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THE JOURNAL OF GEMMOLOGY
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THE RECOGNITION OF THE NEW SYNTHETIC RUBIES

By Prof. Dr E. J. GÜBELIN, C.G., F.G.A.
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The older generations in the gemstone and jewellery branches of our trade will look upon the new synthetics made by Chatham, Kashan and Knischka—particularly the new synthetic rubies—with a certain amount of nostalgia for the 'good old days' when it was comparatively easy to distinguish synthetics from their natural counterparts. Whereas in those days the tendency among manufacturers was to create best quality stones, that is to say purer synthetics, the aim nowadays is to produce synthetic stones with inclusions as similar as possible to those in the natural mineral.

For several years now synthetic rubies (and soon sapphires will too) have crept in increasing quantities into the market. Their inclusions are bewilderingly similar to those found in natural rubies, and indeed many dealers, jewellers and even gemmologists have been deceived lately and have purchased synthetic rubies as natural ones.

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Uncertainty about synthetic stones is nothing new, but the synthetic rubies by Chatham and Kashan as well as the newest by Knischka (K-rubies) are quite a different matter; that is to say, they differ so widely from previous synthetics and are so similar to their natural counterparts that all the old rules of distinguishing them are no longer valid. Inclusions of liquid banners, rutile dust, rutile needles, and even angular zonal structure, can no longer be regarded as identifying proof of the natural stone. The author therefore spent a great deal of time and care on a thorough investigation of possible distinguishing factors, and he is convinced that, thanks to the experience thus gained, synthetic rubies no longer present serious problems. The diagnostically important properties of the new synthetics are:

Colour

It is well known to all experts that the colour of a gem, whether natural or man-made, is the least dependable factor, and that one can therefore not rely upon it. This rule applies for synthetic rubies too—especially for the products of Chatham and Knischka, but also for the paler synthetics by Kashan. Dark red synthetic Kashan rubies often show a subordinate tinge of brown to orange which is even more intensive than in the majority of Thai rubies, to which they nevertheless bear a strong resemblance.

Dichroism

It is well known that the mixture of the twin colours of a stone procures the hue beheld by the human eye. The dichroism of the new synthetic rubies by Chatham and Knischka as well as of the paler ones (pink and rose) by Kashan does not differ from that of natural rubies. On the other hand the dark red rubies with a brownish or orangy cast by Kashan betray themselves by their conspicuously orange hue for the extraordinary ray, and this feature may be valued as an indication.

Behaviour under Short-wave Radiation

The luminescence varies according to the colour of the synthetic ruby and the wavelength of the radiation. In short-wave ultraviolet light it is a medium to strong red; in long-wave ultraviolet light, medium to bright red. The deep red samples luminesce less intensively than the pale to pink samples, which contain some titanium.

The x-ray luminescence varies from strong to very strong red with an afterglow. This—known as phosphorescence—although visible, is neither intense nor of long duration (approx. 3-7 seconds), but can nevertheless be considered as a definite indication.

Absorption-spectrum

Viewed through the normal gemmological absorption-spectroscope, the difference between natural and synthetic rubies is seldom apparent. The synthetic rubies behave in the same way as natural ones, that is to say, they show the familiar lines in the red region at 694.2, 692.8, 668 and 659.2 nm, and in the blue region at 476.5, 475 and 468.5 nm. Under the spectrophotometer, which also covers the ultraviolet region, the result is quite different: at the short-wave end of the spectrum the absorption-curve shows a marked transmission gap of varying breadth between 250 and 400 nm which reaches its maximum at 335 nm (Figure 1). A similarly reliable distinguishing factor is the shape of the transmission in the blue region between 465 and 478 nm. These characteristics of the absorption and transmission in the new synthetic rubies, although not equally strong in each case, are a certain and reliable distinguishing factor for the experienced spectroscopist.

Inclusions

The confusingly natural-looking inclusions in the interior of the new synthetic rubies are largely responsible for the fact that so many buyers have already been hoodwinked; for with a pocket lens or even with the microscope these can hardly be distinguished from each other by inexperienced professionals. For this reason the main emphasis of the following study is laid upon inclusions. Honouring the Chinese saying: 'A single picture is more eloquent than a thousand words', the following descriptions are exemplified by many illustrations.* For a comparison with similar inclusions in natural rubies, the reader is invited to turn to pages 117-26 of 'Internal World of Gemstones' (Gübelin, 1973).

A certain type of inclusion in the new synthetic rubies catches the eye immediately whenever it occurs, and could be described

*Figures 2-42, which follow on pages 483-496.

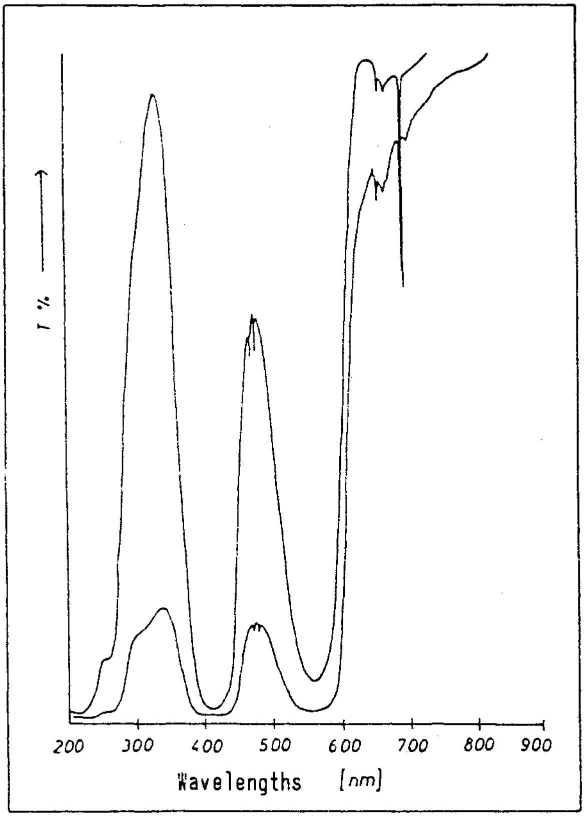

FIG. 1. Two superimposed absorption curves of synthetic rubies by Kashan demonstrate two extreme cases with regard to their transmission maxima in the near ultraviolet region of the spectrum. The transmission ends at 210 nm and 270 nm respectively. For a predominant majority of natural rubies the absorption edge occurs closer to 300 nm.

with expressions such as ‘flags’, ‘veils’, ‘nets’, ‘wisps’, or something similar (Figures 2 & 13-23). These formations occur singly as well as in the form of crazily-wound spools, producing an inclusion pattern reminiscent of those in the early synthetic emeralds (Figures 2-4). According to the method of synthesis (i.e. whether hydrothermal or by flux fusion) these inclusions consist either of drops or liquid tubes or as grains, feathers, and irregular shapes of flux. They usually form whitish, irregular accumulations of individual drops or grains (Figures 11, 12 & 35), coarse feathers (Figures 16-23), formless rags (Figures 6 & 7), parallel tubes

(Figures 9, 10 & 13), single or manifold chains of grains (Figures 11-13), or zones of varied drops (Figure 15), or lace-like concentrations of flux (Figures 22-26), which permeate and traverse the interior of the new synthetic rubies.

The lace-like formations are particularly typical of the synthetic Chatham rubies (Figures 16-18). The appearance of the coarser inclusions can best be compared to that of the sugary precipitation of quince jelly (Figures 6-10). Two x-ray analyses made with the Gandolfi-camera proved that these flux inclusions are a fine white powder of cryolite (Na_3AlF_6). Cryolite occurs in nature as a monoclinic crystal (high-temperature-polymorph > 570 °C—cubic) as a result of granitic intrusions and their pegmatites. It appears as a dull-white, altered, paramorphic mineral. Today this substance is synthetically produced in great quantities for technical purposes, and it is obviously used by Kashan as a flux to keep the temperature of the melt down.

Single grains are often aligned in zig-zag rows or V-shapes (Figure 24), or they take on the appearance of hieroglyphics (Figure 25), simulate baroque and oddly-shaped pearls, and even look like negative crystals and crystalline guest minerals (Figure 26). The fantastic variety of shapes is indescribable, and thus different in every stone, although certain elements are always present which facilitate identification, as is shown clearly by the accompanying illustrations. It is these formations which are most easily confused with the liquid feathers (healed fractures) in natural rubies from Burma, Sri Lanka and Thailand.

Far more difficult to determine are the fog-like swathes which either fill the interior of these synthetic rubies as a whitish cloud (Figure 27), or traverse it in narrow bands or even fine lines (Figures 28 & 29). This type of inclusion is usually observed in the deep to dark red stones by Kashan. The so-called 'hair-pins'—two or more divergent lines (Figure 30)—and the 'comets', also belong to this category. The latter consist of tiny bright melt-drops from which a tail of two or more extremely fine white lines emerge, as shown in Figure 31. They provide an absolutely infallible identifying factor of synthetic Kashan rubies! 'Fog', 'hair-pins' and 'comets' are very difficult to perceive and can usually only be made visible with the help of fibre-glass illumination, whereas, on the other hand, the triangular and hexagonal black platelets of platinum very often present in synthetic rubies by Chatham and

Knischka are not only very easy to see but are also a highly characteristic internal hall-mark of synthetics (Figure 7). In inclined position they reflect with a strong metallic, silvery lustre. So far, Kashan synthetic rubies seem to be devoid of the latter, yet one must always be aware of the fact that the producers of synthetic stones are free to alter or completely abolish such features. Fine well-formed, bright or black needles of varying length—in some cases very short and in other cases very long (Figures 32 & 34), and yet sometimes in broken lines like a row of dashes (Figure 33), or in divergent lines, or even 'knee-twins', like rutile (Figure 35)—present a grave challenge, for they look like fine rutile needles, and might indeed be so, for because of their fineness they have not yet been identified. However, these are distinctly different from the well-known traces of the edges of twin lamellae which traverse Thai rubies, forming a pattern like a chess-board. Therefore single needles and concentrations as well as bundles of needles, not only parallel to each other but also at various angles to each other, can no longer be rated as proof of natural origin.

The inclusion elements in the new synthetic rubies which are the most confusing, are the straight parallel growth-bands (Figure 36), sometimes at regular angles to each other (Figures 37-39) exactly like those we were accustomed not only to observe but also to value as the exemplary symptoms of natural origin. The phenomenal appearance of these growth-bands is extremely elusive, that is to say, they are extremely difficult to find and apprehend. They disappear with the slightest movement of the stone or the objective of the microscope. This means that the observer must adjust the stone, the light-source and the objective constantly during the examination in order to view the interior of the stone in all positions. These angular zones often lie near the girdle of the stone, that is to say, under the crown facets, or in a similar position of the pavilion. There is hardly any difference in appearance between these angular bands in synthetic rubies and the well-known angular zonal banding of natural rubies. On the other hand, they are readily distinguishable from the appearance of polysynthetic twin-lamellae in natural ruby. Whereas the planes of the twin-lamellae can be followed deep into the interior of the gem, the synthetic growth-bands disappear when raising or lowering the objective. Thus they behave very similarly to those familiar curved growth-bands in the synthetic rubies by Verneuil.

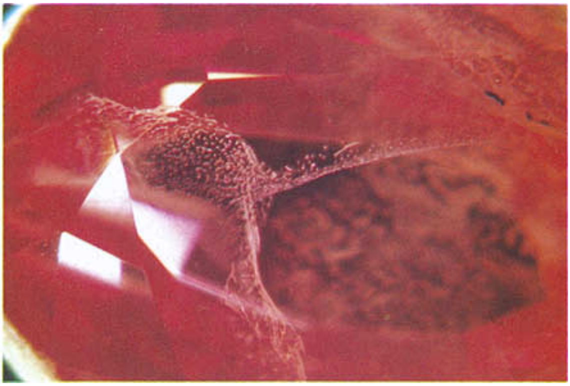

FIG. 2. Wisp-like appearance of 'fingerprint'-feathers in a synthetic ruby by Chatham. 10×

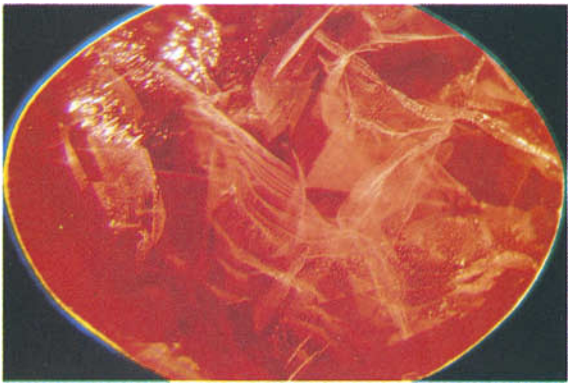

FIG. 3. Survey of the inclusion scenery with wisp-like feathers in a synthetic ruby by Kashan. 18×

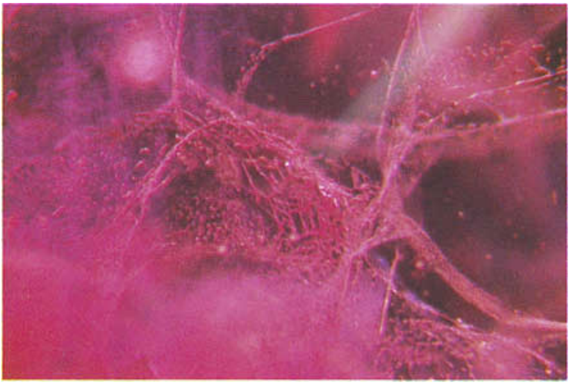

FIG. 4. Typical entanglement and appearance of 'feathers' surrounding a turbid cloud in a synthetic ruby by Knischka. 25×

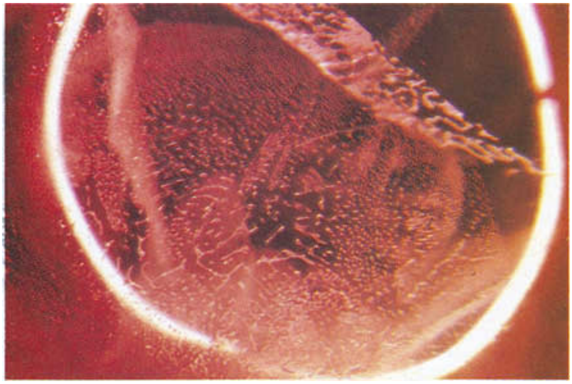

FIG. 5. Deceptive inclusion scenery draped by a large and delicately designed 'fingerprint'-feather and a feather of coarse pattern of flux in a synthetic ruby by Kashan. 25×

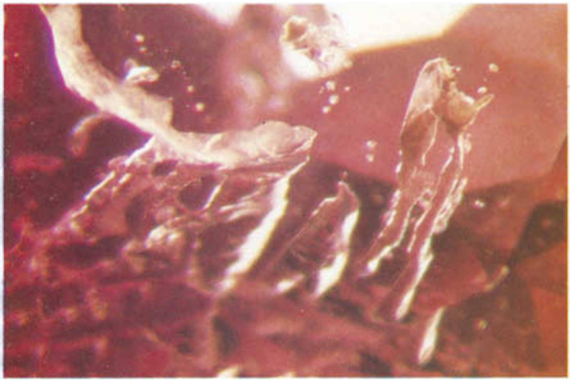

FIG. 6. Coarse 'rags' of flux inclusions (cryolite) in a synthetic ruby by Kashan. 35×

FIG. 7. Large shapeless flux inclusion enveloped by a net-like feather (misleadingly consistent with the rosettes in Thai rubies) in a synthetic ruby by Knischka. 32×

FIG. 8. Profiled 'tubes' of flux inclusions in parallel alignment in a synthetic ruby by Kashan. 30×

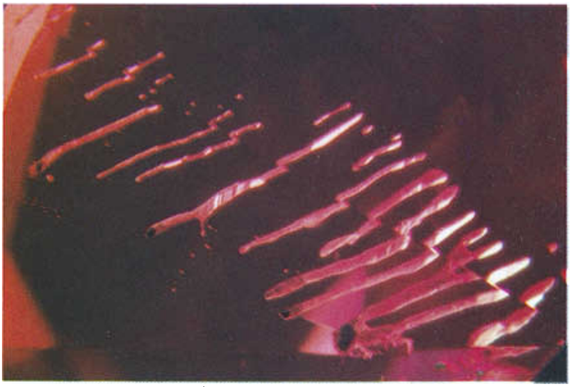

FIG. 9. A conspicuous band of parallel rods of flux inclusions traversing a synthetic ruby by Kashan. 30×

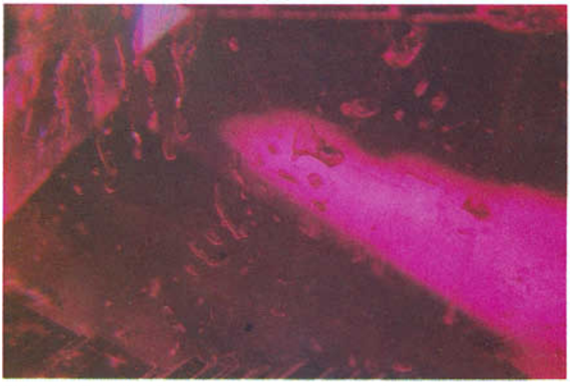

FIG. 10. Tube-like flux inclusions swarming around an unusual three-phase inclusion, the solid phase of which is a black platelet of platinum. Synthetic ruby by Knischka. 25×

FIG. 11. Parallel rows of small to tiny grains of flux (some with crystalline aspect) in a synthetic ruby by Kashan. 30×

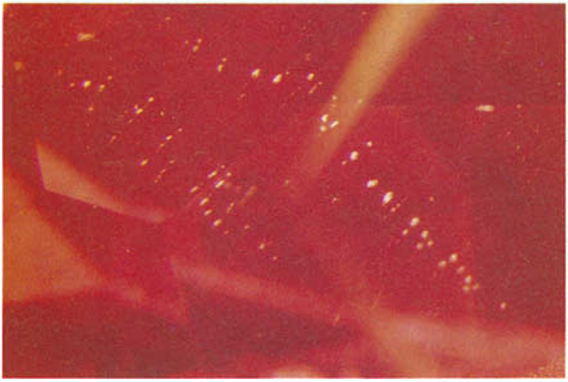

FIG. 12. Parallel bands of minute flux grains (in parallel alignment among themselves) in a synthetic ruby by Kashan. 30×

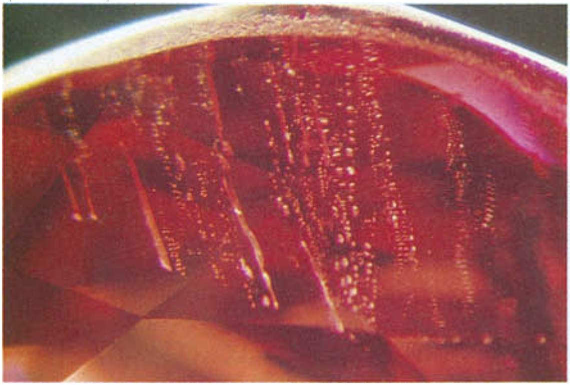

FIG. 13. Rods and tube-like formations accompany rows of tiny flux grains in parallel orientation in a synthetic ruby by Kashan. 16×

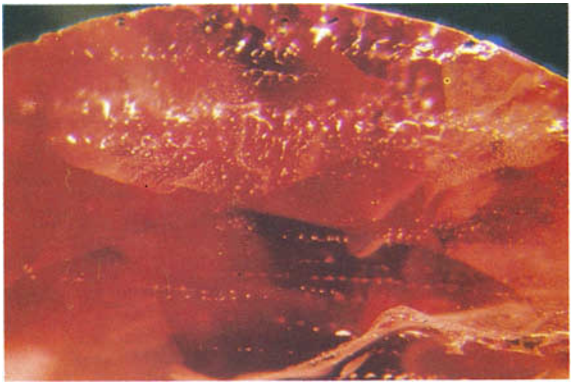

FIG. 14. Dotted rows and bands of coarser inclusions of drops and grains of flux in a synthetic ruby by Kashan. 13×

FIG. 15. Broad zones of delusive dactyloptical inclusions in a synthetic ruby by Kashan. 32×

FIG. 16. Tell-tale lace-like inclusions (left in dark-field, right in bright-field illumination) in a synthetic ruby by Chatham. 8×

