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GEMMOLOGICAL ASSOCIATION
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INSPIRING HOURS AS AN INVIGILATOR

By PROFESSOR E. J. GÜBELIN, Ph.D., F.G.A., C.G.
Lucerne, Switzerland

HAVING invigilated over the candidates sitting for the Preliminary and Diploma Examinations of the Gemmological Association of Great Britain in Lucerne, Switzerland, for the past twenty years I am pleased to admit that it has always proved a most rewarding task, also offering considerable personal satisfaction. Over the course of the years the questions have become more and more interesting, acting as a true examination of the candidate's actual knowledge and mastery of the science of gemstones rather than merely challenging his talent of simply memorizing the data. Simultaneously, the test stones for Part III of the Diploma Examination became increasingly intriguing, i.e. demanding a greater empiric proficiency of the candidate, that is to say, his skill of practical testing tactics.

Before the examination was about to commence I have always shared the same tension as the poor candidates, as the envelopes of the questionnaires are opened in front of their anxiously watching eyes, and I have always found it most inspiring to study the questions carefully and answer them for myself. Unfortunately, my answers have never been subject to a corrector. Without seeing the question papers before the examination started, I usually took the liberty of identifying the examination stones.

It has always been my habit to scrutinize any gemstone at first sight by means of the microscope or the pocket lens, and at the same time to decide upon the manner of procedure and thus determine by which method or methods I would reach an accurate assessment without too much loss of time. Very often I was delighted by a magnificent inclusion and rewarded by its diagnostic shape or nature identifying the gem at my first glance—in the full sense of the expression. Identification by means of the optical spectroscope proved to be another conclusive method which repeatedly found my enthusiasm and enabled identification of an unknown gem "within a matter of seconds". I invariably felt sorry for those candidates taking the practical part of the Diploma Examination on observing their loss of valuable time due to lack of system and practical experience. Empirical knowledge is of indispensible importance—a fact which was overwhelmingly corroborated again last June (1973), when we in Switzerland received a collection of test stones unusually well chosen for rapid arrival at an exact verdict by means of a systematic and proficient procedure.

The test stones of groups A, B and D need not be taken into consideration here because their determination is usually prescribed. All the more interesting were the specimens of the group C which could be identified by means of all tests available. Thanks to some outstandingly diagnostic features, such as inclusions and absorption spectra, it was possible to ascertain their nature within half an hour:

C 1 was a square-cut, grass-green stone resembling an emerald. It betrayed itself at the first glance under the microscope by its tell-tale inclusions which consisted of a typical wisp feather with a characteristic net-pattern of its liquid channels. This feather was accompanied by a well shaped phenakite crystallite (Fig. 1). This test stone was a *synthetic emerald.* In order to verify this verdict the stone's dichroism (bluish-green/yellowish-green) was checked and its refractive power against the immersion liquid (benzylbenzoate had been chosen for this purpose right from the beginning) showed to be lower.

C 2 was a cabochon-cut, translucent leek-green stone and did not reveal any particular feature under the microscope. However, under the spectroscope it showed a distinctive absorption line at 4370Å so conclusive for *jadeite.* The specimen hovering in methylene-iodide (d = 3·33) and giving a reading at 1·66 on the refractometer proved the first finding.

C 3 was a trap-cut gem of a pale straw-yellow colour. Its interior teemed with tiny liquid drops either irregularly distributed in

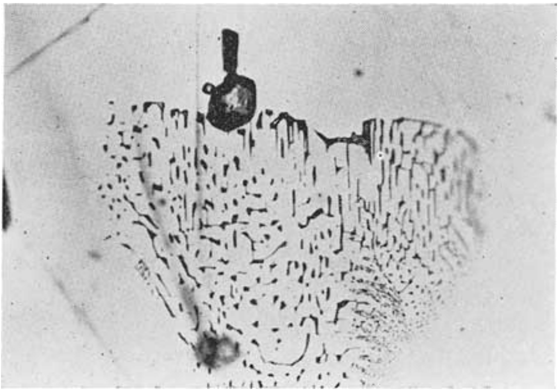

FIG. 1. Characteristic pattern of the "undigested" liquid drops in a wisp-like recreation fracture of a synthetic emerald in the immediate neighbourhood of a phenakite crystal. 50 ×

loose patches or arranged in arrays and then they excelled in "lost form" shapes with serrated border lines. Their indicative character existed not only in an extremely faint relief, advertising a small difference of R.I. between the liquid filling and the host gem, but also in the fact that apart from a majority of two-phase inclusions there were some three-phase inclusions, wherein the solid phase consisted of the ordinary cubic halite crystal announcing the hydrothermal origin of this specimen. All these observations (shape of the inclusions, their weak relief and their three-phase fillings) point to *fluorspar* (Figs 2, 3 and 4). Unchanged extinction between crossed polaroids and a refractive index of 1·44 confirmed the previous verdict.

C 4 a brilliant-cut stone of red colour. The first look through the microscope revealed this stone to be assembled, in that a score of spherical air bubbles appeared in the junction zone. The upper part contained rutile needles of the well-known three-dimensional arrangement, while the pavilion showed rounded facet edges and a smooth conchoidal fracture. Thus the *doublet* consisted of an almandine crown and a paste body. Immersion in water endorsed the conviction of having examined an almandine/paste doublet.

C 5 was a tablet-shaped slice cut across a prismatic crystal with a triangular basal pinacoid. While this contour already served as an excellent hint the thread-like inclusions proved to be even

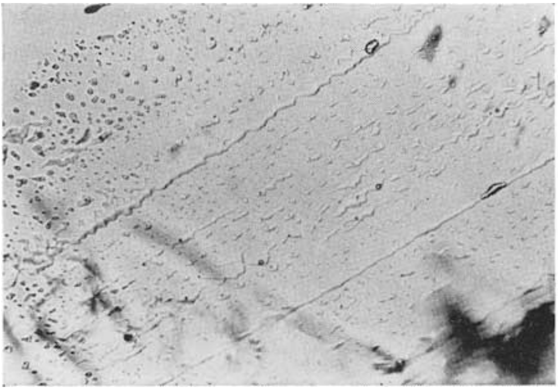

FIG. 2. Parallel rows of residual liquid drops forming two-phase inclusions in a cleavage plane. Their appearance and their lost-form shapes denote their host gem as fluorspar. 20 ×

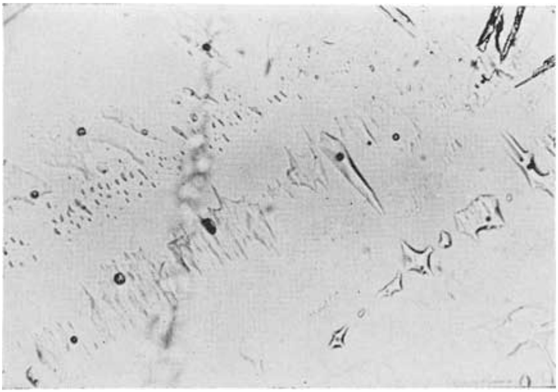

FIG. 3. Two-phase inclusions with spiky contours arrayed along parallel lines in a cleavage fissure. Weak relief and shape of these inclusions betray the fluorspar. 60 ×

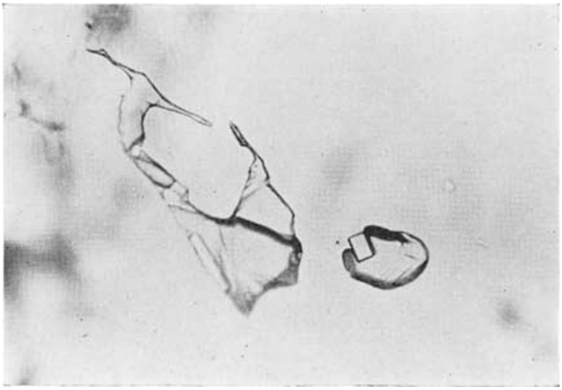

FIG. 4. Three-phase inclusions of this kind are very typical of hydrothermally formed fluorspar. The smaller inclusion embraces a well shaped halite crystal. 100 ×

more conclusive. They disclosed those hair-fine formations with two-phase fillings which are known as trichites and infallibly mark the *tourmaline* (Fig. 5). Further tests with the microscope, such as Becke's method in monochlornaphthalene in combination with the uniaxial conoscopical figure agreed with the internal picture of this specimen.

C 6 a yellowish brown, brilliant-cut gem which under the pocket lens displayed a very strong doubling of the pavilion facets. The suspicion of observing a *zircon* was substantiated by the absorption spectrum which was enhanced by a very strong absorption line at 6535Å.

C 7 seemed by all appearances to be a sapphire—either genuine or synthetic. It had the ordinary mixed cut and was of oval shape and of dark blue hue. It required not much playing under the microscope to discover growth striae which met at an angle of 60° (Fig. 6): keeping the gem in this position and rotating it under the microscope between crossed polars it remained isotropic, while the conoscopical figure was uniaxial. The dichroism was green-blue and deep blue. Although doubtlessly this gem was a *genuine sapphire*, a very strong and broad absorption band between 4500 and 4720Å delivered further proof of this result.

C 8 was an oval-cut faceted stone of a violetish red hue. It did not exhibit a very striking internal world except a few rutile needles running through the gem's body in three distinctly different directions thus designating it as a garnet of the pyrandine group. It could hardly be a pyrope because of its colour and also on account of the acicular rutiles. Absorption bands of moderate strength at 5050, 5370 and 5760Å indicating a medium content of iron and a R.I. of 1·765 identified this test stone as a *rhodolite garnet*.

C 9 a rectangular, step-cut specimen of pale yellow hue and completely devoid of any inclusions offered the greatest difficulty as far as rapid *and* reliable testing was concerned. Since the microscope failed in this case the spectroscope was taken recourse to and indeed it proved to be of decisive assistance in that it disclosed faint, narrow lines between 5700 and 5800Å which are known to be due to didymium. This observation indicated *apatite* and it was confirmed by the refractometer,

FIG. 5. Highly elucidating picture of the inner world of tourmaline consisting of hair-fine liquid channels (trichites) with two-phase fillings. 20 ×

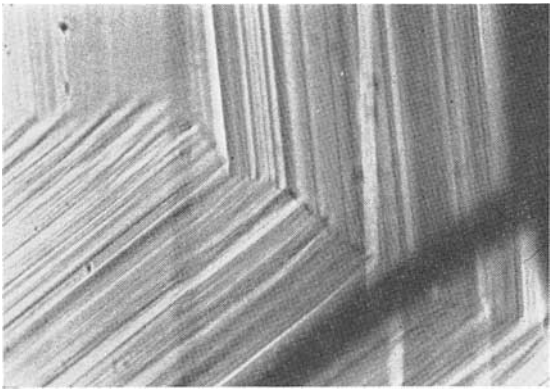

FIG. 6. The well-known zonal structure of genuine sapphire formed by growth layers meeting at angles of 120° and enhanced by unequal coloration. 10 ×

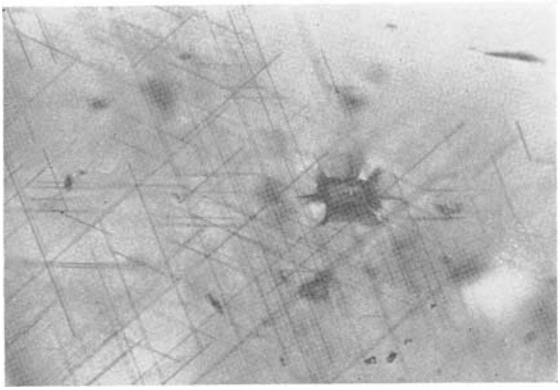

FIG. 7. Loosely woven silk of fine rutile needles aligning along the edges of the rhombododecahedron. The dark rounded grain in the foreground is a metamict zircon with stress halo. 30 ×

which gave readings at 1·640 and 1·644 yielding a birefringence of 0·004.

C10 offered no difficulties at all. It was a faceted, oval, dark red gem with a brownish tinge. Its internal paragenesis was exclusively qualified by that unique pattern of rutile needles running in three-dimensional directions and being so diagnostic for *almandine garnet* (Fig. 7). Further confirmation of this opinion was delivered by a score of heavy and broad bands in the green and the blue regions of the spectrum at 5760, 5270, 5050, 4760, 4620, 4380 and 4270Å—a characteristic spectrum of ferrous iron, which is one of the essential ingredients and the colouring agent of almandine garnet.

