL.B., M.B.A., Ph.D., G.G., F.G.A., who is a Professor of Law and Management at the Community College of Northern Virginia, has been appointed President and Chief Executive of Forensic Gemologists Inc.

On 18th January, 1984, Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., gave a 30 minute talk on Radio Kent. The subject was man-made gemstones.

On 3rd April, 1984, Mr Peter Read, C.Eng., F.G.A., gave an illustrated talk on 'New gem test instruments and techniques' at the Brazilian Institute of Gems and Precious Metals, in Rio de Janeiro.

MEMBERS' MEETINGS

Midlands Branch

On 30th March, 1984, at the Society of Friends, Dr Johnson's House, Bull Street, Birmingham, Mr A. G. Green gave a talk on lost wax casting as applied to the jewellery trade.

On 17th April, 1984, at the Barn Restaurant, Hockley Heath, a dinner was held for Branch members and guests.

On 27th April, 1984, at the Society of Friends, the Annual General Meeting of the Branch was held, at which Mr C. L. Hundy, F.G.A., and Mr D. M. Larcher, F.G.A., were elected Chairman and Secretary respectively. The meeting was followed by a showing of slides and stones supplied by members.

North-West Branch

On 17th May, 1984, at Church House, Hanover Street, Liverpool, Mr Michael O'Donoghue, M.A., F.G.S., F.G.A., gave a talk on the quartz family of minerals.

ANNUAL GENERAL MEETING

The 53rd Annual General Meeting of the Association was held on Friday, 24th April, 1984, at the Great Hall, Kensington Town Hall, London, W8.

Mr David Callaghan, F.G.A., the Chairman, presiding over the meeting, welcomed members, some of whom had come from as far away as Scotland in the U.K., and from the Netherlands, Italy and Thailand. He referred to some of the items mentioned in the Annual Report, such as the continued high standard of the *Journal,* the Examinations, and the Annual Presentation of Awards, where a Canadian, Douglas Bagnall, and Mrs Fiona Quick, from Zimbabwe, received the Anderson/Bank Prize and the Anderson Medal respectively. These had been presented to them by Professor Dr Hermann Bank, F.G.A., who also had the opportunity of presenting a Diploma to his daughter, Monika.

He proceeded to mention the activity of the Education Committee in redesigning the Correspondence Course, which it was hoped would be ready for 1985, and the formation of an Advisory Committee to help the Chairman and the other Officers (this had proved to be very useful); and he thanked the Branches, which had been busily furthering the interests of gemmology in their areas.

He next referred to the unfortunate absence of the President, Sir Frank Claringbull, who had broken his leg earlier in the year and had sent his apologies, saying he did not feel sufficiently mobile to attend; and finally he welcomed the presence of the Vice-President, Mr Harry Wheeler, and of his brother, Douglas.

Mr Nigel Israel, the Honorary Treasurer, presented the audited accounts for the year ended 31st December, 1983, and the Chairman moved the adoption of the Report and Accounts; the motion was seconded by Mr Peter G. Read, F.G.A., and carried unanimously.

Sir Frank Claringbull, Mr David Callaghan, Mr Noel Deeks, and Mr Nigel Israel were then re-elected as President, Chairman, Vice-Chairman and Honorary Treasurer respectively; and Dr J. B. Nelson and Messrs A. J. French, D. Inkersole, D. M. Larcher, W. Novak and C. H. Winter were re-elected and Mrs E. Stern and Mr D. Morgan were elected to the Council.

The Chairman, after referring to the sad loss suffered by the Association by the death of their senior Vice-President and senior Examiner, Mr B. W. Anderson, then expressed his pleasure in proposing, on the nomination of the Council, the election as a Vice-President of Mr R. Keith Mitchell, F.G.A., and, when duly seconded and put to the meeting, this was carried unanimously.

Messrs Ernst & Whinney were appointed Auditors, and the proceedings then terminated.

COUNCIL MEETINGS

At the Meeting of Council held at the London Tara Hotel, London, W.8., on Tuesday, 21st February, 1984, the business transacted (in addition to the election of Members already reported on p.204 above) included the following:
(1) it was resolved to nominate Mr R. Keith Mitchell, F.G.A., (Tully Medallist 1934) for election at the Annual General Meeting as a Vice-President of the Association;
(2) a request received from the Gemmological Association of South Africa for affiliation with the Association was considered and affiliation was granted.