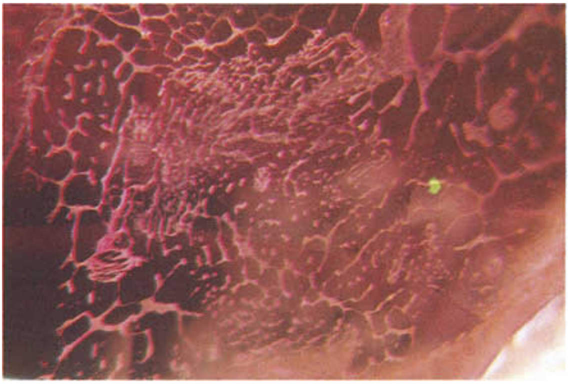

FIG. 17. Inclusions reminiscent of a shredded net identifying a synthetic ruby by Chatham. 30×

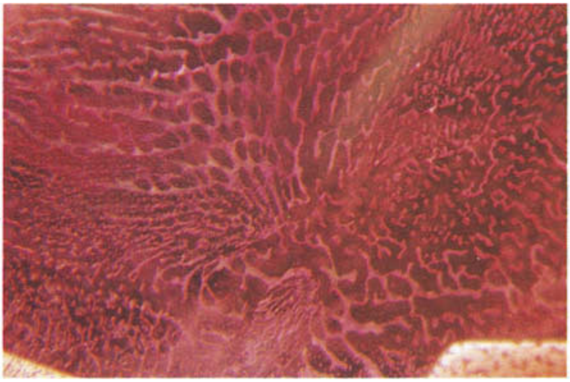

FIG. 18. Characteristically lace-like pattern of a large 'feather' in a synthetic ruby by Chatham. 40×

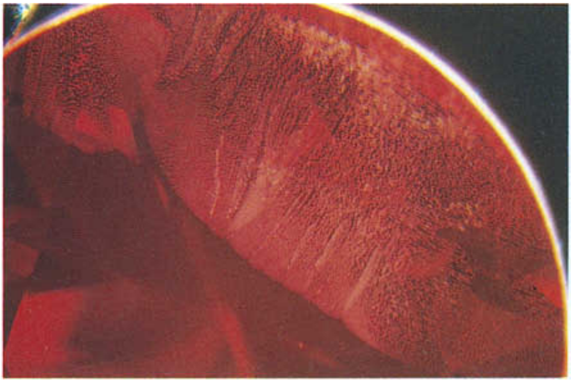

FIG. 19. 'Feathers' with such 'folds' have heretofore been considered as typical hallmarks of Burma rubies. Yet here they were observed in a synthetic ruby by Kashan. 25×

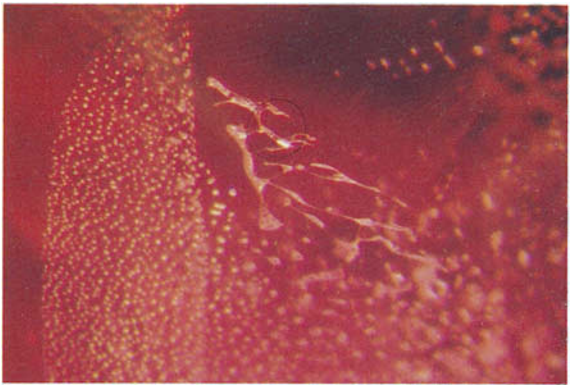

FIG. 20. Tiny grains and large irregular flux inclusions in a synthetic ruby by Kashan. 30×

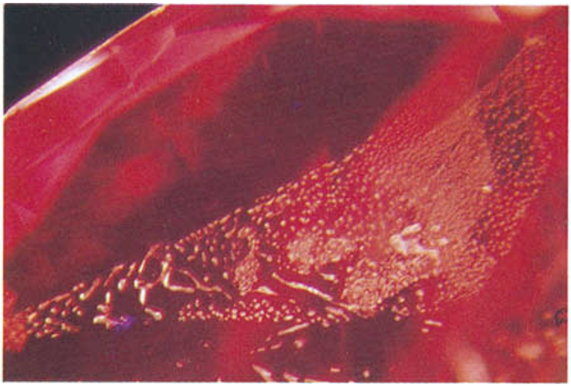

FIG. 21. Illusive feather of variously formed flux inclusions in a synthetic ruby by Kashan. (Such formations might just as readily appear in genuine rubies) 35×

FIG. 22. Misleading inclusion scene which one might expect to find in Thai rubies, yet photographed in a synthetic ruby by Kashan. 30×

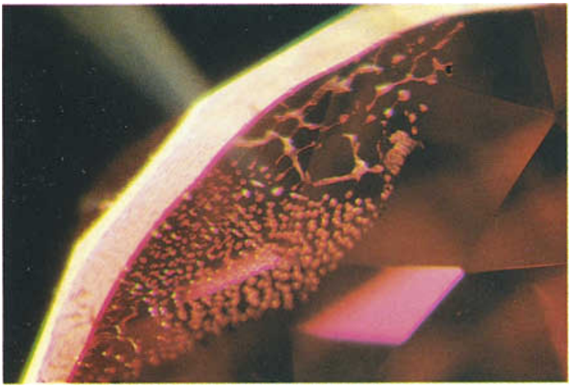

FIG. 23. Deceptive 'feather' near the girdle of a synthetic ruby by Kashan. 25 ×

FIG. 24. A V-shaped arrangement and discrete rows of tiny grains of flux in a synthetic ruby by Kashan. 28 ×

FIG. 25. Flux inclusions simulating archaic characters in a synthetic ruby by Kashan. 30 ×

FIG. 26. Tiny flux inclusions looking like crystal shapes accompanied by a double row of minute flux grains in a synthetic ruby by Kashan. 50×

FIG. 27. Survey picture of a synthetic Kashan ruby rendered turbid by a large cloud with numerous 'hairpins' and 'comets'. 13×

FIG. 28. Narrow, parallel striations of so-called 'fog' in a synthetic ruby by Kashan. 15×

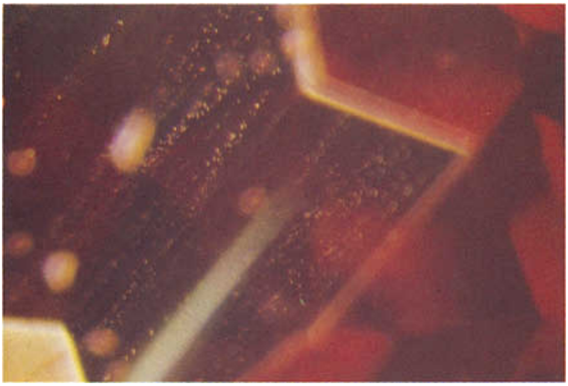

FIG. 29. Slight turbidness caused by narrow bands of 'fog' in a synthetic ruby by Kashan. 45 ×

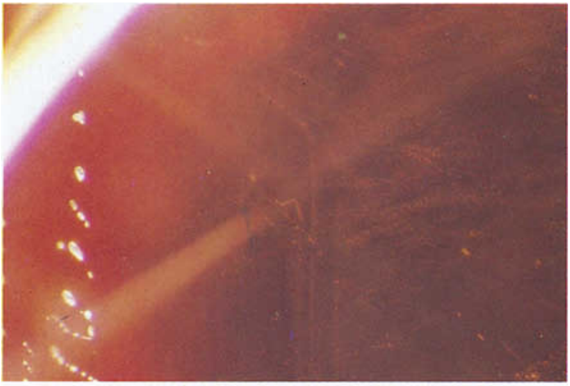

FIG. 30. Two 'hairpins' and a slight fog, being typical internal features of synthetic rubies by Kashan. 50 ×

FIG. 31. Several 'comets' consisting of a tiny grain of flux in connexion with divergent tails of ultra-fine flux in a synthetic ruby by Kashan. 50 ×

FIG. 32. A minute, almost invisible needle, highly reminiscent of a slender rutile needle, in a synthetic ruby by Kashan. 40×

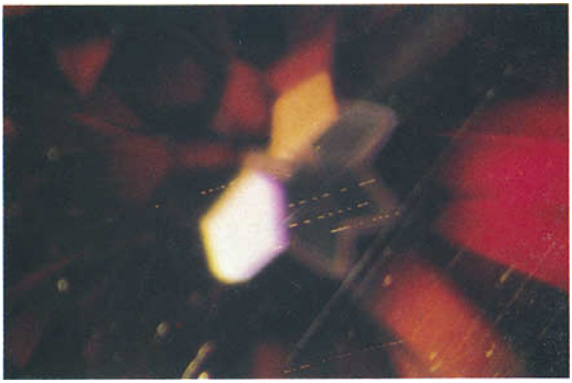

FIG. 33. Parallel rows of broken lines, deceptively similar to natural rutile needles, in a synthetic ruby by Kashan. 20×

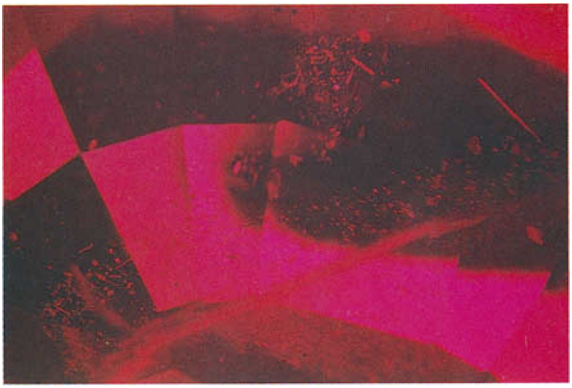

FIG. 34. Very similar short and long needles, misleadingly like rutile needles in genuine rubies, observed in a synthetic ruby by Chatham. 15×

FIG. 35. Two needles meeting at an odd angle simulate one of the rare knee-twins of natural rutile, here accompanied by tell-tale grains of flux in typical arrangement in a synthetic ruby by Kashan. 80×

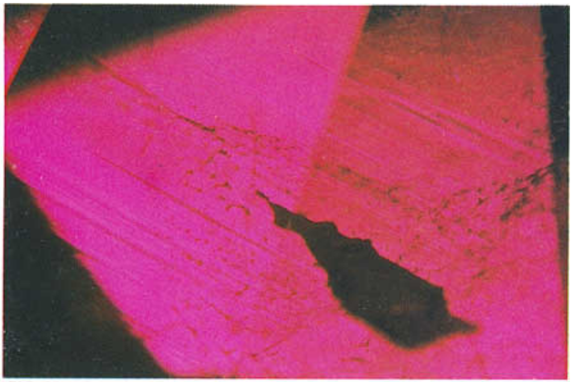

FIG. 36. Growth striation and exemplary lace-like feather in a synthetic ruby by Chatham. 35×

FIG. 37. Hexagonal growth-bandings, imitating those which have until recently hallmarked genuine rubies only, in a synthetic ruby by Kashan. 32×

FIG. 38. A narrow blue band appears to mark the hexagonal outline of a seed crystal in a synthetic ruby by Chatham. 13 ×

FIG. 39. One of those strange two-phase inclusions in front of a background of hexagonal banding in a synthetic ruby by Knischka. 20 ×

FIG. 40. Small and large negative crystals in parallel orientation and filled with a fluid and a gas bubble in a synthetic ruby by Knischka. 25 ×

FIG. 41. Two large ellipsoidal two-phase inclusions, which may occasionally extend into long hoses. They always contrast strongly with the enclosing body of the synthetic rubies by Knischka. 50×

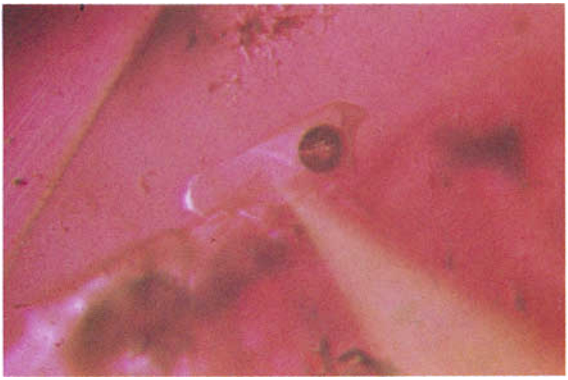

FIG. 42. One of those strange two-phase inclusions with almost invisible relief, yet large and conspicuous gas bubble, in a synthetic ruby by Knischka. 64×

Professor Paul Otto Knischka, an Austrian engineer, has been successfully producing synthetic rubies by a new method that he invented. This material is distinctive from other synthetic rubies in various features such as crystal forms, optical properties, and inclusions.

Although it is known that these new synthetic rubies are grown from a melt, Professor Knischka thus far has revealed only that they are crystallized synthetically by an as yet undisclosed method of gradient technique through supercooling and supersaturation. The finished crystals display flat brilliant growth faces with mineralogically significant indices. So far he has grown a very great quantity of discrete crystals, twins and clusters, which he is mounting as pieces of personal adornment in gold jewellery. Nevertheless, nothing can prevent him from having his synthetic ruby crystals cut, and thus introducing them on the gem market, and as this possibility must be taken into account, it appears imperative to include this new synthetic ruby in the present review. The product will eventually be marketed under the trade-mark ꟼK-ruby (Paul Knischka's initials with the 'P' inverted).

As far as colour is concerned, the synthetic rubies made by Chatham and by Knischka, contrary to those by Kashan, resemble more, and in a deceptive way, Burma rubies, and they also distinguish themselves clearly from synthetic Kashan rubies, which look more like Thai rubies. Compared to the physical properties (except absorption) of natural and other synthetic rubies, the Knischka synthetic rubies do not excel by any distinction. Yet the internal scenery of the inclusions is so characteristic as to distinguish synthetic Knischka rubies distinctly from genuine rubies and other synthetic rubies. Indeed, despite a certain similarity between the inclusions in these new synthetic rubies and those in natural rubies, one can, with careful and concentrated investigation, discover distinguishing characteristics which permit an undeniable statement.

While to the unaided eye there is nothing to be seen inside the material that might give definite and immediate proof of synthesis, viewed with a pocket lens—or even better under the microscope—the variegated wealth of inclusions is revealed in considerable detail with swirls of colour, clouds, liquid feathers, negative crystals, black platelets, melt residues and two-phase inclusions.

The nature of the turbid clouds could not be determined even with the strongest magnification. The liquid feathers, with their irregular course and net-like pattern (Figure 4) are remarkably similar to those in the synthetic rubies by Chatham, and are sometimes difficult to distinguish from the fluid inclusions in natural ruby.

The negative crystals (Figure 40) unmistakably follow the characteristic habit of rubies grown by this particular method. They perch, usually alone or in small groups, on the ends of long crystalline tubes, and they can be considered identifying features.

Equally characteristic are the small, triangular or hexagonal distorted platelets of platinum or silver that can be observed now and then in synthetic K-rubies (Figure 7), but are never seen in natural gemstones. However, the manufacturer of this product can now repress the formation of such platelets during the growth process.

Being the result of a melt process, flux residues may be expected in synthetic Knischka rubies, and indeed they are present with similarly bizarre shapes to those in synthetic rubies by Kashan (Figures 7 & 10), and are equally efficient as marks of distinction.

Apart from the negative crystals of Figure 40, there are two types of two-phase inclusions: those with a strong relief and a large gas-bubble which are therefore readily observed (Figure 41), and those whose contours within the ruby are astonishingly delicate—almost to the point of invisibility (Figure 42). These inclusions, which sometimes appear as negative crystals and sometimes as irregular shapes, must contain a highly refractive substance, the chemical properties of which could only be determined by mass-spectroscopy or by the manufacturer's disclosure of the process he has developed. This knowledge, however, is of little importance in the recognition of these synthetic rubies, or in their distinction from either natural or other synthetic rubies. In extremely rare cases, even three-phase inclusions may be observed, in that a platinum platelet forms the solid phase in connection with a liquid and a gaseous phase (Figure 10). These distinctive two-phase and three-phase inclusions in the interior scene of these synthetic rubies are a novelty, and can be regarderd as an identifying characteristic of Professor Knischka's synthetic rubies.

SUMMARY AND OUTLOOK

Although the new synthetic rubies no longer present a problem for the gemmological laboratories, this does not however apply for the trade; that is to say, the problem remains for all those who have access to neither an x-ray apparatus nor a spectrophotometer. For the more modestly equipped professional, the inclusions (perhaps together with the dichroism in the case of orangy Kashan rubies) therefore present the most important means of identification, and he is urgently advised to obtain a small collection of representative Chatham, Kashan and Knischka synthetic rubies with exemplary inclusions, so that in case of doubt, comparisons can be made.

The producers of the new synthetic rubies decidedly and very credibly deny any suggestion that they desire to cheat or deceive; indeed, they even attempt to control the sale and distribution on the market. However, they must nevertheless be aware of the possibilities of cheating and deception, when they proudly declare that they have not only copied the natural product but improved on Nature. The opportunity of the fraud—somewhere along the distribution line—lies precisely under these circumstances.

The trade centre of synthetic Chatham and Kashan rubies today is Bangkok, where rough as well as cut stones are traded. The cut stones are offered either singly or in parcels—often together with natural rubies!—whereby the salesman is often ignorant of the exact composition of the lots. It is therefore absolutely necessary for buyers to obtain experience and practice in noticing the characteristics—especially the typical inclusions—with a pocket lens at home (a microscope will hardly be available abroad!). May the inclusion-scenes illustrated here help to protect all buyers of rubies—tradesmen, goldsmiths and jewellers—from grave future errors of judgement.

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PHLOGOPITE AS AN INCLUSION IN PAINITE

By S. HORNYTZKYJ, F.G.A., and A. M. CLARK, Ph.D.

A well-formed, though rather water-worn, singly terminated transparent deep-red crystal weighing 1.7 g was discovered in 1952 in gem gravel from one of the small ruby mines near Ohngaing village, Mogok, Upper Burma. Claringbull *et al.* (1957)(1) identified the crystal as a new mineral of gem quality and named it after A. C. D. Pain who had first recognized its unusual nature. Moore and Araki (1976)(2) found the crystal structure of painite to be related to that of jeremejevite and fluoborite; they also redetermined its chemical composition. Povarennykh *et al.* (1978)(3) demonstrated, on the basis of a study of its infrared spectrum, that the structure is better represented by the formula $CaAl_9ZrO_{15}(BO_3)$.

Painite is hexagonal with a Mohs' hardness of 8 and a specific gravity of 4.01. It is uniaxial negative with refractive indices of ω 1.816 and ε 1.787. It is pleochroic, ranging from ε ruby-red to ω pale brownish-orange. The absorption spectrum shows faint chromium lines. Between crossed polars the original specimen showed a red colour; in long-wave ultraviolet light a weak red glow, and a stronger red under short-wave UV. In x-rays the glow was a very dim bluish-yellow.

Painite is an extremely rare mineral; only three specimens have so far been found, two of which are preserved in the British Museum (Natural History). The second of these was also found by A. C. D. Pain, while the third, a much smaller stone also from Burma, is in the possession of the Gemological Institute of America(4).

Claringbull *et al.*(1) give a short description of inclusions in the original painite crystal. They state (p.421) that 'The crystal contains a number of inclusions, some rounded and others tabular and hexagonal in outline, as well as some feather-like sheets of minute cavities similar to those seen in gem-corundum'.