With the foregoing report I hope to have convinced the readers—especially beginners and "young" gemmologists—of the eminent importance of the microscope and the spectroscope and I trust to have fostered their confidence in the outstanding reliability of the microscopic and the spectroscopic methods. May these hints encourage students of gemmology to develop their own testing tactics and benefit from the above information by continual expansion and improvement of their personal experience, observations and efficiency.

DEFECTS IN THE COLOURED VARIETIES OF QUARTZ

By D. R. HUTTON, B.A., Ph.D., M.Sc.
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THE use of modern methods in gemmological research has revealed much information about gems, both natural and synthetic. Colouring mechanisms in particular have excited the interest of many workers.

Many of the colours of allochromatic gems are associated with defects or impurities which are paramagnetic, that is, they possess unpaired electrons or nucleons (neutrons and protons) which give the stone unique magnetic properties. The new research methods based on these properties therefore yield data which are valuable in explaining gem colours and interpreting changes.

Electron spin resonance (ESR) and nuclear magnetic resonance (NMR) spectroscopies are sophisticated ways of looking at the magnetic susceptibility of gemstones. ESR gives spectroscopy signals, usually in the microwave region of the spectrum, from unpaired electrons which can arise from defects and broken bonds or from transition metal ion impurities such as iron, chromium, vanadium and cobalt. The spectra allow positive identification of the impurity and its valence state, and give much information about the crystal site of the defect or impurity, for example the symmetry of the crystal field and the axes of any distortions.

NMR signals occur in the radiofrequency band and come from the nuclei of atoms in the gem which have unpaired neutrons and protons. The most mineralogically important of these are ^{1}H, ^{7}Li, ^{9}Be, ^{11}B, ^{23}Na, ^{27}Al, where the superscript gives the number of nucleons in the nucleus. The spectra allow determination of the coupling of the nucleus to the crystal field gradient (quadrupole coupling constant) and determinations of symmetry and directions of cation site distortions. A newer branch of spectroscopy, and indeed one of the most powerful tools yet used for the study of defects, is ENDOR, electron nuclear double resonance. This is a combination of ESR and NMR, and it allows accurate determination of the coupling between paramagnetic nuclei and electrons over large distances within the gem or mineral.

Defects are also studied with dielectric relaxation experiments. Here the experimenter relies on the fact that an aliovalent impurity (for example Al^{3+} replacing Si^{4+} in quartz) usually requires a vacancy or interstitial ion (e.g. Na^+) to balance the charge in the crystal and these two defects together make up an electric dipole whose electric susceptibility can be studied by application of an alternating electric field. These defect pairs can also often be annealed or removed by heating, and the resulting thermoluminescence radiation, plotted intensity versus temperature, gives the "glow curve" of the mineral or gem.

Finally, the electron microscope deserves a mention for its valuable contributions to defect studies, revealing as it does details of twinning, dislocations, bubbles and inclusions. Of course all of these newer spectroscopies only complement more traditional methods of study such as optical, infra-red and ultra-violet spectroscopy, and the full picture of defects relies very much on evidence gathered by all techniques.

Quartz has received much attention recently, not only because it is a gem of some importance, but also because it is a material used commercially in many areas, from quartz crystal oscillators to oxide layers in FET transistors, where knowledge of its defects is important. Figure 1 illustrates the absorption spectra of some of the coloured varieties of quartz.

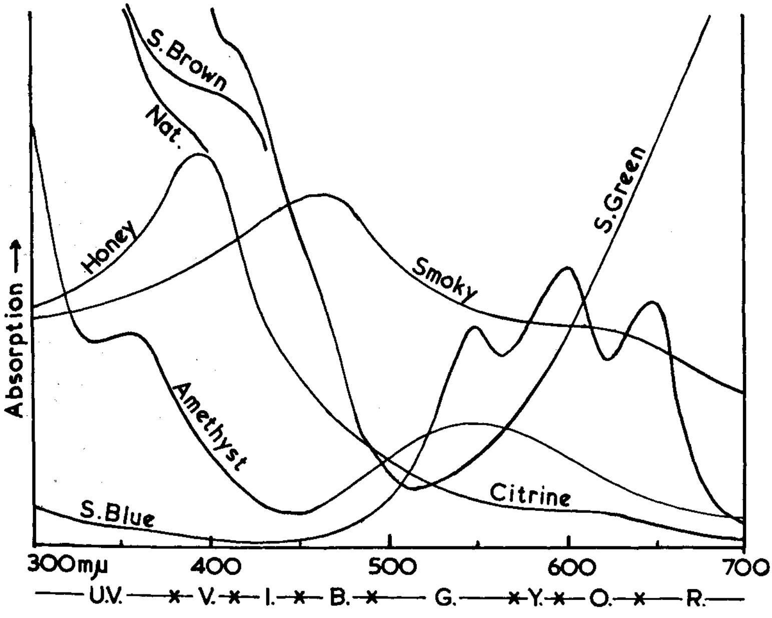
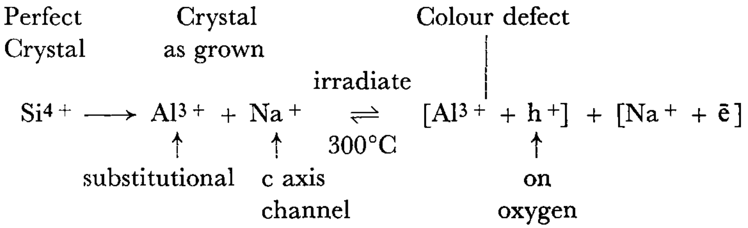


FIG. 1. Optical absorption spectra of some of the coloured varieties of quartz.

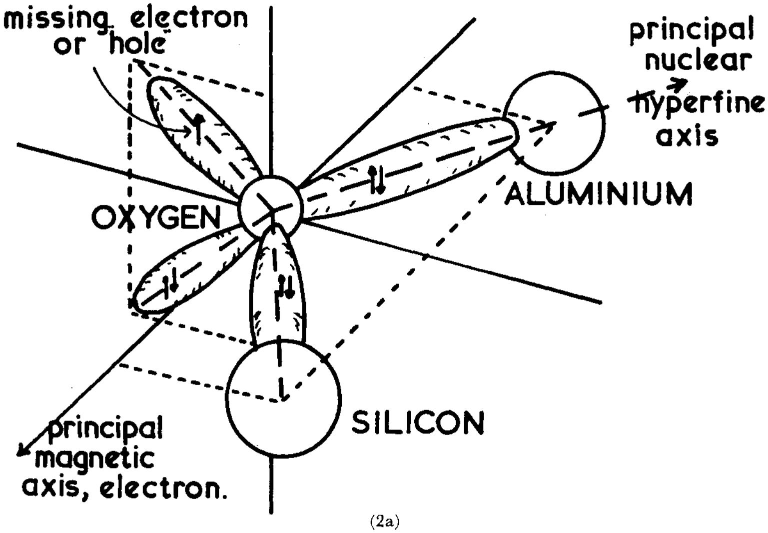
The colour of smoky quartz is due to broad absorption bands (Mitchell and Page 1965) in the visible spectrum centred at about 480 mμ and 620 mμ (6200Å). The ESR study by Griffiths, Owen and Ward (1954) resulted in O'Brien (1955) showing that the smoky colour is caused by the absence of an electron from an oxygen, which is next to a defect aluminium, substituted for silicon in the structure. Thus quartz which can be turned smoky on irradiation grows with Al^{3+} ions replacing Si^{4+} ions. To compensate the Al^{3+}, Na^{+} (or Li^{+}) sits near to it in one of the large channels parallel to the c axis. On irradiation an electron jumps from one of the neighbouring oxygens leaving a "hole" or effective positive charge behind. This leaves the defect site with four positive charges without the Na^{+} ion as charge compensator, so this ion diffuses away, trapping the electron as it moves to a stable mooring elsewhere in the crystal. Equation 1 summarizes these processes:—



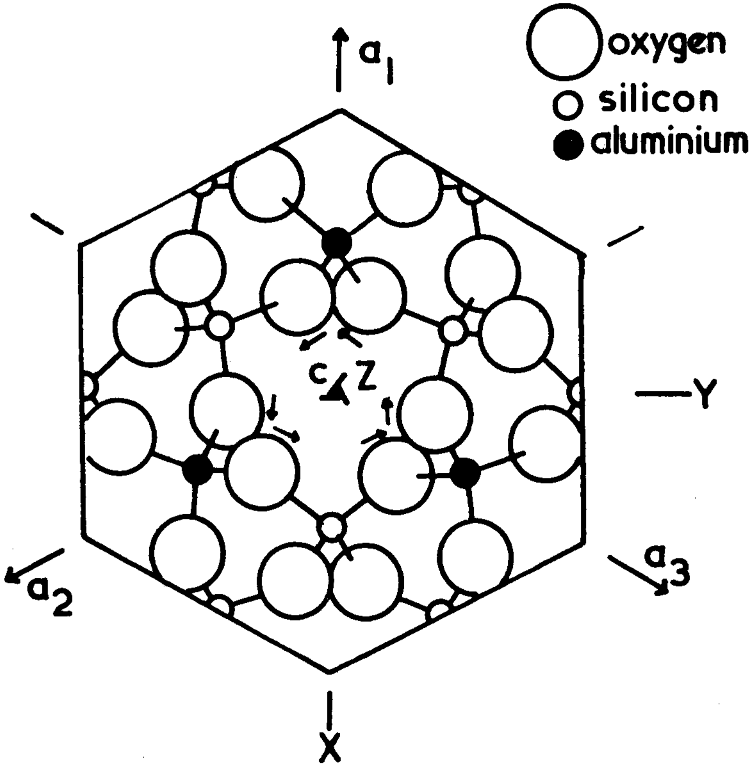
$$\underset{\text{Perfect Crystal}}{Si^{4+}} \longrightarrow \overset{\text{Crystal as grown}}{\underset{\uparrow \atop \text{substitutional}}{Al^{3+}} + \underset{\uparrow \atop \text{c axis channel}}{Na^{+}}} \underset{300^{\circ}C}{\overset{\text{irradiate}}{\rightleftharpoons}} \overset{\text{Colour defect}}{[Al^{3+} + \underset{\uparrow \atop \text{on oxygen}}{h^{+}}]} + [Na^{+} + \bar{e}]$$

Figure 2a (after Taylor and Farnell 1962) shows a diagrammatic representation of the aluminium hole defect. The ESR studies show, from the crystal field effects and the magnetic coupling between the hole and the aluminium nucleus, that there are six possible positions for the holes, related in pairs to the three possible aluminium positions. Figure 2b illustrates these positions as seen looking down the c axis of the quartz structure. Taylor and Farnell show that the three pairs can be unequally populated by defects, but that the populations *within* the pairs are always equal unless an electric field is applied. His dielectric loss experiments demonstrate that the holes can jump backwards and forwards between the two oxygens neighbouring the aluminium, thus acting as electric dipoles.

FIG. 2. (After Taylor and Farnell)
(*a*) shows the missing electron or hole of the smoky quartz aluminium defect.
(*b*) shows the atoms of quartz as seen looking down the c axis.


missing electron
or "hole"
principal
nuclear
hyperfine
axis
ALUMINIUM
OXYGEN
SILICON
principal
magnetic
axis, electron.