At the Meeting of Council held on Tuesday, 24th April, 1984, at the Kensington Town Hall, Hornton Street, London, W.8., the business transacted included the election to membership of the following:

FELLOWSHIP

Chamberlain, Roger P., Antwerp, Belgium. 1983
Hutchings, Trevor J., St Saviour, Jersey. 1983
Krikos, Alexandra A., Athens, Greece. 1983
Triantaphyllides, Zoe M., Athens, Greece. 1983

ORDINARY MEMBERSHIP

Alahendra, Jayatilaka, Kandy, Sri Lanka.
Attar, Aviva, London.
Brown, George E., Tucson, Ariz., U.S.A.
Fearn, Ian F., Gillingham.
Francis, Shirley J., Frinton-on-Sea.
Gosling, Robert G., Christies Beach, S. Australia.
Kasparian, Annie, Marseilles, France.
Mehta, Anoop K., London.
Miller, Harward S., Farmington, N. Mex., U.S.A.
Moline, George S., Spokane, Wash., U.S.A.
O'Mahoney, Niamh, Cork, Ireland.
Peavey, Charles A., Norwalk, Ca, U.S.A.
Perea, Hilario L., Farmington, N. Mex., U.S.A.
Potgieter, Ernestine, Cape Town, S. Africa.
Roper, Jane, Madrid, Spain.
Roy, Stephen B., Tucson, Ariz., U.S.A.
Stafford-Smith, Reginald, Brisbane, Qld, Australia.
Stoecklein, Patricia A., Trafalgar, Indiana, U.S.A.
Tippins, Harry, Signal Hill, Ca, U.S.A.
Walker, Gordon S., Belmont, N.S.W., Australia.
Wanigasekera, Vimal, Kandy, Sri Lanka.

THE NEW VICE-PRESIDENT

Mr R. Keith Mitchell, F.G.A., was elected a Vice-President of the Association at the Annual General Meeting as reported above.

In 1928, at the age of 16, R. Keith Mitchell entered the buying department of Mappin & Webb Limited. In these early years he spent his time buying silverware for export. In 1932 he started at Chelsea Polytechnic, and it was not until 1933 that he obtained a transfer to the jewellery department. He was very interested in gemstones and spent most of his lunch times in the Geological Museum, then situated in Jermyn Street, London, W.1.

In 1934 he passed his Diploma Examination, not only with distinction, but gaining the Tully Memorial Medal, beating very tough opposition from the late Robert Webster, who passed in the same year. It was the practice at that time for Tully Medallists to be immediately seconded to the Council, and until the War he served as a Council Member. Being drafted into the Royal Corps of Signals, he was posted to Singapore where, when it was captured by the Japanese, he was taken prisoner. He was shipped to Japan and spent the remainder of the War in a Japanese Prisoner of War Camp.

Upon his return in 1947 he took up the post of assisting Thorold Jones* with the practical classes at Chelsea Polytechnic. In 1950 he took over the first year correspondence course as Instructor, and a year later in 1952, he took over the second year instructorship as well. He ran both courses single-handed, until Vera Hinton took over a number of first year students. He continued in this position until 1969, when ill health forced his retirement from this work; he had, in fact, run both courses single-handed for over ten years. During the whole of this period he was re-elected to the Council and indeed throughout this period played an active part in setting the high standards that the Gemmological Association enjoys today.

He published his first paper on gemmology in 1935 and has published a total of more than forty papers to date, not to mention the innumerable Abstracts he has provided us with in recent years.

Keith Mitchell ran his own business dealing in gemstones for many years, until his retirement in 1979. During that period he obtained many gemstones, of which a number now form part of the National Collection in the Geological Museum in London. The most notable of the stones he handled and indeed still owns, is the original taaffeite, discovered by Count Taaffe in 1945. This stone is currently on loan to the Geological Museum and is the Type Specimen of the species.