Recently the authors have examined a small tabular yellowish-brown crystalline inclusion about 0.5 mm in diameter situated in a slight depression in the $(1\bar{1}00)$ face of the original painite crystal (BM 1954, 192). This inclusion was partially exposed, with its

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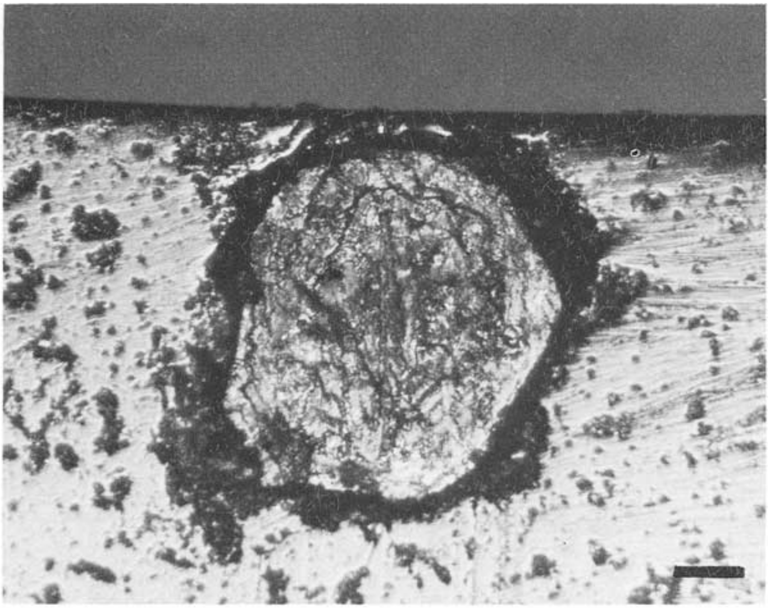

FIG. 1. Tabular and hexagonal phlogopite inclusion partly exposed in the $(1\bar{1}00)$ face of painite crystal BM 1954, 192. This is the striated face shown to the left-hand side of Figure 2 of Claringbull *et al.*(1) The scale bar here represents 0.1 mm.

tabular face parallel to the plane of the painite crystal face (Figure 1), and was therefore suitable for examination with the electron microprobe. The analysis (Table I) was obtained by mounting the whole painite crystal in a Cambridge Instruments Geoscan microanalyser fitted with an energy dispersive system. The analysis was obtained using a 15 kV accelerating potential and 100 sec live-time. As reported it gives a somewhat low total which is thought to be largely due to the lack of polish on the inclusion surface. A fully treated surface for the analysis was out of the question because of the extreme rarity of the mineral and the necessity to preserve its natural crystal faces. The analysis has therefore been normalized to 100% following the assumption that 4 (OH) are present in the mineral's formula.

The analysis shows the presence of Al, Mg, K and Si, with some Fe and Ti and traces of Cr. The oxide percentages, together with the results of an optical examination and the typical hexagonal tabular habit, indicate that the inclusion is the mica phlogopite.

TABLE I.
Electron microprobe analysis of phlogopite inclusion in painite.

	Wt %	Normalized with 4 (OH)	Recalculated to 24 (O, OH)		
SiO_2	34.93	38.64	Si	5.36	8.00
TiO_2	2.05	2.27	Al	2.64	
Al_2O_3	17.85	19.75	Al	0.59	5.83
Cr_2O_3	0.19	0.21	Ti	0.24	
FeO	0.74	0.82	Cr	0.02	
MgO	21.34	23.61	Fe	0.10	
Na_2O	0.47	0.52	Mg	4.88	
K_2O	8.91	9.86	Na	0.14	1.89
H_2O	—	4.32	K	1.75	
Total	86.48	100.00	OH	4.00	

Claringbull *et al.* describe the inclusions they observed as 'tabular and hexagonal in outline' (there is a good photograph in Webster,(5) p.300). They were oriented parallel to the *a* crystallographic axes of the painite crystal and it is likely that these, too, are phlogopite crystals.

Phlogopite commonly occurs in metamorphosed limestones and ultrabasic rocks.(6) It is abundant and evenly distributed in the Mogok limestone from which the spinels and most of the rubies found in the gem gravels of Mogok are derived.(7) The limestone is a white, coarse-grained, partly dolomitic marble, in places intruded by pegmatite and granite.(7) The sapphires found with the rubies and spinels are generally derived from the pegmatite and granite, although they have also been reported in the limestone.(7) Gübelin(8, 9) records the occurrence of phlogopite as an inclusion in red spinel and blue sapphire from Mogok, attributing it to syngenetic growth.

Both the high MgO/FeO ratio of the phlogopite inclusion (Deer *et al.*(6)) and its position on the ($Fe_2O_3 + TiO_2$)-($FeO + MnO$)-MgO diagram of Heinrich(10) associate it with phlogopites from metamorphosed limestones. It seems probable therefore that the Mogok limestone is the source of the phlogopite and, consequently, of its host mineral, painite.

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HELIOLITE, A TRANSPARENT, FACETABLE PHASE OF CALCIC LABRADORITE

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A number of years ago, when the U.S. National Museum of Natural History's gemstone display was of modest significance and educationally oriented, visitors might notice, if they were gemmologically informed, a small carat-sized red brilliant-cut stone that seemed obviously mislabelled and mislocated; it was clearly a red spinel. The only problem was that it was in an institution where one does not question labels, and its label said it was labradorite, and so it must have been. However, it was, and is, unlike any labradorite with which gemmologists are familiar. Its source was near Plush, Oregon, a general-store post-office group of homes, fairly near Lakeview, about in the centre of the southern part of the state (see Map). Geologically, it is a volcanic area in a region where there have been numerous volcanic episodes, with

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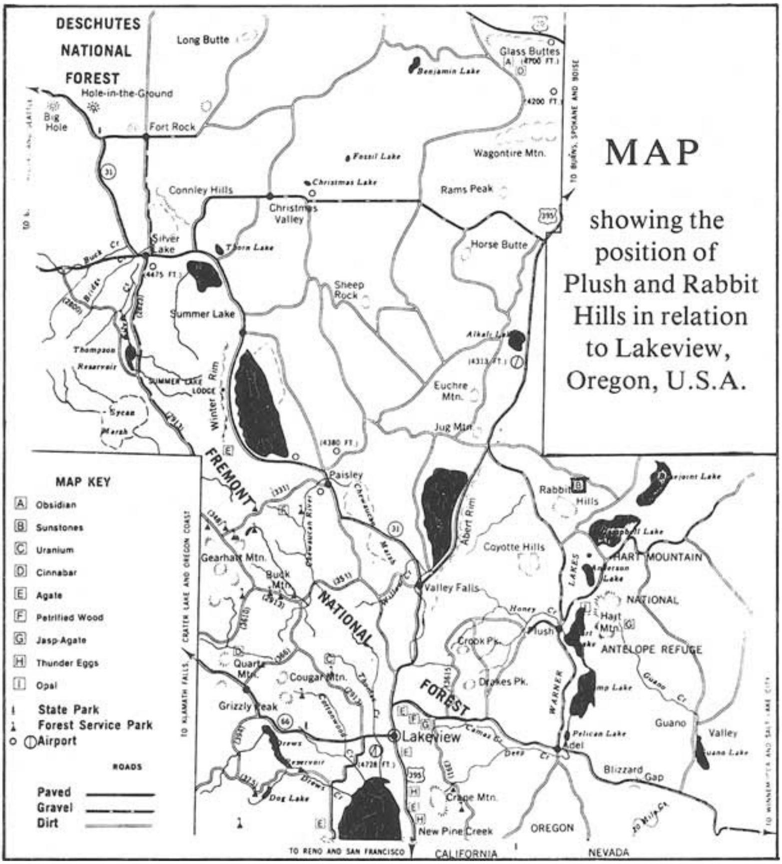

MAP showing the position of Plush and Rabbit Hills in relation to Lakeview, Oregon, U.S.A.

flows emerging from low dome volcanoes and fissures. The flow with which we are concerned is very late, a pahoehoe-type flow covering about seven square miles and forming a small ridge, the Dudeck Ridge, overlying a pumice-rich tuff. The tuff, in turn, overlies a dense black basalt of undetermined thickness. The basalt is very coarsely granular and consists of at least 50% feldspar, with small amounts of pyroxene, olivine, and magnetite. In the normal sense of a typical basalt, a dense fine-grained black rock, it is very different. With a coarse shattered feldspar groundmass, it is, nevertheless, a basalt porphyry, for the fresh rock is studded with flat crystals several inches in length and width, but under one inch in thickness. The phenocrysts can be exposed on a fractured surface, where they exhibit a frosted face, rounded corners and innumerable fractures. Intact crystals could only be recovered by fossil-collecting techniques, for all are shattered as they lie in the rock. Their surroundings would appear to have been a mush of shattered colourless, glassy feldspar fragments of like composition. Sudden cooling and viscous flow probably contributed to the shattering of the phenocrysts. Although feldspar has several distinct cleavages few of the larger size broken surfaces are flat cleavage planes, most are conchoidal when they are freed, by weathering, from their prison. The smaller fragments of the matrix, on the other hand, show the plane reflections we would expect. Until lately, this particular flow unit, occupying only a small area in the Rabbit Basin north of Plush, seemed to be unique. As such, it would represent the surface expression of a small differentiated lava pocket; one might interpret it as a magma bit which dawdled upwards and managed to stratify itself by selective crystallization into a crystal mush with scattered larger phenocrysts just strong enough to hold themselves together for the journey and probably not unlike the feldspar crystals at other localities.

Calcic labradorites, normal labradorites and bytownite phenocrysts in basalt lava flows are known to many amateur mineral hobbyists as collectables at numerous localities all over the world. An area in Mexico, near Rocky Point, at the head of the Gulf of Lower California, is well known as a source of clear feldspar fragments, essentially identical with the common ones lying beneath the volcanic slopes of the Rabbit Hills. Milford, Utah, has also been a source of similar colourless to straw-hued glassy fragments of labradorite. The Oregon area seems richer, however, and the proportion of labradorite in the lava very much higher. The matrix in Utah and in Mexico seems more of a normal basalt in grain size and appearance.

So rich is this area that it has become known as the 'Sunstone Area' and a summer-time collecting goal of many a lapidary hobbyist. Little soil covers the basalt and much of the erosion has probably been wind erosion. As the rock broke down into tiny fragments breezes swept away the sand-grain size particles, leaving behind the larger, coarser pieces which lie strewn over the near-desert surface, hardly concealed by the sparse vegetation. Hundreds of collectors have trudged up and down, back and forth, over this seven square miles, seeking the now scarce and elusive

FIG. 1. Oregon's Sunstone area, a weathered lava surface windswept almost bare of soil and strewn with labradorite chips. (Photo by H. M. Dunn)

larger bit of facetable material. In the beginning, inch-size pieces were not at all uncommon, with phenomenally large bits, two or three times this size, not impossible. Their surfaces were slightly dulled by sand-blasting in many cases, but their clarity was such that they gleamed in the slanted rays of the sun (collecting is best going toward the sun in early morning and toward evening—summer noons are very hot anyway!). Local dealers sold run-of-the-field pieces by the pound, only a few dollars, so abundant were the sunstones; a family, from any age up, had no trouble collecting many pounds in a few hours. To the local, the name sunstone has come to have a different meaning from the original usage. Today, it is the Sunstone Area, where the ground is studded with gleaming 'sunstones': clear, white to yellowish, and sparkling. That is not correct, nor is it in accord with the original use.

Parenthetically, it is an interesting fact that physiographers seem to have overlooked in their studies of 'Dreikanters' and sand ablation. We note here, as we did in the Namibian Desert, that sand blasting and shaping of pebble forms on the desert surface is not a current wind activity and must represent some earlier time of stronger winds, perhaps a glacial period. Rose quartz in Namibia, labradorite fragments in Oregon have a coating of desert varnish which would seem to be an anachronism if current wind-blown sand were actively shaping protruding pebbles on the desert floor. On black basalt one notes it not, but on white or pink glassy fragments it is all too evident after an acid wash, how brightly they then sparkle.

To revert to the question of the nomenclature and the term sunstone. Sunstone, of course, is the accepted, traditional, name for a feldspar with numerous schillering haematite (or some similar oxide) inclusions which give something of the appearance of brown aventurine or the glass known as 'goldstone'. Originally it was correctly applied to 1% of the finds in the Rabbit Hills area. About one of every hundred bits collected contained an array of tiny reddish inclusions which are aligned to give a plane of golden-red reflections when turned to a proper angle. Most, and traditional, sunstone is a reddish-brown, clouded white to orange feldspar, found as the feldspar constituent of pegmatites, as in Norway, Ontario and India. The Oregon sunstone is a very different substance, a gem material (in the past we would have said semi-precious, were we not sworn to eschew this term) as opposed to a decorative stone. A cabochon cut is favoured, though they are often faceted (an unsuitable treatment for a dusty stone). Nonetheless, they are attractive and, on occasion, spectacular.

In the past, lucky searchers came upon really red stones, labradorite chips bounded by conchoidal frosted surfaces, that were clear, no haematitic motes, and actually red. The old ratio was one to a hundred of the schiller stones; today it is considerably lower. Colour patches in the labradorite tend to occupy only a portion of the chip, so with the earlier, larger bits, there were more often areas with schiller and with red. Now that all the larger bits are gleaned, the red ratio has sunk close to the vanishing point and few are found in surface scans. Fortunately, free enterprise has discovered another route to the red: excavation.

In the years before 1970, when the Bureau of Land Management heeded the local collectors' request to withdraw a large area, about four square miles, from mining claims, a number of the more enterprising collectors discovered that there were pipe-like areas of local decomposition where the lava was crumbly and pits could be sunk. A number of claims were staked within the bounds of the now withdrawn area, and have been the subject of

FIG. 2. The camp site of the Rodgers Claim, a dry and dusty summer-time haven; cold, snowy and bleak in winter, uninhabitable for man or beast. (Photo by H. M. Dunn)

some discussion with the B.L.M. as to the validity of a retroclosure. As of the moment the chief claimant, Robert Rodgers, seems to have been able to support his right to a valid claim, staked and proven some years before the withdrawn area was delineated. Subsequently, numerous other optimists have staked out all the sunstone-bearing area outside of the withdrawn area, though in most cases little or no claim work is apparent and one would wonder how many are currently valid. Meanwhile, Rodgers has pursued his work and has amassed, in over a decade of hard, primarily manual, labour, a respectable stock of the transparent coloured stones.

Somewhat larger sagebrush bushes are recognized as an indication that their root system has been able to penetrate the ground more deeply, and indication to the digger that below for five to ten feet lies a potentially softer and diggable 'pipe'. The cause of these locally weak zones in the lava is unexplained, but from personal experience trudging over Parícutin flows, the writer inclines toward a theory that areas of potentially easier decomposition in the aeons to come lie beneath gas vents, known as

FIG. 3. Typical bulldozed excavation of soft area within the flow confines, an operation only allowed on a patented claim. Handwork is the general rule for peripatetic collectors. (Photo by H. M. Dunn)

hornitos in Mexico. (Could zeolites zones, too, be seeded by rainwater running down gulleys beneath a flow, which, in Parícutin, at least, did not dam the runoff, and boiling up through it while the lava remained hot?)

In excavating in the crumbling rock, the labradorite phenocrysts are found in place and still intact, though shattered almost beyond intact recovery. Some measure two inches across and in many there are red and green areas near their cores. The origin of the colour is still unknown; various attempts to explain it have been unavailing. Microprobe analyses show no significant compositional differences between the clear and the coloured labradorite and the highest magnifications show no visible intruders in the clearest red or green regions. The origin of the colour remains a mystery, though in many cases we note a combination of red body-colour and schillerizing particles. Some of the red is pleochroic; we find many bits where the red area is rimmed with green, in plain or polarized light, but above the latter, as the stone is turned the green area becomes red too. Not all the green is pleochroic in this fashion; some green stones remain green. The red, on the other hand, generally remains red through the rotation cycle. We have discussed the problem with several feldspar specialists, who turned out to be as mystified as we, so we leave the explanation to our readers.

FIG. 4. Sorting apparatus at mine location. (Photo by Laura J. Ramsey)

The colour-distribution is unpredictable but tends to be central in the phenocrysts. The crystals, as they lie in the rock and as they are freed, are crossed by numerous fractures which only casually follow the cleavage planes and are not what we would expect in a mineral with feldspar's cleavage. (In wear and cutting, too, we find the cleavage not a dominant or really weakening factor.) The colour never reaches the fracture surface, and seems to have been leached from the last mm of labradorite. Often it is zoned, a thin skin of green separates the clear margin from the red centre of the

FIG. 5. Finding heliolite at the mining location. (Photo by Laura J. Ramsey)

FIG. 6. Heliolite rough with typical colour distribution: a clear border, green (dichroic red-green) band enclosing red (non-dichroic) core—photographed in immersion cell with 35 mm edge. (Photo by author)

chip. A skilled lapidary can make very attractive and interesting stones from these bits; only a little red at the culet, as Sri Lankans well know in their sapphire cuts, will impart a fine red hue to a much larger stone.

Inasmuch as gem labradorite is long and well known as a decorative (and even near-precious from Finland) stone and the average gemmologist and every lay reader thinks of the Brazilian-butterfly blue-sheened stone when labradorite is mentioned the question of proper nomenclature is a real problem. 'Spectrolite' for a slightly richer-hued and better, but yet identical, phenomenal labradorite is a questionable complication of our gem names; 'precious labradorite' would be a not unprecedented Finnish alternative to warrant the switch from pound to carat price quotes. But transparent, faceted, red, green, and andalusian red and green combinations are a far cry from what the jeweller and his clients envisage when labradorite is mentioned. Hence, it has seemed essential that a new name be supplied along with the stones, so, harking back to tradition, Mrs Rodgers has proposed what appears to be a logical, euphonious and practical species name, heliolite. While out of the purview of the I.M.A., the name was presented to a session in Orleans and met with no clamorous dissent, so it would seem to be acceptable. (We shall not insult our readers by going into the roots of the word; we give them credit for not needing it.)

Heliolite is a feldspar; hence its hardness is 6. Though normally possessed of a good cleavage which might be a risk factor in wear, these stones seem to be less prone than usual to fracture on the cleavage planes. Whilst their refractive index is low, about the same as quartz, they cut surprisingly bright stones, an observation we made years ago in discussing clarity as a factor in stone brilliance, when it was noted that Madagascar orthoclase seemed more brilliant than most rock crystal quartz of seemingly perfect transparency. The majority of heliolites will be small, carat sizes for the most part. Unlike many other stones, the colour distribution and range is great, so that hardly any two are exactly alike. The reds range from pink, sometimes almost a pink sapphire pink, to rich spinel reds. The greens are much scarcer, few entirely greens will be offered. The green resembles that of some light tourmalines or the greened amethyst that was produced some years ago by heating Brazil's Montezuma Mine stones. (We proposed the name 'peridine' for this material, but it did not meet with enthusiastic acclaim, logical though it was, from proponents of *prasiolita* and other more rootless names.) Interesting variants are the bi-colour stones, better seen in non-brilliant cuts, that are very reminiscent of bi-colour tourmalines, with hues very like andalusite green and redder reds.

Through the decade of dedicated work, Rodgers has managed to collect a considerable weight of larger sizes of the rough, with the consequence that some impressive stones are available, ten and twenty carat sizes. Each is an individual; no two are alike. The larger sizes have been cut by skilled semi-amateur lapidaries to get the most from the rough; when such rough is cut, one dares not leave it to the average mass-production commercial cutter.

No real marketing arrangements have yet been made; Rodgers would like to sell his claim and stock; years of summers in a windswept Oregon desert do leave a little something to be desired in the way of life fulfilment, but he dares not leave unguarded his lifetime grubbings. A corporation to promote the mining and distribution

FIG. 7. Unusually large heliolite with very deep red colour, with the green as well. (Photo by Laura J. Ramsey)

FIG. 8. A drop of red in the centre area of this large heliolite shows a common way in which the colour presents itself. (Photo by Laura J. Ramsey)

FIG. 9. Common colour of heliolite-sunstone with salmon-colour schiller. (Photo by Laura J. Ramsey)

FIG. 10. An extremely unusual heliolite, that is a fine rich red colour with schiller across the entire face of the stone to give it the sparkling look. (Photo by Laura J. Ramsey)

of the heliolites, an All-American gem of considerable merit and rarity, was tentatively formed last year, but it needs financing and implementation, so it is presently hard to say what the future will bring. There are some other claims, one quite actively worked, outside the withdrawn area; so the supply is not entirely a one-man dependent operation. There is also a possibility of further deposits.

At the outset we mentioned that the Rabbit Hills area had, until recently, been regarded as unique, a single tiny differentiated lava pocket. However, two or three years ago, a second locality for very similar material was discovered in Harney County, near Burns, Oregon, over a hundred miles to the north, by Charles Weightman and John Hinton, of Burns and Hines, Oregon. Their stones are very similar in hue, some perhaps a little richer but, as yet, none so large as the best of Rodgers's stock. Their association, the H. & W. Mining Company, is still locating and delineating their claims as well as cutting and selling a few stones. It is too soon to venture any predictions about the importance of their production, except to indicate that heliolite is no longer confined to a single region, and that there exists a possibility for further extrusions of this unusual lava in intermediate terrains.