(2a)


a1
oxygen
silicon
aluminium
c
Z
Y
a2
a3
X

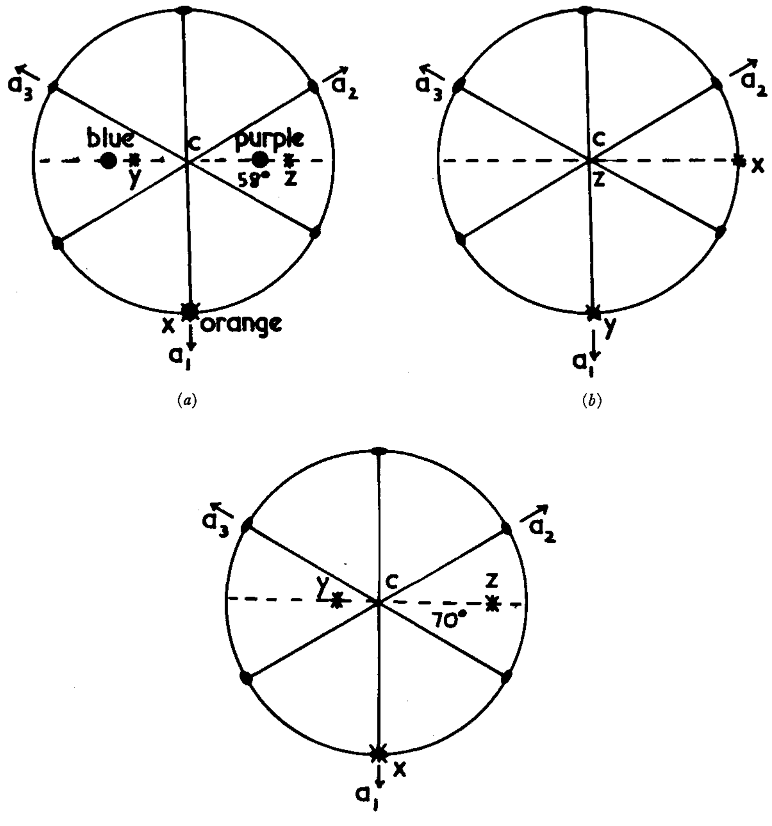
(2b)

Now smoky quartz has been shown to exhibit anomalous pleochroism (Cohen 1956), and Tsinober *et al.* (1967) show that this is due to the unequal occupancy by Al of the three possible substitutional positions during growth of quartz on its rhombohedral planes. This is an interesting case of asymmetrization, the growth of colour-centre defects on a face of lower symmetry leading to a breakdown in the optical symmetry (here pleochroism in a trigonal crystal). If the crystal is heated to temperatures greater than 600°C the aluminium migrates to populate the three possible sites equally. Thus on cooling and reirradiation the ESR shows three equal pair populations and optically the crystals are now dichroic.

As Figure 2b shows, there are four oxygen atoms neighbouring each aluminium and researchers were puzzled as to why the hole came only from two of the oxygens. This problem was resolved by the x-ray results of Smith and Alexander (1963) who showed that two of the Si-O bonds are longer than the other two. Schnadt and Schneider (1970) were able to show, using ESR, that as smoky crystals were warmed up, some of the holes did indeed get excited enough to hop over to the other two oxygens, thus giving six more defect centres in the crystal. De Vos and Volger (1967, 1970) confirmed that holes hopping among equilibrium oxygen sites were the likely causes of smoky quartz's dielectric losses.

There have been many recent studies (e.g. McMorris 1971) to determine the detail of the bleaching of smoky quartz, since it is now realized that the accumulated radiation damage, revealed by the thermoluminescence glow curve produced by the recombination of the defects, can be used for accurate dating (Fleming 1974) of archaeological samples. Although much is now understood about smoky quartz, there is still a lot unknown, for example the detailed mechanism for the light absorption is still not understood; thus active research continues.

Violet amethyst-quartz exhibits many characteristic features (Frondel 1962) which must be explained by any theory of the defect structures. Some of these features are similar to those of smoky quartz; the colour is produced by irradiation, anneals by heating to about 300°C, and tends to be in bands parallel to external faces especially the r growth loci. Although the main absorption band is at 540 mμ, crystals often show anomalous pleochroism with trichroic colours blue, red and orange (Pancharatnam 1954).



(*a*) (*b*)

(*c*)

FIG. 3. Stereographic projections showing
(*a*) The distortion axes of the iron substitutional centres (S_1) and the pleochroic axes for amethyst.
(*b*) The distortion axes of the interstitial centres (I) in citrine and synthetic brown quartz.
(*c*) The distortion axes of the titanium lithium centres in rose quartz.

The ESR measurements of Hutton (1964) were the first to demonstrate that iron as Fe^{3+} substitutes into the silicon sites in amethyst with the directions of the distortion axes almost the same as the trichroic colour directions (Fig. 3a). Soon Barry, McNamara and Moore (1965) demonstrated that the unequal site occupation of the Fe^{3+}, produced at the time of growth, explained the observed biaxiality. They also detected alkali ions next to the Fe^{3+} ions by their nuclear magnetic interaction with the iron electrons. McLaren and Phakey (1966, 1968) using electron microscopy showed that the brazil twin boundaries, very common in amethyst, would act as efficient traps for impurities migrating along the c axis channels. However, the Fe^{3+} defects detected so far could not alone cause the amethyst colour since heating, although it equalizes the distribution of centres and removes the biaxiality, does not remove the Fe^{3+} centres with the colour bleaching. Schlesinger and Cohen (1966) proposed many defects which incorporated electrons or holes but Chentsova *et al.* (1966) quickly pointed out that such defects were not detected by ESR and therefore were not present. Lehmann and Moore (1966) discovered two more Fe^{3+} centres in synthetic brown quartz, this time with distortion axes (Fig. 3b) which indicated both substitutional (S_2) and Interstitial (I) sites.

On the basis of optical spectra and the temperature variation of ESR spectra Lehmann (1967) then proposed for amethyst that, on irradiation, an electron is removed from some of the S_1 centres converting them to Fe^{4+} and transferred to some of the interstitial iron ions converting them to Fe^{2+}. At the same time ferric-hydrogen S_2 centres are produced. Equation 2 summarizes the proposed processes occurring at irradiation and bleaching.

$$\begin{array}{rcll} x\,Fe^{3+}(S_1) & \longrightarrow & x\,Fe^{4+}(S) + x\bar{e} & \text{(oxidation)} \\ x\bar{e} + x\,Fe^{3+}(I_4) & \longrightarrow & x\,Fe^{2+}(I_6) & \text{(reduction)} \\ y\,Fe^{3+}(S_1) & \longrightarrow & y\,Fe^{3+}(S_2) & \end{array}$$

$$(x+y)\,Fe^{3+}(S_1) + x\,Fe^{3+}(I_4) \underset{\text{heat}}{\overset{\text{irradn}}{\rightleftharpoons}} x\,Fe^{4+}(S) + x\,Fe^{2+}(I_6) + y\,Fe^{3+}(S_2)$$

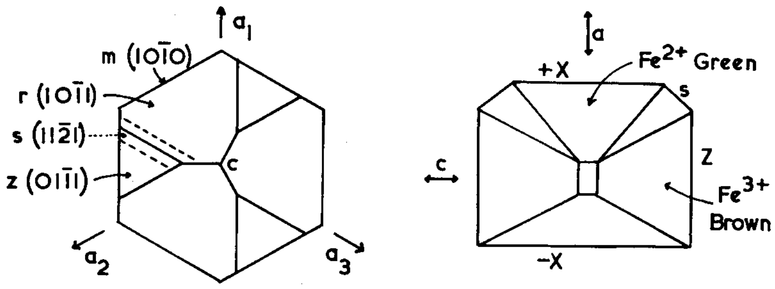
The I_4 and I_6 positions are 4 and 6-fold co-ordinated interstitial positions down the c axis channels. Vereshchak *et al.* (1973) think they have detected Fe^{2+} in low symmetry sites in quartz using Mössbauer spectroscopy but their results are not unambiguous. Unfortunately, both Fe^{2+} and Fe^{4+} ions are difficult to detect with conventional ESR techniques but modern developments involving the use of thermal detection of the spectra, and acoustic paramagnetic resonance (APR) which involves detecting the ions by their effect on vibrational waves propagating in the crystal, offer some hope. However, what is already known about the basis for amethyst coloration has allowed some deductions to be made about the geological conditions for growth, and Dennen and Pucket (1972) have shown that careful, future study of amethysts may give us a useful geothermometer.

Many amethysts when heated to 500°C become citrine-coloured and the colour of "iron" citrines has been shown by the ESR and optical studies of Samoilovich *et al.* (1969a) and Lehmann (1971) to be due to interstitial Fe^{3+} and heterogeneous inclusions of Fe_2O_3. Both of these authors also discuss the rarer radiation "honey" citrine and show that the colour of this variety is due to the presence of aluminium together with a high concentration of hydrogen and lithium. Irradiation then produces hole centres which are similar to those of smoky quartz except that the charge compensators do not diffuse away on irradiation.

X-ray produced, hydrogen and lithium compensated centres have also been detected by ESR in rose-quartz by Wright *et al.* (1963) and Rinneberg and Weil (1972) where the paramagnetic impurity is titanium and not manganese as had long been supposed. Ti^{4+} and Al^{3+} grow into the crystal together with H and Li atoms in the interstititial channels. On irradiation, electrons released from the aluminium centres are trapped by the Ti^{4+} converting them to Ti^{3+}; these in turn attract hydrogen or lithium ions as charge compensators.

$$Ti^{4+} + \bar{e} + Li^{+} \underset{\text{uv, heat}}{\overset{\text{irradn}}{\rightleftharpoons}} [Ti^{3+}, Li^{+}]$$

Figure 3c shows the axis directions for the lithium defect centres. However, these defect centres do not directly cause the optical absorption at 496 mμ which gives the crystals their rose colour, since the defects can be removed by exposure to UV or heating without affecting the colour. The colour-causing defect is probably more complex, perhaps in aluminium and titanium occurring as nearest neighbours in the lattice.



(*a*) (*b*)

FIG. 4. (*a*) The growth faces of natural quartz crystals.

(*b*) Growth faces and areas of synthetic crystals grown from a seed long along the Y direction, (perpendicular to the page).

Many coloured varieties of quartz have now been synthesized, in both Russia and the U.S.A. (Sawyer 1967), and many studies have been carried out to determine the cause of the colours and the nature of the defects. Lehmann (1969) has shown that synthetic yellow quartz is caused by cobalt Co^{3+} trapped in interstitial six co-ordinated (I_6) positions. Heating such crystals to 500°C changes the crystals to blue and causes a reduction of the cobalt ions to Co^{2+} and their migration to four co-ordinated (I_4) positions.

Growth of crystals from solutions which are rich in iron and alkalies produces colours which depend on the direction of crystal growth and subsequent treatment. Growth perpendicular to X (see figure 4b), perpendicular to Z, and on r (followed by irradiation) produces crystals coloured green, brown and violet respectively. Samoilovich *et al.* (1969b) show that green quartz can be produced by heating brown and deduce that brown, green (and blue) are all due to colloidally dispersed silicates of iron (and cobalt). However, Lehmann (1971) shows that brown quartz is caused by Fe^{3+} in I_4 positions, and green by Fe^{2+} in I_6 positions. It seems likely therefore that "greened" amethyst from Montesuma, Brazil, has had reduction from Fe^{3+} to Fe^{2+} without citrine precipitation.

This article has attempted to survey some of the more recent research on the coloured varieties of crystalline quartz which are already, or are likely to be in the future, of importance to gemmology. The main results are summarized in the concluding Table 1.

TABLE 1

THE COLOURED VARIETIES OF QUARTZ

COLOUR	VARIETY	FORMATION	CAUSE OF COLOUR
Violet	Amethyst	Fe^{3+}, Na^{+}, irradiation	$Fe^{4+}(S)$, $Fe^{2+}(I_6)$
	Synthetic	Growth on r + irradn	$Fe^{4+}(S)$, $Fe^{2+}(I_6)$
Brown/black	Smoky	Al^{3+}, Na^{+}, irradiation	$Al^{3+} + h^{+}$ (O^{-})
	Synthetic	Growth with Ge + irradn	Germanium colour-centres
Pink	Rose	Ti rich pegmatites	Titanium colour-centres
Yellow	"Iron" citrine	Heat amethyst to 500°C	$Fe^{3+}(I)$, Fe_2O_3 precipitates Finely dispersed iron silicates
	"Radn" honey	Al^{3+}, hydrogen, irradn	Al — H hole centres
	Synthetic	Growth from cobalt solutions	Co^{3+} (I_6)
Blue	Natural	Ti rich granites	Rutile needle scattering
	Synthetic	Reduction of synthetic yellow by heating	$Co^{2+}(I_4)$, finely dispersed cobalt silicates
Brown	Synthetic	Growth perpendicular to Z	$Fe^{3+}(I_4)$, $Fe^{2+}(I_6)$, finely dispersed iron silicates
Green	Synthetic	Growth perpendicular to X	$Fe^{2+}(I_6)$
		From brown by heating	Finely dispersed iron silicates
	"Greened" nat.	Reduction of amethyst by heat	$Fe^{2+}(I_6)$
White	Milky	Heat citrine to high temps.	Aggregated inclusions and bubbles in twin boundaries

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NOTES FROM THE LABORATORY

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

SOME items mentioned are chosen for their gemmological interest somewhat divorced from the commercial side of the laboratory's normal routine work. We do, of course, see marvellous pieces of jewellery, fine pearl necklaces, brooches and rings, superb rubies, large alexandrites, jadeites, nephrites, black opals, demantoids in dozens, the usual run of the mill stuff.