It is now 50 years since he gained the Tully Memorial Medal, serving the Gemmological Association for all his working life, playing an important part in gemmological education, supplying many examples of new materials for the first time in this country, and indeed making many original observations, on new and existing gemstones. C.R.C.

1984 REUNION OF MEMBERS AND PRESENTATION OF AWARDS

The Annual Reunion of Members and Presentation of Awards will take place at Goldsmiths' Hall on Monday, 12th November, 1984.

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*See *J. Gemm.*, 1973, **XIII** (7), 26, or *50 Years of Gemmology* at p.29—Ed.

THE BRITISH GEM TESTING LABORATORY

On 12th March, 1984, the name of the Gem Testing Laboratory of the London Chamber of Commerce and Industry, at 27 Greville Street, Hatton Garden, London, E.C.1., was changed to The British Gem Testing Laboratory.

INTERNATIONAL COLORED GEMSTONE ASSOCIATION

At meetings held at Acapulco, Mexico, which took place from 28th January to 2nd February, 1984, and were hosted by the American Gem Trade Association, it was decided to found an International Colored Gemstone Association to foster interest in coloured gemstones and deal with any problems connected with the industry in conjunction with C.I.B.J.O. and national institutions. Founder Members included Messrs Con Lenan and E. A. Jobbins, FF.G.A., from the United Kingdom and Messrs Richard T. Liddicoat, Jr, Hon.F.G.A., and Michael Roman from the U.S.A., as well as Professor Dr E. Gübelin, F.G.A., from Switzerland. Further information may be obtained from Mr Con Lenan, Saint Dunstan's House, Carey Lane, London, EC2V 8AB.

SOCIETY OF JEWELLERY HISTORIANS

The Society of Jewellery Historians, which was formed in 1977, holds regular meetings in London (at the Society of Antiquaries, Burlington House, Piccadilly) with speakers from a wide range of disciplines: its aim is to stimulate and satisfy interest in jewellery of all ages and cultures. The Society is to publish this year the first number of its annual journal, *Jewellery Studies,* as well as continuing to produce its News-sheet three times a year. Further particulars (including subscriptions—at present £10 p.a. for an individual member) may be obtained from the Hon. Secretary, Judy Rucoe, Department of Medieval and Later Antiquities, British Museum, London, WC1B 3DG, to whom applications for membership should be sent. (Telephone: 01-636 1555 - ext 601/415).

CORRIGENDA

In *J. Gemm.*, 1983, XVIII (8)—
on p.692, in caption to Fig. 29, for '(verneuil) *c*-axis' read '(Verneuil) ‖*c*-axis'
on p.694, in caption to Fig. 31, for 'Sri Lanka *c*-axis,' read 'Sri Lanka ‖*c*-axis,' and in caption to Fig. 32 for 'Chatham *c*-axis,' read 'Chatham ‖*c*-axis,'
on p.706, in line 8, for 'diffusionbehandelter' read 'diffusionsbehandelter', and, in line 9, for 'difusions behandelten' read 'diffusionsbehandelten'
on p.709, delete the first two lines ('The play of colour . . . create the conditions')
on p.721, in line 22, for 'bam' read 'beam'
on p.748, in Table 3, for 'Marekanite' read *'Marekanite'*
on p.757, Footnote, in line 2, for '$\sqrt{k}.t$' read '$\sqrt{k.t.}$', and, in line 6, for '$A.e^{I/RI}$' read '$A.e^{E/RT}$'
on p.765, in line 19, for '5920A' read '5920Å'

In *J. Gemm.*, 1984, XIX (1)—
on p.21, under third Figure add 'Fig. 9.' and for 'Fig. 9.' read 'Figs 7, 8 and 9.'
on p.67, in line 17, for 'Gems, **5**,' read 'Gems, **15**,'