As a jewellery stone, heliolite seems to have good possibilities; it is attractive, it is as durable as many of the newer highly advertised stones (tanzanite and tsavolite), it is common enough in smaller sizes to be commercial and rare enough in larger and impressive sizes to bring a good price. There is little danger of excessive supply, and the rarity of really fine stones insures its retention of value. It remains to be seen whether it becomes popular and well known or fades back into the purlieu of the amateur rockhounds and lapidaries. It is our impression that it has considerable merit and deserves its day in the limelight.

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AN UNUSUAL ORNAMENTAL STONE: COLLOPHANE

By J.-P. POIROT

Service Public du Contrôle des Diamants, Perles Fines et Pierres Précieuses, Paris.

We recently had an opportunity to examine a carved snuff-bottle, green with some small yellow chatoyant areas (Figures 1, 2 and 3). The macroscopic appearance of the stone did not suggest any known material. The oriental shape of the specimen could not, of course, reveal its true origin; and its geological or even its geographical source is consequently unknown.

This snuff-bottle, 5.95 cm high, 4.05 × 2.42 cm in greatest and least sectional width, with a weight of 45.28 g, had a specific gravity of 2.01. Scratched by calcite, but not by gypsum, its hardness was about 2½, and it was therefore a 'soft rock' in spite of the delicacy of the carving. By the distant vision method, we were able to determine a refractive index near 1.61-1.62. Some very inconsistent physical data!

Chemically a drop of concentrated hydrochloric acid (d = 1.19) on the surface turned yellow, with a slight effervescence.

The texture of this rock can be described as a juxtaposition of perceptibly cylindrical patches, with minute yellow fibres radiating from a dark green centre. An amorphous material, light green, very small in amount,* cements these elements together (Figures 4 and 5). The yellow chatoyancy macroscopically seen in some areas proceeds from the play of the light on the minute yellow subparallel fibres.

The Debye-Scherrer x-ray powder diffraction pattern shows some diffuse lines corresponding to d-spacings 2.85 Å to 2.70 Å (strong band with a maximum of darkness near 2.80 Å), 3.40 Å (medium), 2.26 Å, 1.96 Å, 1.83 Å and 1.74 Å (weak), 3.06 Å, 1.46 Å and 8.3 Å (very weak). These data are close to those of P D F† cards for apatite (see Table 1). The absence of the weakest reflections and the width of all the reflected rays (particularly that

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*So small as to be negligible in considering the composition of the whole of the rock.
†Powder Diffraction File published by JCPDS—International Center for Diffraction Data, 1601 Park Lane, Swarthmore, Pa 19081, U.S.A.

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FIGS. 1, 2 and 3 General view of the snuff-bottle with scale in millimetres

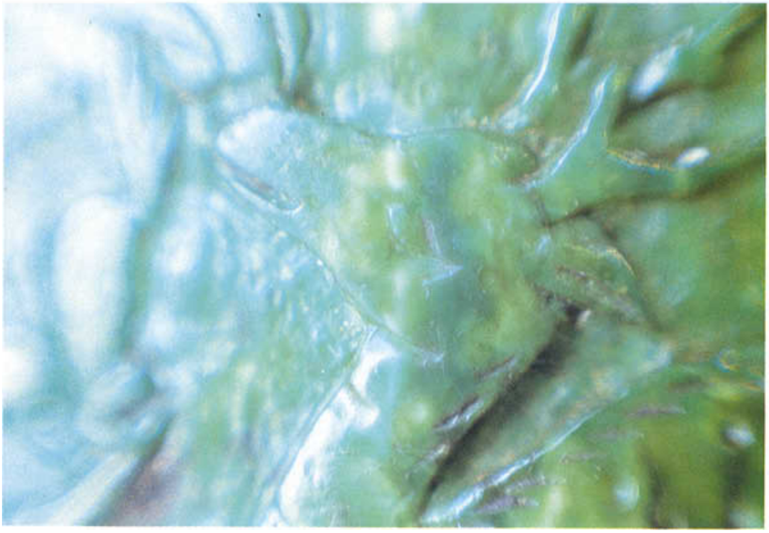

FIG. 4 Structural details: total length 2.5 cm

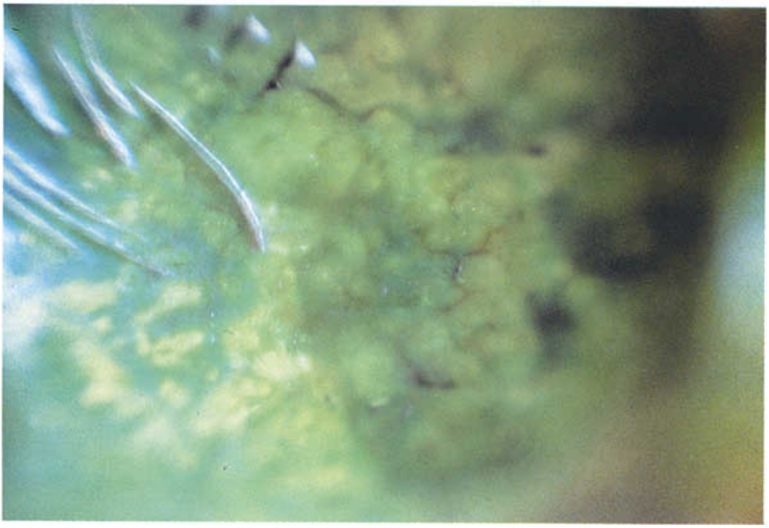

FIG. 5. Structural details: total length 1.5 cm

TABLE 1

X-ray powder data for various apatites

h k l	Hydroxyl-apatite PDF 25/166 d Å	I/I$_1$	Snuff bottle d Å	I/I$_1$	Odontolite (office's collection) d Å	I/I$_1$	Carbonate-hydroxyl-apatite PDF 21/145 d Å	I/I$_1$	Carbonate-fluorapatite PDF 31/267 d Å	I/I$_1$
1 0 0	8.24	8	8.3	10	8.1	10	8.13	18	8.04	18
1 0 1	5.28	4								
1 1 0							4.69	4		
2 0 0	4.12	6			4.03	10	4.06	10	4.04	16
1 1 1	3.90	4			3.86	10				
0 0 2	3.45	35	3.4	50	3.44	50	3.43	16	3.43	20
1 0 2	3.16	6			3.16	20			3.16	6
2 1 0	3.11	16	3.06	10	3.05	20	3.08	25	3.05	35
2 1 1	2.827	100	2.85		2.80	100	2.811	80	2.790	35
1 1 2	2.775	30	to	100			2.774	25	2.769	16
3 0 0	2.730	75	2.70		2.69	50	2.717	100	2.692	100
2 0 2	2.632	16			2.61	20	2.627	12	2.619	8
3 0 1	2.544	4					2.526	4	2.506	4
212/003	2.298	4			2.29	5	2.293	6		
3 1 0	2.281	10	2.26	30	2.25	20	2.261	35	2.240	45
3 1 1	2.162	4					2.149	6	2.134	4
203/400	1.997	4							2.021	4
2 2 2	1.950	30	1.96	30	1.93	20	1.941	16	1.931	12
$3\bar{1}2/132$	1.901	8					1.889	8	1.887	8
2 3 0	1.883	10			1.88	10			1.855	8
2 1 3	1.842	50	1.83	30	1.83	20	1.841	12	1.834	10
231/321	1.819	10					1.805	16	1.790	12
4 1 0	1.794	10			1.78	10	1.781	12	1.783	25
4 0 2	1.761	6	1.74	30	1.75	10				
3 0 3							1.757	8	1.754	8
0 0 4	1.718	8			1.73	10	1.720	4	1.720	4
3 2 2	1.653	4			1.65	5				
1 3 3	1.614	6								
2 1 4	1.499	4			1.50	10				
3 2 4	1.453	8	1.46	10	1.46	10				
5 1 1	1.445	4								

band enveloping the indexed reflections at 2 1 1, 1 1 2 and 3 0 0) yet show a certain disorder in the dimensions of the crystal's cells in the specimen.

So the snuff-bottle we examined is composed mineralogically of a massive carbonate-hydroxyl-apatite; however, in view of its massive fibrous radiated texture, it is preferable to call it 'collophane', a name which is used as a generic designation for many cryptocrystalline types of apatites. The inhomogeneity of the crystal-cells of apatite in this rock, the low specific gravity which (as also the low hardness) indicates a certain porosity, and its fibrous radiated texture along dark more or less parallel filaments, all suggest fossilization as a possibility; the texture, very different from that of fossilized ivory (or odontolite, which is phosphatized mammoth tusks found especially near Auch in southern France and suggests the colour of turquoise), is similar to that of haversian systems in bones. We are thus led to believe that the snuff-bottle which we examined was a carved piece of apatite-fossilized bone, which, to the best of my knowledge, has never clearly before been noticed in the literature.

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[*Manuscript received 8th October, 1982.*]

'SILK' IN SAPPHIRES FROM A NEW SOURCE

By R. KEITH MITCHELL, F.G.A.

In the last ten years some quite large parcels of sapphires of a somewhat washed-out blue colour have been offered by one firm, with African connexions, on the London market. Often lacking in 'life', the stones superficially resemble those known to come from the Umba River in northern Tanzania, and, when I questioned this origin with the suppliers' representative, it was not contradicted. A few finer stones were produced and some fancy colours, including some with colour changes, as in the case of the Tanzanian material.

It is now known that these parcels originate from material mined in substantial deposits occurring at Chimwadzulu (Chiradzulu?), some 800 miles south of the Umba River and close to the border between Malawi and Mozambique, fairly near Blantyre—a wild and none too safe area, if my informant is now to be believed.

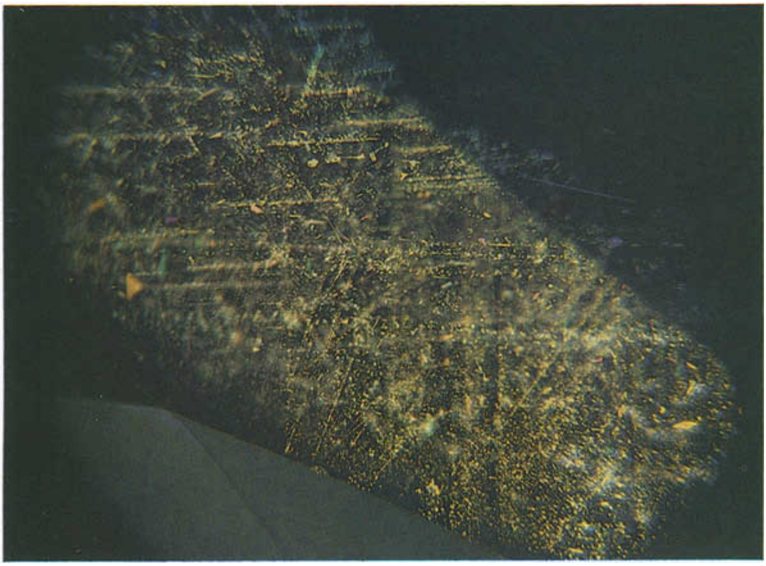

FIG. 1. Unusually angled 'silk' in sapphire from a new source.

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Most stones show inclusions and cracks rather similar to those in the Tanzanian sapphires, and there is some suspicion that cracks, at least, may have resulted from heating to try to improve the colour. But a few stones exhibit a coarse and very marked 'silk' which differs from silk found in any other corundums that I have seen.

Under magnification this is seen to group in straight lines, often nearly at right angles, but in the form of extremely thin and apparently hollow cavities, and not the normally expected needles of rutile. These are often sufficiently thin to impart Newtonian interference colours to light reflected vertically from them.

What is even more interesting is the strange assortment of angles of intersection that can be seen between the lines, and in the angles of the larger inclusions themselves. My illustration (Figure 1) gives a good idea of the mass of silk encountered in one of these stones. A negative print was made from this transparency and the lines were then extended to allow angles to be measured with an ordinary protractor. The photograph is taken through the table facet so there is no distortion caused by the inclusions being seen through several different facets.

Angles measured range from some very low ones, for lines which at first glance appear to be parallel, but which are not, through groups which are probably the same angles suffering from the inaccuracies of my rather crude measuring, to very large angles. The predominant groups are nearly but not quite at right angles. The latter consist of intersections at 87°/93°, close enough to the angle between rhombohedral faces of corundum (93°56′) to be connected with that form. The angle between the rhombohedron and the basal pinacoid (57°34′) is also closely approached. But the actual values measured were very wide ranging indeed and I have recorded 4°, 7°, 11°, 13°, 19°, 24°, 29°, 31°, 37°, 49°, 52°, (56°, 57°, 58°), 62°, 64°, 71°, (86°, 87°, 88°), (91°, 92°, 93°, 94°), 105°, 110°, 116°, 125°, 142°, 144°, 150°, and 161°. The groups bracketed are probably equal angles which have suffered from experimental errors on my part, many of the lines of inclusions are of substantial width, and I have had to approximate to their mean centres.

Most of the lines are more or less parallel to one plane, but in some cases measurement has had to be made on inclusion lines which are receding from the main plane. I acknowledge that this may have upset some measurements. But this does not affect the basic fact that here we have a sapphire with silk which does not conform even remotely to the normal 120° which we always expect in corundums.

I have no explanation for the phenomenon beyond the possibility that some of the lines may be following parting directions normal to sapphire. But why are they restricted to a linear formation? Individual exsolution cavities show angles approximating to 93°, 49°, and 38°, but there are others which have narrow wedge shapes with angles of 4° and 7° to their sharp points. What dictates these wide variations in what are so evidently exsolution cavities?

I have seen these angles in 'silk' in perhaps half a dozen stones among the many which were superficially examined. The best example came to hand at a time when it was quite impossible to photograph it, and I had to wait a while before the present stone turned up. Most of the others showed the 87°/93° angles and little else. This was unusual enough, but I wanted to show the much greater range of angles I had seen in the one fine example. I think the present picture shows this reasonably well.

[*Manuscript received 4th November, 1981.*]

NOTES FROM THE LABORATORY

By KENNETH SCARRATT, F.G.A.

The Gem Testing Laboratory of the London Chamber of Commerce

It is remarkable how the use of a few seemingly innocent words can have the effect of either galvanizing a person into action or calming him. In particular I am thinking of two phrases which are widely used in the gemstone trade.

The first is used in connexion with the higher quality gems and is a phrase which often misleads one into thinking a perfectly natural stone is a synthetic or an imitation—'too good to be true'—but, at least, it plants the seed of suspicion which turns the mind to thoughts of the very real possibility of the stone being other than natural.

The second phrase is used when referring to gems of a moderate quality, but whereas the first phrase worries the mind into action, this one has a calming effect—'who would bother manufacturing something of "that" quality?'. It almost has the effect of a tranquillizing drug; when used it is often enough to suppress any suspicions a person might have. It is certainly enough to dissuade a trader from incurring the expense of having his stones authenticated. This latter attitude is dangerous in the extreme. Synthetics and imitations of the lower qualities of gemstones *are* made, and the cost of recalling large stocks can be enormous.

It is a sad thing to request, but in this very trusting trade we must ask traders to be always on their guard, no matter what type or quality of gem they are dealing in. In recent weeks there have been a number of incidents, chiefly concerning the importation of goods from the Far East, which bring this point to the fore.

* * *

The first concerned that ever troublesome material, turquoise. To see the perfect piece with no imperfections and a superb colour would make most gemmologists assume the worst—plastic bonding, silica bonding, waxing, imitation, synthetic, etc. However, to see a piece with black veins running through it brings the guard down, and this is where the problem begins.

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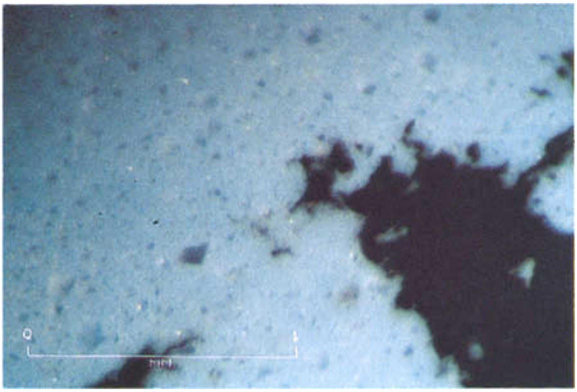

FIG. 1. The surface structure of an imitation turquoise with a high proportion of calcite.

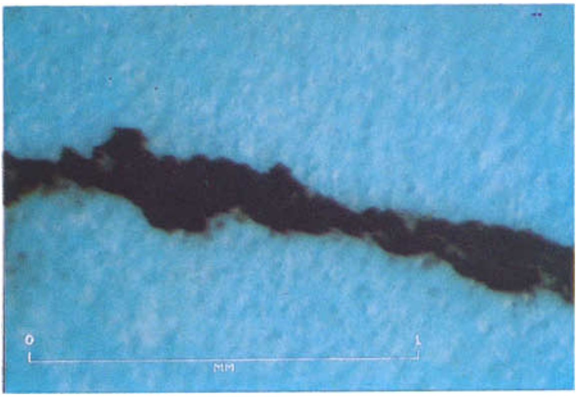

FIG. 2. The surface structure of the 'neolith' imitation turquoise.

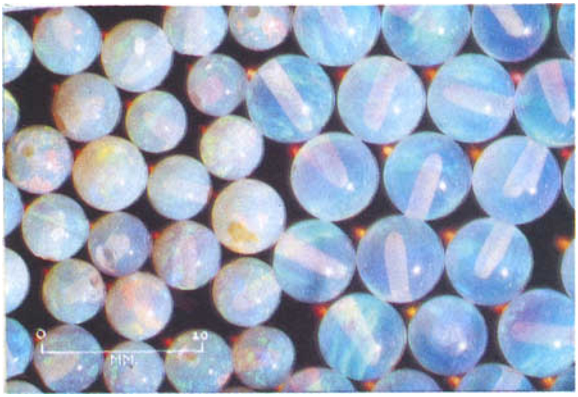

FIG. 3. Larger synthetic opal part drilled beads compared with smaller natural opal part drilled beads *(photo E. A. Jobbins).*

In 1957 an imitation of turquoise with dark veins running through it was produced in Germany. It was a mixture of Bayerite and copper phosphate.(1) The Laboratory samples of this material revealed that the surface was easily etched with dilute hydrochloric acid and that the SG was in the region of 2.36. This material has rarely, if ever, been seen on the British market in the last decade, and so when similar looking material started to appear, set in odd items of jewellery, during the past year, we insisted on the clients removing them from the settings. Whilst this material superficially appeared identical to the German material, which incidentally was marketed under the name 'neolith', examination revealed that a high proportion of calcite was present and that the SG was somewhat lower—in the region of 2.22. Under magnification the surface structure of this and the German material seemed quite similar (Figures 1 and 2) but the neolith's structure was a little finer and appeared a little more 'regular' than this latter material. We have more recently examined parcels of the calcite material and have been told that they emanate from the Far East. We are assuming at present that this material is the same as that investigated by Schmetzer and Bank,(2) and therefore a product of Gilson.

* * *

The next item is also a product of Gilson. Most gemmologists have seen and can easily recognize the better qualities of the Gilson synthetic opal, both black and white. Some of the structures seen in this product(3) are very distinctive and this has created an attitude of security, so much so that it is often thought that should these structures not be observed, then the stone must be natural. This is not a desirable attitude to take, especially when combined with the fact that the opal may not appear to be of the best quality (where the second 'tranquillizing phrase' may once again take effect).

We have, in recent months, examined a number of parcels or samples from parcels of synthetic white (almost water opal) opal beads, both drilled and part drilled (Figure 3) and cameos carved from the same material. In all cases the usual cross section structure to the columns of colour, either the 'lizard skin' or 'chicken wire' type, was either extremely difficult to observe, or, as in most cases, not visible at all. The columnar colour structure was in many cases the only indication of synthetic origin and this very often, as can be seen from Figure 3, was not very obvious. To prove the origin of these stones a very close and careful examination is required for each stone, nothing is obvious and patience is of the essence. If one first finds the columnar structure and then finds the cross section to that structure, whilst in the main the 'lizard skin' or 'chicken wire' effect will not be present, with a little agility one should be able to pick up the crenulate margins(3) (Figure 4) to these cross sections.

Whilst not being a positive identifying factor, as some synthetic white opals do phosphoresce, it was found that all of these synthetics did not phosphoresce after exposure to long wave ultraviolet radiation. All the natural white opals I have examined, of this quality, phosphoresce quite strongly after such exposure.