Occasionally we are lifted out of this channel to the higher echelons of gemmology. Beauty, rarity and durability are the three requisites of a gemstone in the commercial world. However, gemmologically a stone can be ugly and unusual, it can be a member of a large family, tourmaline, spinel, garnet or zircon, and providing it has an unusual colour or something different in its makeup it becomes a rarity and desirable to the few connoisseurs who appreciate with knowledge. The other day a parcel of gemstones sent in for testing (the packet incidentally marked "tourmalines") contained everything but a tourmaline—which whets ones appetite for an earthy rarity. One of the stones (about 5 ct in weight) was a very anaemic pale pink transparent stone, which by appearance could be a tourmaline or a spinel—that kind of colour. The routine testing was carried out but my colleague Alan Clewlow, B.Sc., who found it to have a R.I. of 1·730 and a S.G. of 3·70, this latter figure agreed later on by B. W. Anderson. The stone fluoresced a decided pink fluorescence between crossed filters and had a fine thin distinct line in the blue end of the spectrum at 4320Å. This was puzzling, since it seemed like a high reading for spinel or a low reading for garnet: both are singly refracting, but spinel of the two much more likely to have a chromium content. We sent the stone by post to B. W. Anderson for his expertise, who returned it stating it to be a garnet of the pyrope (chromium)-spessartite range, the 4320Å line being the first of the strong absorption bands of spessartite (manganese). He also sent me a typical Anderson graph (Fig. 1) plotting the R.I.s and S.G.s—R.I.s from 1·71 to 1·81 and S.G.s from 3·58—4·22. A line drawn commencing at a theoretically pure pyrope to spessartite reading cut cleanly through our garnet at 1·730 R.I. and 3·70 S.G., which illustrated graphically the variations caused to characteristics of garnet readings

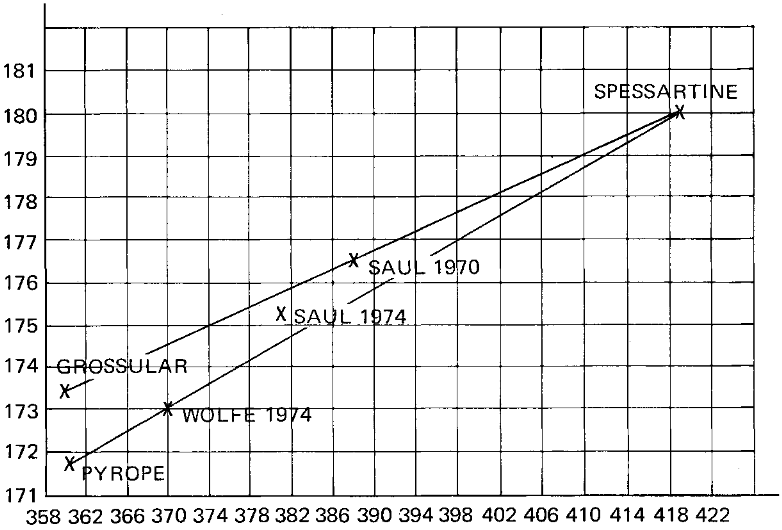

FIG. 1.

due to isomorphous replacement (one might almost say integration). On the same graph was plotted a colour-change garnet written up in *Gems & Gemology*, Vol. XIII, No. 6, pp. 174-177.

Another item of interest was a gift to me by my friend Richard Digby, a well known connoisseur and dealer in intaglios, cameos, etc. of early periods. This stone was to all intents black to look at but by transmitted light a dark green. Sombre and unusual colours intrigue me. This I thought looked like a Ceylon metamict zircon. The spectrum not only confirmed it—it was so tremendously powerful it looked like some permanent grooves cut into the prisms of the spectroscope. I took its refractive index (singly refractive) at 1·782—very, very low for such a sharp spectrum. Alan Clewlow did a density and arrived at a figure of 3·922. Once again it seemed logical to show such a stone to B. W. Anderson, since he is our major expert on spectroscopy and his first good absorption spectrum of zircon was one such zircon which they (B. W. Anderson and C. J. Payne) thought to be typical for zircon!

Needless to say B. W. Anderson enjoyed this stone and commented that the spectrum "was that of one of the very scarce low metamict zircons, which has by some means been heated naturally late in its geological career giving a final shake out to the zircon broken-down lattice and building up crystallites of ZrO_2 (probably cubic) in an amorphous silica setting". Thus our second stone proved to be a rare metamict zircon from Ceylon with a R.I. of 1·782 and a S.G. of 3·922 and what I like to term a superabundant spectrum.

The third stone of note was already known to be an ekanite by its owner, who was persuaded to have it tested so that its characteristics could be recorded. This test was carried out by B. W. Anderson at the laboratory during my absence on holiday. Most interesting things have happened at the laboratory usually when I am away on holiday or sick. There seems to be a moral here somewhere for me to have more holidays.

The ekanite was (with all due respect) quite ugly, very large (43·84 ct) and blackish in colour. The specific gravity was found to be 3·288 and refractive index was 1·595; the absorption spectrum showed two lines at 6300Å and 6580Å in the orange/red sector of the spectrum. The inclusions were oriented and the stone was found to be strongly radioactive by producing a strong self-portrait on a sensitive photographic film.

It is strange how things seem to run at times—by coincidence, I noted in *Technica*, the Belgian Jewellers' Journal, that Hubert Mornard, their laboratory director and vice-president of the Belgian Gemmological Society, had written an article. He describes two brown stones, said to be uranites by their owner, and a series of tests, including long-wave and short-wave U.V. fluorescence tests, density and R.I., plus heating a fragment and crushing a portion to observe its structure. After contact with a photographic paper for 72 hours one stone showed a sharp line and the other an auto-radiograph of its outline. Final conclusion was *metamict zircon.*

GEM SPODUMENE AND ACHROITE TOURMALINE FROM AFGHANISTAN

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INTRODUCTION

Beautiful crystals of gem quality spodumene and tourmaline have recently been discovered in pegmatites in Afghanistan. The locality is in a mountain range in Nuristan province, and the closest city is Chigha Sarai, which is north-east of Jalalabad. The spodumene deposit has been worked since late 1970 and spodumene is presently being recovered. It is associated with tourmaline, mica and quartz. The tourmaline described here is from another pegmatite in the same mountain range.

It should be noted that due to local dialects and language differences in this part of Afghanistan the spellings of the place names may vary somewhat. Since the locality is close to the Pakistan border, some of the gems may enter the market through that country.

SPODUMENE

The gem crystals are free of matrix, although one crystal has an attached remnant of watermelon tourmaline. The majority of crystals are stout, prismatic, elongated parallel to the *c*-axis, and vary in length from 5 to 42 cm. The majority of the crystals are twinned on $\{100\}$. One particularly stout crystal was examined which measured 7 × 12 × 14 cm on the *a*, *b* and *c*-axes respectively. Dominant forms are the front pinacoid *a* $\{100\}$, the side pinacoid *b* $\{010\}$, prisms *m* $\{110\}$ and *f* $\{011\}$, and fourth order prisms. These forms are shown in Figure 1, which is a drawing of a typical crystal. The forms are easily discerned by their different surficial characters. The *a* pinacoid is deeply striated parallel to the *c*-axis, and the *b* pinacoid is dull. The prism *f* is quite bright and covered with acute hillocks with their apices pointing to the termination of the crystal. In general, the etching has enhanced the beauty of the crystals. Equal development of *a* and *b* pinacoids results in crystals of square cross-section ideally suited to the cutting of large stones.

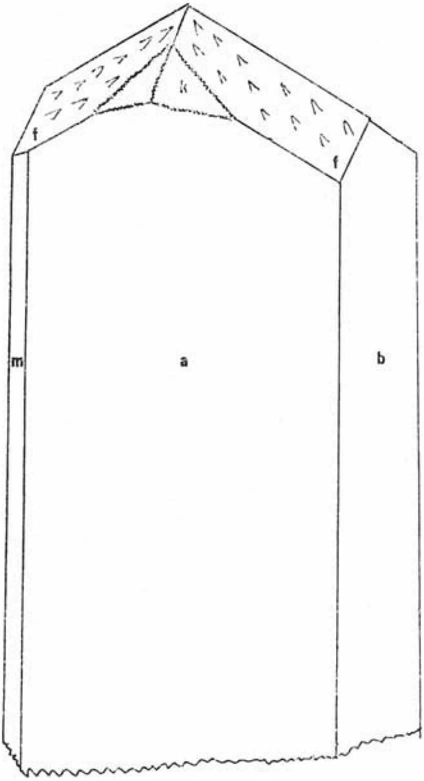

Figure 1. Spodumene from Afghanistan

The gem potential of this material is excellent. The spodumene is found in three distinct hues—yellow, pale violet and violet-blue. The yellow crystals are a deep greenish yellow at the base and lighten at the termination to a very pleasing yellow. One yellow crystal 3 × 4 × 17 cm in length is terminated by a 2 cm zone of light yellow. The yellow spodumene exhibits weak trichroism, which is not noticeable upon casual observation. The pale violet crystals are too lightly coloured to produce significant gems. The violet-blue crystals are violet at the base and change toward the termination to pleasing blue and green hues. The strongly pleochroic violet-blue spodumene, when observed in non-polarized daylight, has the following colours: for light passing parallel to the *a*-axis, light green; for light passing parallel to the *b*-axis, light blue; and for light passing almost parallel to the *c*-axis, deep blue-violet. The above observations were made on a 4 × 4 × 8 cm crystal so the colours will appear somewhat lighter in cut gems of moderate size. Gems cut with the table normal to the *c*-axis will be of a fine and unusual blue-violet colour, and gems cut with the table normal to the *b*-axis should have a beautiful light blue colour.

TABLE ONE

OPTICAL DATA FOR SPODUMENE FROM AFGHANISTAN

$$\alpha = 1{\cdot}660\ (\pm 0{\cdot}002)$$
$$\beta = 1{\cdot}662\ (\pm 0{\cdot}002)$$
$$\gamma = 1{\cdot}676\ (\pm 0{\cdot}002)$$
$$Z \wedge c = 27^\circ$$

Optic sign (+)

	yellow spodumene	violet-blue spodumene	pale violet spodumene
X	light greenish yellow	deep violet	medium violet
Y	light greenish yellow	light violet	very light violet
Z	colourless	light green	light green

Refractive indices and optical data are summarized in Table 1. There was no measurable difference in the refractive indices for different coloured crystals. No diagnostic absorption spectra were observed. The specific gravity is 3·19. Refractive index determinations were made with chips on the spindle stage of a petrographic microscope, in sodium light.

The spodumene is luminescent in ultraviolet and x-radiation. Under short-wave ultraviolet the yellow spodumene fluoresces a very weak orange. Under long wave ultraviolet the violet-blue and light violet crystals fluoresce a weak violetish pink and the yellow spodumene fluoresces a strong pinkish orange. The yellow spodumene does not phosphoresce; the violet-blue crystals phosphoresce weakly after two hours exposure to long wave ultraviolet. Copper and molybdenum x-radiation cause both the yellow and violet-blue and light violet spodumene to fluoresce a vivid orange. None of the spodumene is transparent to x-rays. After x-radiation, the yellow spodumene phosphoresces a weak orange and the violet-blue and light violet crystals a strong orange. In both cases the phosphorescence is quite persistent, being visible 10 minutes after a 10-second exposure.