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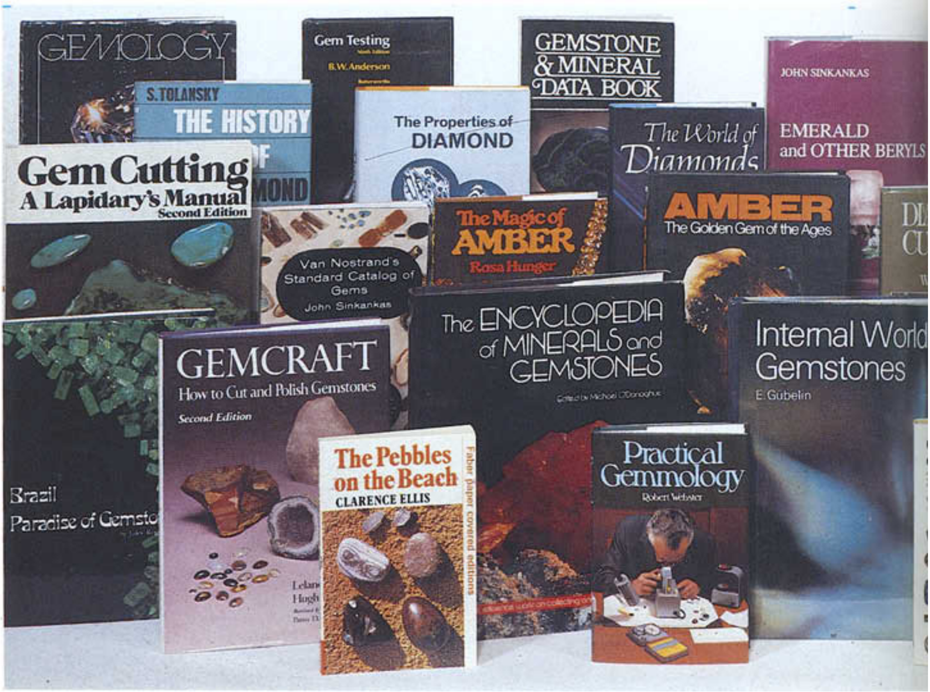

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OVERSEAS ORDERS

Overseas customers should not send a remittance with their order as they will be sent a pro forma invoice. All orders, whether U.K. or overseas may be paid by the use of the following credit cards: Visa, Access/Master Card, Diners Club, American Express.

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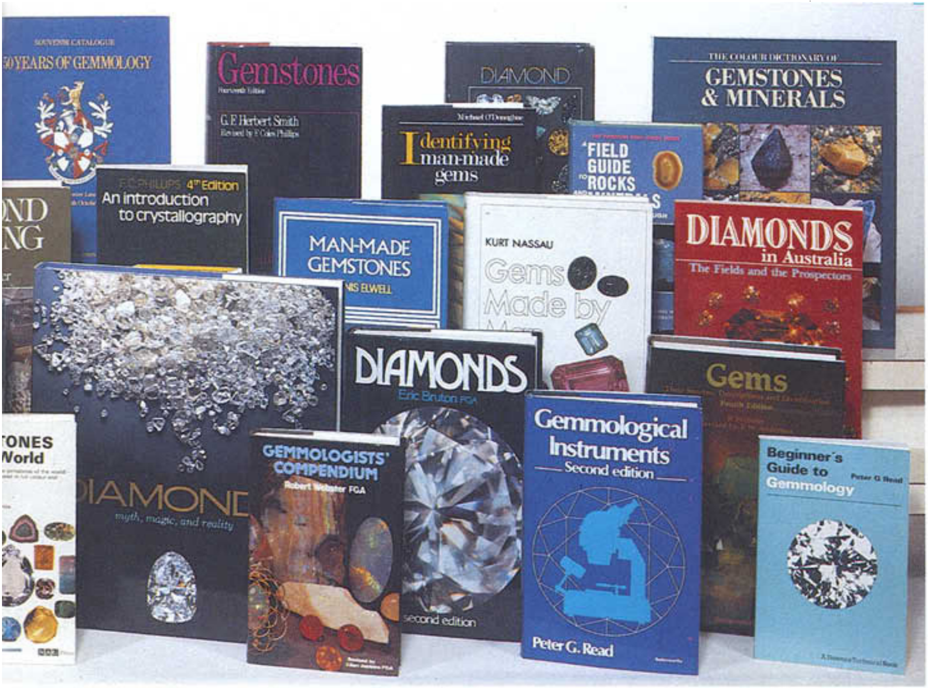


Rayner
MADE IN ENGLAND

Historical Note

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

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

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

Notes for Contributors

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

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

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

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