* * *

A number of articles have been written about the diffusion process for the colouring of corundum both in this and other journals.(4,5) Identifying factors have been discussed and published,(6,7) and in the main it is considered that identification, particularly of faceted stones, is quite straightforward. There are, however, a number of problems concerning the identification of cabochon cut stones and I will touch upon them briefly here.

If the natural colour zoning is very strong it may be very difficult to observe any surface coloration, especially if a great deal of it has been taken off during repolishing, and if there are no surface cavities in which one may observe the 'bleeding' effect described by Crowningshield(4) then identification becomes difficult.

After examining a parcel of thirty cabochon 'blue sapphires' recently, all of which showed signs of heat treatment and had strong colour zoning, we were able to identify one of that number as having been treated by the diffusion process. The identifying factor was the colour concentration along the line where a feather broke the surface of the gem (Figure 5). I hope that this discovery amongst a parcel of otherwise acceptable sapphires is the exception rather than the rule. If it isn't, then obviously every parcel of sapphires imported into this country would have to be thoroughly examined before general distribution.

* * *

The new Knischka (𝒦) synthetic rubies which have been so excellently described by Knischka and Gübelin(8) could, if only conventional methods are used, prove at times to be one of the more difficult rubies to identify.

The observation of either the platinum platelets depicted in Figure 6 or especially the peculiar two phase inclusions depicted in Figure 7, however, should certainly point the examiner toward the correct conclusion.

* * *

Whilst going through the Laboratory collection recently, I came across an almost colourless octahedron which proved to be a spinel. In itself this, to some people, might not appear to be something to delight in, but since then, as a way of light relief, I have had a good deal of harmless fun with colleagues, students and friends, because on the octahedral faces of this near colourless crystal are, as can be seen in Figure 8, some quite clear 'trigon'-like markings!

* * *

Unfortunately from time to time we are asked to examine damaged gemstones. This is not one of our more pleasant tasks, because the damage in most cases is irreparable. Jewellers in the main make sure that their staff are given as much trade education as is practicable, so that they may give the buying public the correct advice about the item of jewellery they are buying, but at the same time there is still a lot of ignorance within certain areas of the trade about the goods they are handling. One of the sorriest sights I have seen for some time was the result after what was presumably a nice piece of lapis lazuli, set in a ring, was placed in an 'acid bath' for cleaning! (Figure 9.)

* * *

It is with gratitude that I acknowledge the photographic expertise of Mr Alan Jobbins in producing Figure 3 and the generosity of Professor P. O. Knischka in donating a sample of his synthetic ruby to the Laboratory. I also wish to express my appreciation to Mr George Bosshart and Dr Henry Hänni for the loan of further Knischka synthetic ruby specimens.

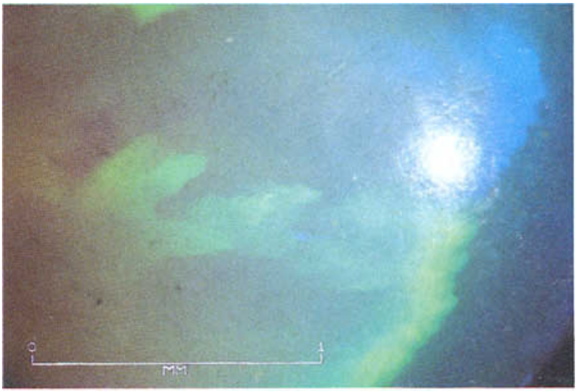

FIG. 4. The barely visible crenulate margins to the cross sections of the columns of colour in a synthetic opal bead.

FIG. 5. The blue colour concentration where a feather meets the surface of a cabochon-cut treated blue corundum.

FIG. 6. Platinum platelets in the Knischka synthetic ruby.

FIG. 7. Peculiar two-phase inclusions in the Knischka synthetic ruby. The high relief of the bubbles contrasts with the hardly visible outlines.

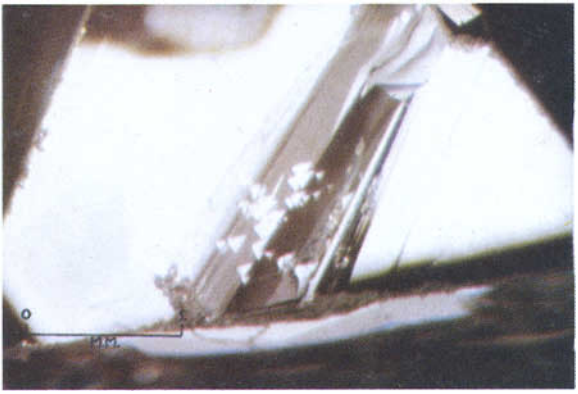

FIG. 8. 'Trigons' on the surface of an octahedral face of a near colourless spinel octahedron.

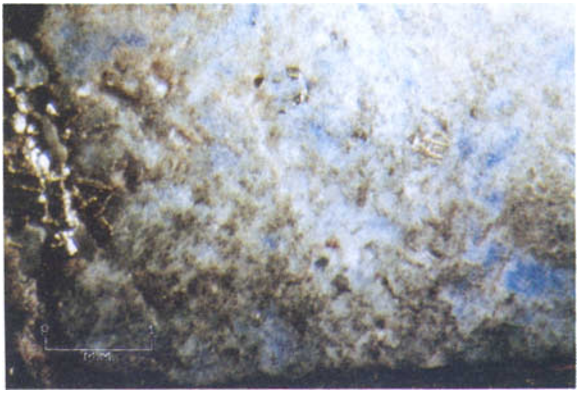

FIG. 9. The surface of a piece of lapis lazuli after 'cleaning' in an 'acid bath'.

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CONTRIBUTIONS TO THE STUDY OF THE DISTINCTION OF NATURAL AND SYNTHETIC EMERALDS

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(a summary based on a thesis submitted to the University of Mainz in 1981 and partially reported at the annual meeting of the Deutsche Gemmologische Gesellschaft at Idar-Oberstein the 24th of May 1981.)

ABSTRACT

The chemical analyses of trace elements of emeralds may be taken as a modern method that can be used to distinguish between natural stones and their synthetic counterparts. It is also possible to differentiate between the localities of the natural emeralds according to their chemical composition. The significant chemical characteristics of both natural and synthetic emeralds are discussed in this paper.

INTRODUCTION

Generally synthetic and natural emeralds are distinguished mainly by their physical properties and by the appearance of their inclusions as seen under the microscope. Although it is obvious that differences in the chemical content, particularly of trace elements,

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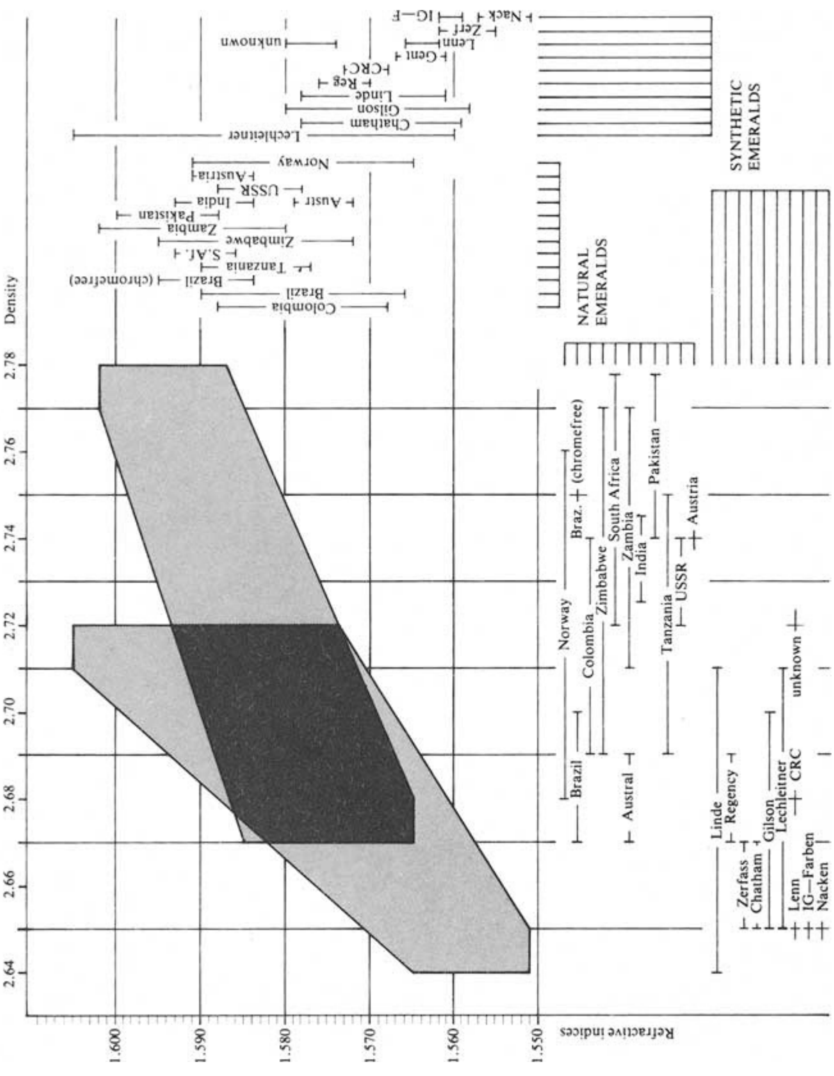

FIG. 1. Sectors of the natural and the synthetic emeralds from different occurrences and producers with regard to their densities and their refractive indices

cause alterations of the physical characteristics, such as refractive indices, double refraction, density etc., it has been shown in Figure 1, that these small differences do not provide an unambiguous way of distinguishing emeralds, since the sectors of the synthetic and natural emeralds with regard to their refractive indices and their densities overlap each other.

Moreover with recent technical improvements there has been a drastic reduction in the number of inclusions in the synthetic emeralds. In some cases the synthetic emeralds are completely devoid of inclusions of any kind. Due to the fact that the inclusions in synthetic emeralds are very similar to those in natural ones and also because the existence of totally 'clean' stones could not be excluded in nature it is of great importance to discover specific criteria that distinguish synthetic from natural emeralds. This is particularly so when both synthetic and natural types are of high quality.

It is known that emeralds from different localities show marked differences in colour and quality. These differences have been attributed to the varying conditions of their origin and also to the variations of trace element contents in the samples. The different conditions of origin of synthetic and natural emeralds should be revealed in differences in their trace element contents. By the application of the analytical techniques of neutron activation analysis (NAA) and optical emission spectroscopy (OES) significant differences in these trace element contents have been found.

ANALYTICAL METHODS

A total of fifty-eight natural and synthetic emeralds—specimens from different occurrences and producers (see Table I)—have been investigated in order to study their characteristic chemical differences according to their place of origin or synthesis as the case may be, i.e. natural or synthetic.

Seven specimens, one from each group, were chosen and their element contents determined by NAA—an extremely accurate and reliable method used in the investigation of trace elements in gemstones. The disadvantages of this method however are:

—the need for a nuclear reactor,

—the long time required to obtain an analysis from a sample (order of days),

Natural emeralds	Africa	A	33	South Africa, Cobra Mine, Transvaal
		A	36	South Africa, Cobra Mine, Transvaal
		A	40	South Africa, Cobra Mine, Transvaal
		A	42	South Africa, Cobra Mine, Transvaal
		A	43	South Africa, Cobra Mine, Transvaal
		A	48	South Africa, Cobra Mine, Transvaal
		A	55	South Africa, Cobra Mine, Transvaal
		A	62	South Africa, Cobra Mine, Transvaal
		A	64	South Africa, Cobra Mine, Transvaal
		A	66	South Africa, Cobra Mine, Transvaal
		A	L 1	South Africa, Leydsdorpdistrict
		A	L 2	South Africa, Leydsdorpdistrict
		A	Rh 1	Zimbabwe (Rhodesia)
	America	B	9	Brazil
		B	10	Brazil
		B	11	Brazil
		B	13	Brazil
		B	14	Brazil
		B	16	Brazil
		B	17	Brazil
		B	19	Brazil
		B	20	Brazil
		B	22	Brazil
		B	S 1	Brazil, Salininha
		B	S 2	Brazil, Salininha
		B	C 1	Brazil, Carnaiba
		B	ST 1	Brazil, Santa Terezinha de Goiaz
		B	MG 1	Brazil, Minas Gerais
		B	MG 2	Brazil, Minas Gerais
		C	45	Colombia, Chivor
		C	49	Colombia, Chivor
		C	60	Colombia, Chivor
		C	62	Colombia, Chivor
		C	73	Colombia, Chivor
		C	78	Colombia, Chivor
		C	84	Colombia, Chivor
		C	87	Colombia, Chivor
		C	89	Colombia, Chivor
		C	91	Colombia, Chivor
	Asia	P	1	Pakistan
		P	2	Pakistan
	Europe	R	1	USSR, Takowaja, Siberia
		R	2	USSR, Takowaja, Siberia
		Ö	1	Austria, Habachtal, Salzburg
Synthetic emeralds		CH	1	Chatham, USA
		CH	2	Chatham, USA
		CH	3	Chatham, USA
		CH	4	Chatham, USA
		CH	5	Chatham, USA
		G	1	Gilson, France
		G	2	Gilson, France
		G	3	Gilson, France
		G	4	Gilson, France
		G	5	Gilson, France
		G	6	Gilson, France
		LL	1	Lechleitner, Austria
		Le	1	Len Lens, France
		CV	1	Inamori (Crescent Vert), Japan

TABLE I
Samples investigated

—the fact that certain elements cannot be investigated by this method, and

—the high cost involved.

Due to these reasons all samples, including the seven investigated by NAA, have been investigated by OES, which provides very good comparable results. A great advantage of the method of OES is that only a small amount of the sample (10 mg) is needed.

RESULTS

Iron (Fe)

Even though iron was found in all the specimens, the amount of iron in the samples varies considerably according to their origin (see Figure 2)*; however even in the samples from the same occurrence (Africa, Brazil, Colombia) wide variations in iron content were found.

In general the emeralds from Brazil, Soviet Union, Austria and Pakistan have been found to contain 0.4%->0.5% iron, whereas African emeralds have less iron (up to 0.4%); and

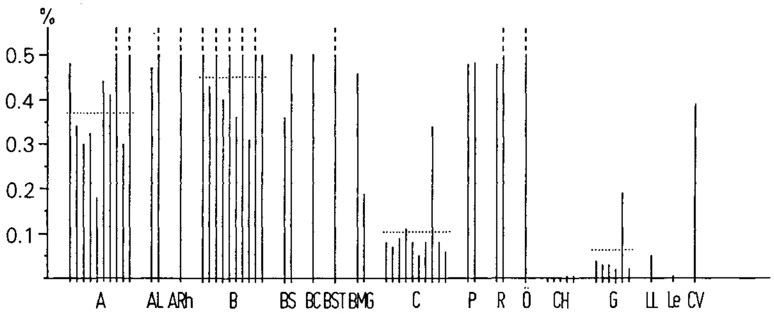

FIG. 2. Diagram showing the contents of iron in the samples

*Abbreviations and signs in Figures 2-9:

A = South Africa, Cobra Mine
AL = South Africa, Leydsdorpdistrict
ARh = Zimbabwe (Rhodesia)
B = Brazil
BS = Brazil, Salininha
BC = Brazil, Carnaiba
BST = Brazil, Santa Terezinha de Goiaz
BMG = Brazil, Minas Gerais
C = Colombia, Chivor

P = Pakistan
R = USSR, Takowaja, Siberia
Ö = Austria, Habachtal, Salzburg
CH = Chatham synthetic emerald, USA
G = Gilson synthetic emerald, France
LL = Lechleitner synthetic emerald, Austria
Le = Len Lens synthetic emerald, France
CV = Inamori (Crescent Vert) synthetic emerald, Japan

········ average content

⋮ limit of the standard i.e. content greater than. . . .

The sequence of the samples in Figures 2-9 (left to right) is the same as listed in Table I.

distinctly smaller contents of iron are present in the Colombian emeralds (0.1%).

On the other hand in comparison with natural stones synthetic emeralds have been found to be almost free of iron. With one exception they have less than half of the already small iron content of the Colombian emeralds.

In general it could thus be said, that the Colombian emeralds can be easily distinguished from natural emeralds from other countries. Synthetic emeralds contain distinctly less iron. Previous generations of synthetic Gilson emeralds with higher iron contents could be easily detected by their characteristic optical spectrum (Eppler 1973).

Magnesium (Mg)

Magnesium has also been found only in natural emeralds, the exception being one synthetic emerald from Lechleitner with 0.02% magnesium content (Figure 3). Whereas relatively small amounts of magnesium have been found only in some African samples; the magnesium concentrations in other samples range from 0.3% to >0.5%.

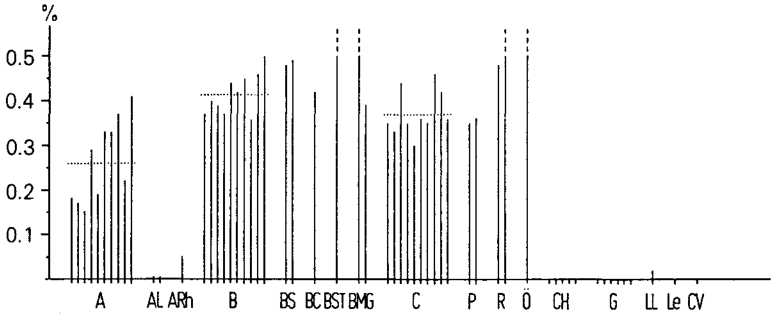

FIG. 3 Diagram showing the contents of magnesium in the samples

Manganese (Mn)

Because of the very sensitive methods of investigation manganese could be detected even in very small contents (detection limits by OES for Mn: 2 ppm or 0.0002%).

In synthetic emeralds only traces of manganese, less than 2 ppm, were found, whereas the manganese contents in natural emeralds were found to lie between 0.0010% and >0.0035% (i.e.

10 ppm to >35 ppm)—see Figure 4. Remarkably strong variations were found in the Brazilian (15 ppm to >35 ppm) and Colombian samples (<10 ppm to 26 ppm).

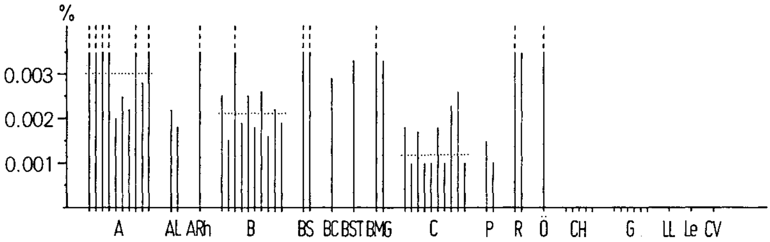

FIG. 4 Diagram showing the contents of manganese in the samples

Gallium (Ga)

Chemically gallium is similar to aluminium and in natural emeralds it ranges from 13 ppm to 18 ppm, while in synthetic stones a lower range of 11 ppm to 14 ppm was found.

Molybdenum (Mo)

As expected molybdenum was found only in synthetic emeralds, the amounts ranging from less than 10 ppm up to 1120 ppm. Molybdenum can thus be used to clearly distinguish between synthetic and natural emeralds. However, due to the fact that the composition of a flux generally depends on the system of synthesis, the absence of molybdenum does not necessarily prove the natural origin of an emerald.

Chromium (Cr)

Chromium (Figure 5) has been found in all the specimens examined, the exception being the emeralds from Salininha, Brazil. Even in these specimens chromium has been found by Leiper, (1965) in quantities which are lower than the limits of detection for chromium by the OES-method (0.05%):

As a rule chromium contents of natural stones vary considerably even in stones from the same locality, and similarly synthetic stones from the same producer also vary (natural emeralds : 0.05% to 0.47%, synthetic emeralds: 0.13% to 0.5%).

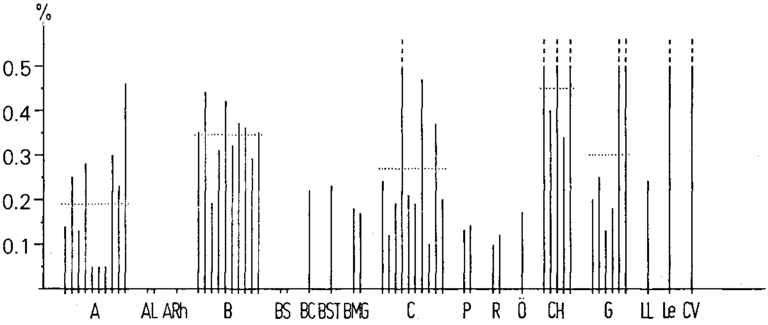

FIG. 5 Diagram showing the contents of chromium in the samples

Vanadium (V)

Vanadium has been found in nearly all the natural specimens with considerable variations in stones from one locality. Some African emeralds appear to have no vanadium. Only in newer synthetic emeralds made by Gilson, was vanadium found. These amounts range from 289 ppm to 430 ppm (Figure 6).