INCLUSIONS

Hollow tubes and clusters of bubbles, so characteristic of spodumene, are found in the Afghanistan material, but clear sections with a minimum of such inclusions are available and large stones could be cut from this material. Also present as inclusions are minute, prismatic, colourless unidentified crystals, in clusters and as single crystals, usually oriented parallel to the *a*-axis of the host. The detailed study of these inclusions must await the procurement of smaller pieces suitable for cutting and preparing for x-ray diffraction and microprobe examination. The 16 crystals examined in this study are much too beautiful to be cut and will be preserved as display specimens.

TOURMALINE

The tourmaline occurs in a wide range of colours and hues. Especially noteworthy are the colourless crystals, perfect achroites. The crystals are prismatic and have typical tourmaline morphology. Twelve crystals were examined with lengths varying from 3 to 7 cm. The finest crystals are weakly coloured in pastel hues of pink and green. Some crystals with a light pink or green base have colourless terminations and the finest of these has a $3\frac{1}{2} \times 1$ cm termination that is completely colourless and flawless. The colour-zoning is perpendicular to the length of the crystals. In four of the nine crystals examined the zoning is strong: in the remaining crystals it is gradual and almost imperceptible.

Refractive indices of twelve cut stones were determined on the dialdex refractometer in sodium light. Some are deeply coloured and some quite pale, of a variety of hues of pink and green. The indices varied from $\varepsilon = 1{\cdot}617$ and $\omega = 1{\cdot}635$ to $\varepsilon = 1{\cdot}621$ and $\omega = 1{\cdot}639$, and there was no observed correlation between colour and refractive index. The birefringence in all stones was 0·018. The refractive indices of the achroite are $\varepsilon = 1{\cdot}615$ and $\omega = 1{\cdot}633$ ($\pm 0{\cdot}003$), measured with the dialdex refractometer on a flat prism face of an uncut crystal. The specific gravity of the cut stones varies from 3·03 to 3·07. The specific gravity of the achroite is 3·02.

The pastel and colourless tourmaline was irradiated with long and short wave ultraviolet radiation, and copper and molybdenum x-radiation, with some interesting results. Although they do not fluoresce in long wave ultraviolet, they respond to short wave. The achroite fluoresces a bright and vivid violet, while crystals of pastel shades of pink and green fluoresce a weaker violet corresponding to the intensity of the colour-zoning. Crystals with sharp colour-zoning do not fluoresce as strongly as those with almost imperceptible colour-zoning. None of the 12 cut stones fluoresced. There was no perceptible phosphorescence observed in any of the tourmalines. No tourmaline from this deposit fluoresced in copper or molybdenum x-radiation. All of the pastel crystals were transparent to x-rays. The only notable inclusions in the Afghanistan tourmaline are small crystals of randomly oriented lepidolite.

The author is indebted to Dr George Switzer and Mr John S. White, Jr, for critical readings and valuable suggestions for improvements in the text.

AN IRRADIATED QUARTZ

By ROBERT WEBSTER, F.G.A.

ARISING from an advertisement in the *Watchmaker, Jeweller and Silversmith*, the Gemmological Association approached the advertisers, Toktraders International, Tokyo, Japan, who kindly forwarded two specimens of their wares for our examination. One of these was a colourless round brilliant-cut stone weighing 9·95 carats, and the other a dark brown trap-cut (emerald-cut) stone weighing 10·11 carats. The first of these seemed to be untreated rock crystal, probably sent for comparison, while the other was presumably coloured by irradiation.

The covering letter from Toktraders International was not too informative and simply said—"Radiated smoky topaz was made through radiation processed rock crystals, with ray of 4-5 mg. Rock crystals are very common stuff as you observe". This wording calls for some comment, the first being that "smoky topaz" should read "smoky quartz". This is not an unusual error but is one that should be avoided in trading. The second part "ray of 4-5 mg" is less easily explainable, for mg is the symbol for milligram and the connexion with irradiation is not at all clear.

The usual units of radioactivity are the *Röntgen* (r), or more commonly the *Curie* (Ci). Experts whom the writer consulted could only suggest that the reference may be a misprint for *milliröntgen* (mr) or *millicurie* (mCi). However, it must be remembered that the *curie* was originally defined as the quantity in radioactive equilibrium with one gram of radium, but is now extended to cover all radioactive isotopes by the definition "that quantity of radioactive isotope which decays at the rate of $3{\cdot}7 \times 10^{10}$ disintegrations per second"(1).

In view of this uncertainty the Gemmological Association again wrote to Toktraders International for clarification of the entries in their first letter. Their reply stated that it should be *megacycles*. This makes the situation even more confusing, for 4-5 (say 4·5) megacycles (more properly Mc/s) is in the high frequency (HF) range of radio waves and works out at a wavelength of approximately 66 metres! The only conclusions one can draw from these replies is that there had been a clerical error in translating scientific data; or it is the policy of the Company not to disclose the actual method of irradiation. If the latter is the answer, then why do they not say "by a secret process", as is the normal procedure in such cases?

This then leads to the question—What *is* the type of radiation being used to colour these stones? It has been mooted that the *gamma* radiation from the isotope Cobalt 60 is used. The use of *gamma* radiation has recently been investigated in the coloration of such species as quartz, beryl and topaz(2).

Examination of the treated stone showed the refractive indices to be those of quartz, that is 1·544-1·553 with the usual double refraction of 0·009, and the density was found to be normal for quartz. The dichroism was comparable to natural quartz of similar colour, although the effect may be very slightly more distinct in the radiated quartz. No convincing absorption spectrum was observed using a hand spectroscope, nor was there any colour-banding seen by lens or microscope examination, which is an effect often seen in brown quartz. That there was no residual radioactivity was proved by placing the stone on a piece of bare photographic film (double coated x-ray film), with a slice of a rolled pebble of Burma zircon as control, and leaving the stones in position for one week. On developing the film there was no darkening of the film where the irradiated quartz had rested, whereas the zircon had produced a pronounced blackening of the film which clearly outlined the shape of the zircon slice.

The colour of the irradiated stone cannot be said to be attractive and the cutting seems not to be up to professional standards. These criticisms may be to some extent harsh and it may be that more attractive brown colours, such as golden-browns, can be produced; nor is it known what price is to be charged for these stones coloured by irradiation. Brown quartz is not a rare commodity and the commercial viability seems doubtful, unless, as mentioned before, something like a good attractive brown colour can be produced.

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WHERE IS THE DIVIDING LINE BETWEEN EMERALD AND GREEN BERYL?

By IAN C. C. CAMBELL, F.G.A.

THIS is a modification of a paper presented to a meeting of the Gemmological Association of Rhodesia in 1971 by the author.

Much interest has been aroused by the question "Where is the dividing line between true emerald and green beryl?".

It is of particular importance in a country where it is illegal to deal with emerald in the rough without a licence—such as in Rhodesia.

Some authorities say that the trace of chrome as the colouring element in emerald should be evident in the absorption spectrum; others maintain that the inclusions in emerald are so different from those in ordinary green beryl that this is diagnostic; while others yet again suggest that colour and colour alone should dictate what the stone should be classified as.

The problem of correctly designating emeralds arises when consideration is given to a variety of beryl (alias "pale green emerald") from the Filabusi area of Rhodesia. Some of the mines which have produced such stones are: Mustard claims, Pepper claims, Rhodesian Gem claims, Sydkom claims (the Sydkom mine itself basically yields scheelite), and other unknown lesser origins.

The claims just mentioned yield comparatively little and some have, for that matter, closed down. Nevertheless the stones are in existence.

Pale stones of ambiguous colour have also been seen from the Chikwanda claims near Bikita, but these are still very different from the Filabusi stones. The stones from the Mustard claims appear to have a more overall bluish-green appearance and, strictly speaking, are therefore not being considered quite as ambiguous in terms of the colour of ordinary green beryl. However, a closer look later on in this article at those stones may be of advantage.

Gemmologist A. M. Taylor, in his report on synthetic vanadium emerald (J. Gemm., 1967, 10, 7, 211-217) touched on the problem of where the dividing line should be between emerald and green beryl. He states that vanadium or chromium is able independently to produce the coveted emerald-green hue in beryl. In a number of analysed emeralds it has also been evident that vanadium was present (together with chrome) in sufficient quantity to affect the overall colour in a pleasing manner in that the green was enhanced in some stones. It seems, says Taylor, that we can blame the ostentatious nature of the chromium absorption spectrum for chromium's mysterious rival, vanadium, being ignored for so long. Taylor's definition of emerald is simply that "emerald is a bright green variety of beryl"—no matter what the cause of the colour is—as long as it is the acceptable (?) hue of green. (The question mark in brackets is mine).

As is known, the mineral which has an adverse effect on the colour of emeralds, and indeed is responsible for the damping or complete obliteration of all fluorescence which is useful in testing, is iron. It is also this iron content that is, to a lesser or greater degree, responsible for the poor colour of the emerald in many cases and thus the ambiguity of colour in the comparatively poorer grades.

Chemical and spectrographic analyses of emeralds from two different sources in the Filabusi area (and I refer to the chrome and iron content only) are as follows:

	MUSTARD CLAIMS	PEPPER CLAIMS	
Fe	0·1%	0·1%	Symposium: Pegmatites in Southern Rhod. 1962.
Cr	0·2%	0·1%	

In addition to the above, Mr I. H. Green, of the Geological Survey Department, Salisbury, has done a spectrographic analysis of emeralds from the Mustard Claims (15th November, 1967)—seven specimens were analysed (which I had access to) and I list here only the relevant details (i.e. obviously only part of the analysis):

Chrome content: 3 contained 0·2%, 1 contained 0·25%, 2 contained 0·3%, 1 contained ∼ 1%.
Iron content: All ∼ 1·0%.
Vanadium: Only 1 contained a trace. < 0·02%.
Nickel content: All contained < 0·02%.

Although spectrographic results are, it is understood, not precisely accurate in the higher concentrations, the results are adequate and reasonably suitable for comparative purposes. With the exception of one specimen (Cr: 0·3%, Fe: ∼ 1·0%, Ni: < 0·02%) which was obviously a more grass-green and deep hue of colour, the other stones appeared to be an overall fairly uniform bluish-green—there were in fact differences, but not perceptible enough to arrive at a useful conclusion. The exception mentioned above contained the highest chrome content, but so did another one which was a more bluish-green in colour (and the analysis was the same as the exception referred to above). This exception, although not fluorescing in the conventional dull red manner, did however show a greyish hue under the Chelsea filter. The balance under the filter merely showed up as yellowish green which was only slightly variable from one stone to another. In addition to this there was no evidence of absorption lines under the Rayner prism spectroscope that indicated a chrome content, although chrome was in fact present as the analysis showed.

The analytical figures are, to a limited extent, given here in relation to the Mustard stones, because they serve as a point of interest when comparing the colour of stones from the same source. This also applies to other "ambiguous" stones from sources in the Filabusi area where, from the same claim, similar variations in colour exist (optical and physical properties, as well as the inclusions, being the same).

The inclusions seen in the pale Filabusi stones are characteristic of the species and different from those seen in ordinary green beryl from other sources in this country and outside our borders. Such stones have also come from the Mustard claims and have been generally classified as "gem beryl" because of their "ambiguous" colour. In many cases the colour can be compared to the paler Colombian stones. Some, of course, do not compare at all.

An analysis is all very well, but one obviously cannot analyse, by destruction, a faceted stone of an ambiguous green colour in order to find traces of chrome, if indeed the stone is to be designated as emerald on chrome content alone. One of these so-called "ambiguous" stones was cut by someone who genuinely thought that it was ordinary green beryl. When it was examined one could see why—particularly when one is familiar with the fine green colour of the well known stones from the Belingwe area and in particular Sandawana. The stone in question could pass as ordinary beryl on sight, yet it could also be technically designated an emerald though be it a very poor one.

The details of the above mentioned faceted stone are as follows:—

Conventional emerald-cut of weight 1·735 metric carats; S.G. 2·73; R.I. 1·575—1·580 (D.R. 0·005). No fluorescence evident under the Chelsea filter. Absorption spectrum—no indication of chrome content, but a barely perceptible line in the blue (iron). Inclusions are different to those in normal green beryl. What appear to be relatively wide, pale whitish bands at right angles to the C axis are in effect reflections of light from spikey type inclusions concentrated in zones, which in themselves are part of fine tubes and spikey inclusions orientated parallel to the length of the crystal. This may sound contradictory, but it is emphasized that the inclusions are more concentrated laterally in adjacent positions in the same plane, thus giving the appearance that the "bands" themselves are actually at right angles to the C axis as stated. This type of inclusion, with the exception of the above mentioned "band-like" concentrations, has been seen by the writer in numerous emeralds from the Filabusi area, but generally in a much less concentrated form.