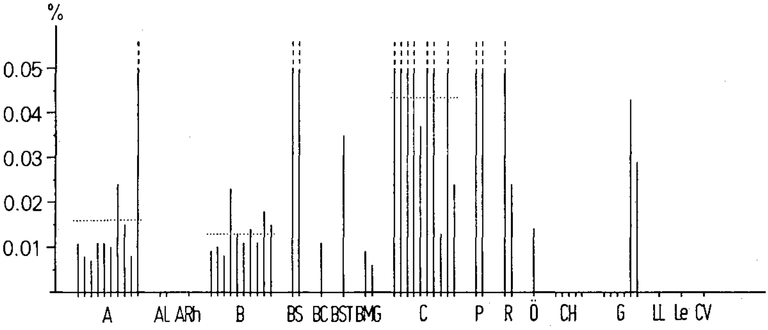

FIG. 6 Diagram showing the contents of vanadium in the samples

Calcium (Ca) and Zinc (Zn)

These two elements were found only in very few samples.

Rhodium (Rh)

Contents of rhodium have been found only in Gilson synthetic emeralds (16 ppm to 60 ppm). The origin of the rhodium content can be explained by the fact that a small wire of platinum serves as a suspension wire in the crucible during the synthetic growth of the crystals: with the aid of laser emission spectroscopy (LMA) it was shown, that this wire was coated with rhodium for enhancing the protection.

Scandium (Sc)

Nearly all natural emeralds were found to contain scandium in varying amounts (Figure 7). The concentration of scandium in emeralds from Pakistan (0.1% to 0.17%) is significantly higher than that in emeralds from other occurrences (to 0.03%).

Synthetic emeralds have scandium contents always less than 1 ppm.

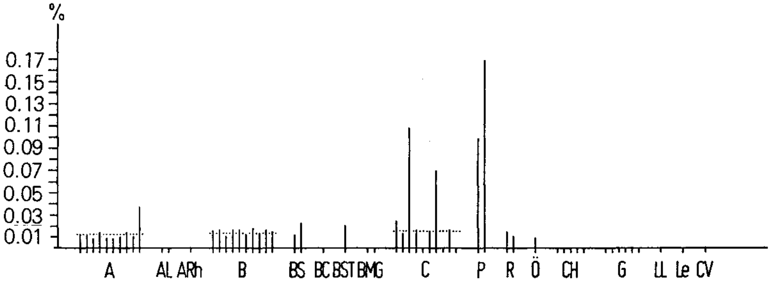

FIG. 7 Diagram showing the contents of scandium in the samples

Sodium (Na)

Sodium has been found in all specimens (up to >1.7%)—Figure 8. Only one African and all synthetic emeralds (12 ppm to 306 ppm) showed amounts very close to the limits of detection for Na (300 ppm) by OES.

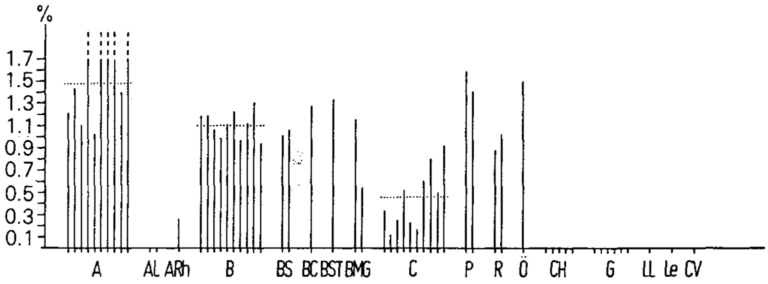

FIG. 8 Diagram showing the contents of sodium in the samples

The emeralds from Pakistan and Africa, which as a rule show higher sodium contents, can easily be distinguished from emeralds from Colombia and Zimbabwe (Rhodesia), which have lower sodium contents.

Nickel (Ni)

According to the chemical data published by various authors nickel has been found only in emeralds from Zimbabwe (Metson & Taylor 1977). But suprisingly nickel has been found in several samples from other occurrences, too. African and Pakistan emeralds have relatively high contents of nickel.

Only some new synthetic emeralds made by Chatham and Gilson have small nickel (6 to 27 ppm). A surprising high amount (283 ppm) was proved for the Japanese synthetic emerald called 'Crescent Vert Emerald' (see Figure 9).

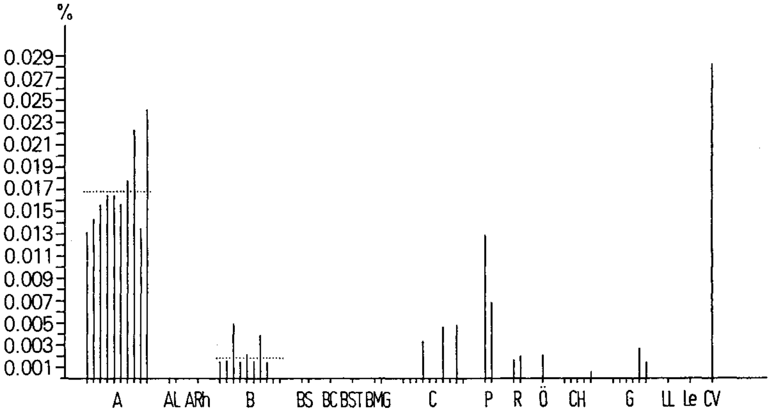

FIG. 9 Diagram showing the contents of nickel in the samples

Yttrium (Y), Titanium (Ti), Copper (Cu) and Zirconium (Zr)

These elements have been found in nearly all the samples investigated, although they have been unknown in emeralds up till now. But the contents of these elements do not enable distinction either between occurrences of natural emeralds or between natural and synthetic emeralds. Only the synthetic emerald from Japan contained remarkably high titanium, 126 ppm.

Caesium (Cs), Potassium (K) and Rubidium (Rb)

These alkalis have been detected in the emeralds in amounts similar to those found in beryls and as reported by other authors (Zambonini & Cagliotti 1928, Jakob 1938, Jayaraman 1940, Simpson 1948, Gübelin 1958, Leiper 1965, Staatz *et al.* 1965, Flanigen *et al.* 1967, Wood & Nassau 1968, Nassau & Jackson 1970, Hickman 1972, Metson & Taylor 1977, Graziani & Lucchesi 1979).

Of these three elements caesium is found in largest concentrations whereas that of rubidium was the least.

In natural emeralds the potassium contents are slightly higher than in synthetic ones (natural emerald : 200 to 330 ppm, synthetic emeralds : 4 to 110 ppm).

Caesium and rubidium contents show very strong variations. By far the largest contents of caesium have been found in the African and Brazilian specimens. Unexpectedly a surprisingly high amount of caesium has been found in one synthetic emerald from Lechleitner, the amount being even higher than the caesium content in natural Colombian and Pakistan emeralds.

Tungsten (W)

The chemical behaviour of tungsten is very similar to molybdenum. Tungstates can be used as flux components, and two synthetic emeralds have been found with small tungsten contents (less than 1 ppm).

Platinum (Pt)

Platinum, besides other metals, is used for the crucibles during the synthesis of emeralds, and so it is quite natural that platinum is present in synthetic emeralds. One specimen from Lechleitner contained platinum.

Lanthanum (La) and Gold (Au)

Lanthanum and gold have been found in some samples in very small traces (Lanthanum : 2 to 5 ppm, gold : less than 1 ppm).

It should be mentioned that the above results do not reflect a complete survey of the trace elements of emeralds. These results show only the ranges and contents of the elements examined in the samples.

DISCUSSION

Comparison of the Natural Emeralds

The chemical analyses present additional criteria that could be used to distinguish between natural emeralds according to locality. On the average, Colombian emeralds have distinctly less iron than the emeralds from all other occurrences. Further characteristic features are the smaller sodium and higher chromium and vanadium contents.

The alkali contents of the African emeralds show some characteristic differences, namely: higher caesium and smaller rubidium contents. In some cases even nickel has been found in abnormally high amounts.

Brazilian emeralds on the other hand have similar caesium but higher chromium and magnesium contents.

Similarly Pakistan emeralds have characteristically high scandium amounts. Besides this, they have higher vanadium and smaller rubidium contents.

The Austrian and the Russian samples show higher magnesium contents. Moreover, the Russian samples are remarkable also for their higher vanadium contents.

Comparison of Synthetic Emeralds

Gilson synthetic emeralds showed characteristic rhodium (16 to 60 ppm). Those from earlier generations contain small chromium amounts (of the order of 0.2%).

Lechleitner synthetic emeralds had significant zinc (0.05%) and rubidium contents (~10 ppm). In addition they showed higher contents of iron and caesium.

The Japanese synthetic emerald contained characteristic nickel and titanium contents.

Chatham synthetic emeralds showed some similarities to those of Colombian emeralds, i.e., small iron contents were accompanied by higher chromium contents.

Chemical characteristics that could be used in the detection of different generations of the production of synthetic emeralds could not be found.

Only a sample produced by Lechleitner permits the supposition that natural seed-plates were used in this case of synthesis. The unusual caesium and rubidium contents in this synthetic emerald may therefore have come from the seed.

General Comparison of Synthetic and Natural Emeralds

For the definite identification of emeralds by chemical investigations the natural or synthetic nature of emeralds can be characterized by the presence or absence of a particular element. Bearing in mind that the synthetic emeralds in future could contain certain elements found in the natural stones, additional elements in the synthetic emeralds should be investigated. In this respect the elements molybdenum, rhodium, zinc, platinum and tungsten could be of great use in proving the synthetic origin of a sample.

This can also be indicated by the presence or absence of iron, scandium, sodium, potassium, rubidium and caesium. Up till now very high iron, sodium and potassium contents have been considered as general indicators for a natural origin.

Lanthanum was found only in the natural emeralds.

According to the present investigation the amount of manganese (more than 10 ppm) also indicates a natural origin, whereas synthetic emeralds generally contain less than 1 ppm manganese.

The Colour of Emeralds

As the colour of a gemstone influences its commercial value, it is appropriate at this point of the discussion to consider the causes of coloration in emeralds.

The colour of the emeralds is not caused by chromium alone and it is known for example that vanadium causes similar or even equal tints of green in beryls.

Many critical investigations have shown that manganese, nickel, and iron also cause a green coloration in beryls (Emel'yanova *et al.* 1965, Jayaraman 1940). Since these elements have been found in all natural stones, one should not neglect their influence, and chromium, vanadium, iron, manganese and partly nickel occur in widely varying amounts in stones of comparable shades of green. We know some emeralds of good colour contain only small amounts of chromium and important amounts of other colouring elements, and this has a bearing on the definition of 'emerald'.

A proposal of A. M. Taylor (1977) should be mentioned in this context. He distinguishes all green beryls* as Type I, and Type

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*Taylor (1977) at the same time also suggested that emerald be defined as a '"grass-green" or "bright-green" variety of beryl', so a green beryl even if containing sufficient chromium to be detectable by hand-spectroscope would not be classified as emerald if not of a 'colour acceptable for emerald'.—Ed.

II emeralds. All green-coloured beryls, which contain enough chromium to be detected by a handspectroscopic method belong to Type I. Emeralds of Type II are those, which have too little chromium to be detected by the handspectroscope. To this type belong all samples, which are coloured green by elements other than chromium or combinations of elements like iron, vanadium, manganese, and nickel. Even specimens with more vanadium than chromium could be easily classified without undue problems, if the chromium content exceeds the limits as described above. This classification is of unique importance since the examination of a stone does not involve its destruction, and the use of dubious terms such as 'chromefree emerald' would no longer be necessary.

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GEMSTONES OF CANADA

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ABSTRACT

Large and relatively unexplored, Canada has yet to produce significant quantities of facetable gemstones. Nephrite jade from British Columbia is the only gemstone produced in large amounts today. Ornamental minerals such as amethyst crystals, labradorite, sodalite, rose quartz, rhodonite, peristerite and amazonite are exploited on a limited scale. Ammolite, an interesting new fossil gem material, has recently appeared on the market. The hessonite variety of grossular and green apatite have had limited commercial success.

Other gemstones discussed are uncommon and/or occur at localities difficult to reach. They are as follows: diamond, corundum, beryl, quartz, grossular and almandine garnets, cordierite, vesuvianite, amber, oligoclase and lapis lazuli.

INTRODUCTION

Canadian gemstones have not received wide recognition in gemmological literature. Aside from the brief descriptions by Field (1948 to 1951) and popular articles by Steacy (1974) and Sabina (1980), little has been published beyond minor references in geological or mineralogical treatises. This paper endeavours to bring up to date descriptions of the more interesting and economic finds. The information has been gleaned from published literature, from specimens in the collections of the National Museum of Natural Sciences in Ottawa and the Royal Ontario Museum in Toronto, and from private collectors. This is not an exhaustive study as it does not include those gemstones we felt to be of minor significance.

DIAMOND

Recently, Brummer (1978) summarized the occurrences of kimberlite pipes and the four known occurrences of diamonds in Canada (Figure 1). Kimberlite is the rock type that is the principal source of most economic concentrations of diamonds throughout the world. Two of the Canadian diamonds were found in

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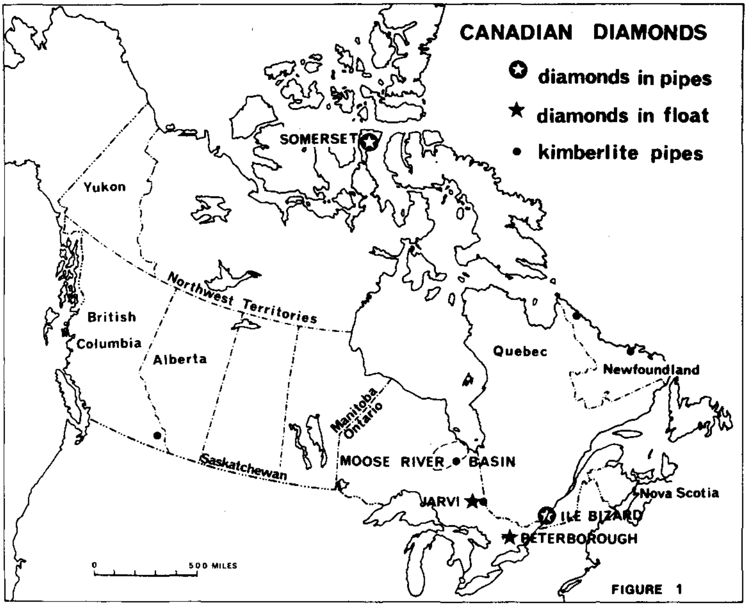


FIGURE 1

transported glacial till in Ontario: the poorly-documented 'Peterborough' diamond (33 ct) discovered before 1920, and the 'Jarvi' diamond (0.255 ct) found in 1971 near Timmins. In 1967, ten small diamonds, weighing only 0.0605 carat, were recovered from a diatreme kimberlite breccia on Ile-Bizard just outside of the city of Montréal, Québec. In the mid 1970s, bulk sampling of several kimberlite pipes on Somerset Island, Northwest Territories, revealed five or six small diamonds (J. Brunet, pers. comm.) but no details are available.

In the north-eastern United States, approximately 82 diamonds of various sizes have been recovered from glacial deposits within the Great Lakes region. These diamonds are believed to have been transported by glaciers from the James Bay Lowlands of Ontario (Gunn, 1968; Satterly, 1971). Since 1960, extensive surveys by government and private exploration companies have resulted in the discovery of numerous kimberlite-indicator minerals in the rivers throughout the area to the south and south-west of James Bay (Brown *et al.,* 1967; Ferguson *et al.,* 1978; Wolfe *et al.,* 1975). These surveys, analysed and interpreted in conjunction with the distribution of glacial drift from the latest Wisconsinian glaciation, narrowed the potential source area to the vicinity of the Moose River Basin. Subsequent exploration in the late 1970s and early 1980s has resulted in the discovery of numerous kimberlite breccias (Selco, 1981), which have yet to be bulk sampled. No *in situ* occurrences of diamonds have been reported from this area and full analytical data on these breccias are not yet available.

Grieve (1981) described numerous diatreme breccias in south-eastern British Columbia, but only one of the three examined in detail contained indicator minerals characteristic of kimberlites. No diamonds have yet been reported from this area, although several private companies are now engaged in the active exploration and definition of other diatreme breccias and kimberlites in this mountainous area of British Columbia.

In summary, there are no known concentrations of diamonds in Canada, although recent intensive kimberlite exploration suggests some potential for commercial diamond concentrations.

CORUNDUM (SAPPHIRE AND RUBY)

The mineral corundum has been known in Canada for close to 100 years and there has been much speculation about the existence of the gem varieties ruby and sapphire. To date, no commercial concentrations have been found. In Hastings Co., Ontario, there are many corundum occurrences, usually of opaque dark-brown crystals. These supplied large quantities of commercial abrasive powder in the years 1902-1917. The Gutz Farm in Brudenell Township, Renfrew Co., Ontario, produces similar bronze-brown crystals, some of which have been cut to show a star (National Museum of Natural Sciences (NMNS) specimen to 5.2 ct). The only known occurrence of sapphire of gem quality is about 16 kilometres north-east of Bancroft, Ontario (Figure 2). This locality near the York River in Hastings County has been known for many years (Ellsworth, 1924; Traill, 1970). The sapphire, found in gneiss, is usually badly fractured but the colour is a ‘very fine deep cobalt blue’ (Field, 1951a, p.76). Faceted gems (6.02, 2.77, 1.00 ct) are in the collection of the National Museum of Natural Sciences. Fine cabochon gems are also known, some of which show weak asterism (Waite, 1945). The crystals are externally a pale greyish colour; only the cores are blue. Specimens were exhibited in the Pan-

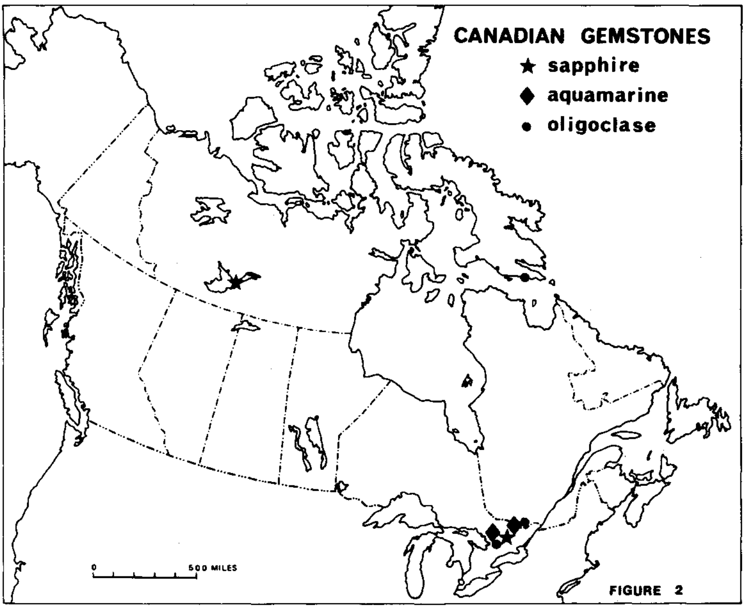


FIGURE 2

American exhibition in Buffalo, New York in 1901 (Field, 1951a). The Lillie Robertson corundum showing, also near Bancroft in Hastings Co., has produced black star-sapphire gems (NMNS 14.40, 5.45, 6.79 ct). These are probably more common than the blue star-stones.

Rounded crystals of blue corundum have been reported from Methuen Township, near Peterborough, Ontario (Field, 1951a). Lord (1951) reported small crystals of sapphire (up to 1.5 cm across) in pegmatitic quartz bodies at the Philmore Mine on a small island in Great Slave Lake, Northwest Territories.