Obviously a more detailed study should be made, in the context of this subject, of stones from known sources in the Filabusi area, as well as elsewhere. It is noted that a good authoritative text appears in the published results of a symposium held on "Pegmatites in Southern Rhodesia", arranged by the Southern Rhodesia Section of the Institution of Mining and Metallurgy, held at the University in Salisbury in 1962. The relative chapter (pages 35-39 inclusive) deals with—and in addition to chrysoberyl—emeralds from the Novello mine near Fort Victoria, from the Mustard claims and Pepper claims at Filabusi, the Chikwanda claims at Bikita, and others. That written contribution, by H. J. Martin, is the only detailed study that the writer has seen on emeralds from sources in Rhodesia other than Sandawana origin and is a most welcome and useful text of recorded information. (In that text, reference is made to emeralds from these sources which do however fluoresce—but I am referring to those that do not and are furthermore classified as ambiguous due to their colour—or lack of it).

This article is merely to bring to notice a problem that technically exists (particularly in Rhodesia)—that of being unwittingly legally at fault for dealing with uncut emeralds while genuinely thinking that the stones are ordinary beryl.

Mr Taylor *does* have a valid point when he advocates that the name "emerald" should apply to a "bright green variety of beryl". Furthermore, the trade obviously abides by this opinion and virtually frowns on emeralds of an ambiguous nature in respect of colour.

Gemmological Abstracts

Anderson (B. W.). *Short cuts to certainty.* Z. Dt. Gemmol. Ges., 1974, 23, 2, 83-88.

The author writes about his work at the Gem Testing Laboratory and elaborates on some ways to shorten and verify gem identifications, using immersion technique, absorption bands and observing fluorescence and phosphorescence.

E.S.

Ball (R. A.): Malin (A. S.). *Iridescence in marine shells.* Australian Gemmologist, 1974, 12, 1, 14-15. 6 illus.

A short article on the examination of sea shells by electron microscopy. The structure of the shells was shown to consist of platelets in parallel arrangement whose regularity and thickness (0·2μm to 0·6μm) control the iridescence of the shell.

R.W.

Bank (H.). *Niedriglichtbrechende braune Turmaline mit hoher Doppelbrechung aus Ostafrika.* (Brown tourmalines with low R.I. and high double refraction from East Africa). Z. Dt. Gemmol. Ges., 1974, 23, 2, 93-94.

Brown tourmalines were examined and were found to have relatively low R.I. (1·617-1·641) and relatively high double refraction (0·023, 0·024, 0·025). X-ray examination pointed to dravite.

E.S.

Bank (H.). *Rote Turmaline mit hoher Licht-und Doppelbrechung aus Kenya.* (Red tourmalines with high R.I. and double refraction from Kenya). Z. Dt. Gemmol. Ges., 1974, 23, 2, 89-92.

Red tourmalines from the Narok district in Kenya were examined with high R.I. (1·630-1·659) and high double refraction (0·029, 0·032).

E.S.

Broughton (P. L.). *Precious topaz deposits of the Llano Uplift area, central Texas.* Rocks & Minerals, 1973, 48, 147-156.

Colourless and blue topaz crystals occur in pegmatites in the vicinity of Mason, Mason County, Texas. Detailed information is given on collecting sites.

R.S.M.

BUCKLEY (B. W.). *Maine tourmaline strike.* Rocks & Minerals, 1973, 48, 308-310, 3 figs.

Gem quality red and green tourmaline crystals occur in pegmatites on Plumbago Mountain, Newry, Maine. A new discovery is reported.

R.S.M.

CASSEDANNE (J. P.) and (J. O.). *Les agates du Morro do Cristal.* (The agates of Morro do Cristal). Bulletin de l'Association Française de Gemmologie, 1974, 36, 9-12.

Morro do Cristal is situated north of Porto Alegre, capital of the state of Rio Grande do Sul. Agates are found on the surface, the rock of the area being a basalt. They are sparsely scattered and are in general of an ovoid form or sometimes spherical. Quartz boules are found in association with the agate, and a fair quality amethyst is found in the neighbourhood.

M.O'D.

CASSEDANNE (J. P.) and (J. O.). *La pegmatite de Baixio (Brésil).* (The pegmatite of Baixio (Brazil)). Bulletin de l'Association Française de Gemmologie, 1974, 39, 4-6.

The area is situated 75 km east of Governador Valadares in the north-east part of the state of Minas Gerais. The pegmatite is more than 200 metres long and runs in a generally north-south direction. In depth it appears not to exceed 10 metres. It is surrounded by decomposed mica schists running locally east-west. Although the general grain size is medium, there are larger decomposed feldspars. Quartz is actively sought and other minerals include garnets of a rose-orange colour. The crystals resemble tetrahedral plaques (320) which have suggested to some that the mineral was morganite. Apatite has also been found. The garnets have a density of $\sim$4·15, an R.I. of 1·810 and a hardness of 7·5.

M.O'D.

CROWNINGSHIELD (R.). *Commercial implications of gamma radiation on gem material.* Z. Dt. Gemmol. Ges., 1974, 23, 2, 95-101.

Gamma radiation is now being used on stones other than diamond to improve their colour, while up to recently only diamond bombardment was well known. In the case of beryls, maxixe characteristics are produced; blue and yellow beryl is produced, the blue variety not fade-resistant. Yellow sapphires fade rapidly; green spodumene fades to kunzite. Experiments were made on pale amethysts, but the colour became smoky. Blue topaz and gamma-treated blue-grey cultured pearls seem to be a commercial proposition. Tourmalines and jadeite are still being investigated.

E.S.

DAHLBERG (J. C.). *Thomsonite, the gem with the Scots name.* Lapidary Journal, 1974, 28, 1, 42-58.

The zeolite mineral thomsonite is found near Grand Marais, Lake Superior. An account of the life of Thomas Thomson is appended.

M.O'D.

DESAUTELS (P. E.). *The Natural Collection of Gems in the Smithsonian Institution, 1965 to 1974.* Lapidary Journal, 1974, 28, 1, 84-100.

Among stones received since the earlier article (*Lapidary Journal*, 19, 1) are the Rosser Reeves star-ruby of 138·72 ct, a bright blue sapphire of 423 ct, a 911 ct blue aquamarine from Brazil, a 113 ct morganite from the White Queen Mine, San Diego County, California, and a 5·34 ct mauve taaffeite.

M.O'D.

EPPLER (W. F.). *Über einige Einschlüsse im Birma-Rubin.* (About some inclusions in Burma ruby). Z. Dt. Gemmol. Ges., 1974, 23, 2, 102-108.

Inclusions in Burma rubies are manifold: only some are described. Most common inclusion is rutile, found in most stones, sometimes in crystal form, often in clouds of thin short needles, rarely as negative crystals parallel to the base. Calcite is also often found, easily recognizable because of its high R.I. (1·658). Quite frequently one finds zircon inclusions in Burma ruby, as well as spinel.

E.S.

Fabriès (J.) and Schubnel (H.-J.). *L'origine et le réorganisation des collections mineralogiques du Museum National.* (Origin and reorganization of the mineralogical collections in the National Museum). Bulletin de l'Association Française de Gemmologie, 1974, 37, 9-12.

The collections of minerals at the Jardin des Plantes have been reclassified and the number of specimens on display has been reduced from 23,000 to 4,000. There are 2,000 gemstones and ornamental mineral specimens.

M.O'D.

Fumey (P.). *L'axinite de l'Oisans.* (Axinite from l'Oisans) Bulletin de l'Association Française de Gemmologie, 1974, 37, 15-16.

Axinite from the Dauphiné Alps has a S.G. of 3·28, hardness of 6·5-7, R.I. of 1·68-1·69 and a D.R. of 0·010. The mineral is found in pockets in a schist in association with prehnite, epidote and quartz.

M.O'D.

Gübelin (E. J.). *The emerald deposit at Lake Manyara, Tanzania.* Lapidary Journal, 1974, 28, 2, 338-360.

Emeralds were found in pegmatites and biotite schists at a location 23 miles north-east of Magugu. The emeralds occur where biotite schists are in immediate contact with pegmatite and in the mining process the majority are found in the schist. Relatively few euhedral specimens occur. The colour approximates to a point situated on a line running between 0·20/0·50 and 0·08/0·80 of the C.I.E. colour plate DIN 5033. In general the colour resembles that of Sandawana and Colombian stones. The S.G. is 2·74 and the R.I. (ω) 1·585, (ε) 1·578, with a D.R. of 0·007. So far as inclusions known to be peculiar to the locality have been observed, those already noted include micas accompanied by liquid-filled cavities. Liquid inclusions fall into three types: primary, prismatic or hexagonal/triangular; secondary, of irregular shape. The third form is prismatic negative crystals consisting of growth voids filled with 2-phase contents.

M.O'D.

GÜBELIN (E. J.). *Schwarze Einschlüsse in Diamanten.* (Black inclusions in diamonds). Z. Dt. Gemmol. Ges., 1974, 23, 2, 109-114.

Mineral inclusions in diamond are the best information regarding their formation. The material used was sawn into six segments out of fairly good octahedra, the inclusions being more or less black centrally situated spots surrounded by a system of fissures, also partly clad in a black substance. These fissures were found to be caused by tension, which in turn was caused by the higher thermal expansion coefficient of the mineral inclusion. The black coloration of the fissures was caused by their cladding with magnetite.

E.S.

IRVINE (W. J.). *Inverell—Australian Aladdin's Cave.* Lapidary Journal, 1974, 28, 1, 102-108.

Inverell is in New South Wales, 420 miles from Sydney. Sapphires are found in creeks and gullies, and diamonds are being actively prospected.

M.O'D.

JOHNSON (B.). *Montana's famed Yogo Gulch.* Gems and Minerals, 1974, 30-36.

The sapphires are found 15 miles south west of the town of Utica and are plentiful in small sizes. At present all the production goes to Japan and the area is closed to collectors.

M.O'D.

LENZEN (G.). *Zur Deutung altindischer Diamanten-Imitationen.* (Explaining old Indian diamond imitations). Z. Dt. Gemmol. Ges., 1974, 23, 2, 115-124.

Between 4th century B.C. and 6th century A.D. diamonds were graded according to magical mystery and according to the crystal form, their deviation from the perfect octahedron, inclusions as far as could be seen with the naked eye and colour as far as the colour was of a definite hue. Thus, diamonds, spinels and magnetite were to some extent substituted for each other. An interesting table gives the topographical analyses of the occurrence, type and colour as graded by the old Indian lapidaries.

E.S.

LIDDICOAT (R. T.), FRYER (C. W.). *Three new gem materials.* Z. Dt. Gemmol. Ges., 1974, 23, 2, 125-127.

Three new materials of gem interest encountered by the G.I.A. Los Angeles Laboratory. The first was a green turquoise rich in copper but not zinc, identified as faustite; the second was also turquoise-like material, either prosopite or an yttrium copper. This material is still being tested, semi-translucent to opaque, in appearance like fine turquoise. The third material was a long thin 1·51 ct emerald-cut stone of pale blue colour, found to be jeremejevite from South West Africa.

E.S.

MALES (P. A.). *Gem quality kyanite crystals from Harts Range, Northern Territory.* Australian Gemmologist, 1974, 12, 1, 5-8. 3 illus.

Details the occurrence of gem quality kyanite crystals in the Harts Range of Northern Territory, Australia. Much is told about the crystals themselves, but no optical properties are mentioned and there is no mention of cut stones.

R.W.

MALES (P. A.). *Ilmenite crystals associated with rutilated quartz from Brazil.* Australian Gemmologist, 1974, 12, 1, 11-12. 2 illus.

Small plates of a black mineral found attached to rutilated quartz from Brazil were, by x-ray analysis, found to be ilmenite. Descriptions are given of the habit and properties of these crystals. It was found that they affected a compass needle but were not attracted to a magnet.

R.W.

MITCHELL (R. S.) and TUFTS (S.). *Wood opal—a tridymite mineral.* American Mineralogist, 1973, 58, 717-720.