In the north-western United States, particularly in Montana, concentrations of sapphire occur in river gravels that are similar to the gem gravels of the Orient. This area is in the foothills of the Rocky Mountain Range. There are two interesting reports from British Columbia, also in the Rocky Mountains and immediately north of the United States-Canada border. A transparent, rolled fragment (7 mm diameter) of green corundum was found in gold washings from the Pend-d'Oreille River, Kootenay District (Field, 1951a; Hoffman, 1898). Similarly, grains of ruby came from gravels of some creeks flowing into the Tulameen River (Johnston, 1915; Sinkankas, 1959). These occurrences indicate that the Canadian Cordillera may have some potential for concentrations of alluvial sapphire and ruby.

BERYL

Beryl in gem-quality crystals is often found in rare-earth, beryllium or lithium pegmatites, which are quite common throughout Canada (Mulligan, 1960; Traill, 1970). Unfortunately little gem-quality beryl has been found, although Field (1948b) and Waite (1945) reported facetable aquamarine from two localities in Ontario (Figure 2)—near Kearney in the Nipissing District, and near Quadeville, Lyndoch Township, Renfrew County. The National Museum's collection has five gems (the largest is 3.1 ct) from Quadeville. There are no other documented occurrences of gem-quality aquamarine in Canada.

With the exception of 'translucent and emerald green' beryl reported from two kilometres north of Quadeville, Ontario (Sabina, 1964b, p.90), there has been no specimen or gem-quality emerald documented in Canada.

QUARTZ FAMILY

Quartz is an extremely common mineral in Canada (Figure 3) as in the rest of the world. No mention will be made of the numerous localities for chalcedony (agate, jasper, cornelian), and silicified petrified wood and dinosaur bone, commonly seen as decorative objects or as cabochons.

Amethyst

Although amethyst quartz has been reported from numerous locations throughout Canada (Sabina, 1964a,b,c; Traill, 1970), there are only two areas in Canada that have produced material of gem quality. The Thunder Bay District of Ontario along the north-west shore of Lake Superior is Canada's most productive amethyst area. The amethyst is associated with major fault structures trending in a south-west to north-east direction in Precambrian granite. There are many outcrops of amethyst veins in this area, and substantial quantities of ornamental and decorative specimens are produced for export. Many crystals contain conspicuous red haematite inclusions and gem-quality amethyst is rare. Robinson

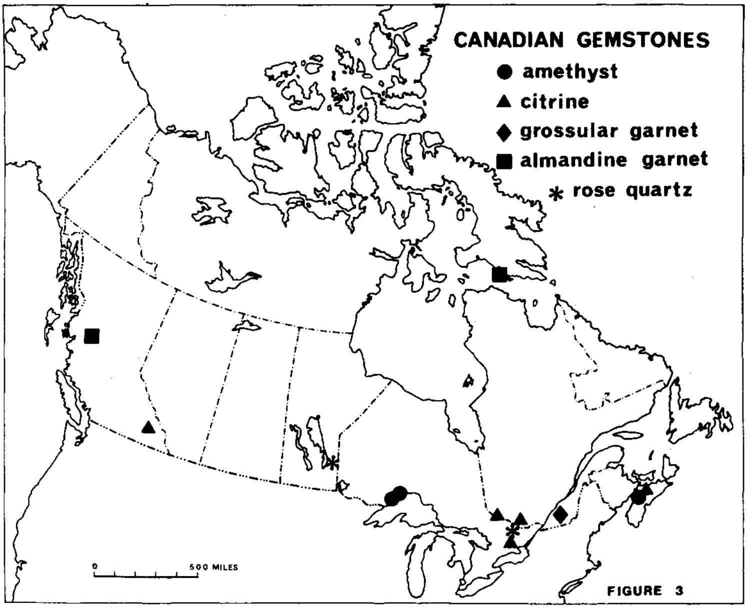


FIGURE 3

(1969, p.265) reported that 'nearly every large crystal from the Dzuba Mine has a dark, solid core of cutting grade amethyst'. Unfortunately, this is not the case at other deposits. Gems from McTavish Township (4.70, 4.40 ct) and Nagunagisic Lake near Nipigon (14.25, 10.9 ct) are in the collection of the National Museum of Natural Sciences, Ottawa.

In Nova Scotia, on the beaches between Cape Blomidon and Cape Split in the Minas Basin, fine amethyst specimens have been found. As long ago as 1605, ten amethyst crystals from Nova Scotia were sent to King Henry IV of France by the Acadians. The gems fashioned from these crystals were part of the French regalia for centuries (Field, 1948a). Unfortunately, such fine material is not available today. The National Museum's collection contains two gems (0.74 ct dark purple; 2.79 ct pale lavender) from this area. Gem-quality crystals of deep-purple amethyst on massive magnetite have been reported by Traill (1970) near Berwick, Nova Scotia. The amethyst at both these localities is derived from amygdaloidal basalts.

Citrine

Some citrine quartz was found recently near Lac Sairs in Villedieu Township, Témiscamingue Co., Québec (Shearer, pers. comm.). There are two very fine gems (69.3, 36.3 ct) from this locality in the National Museum's collection.

Rock Crystal

Fine rock crystal specimens of faceting quality have been found in a quartz pegmatite near Black Rapids in Leeds County, Ontario. They were originally mined for their piezoelectric properties before synthetic quartz production made deposits such as these obsolete. Several other areas in Canada produce quartz crystals which could be faceted: Five Islands in the Minas Basin, Colchester Co., Nova Scotia; Lawrenceville, Shefford Co., Québec; Saint-Rémi-d'Amherst, Papineau Co., Québec (Parsons, 1938) and the Bluebell Mine, Riondel, Kootenay District, British Columbia. The collection of the Royal Ontario Museum contains a 13.4 ct gem from Saint-Rémi-d'Amherst.

Rose Quartz

Massive rose quartz occurs in pegmatites in Ontario and Manitoba. The Ontario locality is near Quadeville in Lyndoch Township, Renfrew County. The National Museum's collection has faceted gems of 23.8, 12.5, 5.9 and 4.6 ct. Some specimens show asterism. The Manitoba deposit, also in a large pegmatite dyke, is near Birse Lake. Cabochons and a carving of this material are in the collection of the Royal Ontario Museum.

Smoky Quartz

Smoky quartz crystals were once found in fields in Annapolis County, Nova Scotia (Field, 1951d), but there are no recent reports.

GROSSULAR GARNET

The Jeffrey Mine at Asbestos, Richmond Co., Québec (Figure 3) is the only major producer of gem-quality grossular garnet in Canada. The locality has been known since 1950 as a source of fine mineral specimens, but faceted gems are less well known. The Jeffrey Mine has been worked for asbestos since 1881.

Grossular garnet, associated with diopside, K-feldspar and quartz, is most commonly found on granitic rocks that intrude the Jeffrey Mine ore body. The grossular varies from colourless through shades of white, pink, orange and green (Grice & Williams, 1979; Wight & Grice, 1981, 1982). The orange-coloured hessonite variety is the most abundant; gems in the 1-5 carat range and small crystal groups mounted in jewellery have been commercially marketed in Canada with some success. The collection of the National Museum of Natural Sciences contains gems of 24 and 14 carats that are particularly noteworthy. The green grossular crystals are less abundant and very small. The one faceted gem in the National Museum's collection weighs only 0.25 ct. Recently, faceted colourless grossular (NMNS 4.64 and 2.94 ct) was described (Wight & Grice, 1981), but it is rare.

ALMANDINE GARNET

Almandine of faceting quality has been reported by Field (1951d) from the Skeena River, Coast District, and the Stikine River, Cassiar District in British Columbia (Figure 3). Transparent cabochons (7.45 and 4.90 ct) of good colour from Stikine River are in the National Museum's collection.

Beautiful red almandine gems have been cut from material brought from 'Garnet Island, Baffinland' in the Northwest Territories *circa* 1915 (Field, 1949, 1951d; Traill, 1970; Walker, 1915, p.64). The National Museum has a 6.3 ct triangular brilliant and there are other gems in the Royal Ontario Museum.

AMMOLITE

Ammolite is the most recent gemstone to become commercially available in Canada. Ammolite has been known under the trade names 'Calcentine' or 'Korite', but the term 'Ammolite' has recently been approved by the Coloured Stone Commission of the C.I.B.J.O. Ammolite is derived from the shell of an extinct ammonite, a mollusc (class Cephalopoda, subclass Ammonoidea), distantly related to the extant *Nautilus,* which is uncommon from the tropical Indo-Pacific Ocean (Wight, 1981). The ammonites that provide the gem material are found in Cretaceous marine deposits exposed along river banks near Lethbridge, Alberta (Figure 4). It is the nacreous layer of the

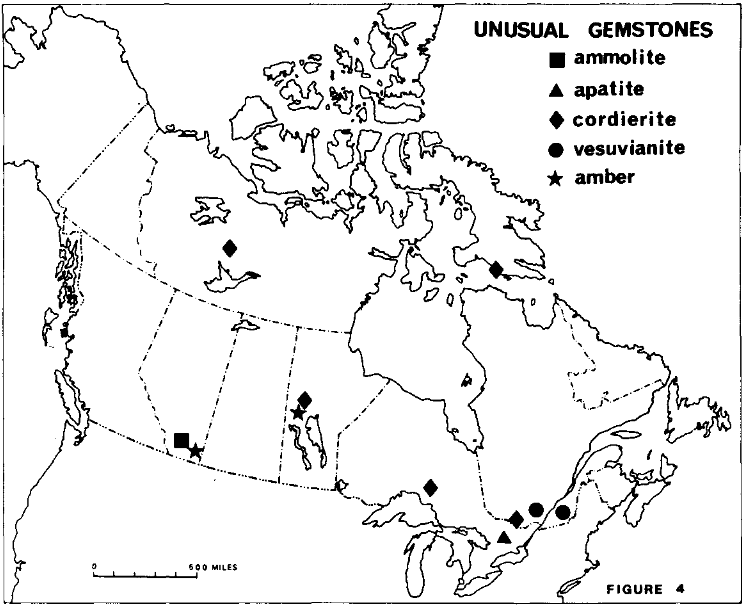


FIGURE 4

ammonite shell that shows the brilliant iridescence, predominately red and green, seen in gem ammolite. Much of the shell material has been cracked and rehealed during the process of fossilization, giving a stained-glass window effect of small patches of brilliant colour framed by darker, non-iridescent lines. The hardness is only four and thus ammolite is often prepared as triplets with a natural shale backing and quartz or synthetic spinel cabochon top.

APATITE

There are several localities (Figure 4) for gem-quality apatite in Canada, near Wilberforce, Haliburton Co., Ontario (Field, 1951c). The Liscombe mine had not been worked since the 1930s, although collectors frequently visited the site to collect apatite crystals and specimens of other minerals. In the mid 1970s, a company called Trilliumite Explorations claimed the old workings and successfully produced some fine specimens, marketing the faceted apatite under the trade name of 'Trilliumite' (Shearer, 1975). One piece of rough (approximately 177 ct) produced an 87 ct gem of a pleasant blue-green colour. Other specimens from this locality include fine green gems (65.5 and 24.6 ct) in the collection of the National Museum in Ottawa. The Cardiff Uranium Mine has calcite—fluorite—apatite veins cutting uranium-rich pegmatites south-south-east of Wilberforce (Sabina, 1964b) and some of this dark-green apatite is said to be gemmy. The National Museum's collection has one fine green gem (3 ct) from a small deposit near Tory Hill, Monmouth Township.

CORDIERITE (IOLITE)

Blue cordierite of gem quality has long been known from several localities in the Northwest Territories: Ghost Lake, northwest of Yellowknife (Lord, 1951) (NMNS 1.5 ct); near Great Slave Lake (NMNS 3.9 ct); and a somewhat-uncertain locality on 'Garnet Island, Baffinland' (Field, 1949, 1951e; Walker, 1915, p.65). Several cabochons from Garnet Island are in the Royal Ontario Museum's collection.

Cordierite of faceting grade has been collected from the Geco Mine, Manitouwadge, Ontario. Fine blue gems (up to 2.2 ct) are in the collection of the National Museum. Similar material occurs at the Stall Lake Mine, near Snow Lake, Manitoba. Near Otter Lake, Pontiac Co., Québec, clean cordierite of 'a cornflower blue to a deep blue' has been collected (Sabina, 1964b, p.153).

VESUVIANITE (IDOCRASE)

Green vesuvianite gems have recently been reported (Wight & Grice, 1981) from the Jeffrey Mine at Asbestos (Figure 4), Richmond Co., Québec. The gems are less than a carat in weight and of a medium dark, slightly yellow-green colour. Larger, golden-brown vesuvianite gems were once obtained from Laurel, Argenteuil Co., Québec (Figure 4), and marketed as 'Laurelite' (Field, 1948b; Sinkankas, 1959). Most gem material from the now-flooded pits of this occurrence has been removed. Several fine golden-brown gems (3.15, 2.95, 2.28, 2.08 ct) are in the National Museum's collection.

AMBER

Amber called 'chemawinite' was first discovered in Canada from the beach of Cedar Lake, Manitoba (Figure 4) by W. C. King, who was in charge of the Hudson's Bay Company trading-post at Chemahawin (Walker, 1934). This is a golden-brown amber of the retinite group, i.e. it does not contain succinic acid as does Baltic amber. The amber is believed to be a secondary deposit, having been washed out of Upper Cretaceous lignitic deposits upstream on the Saskatchewan River, which flows into Cedar Lake (McAlpine & Martin, 1969). The grains of amber are quite small, usually less than 3 cm, and frequently contain insects and other fossils. There were attempts to mine chemawinite commercially; about one tonne was obtained between 1895 and 1937. Construction of a dam has since raised the water level of Cedar Lake, flooding the amber locality.

McAlpine & Martin (1969) have studied amber collected from about 50 Canadian localities, usually associated with low-grade coal and lignite deposits. The collection of the National Museum of Natural Sciences contains polished gem amber from Cedar Lake, Manitoba; Medicine Hat, Alberta, and Coalmont, British Columbia.

NEPHRITE JADE

Nephrite jade from British Columbia (Figure 5) is the best known of all Canadian gemstones, and the only one of commercial significance. According to Leaming's (1980) excellent summary of British Columbia and Yukon Territory jade occurrences, total production in 1975 was 641 tonnes with a value of $1 702 764. There are strong demands for nephrite by consumers in Taiwan, Hong Kong, the Peoples' Republic of China, West Germany, the United States and elsewhere. The estimated world demand is 1180 tonnes per annum, and Canada supplies a large portion of this because of inconsistent or inadequate supplies from other countries such as the United States, Australia, and U.S.S.R.

Most *in situ* deposits of nephrite are associated with metasomatically-altered serpentinite in fault contact with a variety of host rocks. The nephrite deposits are generally small, (110-200 tonnes) ellipsoidal or tabular bodies. The largest mass observed by Leaming was about 10 m × 30 m × 30 m. Alluvial boulders are most commonly found first and traced to source. More nephrite deposits are likely to be found in known ultramafic bodies in areas of mid-Paleozoic to Triassic rocks of the Canadian Cordillera.

There are six areas of nephrite production in the Canadian cordillera, in four principal sections—Southern, Central and Northern British Columbia, and Yukon Territory (Leaming, 1980).

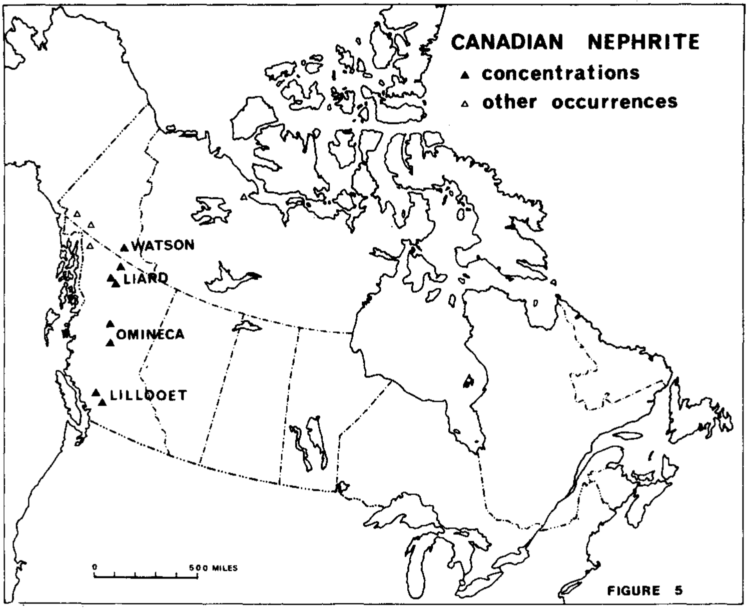


FIGURE 5

The earliest known alluvial and *in situ* concentrations of nephrite are along the Fraser and Yalakom rivers near Lillooet in southern British Columbia. Numerous alluvial nephrite boulders from this area were used by the Indians for many hundreds of years to make tools, items for trade, and decorative artefacts, which were highly prized by the tribes of the Mainland Coast and Vancouver Island (Holland, 1961). Among the Tlingits of northern B.C., a small adze blade was worth two or three slaves (Schmidt, 1975). In Central British Columbia, the Omineca Mining Division has two main areas of production. The first is Mount Ogden, where both *in situ* deposits and alluvial material are known. Over 2000 tonnes of commercial-grade nephrite have been produced from this lode to date. The large 21-tonne boulder that was on display in the British Columbia Pavilion at Expo '70 in Osaka, Japan, was from this area (Sinkankas, 1976). In the second more southerly area of the Omineca Division, subsurface lode concentrations of nephrite are known from Mount Sidney Williams at the head of O'Ne-ell Creek. Sinkankas (1976) reported that this relatively accessible area has estimated reserves of 4000 tonnes of well-exposed nephrite, but much material is of low quality (Leaming, 1980). The Liard Mining Division in Northern British Columbia has the largest concentrations of alluvial boulders and lode deposits in Canada. There are two principal areas within this Division: Cry Lake and Cassiar. The Cry Lake area, 80 km east of Dease Lake, has the potential to produce considerable quantities of nephrite but is severely limited by accessibility. The Cassiar area has been less productive. The Cassiar Asbestos mine used to dump nephrite as a by-product of its mining activities, but the value of the nephrite has now been realized. Cassiar nephrite is somewhat atypical of B.C. jade, since it contains bright flecks of a green chrome garnet. Small *in situ* deposits of nephrite are known near Frances Lake, north of Watson Lake in Yukon Territory. About 16 tonnes were brought out in 1969 (Sinkankas, 1976).

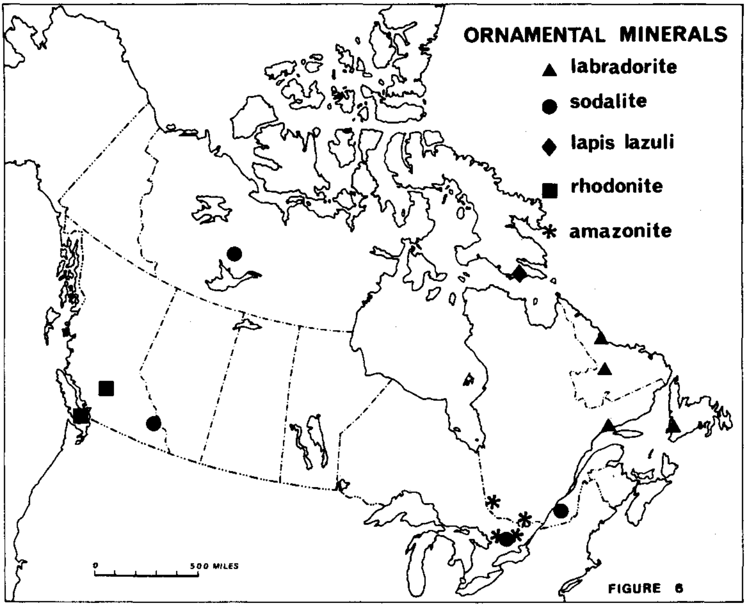
Reports of non-productive nephrite discoveries include boulders from the Rae River, District of Mackenzie, Northwest Territories, first reported in 1851 (Lord, 1951); from the Atlin Lake area in north-western British Columbia (Leaming, 1973); from gravels of the Lewes River near Miles Canyon south of Whitehorse, Yukon Territory (Sabina, 1964a); and from Klukshu Lake in the extreme south-west Yukon Territory (ibid.). These localities are shown on Figure 5.