Although in general opalized fossil wood has a structure approaching high-tridymite, other forms of opal resemble low-cristobalite. Spectrochemical studies show that the silica of tridymite-like opals is more chemically pure than that found in cristobalite or amorphous opals, which contain more Al, Na, B and Zr. The disordered high tridymite structure has been observed in calcareous opal, jasper opal, milk and moss opal and wax opal.

M.O'D.

MITCHELL (R. H.). *Minerals in fact and fantasy.* Rocks and Minerals, 1973, 48, 275-279.

Supernatural powers were once attributed to numerous well-known gems. Some of these legends are reviewed.

R.S.M.

NASSAU (K.). *The effects of gamma rays on the color of beryl, smoky quartz, amethyst and topaz.* Lapidary Journal, 1974, 28, 1, 20-40.

Experiments were conducted in which, under gamma ray bombardment, colourless to pale yellow topaz turned to a sherry colour or to brown, colourless and pale coloured beryl turned deep blue and synthetic quartz gave a smoky or amethyst colour. Some of the colours were not stable to light.

M.O'D.

NOWAK (G.). *Fire opals in the Mojave desert.* Lapidary Journal, 1974, 28, 1, 52-56.

The opals are mined in the El Paso mountains near to the Garlock and El Paso faults. Stones range in size from pinpoints to 2″ across and show a play of colour.

M.O'D.

OUGHTON (J. H.). *Stones seen and discussed.* Australian Gemmologist, 1974, 12, 1, 9-10. 4 illus.

The results of an examination by Dr Eppler of a Poona (West Australian) emerald in matrix are reported. Some ideas are put forward on the mining of such emeralds. Three-phase inclusions are reported to have been seen in topaz from New South Wales, Australia.

R.W.

PETERSON (N. V.). *Oregon "sunstones".* The Ore Bin, 1972, 34, 197-215.

"Sunstone" is a variety of feldspar that exhibits a metallic shimmer due to minute inclusions of hematite or some other impurity arranged parallel to the cleavage. Another term is aventurine feldspar. The "sunstone" found at Rabbit Basin, Lake County, Oregon, is a calcic labradorite which occurs as phenocrysts in a basaltic lava flow, the phenocrysts being formed by primary crystallization in a magma chamber at depth under relatively uniform conditions at a temperature greater than 1100°C. Most of the phenocrysts are fractured (conchoidal), which resulted from flow movement during eruption. A list of a dozen localities for "sunstone" in the United States is included.

M.H.

POIROT (J.-P.). *Les corindons artificiels commercialement dénommés rubis synthétiques et saphires synthétiques.* (Artificial corundums commercially called synthetic rubies and synthetic sapphires). Bulletin de l'Association Française de Gemmologie, 1974, 37, 13-14.

The manufacture of synthetic corundum has proceeded since the experiments of Frémy in 1877. Flame-fusion, pulling, flux-melt and hydrothermal techniques are reviewed.

M.O'D.

POMARAIS (P.). *Un des hauts lieux de la mineralogie francaise: Chessy les Mines.* (One of the high places of French mineralogy—Chessy les Mines). Bulletin de l'Association Française de Gemmologie, 1974, 39, 23.

Chessylite, a hydrocarbonate of copper with the formula $Cu_3(OH/CO_3)_2$ is found at Chessy, a community situated 30 km west of Lyons. The mineral is found in an area bounded on the south-east by crystalline schists and on the south-west by granite. No working takes place now.

M.O'D.

POUGH (F. H.). *Willemite, an uncommon gemstone.* Z. Dt. Gemmol. Ges., 1974, 23, 2, 128-130.

Article describing the various geological occurrences of the fairly uncommon willemite, an anhydrous zinc silicate, first found in Moresnet near Aachen and named after King William I of the Netherlands. The article deals mostly with the abundant finds in the United States, mainly in Sterling Hill and Franklin, N.J., which are characterized by brilliant fluorescence.

E.S.

ROSS (R.). *Lightning Ridge black opal knobby.* Lapidary Journal, 1974, 27, 12, 1796-1802.

An account, illustrated in colour and with a map, of the opening of the new Black Nobby mine at Lightning Ridge.

M.O'D.

Santos Munsuri (A.). *Hornbill—Ho-Ting.* Gems & Gemology, 1973, XIV, 7, 208-211. 7 illus. (two in colour). (Reprinted from Boletin del Instituto Gemologico Español, 1972, 1, 3, 15-20).

Already abstracted in *J. Gemm.*, XIII, 8, 327.

R.W.

Schiffmann (C. A.). *Beobachtungen an Rubinen aus Prilep, Jugoslawien.* (Observations of rubies from Prilep, Yugoslavia). Z. Dt. Gemmol. Ges., 1974, 23, 2, 131-138.

A lot of rough and cut rubies from Prilep in Yugoslavia were examined, the colour varying from red to reddish-pink, transparent to opaque, usable for gem purposes when cut as cabochon. Impurities account for varying density from 3·80–3·85 to 3·90–3·98, i.e. lower than corundum. The stones had a weak Cr absorption spectrum; the Cr content was 0·09%. Orange and red fluorescence was observed. Rubies with similar properties were found in Campolungo in Switzerland, which have been described mineralogically but are of no practical value.

E.S.

Schmetzer (K.), Bank (H.) and Berdesinski (W.). *Eine seltene rote Varietaet der Mineralart Beryll (früher Bixbit genannt).* (A rare red variety of the beryl type formerly known as bixbite). Z. Dt. Gemmol. Ges., 1974, 23, 2, 139-141.

Further work done on the colour and absorption spectra of a red beryl from Utah.

E.S.

Schubnel (H.-J.). *Chronique des musées de mineralogie. L'American Museum of Natural History, New York.* (History of the museums of mineralogy. The American Museum of Natural History, New York). Bulletin de l'Association Française de Gemmologie, 1974, 36, 7-8.

Notable stones in this collection include the De Long star-ruby, of 32 ct. The Star of India sapphire of 35 ct, from Ceylon, the Patricia emerald from Chivor of 632 ct and a large Brazilian aquamarine of 4438 ct. The De Long Ruby and the Star of India, stolen some years ago, were recently recovered.

M.O'D.

SIM (S.). *Some thoughts about agate formation in Scotland.* Australian Gemmologist, 1974, 12, 1, 16-19 (Reprinted from the Lapidary Journal). 1 illus.

Some theories are advanced on the formation of Scottish agates. A number of well thought-out ideas are mentioned and discussed. The writer suggests that the banded structure of Scottish agates is caused by a seasonal variation of the "water table" of the surrounding rocks and not by osmosis and/or the Liesegang ring theory.

R.W.

STRUNZ (H.) and WILK (H.). *Jeremejewit als Edelstein aus S.W. Afrika.* (Jeremejevite as gemstone from S.W. Africa). Z. Dt. Gemmol. Ges., 1974, 23, 2, 142-150.

Although some colourless pegmatites had been known as jeremejevite previously, some cornflower blue crystals have now been found near Cape Cross, north of Swakopmund. Density 3·313, hardness 7, chem. $AlBO_3$, R.I. 1·641-1·649, double ref. 0·008. Optical details are given and behaviour under x-ray treatment described, as are also common inclusions.

E.S.

TILLANDER (H.). *Le Régent. Un des plus beaux et plus parfaits diamants historiques.* (The Regent. One of the most beautiful and most perfect historic diamonds). Bulletin de l'Association Française de Gemmologie, 1974, 37, 3-7.

The Regent diamond measures 30·53 mm in length, 28·9 mm across and 20·8 mm in depth. The weight is thought to approximate to 140·615 ct. A note on the history is included.

M.O'D.

WAIT (G. B.). *Shaping black coral bracelets.* Gems & Gemology, 1973, XIV, 7, 222. 1 illus. (Reprinted from the Lapidary Journal).

Details how the black coral from the Hawaiian Islands can be shaped into bangles, circular earrings, etc., by taking a long stalk of the coral, heating it with a blow-torch and winding the softened coral around a wooden former. The method is only suitable for the black coral, which is nearly pure conchiolin, and will not operate with the calcareous "noble" coral.

R.W.

Webster (R.). *Some interesting aspects of gem testing.* Gems & Gemology, 1973, XIV, 7, 194-199. 4 illus.

Tells of some unusual materials which had in time been submitted to the London laboratory and details how some of the problems were dealt with. These include black coral, sea shell, horn, seed pods and porcelain.

P.B.

Webster (R.). *Thin section examination of organic materials.* Z. Dt. Gemmol. Ges., 1974, 23, 2, 151-160.

The author discusses the application of thin section examination usually used in petrography to organic material used in jewellery. The preparation of the slides is described and the materials dealt with include ivories, bone, horn, vegetable ivory such as material taken from the corozo nut or doom palm nut, corals and elephant hair. This method facilitates the differentiation between various types of ivories and horn. There are 16 photomicrographs, showing the various materials in longitudinal as well as transverse section.

E.S.

Zwaan (P. C.). *Über drei gelungene Faelschungen in der Edelsteinsammlung des Rijksmuseum van Geologie en Mineralogie in Leiden, Niederlande.* (About three successful fakes in the precious stone collection in the Rijksmuseum for geology and mineralogy in Leiden, Holland). Z. Dt. Gemmol. Ges., 1974, 23, 2, 161-164.

The collection was originally a gift of King William I in 1825 consisting of 637 stones. In 1938 various valuable stones were stolen from the collection. The article describes three imitation stones in the original collection, a peridot, a tourmaline cat's-eye, and a sapphire, all three being imitated by glass simulations.

E.S.

BOOK REVIEWS

ALLISON (F.) and (J.). *The Allison Collection of rare jewels and gemstones.* Horowitz Publications, North Sydney, 1971. Not paginated. Illustrated in colour. Price on application.

The Allison Collection is housed in the Diamond Traders Gem Gallery in Sydney and this booklet illustrates without text some of the finest specimens. The quality of reproduction is fair, the plates being printed in Japan.

M.O'D.

AREM (J. E.). *Man-made crystals.* Smithsonian Institution Press, Washington, D.C., 1973. pp. 109. Illustrated in black-and-white and in colour. $5·95.

The Smithsonian Institution now houses the National Collection of Synthetics and this has been drawn upon to furnish the very fine illustrations for the present book. Particular attention is paid to the actual use of synthetic crystals in modern technology and a good deal of simplified information is included on such subjects as lasers, bubbles, transistors and integrated circuits. All forms of crystal are dealt with, including some unfamiliar as yet to the gemmologist, bismuth germanium oxide, lead molybdate (wulfenite in nature) and potassium tantalate niobate. A bibliography would have been most useful. There is a glossary of technical terms and an index, which lists gadolinium gallium garnet as GGG only, although it is mentioned three times in the text.

M.O'D.

ARMSTRONG (Nancy). *Jewellery.* Lutterworth Press, Guildford, 1973. pp. xiii, 286. Illustrated in black-and-white and in colour. £8·95.

An unnecessary book. There seems no point in publishing a book with so little scholarship and such a lumpen style, whose sole aim appears to be to boost the reputation of some modern jewellery designers, who would probably not welcome this kind of publicity. Errors are so many that the whole sense of the book is lost; zircon is not a quartz, nor topaz a beryl. It would scarcely seem advisable to use machine oil as a vehicle for the cleaning of opal. Any of the details of the production of jewellery, which have to be sought among the hackneyed legends and half-statements, are quite easily to be found in other and better books. The illustrations are of fair quality, and there is a bibliography. The information given on education in gemmology is not accurate, but it is hoped that aspiring students will not be reading this book.

M.O'D.

BAUER (J.) and TURZ (F.). *Der Kosmos Mineralienführer.* (Kosmos guide to minerals). Franckh'sche Verlagshandlung, Stuttgart, 1974. pp. 215. Illustrated in colour. DM. 19·80.

Printed in Czechoslovakia, this handy guide is intended for the field identification of minerals, rocks and gemstones. Each species is illustrated in colour and brief descriptions, colour, transparency, hardness, cleavage, crystal system, mode of occurrence and chemical composition occupy the facing pages. There is a short introduction and a bibliography. Although the majority of the examples are shown as crystals, some, including peridot, spinel and pyrope, are shown fashioned, which seems strange for a field guide. Locations are German and Central European.

M.O'D.

BROCKETT (Ron). *The Moscow opal mines, 1890 to 1893.* Published by the author, c/o Lapidary Journal, San Diego, 1974. pp. 63. Illustrated in black-and-white. $3·00 plus postage.

A well-written account of the first commercial opal mine in the United States, this book covers the history of the opal mine established on the property of a William Leasure about 5 miles from Moscow, Idaho. Claims were quickly established when the opal was seen to be of good quality and the book traces the history of the North American Gem Opal Mining Company. Misleading press accounts of the value of the stones recovered and the reasons why the mines ceased to produce are analysed.

M.O'D.

EPPLER (W. F.). *Praktische Gemmologie.* (Practical Gemmology). Rühle-Diebener-Verlag, Stuttgart, 1973. pp. 410. Illustrated in black-and-white. DM. 132.

One of the most important gemmological textbooks to be written for some years, this excellently printed and illustrated work urgently needs an English translation. The book is arranged by stones with tables at the end giving specific gravities, absorption spectra, refractive indices and pleochroism. There is an index but no bibliography, the one serious desideratum in the book. Each stone is introduced by its constants and its crystal habit is illustrated by text-diagrams and sometimes by photographs. The most important feature, however, is that each stone is accompanied by photographs of its typical inclusions and these photographs are of superlative quality. The section on emerald includes a superb illustration of the inclusions in a Hautefeuille and Perrey synthetic and in a Nacken. The author does not mention that the iron-rich Gilson synthetic emerald was discontinued after a relatively small production. I could find no references to chrome kornerupine, nor to chrome chalcedony, but there is a reference to tourmaline-coloured green gahno-spinel and to the hydrothermal growth of tourmaline. The author does not advance a theory on the colouring agent of Blue John fluorspar. But these are small points which the reviewer is irresistibly led to track down in such a book as this.

M.O'D.

FAIRFIELD (Del). *Lapidary.* English Universities Press, London, 1973. pp. 126. Illustrated in black-and-white. Teach Yourself Books. 50p.

A well-printed and clearly-illustrated introduction to lapidary, this book covers tumbling, sawing, grinding, polishing, drilling and lapping with a section on some of the commoner gem materials. A useful chapter deals with the setting up of a workshop and there is a list of British lapidary societies.

M.O'D.

HAMILTON (W. R.), WOOLLEY (A. R.) and BISHOP (A. C.). *The Hamlyn guide to minerals, rocks and fossils.* Hamlyn, London, 1974. pp. 320. Illustrated in colour. £1·95.

Much better than similar productions in the same field, this pocket-sized guide scores heavily by presenting specimen and description on facing pages. There is a short introduction to the mineral classes and to elementary crystallography and a stratigraphical column is of great assistance to fossil collectors, who have not had, at least in recent years, a guide of this type to take into the field.

M.O'D.

LIEBER (Werner). *Bunte Welt der schönen Steine.* (The colourful world of beautiful stones). 3rd edition. Franckh'sche Verlagshandhung, Stuttgart, 1974. pp. 71. Illustrated in colour. DM. 7·80.

With descriptions facing the stones they accompany, this Czechoslovakian-printed pocket-book forms an excellent introduction to minerals. The specimens are classified in traditional order and there is a short introduction. German and Central European locations are given.

M.O'D.

PARKER (R. L.). *Die Mineralfunde der Schweiz.* (Finding minerals in Switzerland). Wepf & Co., Basel, 1973. pp. xii, 433. Illustrated in black-and-white and in colour. Price on application.

Described in the preface as a topographic mineralogy, this book is a new edition of a work which first appeared in 1940. The task of overseeing the complete work has been entrusted during this time to the Schweizerische Geotechnische Kommission. For the purpose of the book the country has been divided into the massifs of the Aar and the Gotthard, the Pennine, eastern and southern Alps, the massifs of Mont-Blanc and the Aiguilles Rouges, the northern Alps and the region of the Jura. Each of these areas has a section devoted to it and they are also illustrated by panoramas and maps, the major ones depicting the mineralized areas on a scale of 1:200,000. There are excellent illustrations, an exhaustive bibliography and a glossary.

M.O'D.

RUTLAND (E. H.) *An introduction to the world's gemstones.* Country Life, London, 1974. pp. 192. Illustrated in black-and-white and in colour. £3·50.

A freshly-written introduction to gemmology, this reasonably-priced book deserves a wide circulation. Particularly welcome is a departure from the laboured didactic style which characterizes some other gemmological texts, and the reader is conducted naturally from the geological processes to the finished gem. Gem testing is not described in detail and the scope of the book does not call for it; instead there are some useful chapters on synthetics and on jewellery.

There is an index and a short bibliography. The coloured illustrations are fairly good, some of them being from the now celebrated Geological Museum slides first used to illustrate the latest edition of Herbert Smith; one or two of the others are a little pale in colour; this applies particularly to the reproduction of the emerald on page 66.

M.O'D.

SORRELL (Charles A.). *Minerals of the world.* Golden Press, New York, 1973. pp. 280. Illustrated in colour. Gold Field Guides Series. $3·95.

The acknowledged aim of the author was to fill a gap between popular guides and college textbooks. This well-illustrated guide fits easily into the pocket and, like some other recent books of similar type, presents text and illustrations on facing pages, a feature much less often found in past years. An introduction deals concisely with simple mineralogy and a particularly welcome feature is a bibliography in which the scope of the work included is explained. United States locations by state are given for the minerals described. It is a little inaccurate to say that uvarovite is prized as a gem and no distinction is made in the text between hiddenite and green spodumene, though they are differentiated in the plate.

M.O'D.

WEIBEL (Max). *Die Mineralien der Schweiz.* (The minerals of Switzerland). Fourth edition. Birkhäuser Verlag, Basel, 1973. pp. 185. Illustrated in black-and-white and in colour. Sw.fr. 24.

The mineral classes introduce the book, which is then arranged in order of mineral occurrence, beginning with the Jura and passing to the high Alps. Directions for finding the commoner minerals are given and there are some excellent maps. Many of the illustrations depict the various forms of quartz, but some interesting examples of other species are also shown, particularly a fine red grossular accompanied by diopside from the Zermatt area.

M.O'D.

WILHELMY (Herbert). *Geomorphologie in Stichworten.* (Geomorphology in catch words). Verlag Ferdinand Hirt, Kiel, 1971.

3 parts. pp. 102, 227, 184. Illustrated. Price on application.

This excellently-produced book further enhances a series (Hirt's Stichwortbücher) already notable for Geologie in Stichworten and Mineralogie in Stichworten (both reviewed in the *Journal,* July 1972, 13, 3, 111). Intended as a textbook for degree students, the whole subject is simply but adequately treated with diagrams of especial usefulness and clarity. Each chapter includes a bibliography.

M.O'D.

Minerals and their characteristics. Department of Mines, Geological Survey of New South Wales, Sydney, 1973. pp. 26. Price on application.

A short guide in tabular form to some of the commoner minerals. Chemical formula, colour, streak, lustre, cleavage, fracture and hardness are given. It would have been easier to use the book had it opened to show the text vertically instead of horizontally, necessitating turning the book round to read it.

M.O'D.

Gemhunting atlas of Australia. Paul Hamlyn, Sydney, 1973. Not paginated. Illustrated in colour. Price on application.

This atlas which is very well printed falls into three sections, of which the first shows the main gem-bearing areas. The chief geological formations are shown in contrasting colours and fossicking areas are included. The second section is divided by state and shows the road systems by which the gem areas may be reached. The third section is an alphabetical index of towns. The maps are admirably clear and the whole book is an essential for the Australian gemmologist.

M.O'D.

Verzeichnis der Schmuck-und Edelsteine. (List of ornamental and precious stones). Verlag Heinz Wöhrle, Göppingen, 1974. pp. 16. DM. 1·50.

A handy small compendium arranged by groups of stones apparently in arbitrary order. Additional tables list stones by colour and alphabetically.

M.O'D.

ASSOCIATION NOTICES

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to the following for gifts presented to the Sir James Walton Library:

Mr A. F. Chapman, McCrae, Victoria, Australia, for three slabs of "Nundoorite" from a recent discovery in the Broken Hill area of New South Wales, Australia. The material is Aegterine augite sodic zeolite.

Mrs Vera M. Honeker for 1 crystal specimen of vanadium from South West Africa.

Mr Eric F. Morris, Christies Beach, Australia, for two "Copeton" diamonds. These stones came from the small town of Copeton, which was abandoned last year when the large Copeton Dam inundated the river valley in which it lay.

Mr Richard Y. M. Sze for 2 sets of coloured cards of jade articles which are located in the National Palace Museum, Taipei, Taiwan.

ACTIVITIES BY FELLOWS

In the discussion which followed the delivery of the sixth Chester Beatty Lecture at the Royal Society of Arts on 24th April by Professor R. V. Jones, C.B., C.B.E., F.R.S. on the subject of "Minerals in the History of Science", in which the lecturer referred to one of the earliest successes in growing crystals by artificial means as being that of M. Verneuil of Switzerland in growing artificial rubies for the watch industry, Mr Robert Webster, F.G.A., pointing out that most of Verneuil's stuff was in Paris, queried whether Professor Jones had any extra information about him which might shed some light on the problem of "Geneva rubies" or "reconstructed rubies". The lecturer, however, disclaimed possession of any such information, saying "I think that you know more than I do about this".

An Exhibition of Gemstones and Ornamental Material combined with a Gem Testing Demonstration was given by Mr Robert Webster, F.G.A., and Mr Colin H. Winter, F.G.A., at the Department of Forensic Medicine, London Hospital Medical College, on Friday, 14th June, as one of a series of exhibits held during the 15th Annual General Meeting of the British Academy of Forensic Science. Grateful acknowledgements were made to the Gemmological Association for the loan of an Olympus Microscope, a polariscope and ultra violet equipment, and also to the Academy and staff of the College for their assistance and hospitality during the day.

Mr Colin H. Winter, who gained the Fellowship of the Association with Distinction in 1973 and who had been appointed lecturer to the newly started gemmology classes at Merton Technical College, has now been admitted as a Member of the British Academy of Forensic Sciences.

EXAMINATIONS IN GEMMOLOGY 1975

The dates for the 1975 examinations are as follows:

Preliminary	Theory	Tuesday, 17th June
Diploma	Theory	Wednesday, 18th June
	Practical	Thursday, 19th June or Friday 20th June (London). Other centres as arranged.

The final date for entry is the 1st March.

Entry forms available from the Association.

MEMBERS' MEETINGS

Nottingham Branch

On the 27th May members of the Branch held a wine and cheese evening at the Mechanics Institute, Birkbeck House, Nottingham, and Mr James Gosling, F.G.A., gave an illustrated talk entitled "Gemstones of Guyana and the setting up of a lapidary industry there". This evening replaced the planned visit to the Institute of Geological Sciences, which had to be cancelled.

Scottish Branch

A belated A.G.M. of the Scottish Branch was held on the 5th September, 1974, in the North British Hotel, Glasgow. The

Chairman, Mr A. H. G. Armstrong, reported on the activities during the past year when three successful evening lectures were arranged. Mr A. McRae reported on instruction at the evening classes held in Glasgow. Mr Henry Whitehead was elected Chairman and Mr Alistair W. Tait, Secretary. The following were elected members of the Committee: Mrs C. Kilpatrick, Messrs D. Hill, A. McRae, I. McKenzie, A. H. G. Armstrong, and M. Turner. A vote of thanks was proposed to the retiring Chairman, Mr A. Armstrong, and Secretary, Mr G. Turner.

The evening finished with a talk with slides about the gem-cutting centre, Idar-Oberstein.

OBITUARY

Mrs Jeanne G. M. Martin, San Diego, California, U.S.A., who gained the Association's Diploma with Distinction in 1953, died on the 5th June, 1974. Mrs Martin was from 1954 to 1966 Associate Editor of *Gems & Gemology* and was a G.G. as well as a F.G.A.

INDEX OF GEM MATERIALS

The Worshipful Company of Goldsmiths in London is compiling an index of materials which have been or could be used as gems—this index to include not only natural but synthetic and other man-made materials. Will any reader having unpublished information within this field please communicate with Michael O'Donoghue, 7 Hillingdon Avenue, Sevenoaks, Kent TN13 3RB, England.

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