FELDSPAR GROUP

Feldspar minerals are extremely common in Canada. There are two broad classes of the Feldspar Group—the alkali and the plagioclase feldspars. The alkaline feldspar most commonly seen as a gemstone in Canada is amazonite, a variety of microcline. The plagioclase feldspars include albite, oligoclase and labradorite. Commonly the two feldspar classes crystallize together in solid exsolution, producing a laminated intergrowth. The name perthite was applied to this type of feldspar when it was first observed associated with other minerals in pegmatite dykes near the town of Perth, Ontario. Peristerite is a micro-perthitic intergrowth of plagioclase feldspars which exhibits a schiller effect (Deer *et al.*, 1963).

Labradorite

Labradorite is the plagioclase feldspar that is commonly associated with Canada and derives its name from Labrador



(Figure 6), a district of the province of Newfoundland on the east coast of Canada. Labradorite feldspar was first reported from the coast of Labrador by a Moravian missionary in 1770. A quarry on Tabor Island about 17 kilometres south-south-west of Nain has been producing sporadically since 1935, when it was opened by the International Grenfell Association. Since then several organizations have operated this quarry, including British Newfoundland Exploration Limited (Brinex), from 1961 to 1964, and subsequently the Nain Crafts Council. Recently, Watson (1980) completed a detailed evaluation of the labradorite gemstone potential in the area of Nain. He found numerous occurrences of labradorite crystals up to 50 cm in diameter showing characteristic blue, green, yellow, bronze, purple and red schiller (or labradorescence) throughout this coastal area. He concluded 'that there is an abundance of labradorite in the Nain area suitable for gem purposes' (Watson, 1980, p.245).

Other occurrences of labradorite showing the characteristic labradorescence have been reported from various locations throughout Labrador and Québec (Sinkankas, 1976). They are all associated with the large bodies (5 to 50 km in diameter) of

Proterozoic anorthosite that intrude rocks of the Grenville and Churchill Structural provinces of the Precambrian Canadian Shield.

Oligoclase

Beautiful specimens of the peristerite variety of oligoclase, usually with a blue schiller on a white or pink background, occur in many places in Ontario (Figure 2): Dungannon and Monteagle Townships, Hastings Co.; Bathurst Township, Lanark Co; Murchison Township, Nipissing District (Field, 1951b; Sinkankas, 1959, 1976) and McConkey Township, Parry Sound District (Traill, 1970). A yellow translucent peristerite has been found near Sundridge, Parry Sound District (Sinkankas, 1959). Peristerite is also abundant in Québec: Villeneuve and Buckingham Townships, Papineau Co.; Callières Township, Charlevoix-Est Co.; and Wakefield Township, Gatineau Co. (Sinkankas, 1959, 1976; Traill, 1970).

The sunstone variety occurs in Ontario at the Gole Quarry, Murchison Township, Nipissing District and at McCue Lake, Monmouth Township, Haliburton Co. (Sinkankas, 1976).

Colourless to pale blue, transparent oligoclase has been found recently near Lake Harbour, Baffin Island, Northwest Territories (Figure 2) by D. D. Hogarth of the University of Ottawa. Faceted gems weighing 6.7 ct (colourless) and 6.8 ct (blue) are in the National Museum's collection, along with a cabochon cut from opaque white oligoclase which shows narrow bands of silvery-white schiller.

Microcline variety Amazonite (Figure 6)

Canada's best amazonite is found in Québec near Kipawa at the north end of Lac Sairs, Témiscamingue Co., (Sabina, 1964b). The National Museum of Natural Sciences has many fine specimens. Amazonite has also been found at the Leduc mine, Wakefield Township, Gatineau Co. (ibid.) in association with gem tourmaline and other fine mineral specimens.

In Ontario, amazonite has been reported from the McCormack, MacDonald and Woodcox mines near Bancroft, Hastings Co.; near Eganville, Renfrew Co.; and north of Quadeville, Lyndoch Township, Renfrew Co. (ibid.). Field (1951b) also reported amazonite from Lyndoch and Sebastopol Townships, Renfrew Co., and Monteagle Township, Hastings Co. Sinkankas (1959) listed an occurrence in Cameron Township, in the Nipissing District of Ontario.

SODALITE

There are two main occurrences of sodalite known in Canada (Figure 6). The only commercial and easily accessible source is the Princess Quarry east of Bancroft, Hastings Co., Ontario, where medium to fine-quality sodalite occurs within nepheline syenite host rocks (Field, 1951c; Sabina, 1964a; Sinkankas, 1976). The National Museum's collection has many fine blue cabochons and a translucent faceted gem (1.9 ct) from this locality. Steacy (1974) reported that 117 tonnes of this sodalite were shipped overseas as early as 1906. Fine sodalite also occurs in the Ice River Alkaline Complex in nepheline and sodalite syenites near Field, Kootenay District, British Columbia (Allan, 1914). Most of the Ice River Complex is now within the boundaries of Yoho National Park and collecting is forbidden. Specimens at the National Museum of Natural Sciences were collected by early Geological Survey field parties or with special permission by Museum staff. The terrain is mountainous and very difficult.

An ornamental rock known as 'beloeilite', found on the north-east slope of Mont St-Hilaire, Québec, is composed of up to 80% sodalite and minor amounts of albite and nepheline (Sabina, 1964b). Sodalite has also been reported from many localities in central Ontario (Sinkankas, 1959), as well as at Bigspruce Lake on Snare River, Northwest Territories (Lord, 1951).

LAPIS LAZULI

There is only one known occurrence of lapis lazuli in Canada—on southern Baffin Island just north of the Innuit community of Lake Harbour, Northwest Territories (Figure 6). The deposit was described by Hogarth (1971), who recorded two deposits within a few kilometres of each other on the north-west side of Soper River. The first published report of this locality was recorded on a map by Davison (1959), although local Innuit had known of the locality for several decades.

The lapis lazuli occurs in Aphebian ($\geqslant$1740 m.y.) metasedimentary rocks and peridotites of the Churchill Structural Province of the Canadian Shield, and is associated with marbles folded within biotite gneisses. There is some finely-coloured material, but in general the quality of the lapis lazuli is considered to be substandard in comparison to lapis lazuli from Afghanistan or Chile. The rock is very often badly fractured because of severe freeze and thaw actions.

RHODONITE

Rhodonite is a beautiful pink ornamental mineral that often has interesting black veining. It is a favourite lapidary material in British Columbia, where it occurs at several localities (Figure 6). Probably the best known area is Hill 60 on the north side of Cowichan Lake on Vancouver Island. The main deposit was once worked as a source of manganese ore and was still posted against trespass in 1966 (Leaming, 1966). The Holling's Claim on Saltspring Island, also in cherty rocks of the Sicker Group, was operated commercially on a small scale in the 1960s (Danner, 1978). The Williams Lake area, mentioned as a rhodonite prospect by Leaming (1966), has since produced cabochons of fine pink colour, some with brown and black veining, which are in the National Museum's collection.

CONCLUSION

Large and relatively unexplored, Canada has yet to produce facetable gemstones in large quantities. Widespread glaciation removed surficial deposits that may have contained gem concentrations. Difficult terrain and harsh climatic conditions prevailing during much of the year in northern Canada cause many problems. Despite these problems, Canada has produced small numbers of gemstones of almost every species, and commercial quantities of some ornamental minerals.

Recent finds of new and unusual gem materials such as ammolite have stimulated more intensive searches for Canadian gemstone localities. As the North becomes easier to reach, and the population increases, it is possible that finds of economic importance will be made.

ACKNOWLEDGEMENTS

The authors wish to thank J. A. Mandarino and R. I. Gait, of the Royal Ontario Museum, and R. Williams, of the National Museum of Natural Sciences, for their assistance with this project.

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[*Manuscript received 17th December, 1981.*]

GEMMOLOGICAL ABSTRACTS

BALITSKY (V. S.), LISITSINA (E. E.). *Synthetic materials used for jewellery and carving and their place among gems.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 28-36, 1980. (In Russian, with English abstract.)

There are two groups of synthetic materials used for jewellery and carving; (1) the synthetic analogues of natural stones, e.g. synthetic ruby, sapphire, spinel, opal, turquoise, etc., and (2) new materials having no natural analogue, e.g. fabulite, YAG, cubic zirconia. The main methods of production of synthetic gems and the treatment of natural gems are outlined. R.A.H.

BANK (H.). (a) *Brauner und gelbbrauner Danburit aus Madagaskar.* (Brown and yellow-brown danburite from Madagascar.) Z.Dt.Gemmol.Ges., **31**, 1/2, 85-6, 1982; (b) *Turmaline diverser Grün- und Rottöne aus Sambia.* (Tourmalines with varying green and red tinges from Zambia.) Id., 91-2, 1982; (c) *Über Grossular und Hydrogrossular.* (About grossularite and hydrogrossularite.) Id., 93-6, 1982.

(a) An old deposit of danburites (described by Lacroix in 1922) yielded some beautiful big crystals producing clean yellow and brown cut stones up to 50 ct. Optical data given. (b) Recently tourmalines of various colours were found in Zambia besides deposits of amethysts and emeralds, along the border with Moçambique. Two types of stones were found: (i) yellow-green stones similar to those of Brazil with very strong pleochroism up to nearly black, nearly clean, yielding cut stones of up to 50 ct. Some green tourmalines with a blue hue can be improved by heat treatment. (ii) Red, brown and violet tourmalines, not quite as clean, but showing good red colour when heated; various sizes, up to 25 ct. Strong pleochroism, but not as strong as the green stones. (c) Green and red translucent 'Transvaal jade' is a mixture of grossularite and hydrogrossularite and vesuvianite. The green variety consists of grossularite and vesuvianite causing anomalous double refraction and low RI = 1.720. The red variety is a mixture of grossularite and hydrogrossularite, the RI depending on proportion lies between 1.700 and 1.712; SG 3.32 and 3.36. E.S.

BANK (H.). *Aus der Untersuchungspraxis.* (Research in practice.) Z.Dt.Gemmol.Ges., **31**, 1/2, 97-9, bibl., 1982.

Notes on findings in the laboratory. An isotropic stone with RI 1.554 in a parcel of citrines was found to be paste, as was a cut stone with RI 1.495 offered as opal: no H_2O bands could be seen with infrared spectroscope. X-ray fluorescence can blacken stones: this was observed in synthetic emeralds and synthetic alexandrites, which became lighter again after a short while. Topaz, citrine and apatite were found in a parcel of yellow-brown danburites. E.S.

BANK (H.). (a) *Geschliffene zonar gebaute Smaragde aus dem Gebiet der Tokowaja, Ural, UdSSR.* (Cut, zonal oriented emeralds from the district of Tokowaja, Urals, U.S.S.R.) Z.Dt.Gemmol.Ges., **31**, 3, 193-4, 1 fig., 1982; (b) *Petalit-Analcim-Katzenaugen aus Simbabwe.* (Petalite-analcime cat's-eyes from Zimbabwe.) Id., 197-8, 1982; (c) *Blassblauer, fast farbloser Cordierit aus Sri Lanka.* (Pale blue, nearly colourless cordierite from Sri Lanka.) Id., 199-200, 1982; (d) *Violetter Skapolith aus Ostafrika.* (Violet scapolite from East Africa.) Id., 201-2, 1982; (e) *Brauner schleifwürdiger Herderit aus Brasilien.* (Brown cuttable herderite from Brazil.) Id., 203-4, 1982; (f) *Geschliffener Pyrargyrit in einer Partie Hämatite.* (Cut pyrargyrite in a parcel of haematites.) Id., 205, 1982

(a) Like Columbian and Zambian stones, these emeralds show definite zonal growth. Inclusions show that these zonal growth characteristics are not interrupted as is the case in other emeralds. The stones can be mistaken for doublets. (b) As well as the colourless and light yellow transparent petalite from the Minas Gerais, Brazil, some translucent pinkish-brown material which consisted mainly of petalite and analcime was found near to Arassuahy. This material shows a good chatoyancy. (c) The pale blue, nearly colourless iolite from Sri Lanka has a low RI of 1.530-1.540 and a Fe content of only 1.14% FeO. (d) Optical data and densities as well as low meionite content of violet scapolites from East Africa published by Zwaan were confirmed. (e) New material from the Virgem da Lapa Mine in Minas Gerais in Brazil was found to be cuttable brown hydroxyl-herderite with the highest so far known RI for that material: $n_x = 1.610$, $n_y = 1.630$, $n_z = 1.642$. The fluorine content was found to be 0.20%F. (f) The pyrargyrite was found in a parcel of cut haematites from Brazil. It is much softer (3½ instead of 6½) and is a silver ore (Ag_3SbS_3). E.S.

BANK (H.), BANK (F. H.). *Schleifwürdige rote Berylle aus Utah, U.S.A., mit niedrigen Brechungsindizes.* (Cuttable red beryls from Utah, U.S.A., with low RIs.) Z.Dt.Gemmol.Ges., **31**, 1/2, 87-8, 1982.

Samples of red beryl with low RI were collected, the RI confirmed and trace elements determined. Specimens from unknown locality with even lower RI (similar to those of pink beryl) seem to be natural as they have same trace elements as those found in Utah, presumably have an even higher alkaline content and even lower RI readings. E.S.

BANK (H.), BECKER (G.). *Durchsichtiger rötlicher, rosa farbener und violetter Adamin aus Mapimi, Mexiko.* (Transparent, reddish, pink and violet adamite from Mapimi, Mexico.) Z.Dt.Gemmol.Ges., **31**, 3, 195-6, 1982.

The adamite crystals were found in the Ojuela mine in Mapimi in Mexico. They are transparent, colourless as well as pink and violet, crystallize in the orthorhombic system and are a zinc-arsenate. E.S.

BANK (H.), PETSCH (E.). *Über ein neues Vorkommen von Smaragd bei Sta. Terezinha, Goyaz, Brasilien.* (About a new occurrence of emeralds near Santa Terezinha, Goya, Brazil.) Z.Dt.Gemmol.Ges., **31**, 1/2, 89-90, bibl., 1982.

The occurrence can be reached from Rio via Belo Horizonte to Goiana, from there to Ceres and then Santa Terezinha. The township is situated on the Rio Acu, a tributary of the Rio Araguaya which flows towards the Amazon. All qualities seem to be present, from very fine to poor. SG 2.66, RI 1.594-1.586 with 0.008 DR. E.S.

BECK (C. M.). *Physical methods used to determine the geological origin of amber and other fossil resins; some critical remarks: comment.* Physics & Chemistry of Minerals, **8**, 3, 146-7, 1982.

The author defends his use of IR spectrometry for determining the geological origin of amber and other fossil resins against the criticisms of S. S. Savkevich (see abstract, J.Gemm., XVII, 7, 494). P.Br.

BOUŠKA (V.). *Moldavites as the precious stones.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 122-7, 2 figs, 1980.

Moldavites dated at 14.8 m.y. occur in S. Bohemia and SW. Moravia. Their total original weight has been estimated at 3000 tons; the average weight of the moldavites as found is 8.03 g. They vary in colour from light green to brown (partial chemical analyses, microhardness, specific gravity and refractive index are tabulated for six colour ranges). In medieval times moldavites were mounted in pendants or in the tops of gentlemen's walking-sticks; later they were cut as gemstones, having some resemblance to peridot or diopside. Nowadays they are used as jewellery in their natural form. R.A.H.

BUKANOV (V. V.), LIPOVSKY (Yu. O.). *New finds of precious corundum in the Eastern Baltic shield.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 110-16, 1 fig., 1980. (In Russian, with English abstract.)

Ruby occurs in highly aluminous rocks of the amphibolite facies in Karelia, where it is associated with rhodolite garnet. It is found as well-formed prismatic crystals up to 1-5 cm long and 0.5-3 cm in diameter, pink and violet in colour, sometimes translucent and suitable for cutting as cabochons. Sapphires occur in pegmatites of the Khibiny alkaline massif, where they are confined to the roof of the complex, in aluminous hornfelses. They have curved faces and form tabular or prismatic crystals up to 3-20 mm; the cornflower blue varieties are 2-15 mm across and confined to nepheline-bearing pegmatites. R.A.H.

BUKIN (G. V.), GODOVIKOV (A. A.), KLYAKHIN (V. A.), SOBOLEV (V. S.). *Synthetic emerald.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 36-44, 6 figs, 4 photos, 1980. (In Russian, with English abstract.)

Synthetic emeralds have been produced in $PbO-V_2O_5$ fluxes at 1000-1200 °C. Emerald crystals containing Cr and V and weighing up to 10 g have been obtained by hydrothermal methods in acid solutions of complex composition. A description is given of the growth of beryl with the help of gas transport reactions. The relationship between ω RI and the Cr and Fe content and the differences between natural and synthetic emeralds are discussed. A correlation between ω and D is noted; the cell parameter a_0 increases regularly with increasing Cr, V and Fe while c remains constant. R.A.H.

BUKIN (G. V.), ELISEEV (A. V.), MATROSOV (V. N.), SOLNTSEV (V. P.), KHARCHENKO (E. I.), TSVETKOV (E. G.). *The growth and examination of optical properties of gem alexandrite.* In: Inhomogeneity of Minerals and Crystal Growth; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed.

Sidorenko (A. V.) *et al.,* Academy of Sciences of the U.S.S.R., Leningrad, 317-28, 4 figs, 1 photo, 1980. (In Russian, with English abstract.)

Crystals of alexandrite 100 × 20 × 10 mm in size were grown by the Czochralski method on orientated seeds from melt stoichiometric to chrysoberyl with V_2O_3, Cr_2O_3 and Fe_2O_3 doping. The isomorphous admixture of Cr_{3+} ions colours the crystals cherry-red in the direction 001, blue-green on 010, and yellow-green on 100.
P.Br.

Collins (A. T.). *Farbzentren in Diamanten.* (Colour centres in diamonds.) Z.Dt.Gemmol.Ges., **31**, 3, 157-92, 19 graphs, 1982.

This is a translation from the article published in J.Gemm., 1982, **XVIII**, 1, 37-75. E.S.

Datta Gupta (S.). *A note on the inclusions in diamonds from Panna area, Madhya Pradesh and Jungel Valley, Uttar Pradesh.* Indian Minerals, **35**, 3, 35, 1981.

Microscopic studies on 117 diamonds were carried out; garnet, magnetite, olivine, calcite, ilmenite and chrome diopside were found as inclusions. In general diamonds from India are more free from inclusions than those from other areas.
M.O'D.

Délé (M. L.), Dhamelincourt (P.), Schubnel (H. J.). *Application de la microsonde Raman-laser à l'identification d'inclusions dans différentes gemmes.* (Application of the Raman-laser probe to identify inclusions in various gemstones.) In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 5-17, 12 figs, 1980.

The Raman-laser probe has been used to study micro-inclusions in gemstones. Some details are given of pargasite in sapphire, sphalerite and calcite in ruby, feldspar in aquamarine, monazite, zircon and britholite in sapphire, apatite in garnet, and liquid and gaseous CO_2 in beryl. R.A.H.

Deshpande (M. L.). *Diamond bearing kimberlites.* Indian Minerals, **34**, 1, 1-9, 1980.

A general account of diamond-bearing formations on a world-wide scale is given. M.O'D.

Diehl (R.). *Edelstein-Nachahmungen.* (Imitation gemstones.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 43-50, 2 figs, 1981.

A review of glass gemstone imitations and composite stones. M.O'D.

Diehl (R.). *Möglichkeiten der Edelsteindiagnose mit Hilfe der Röntgentopographie.* (Possibilities of gem identification with the help of x-ray topography.) Z.Dt.Gemmol.Ges., **31**, 1/2, 3-22, 30 figs, bibl., 1982.

In the course of crystal growth, defects such as dislocation or small angle boundaries are incorporated in the crystal lattice. These defects can be highly diagnostic for the growth method, whether synthetic or natural. The defect structure is shown by means of x-ray topography, as crystal defects generate characteristic intensity contrasts during x-ray diffraction. The potential of x-ray topography to fingerprint gemstones, especially diamonds, is discussed. Modern imaging techniques include projection, section and surface reflection topography. E.S.

FOORD (E. E.), ERD (R. C.), HUNT (G. R.). *New data for jeremejevite.* Canadian Mineralogist, **19**, 303-10, 1981.

A new study of material from the two known localities of Mt Soktuj, U.S.S.R. and Cape Cross, Namibia, has given the composition as $Al_6B_5O_{15}F_3$ with a hardness of 7½, SG of 3.288. Refractive indices are 1.644, 1.637. M.O'D.

FRÈRE (A.). *Proportionen bei Diamant-Brillanten.* (Proportions of brilliant-cut diamonds.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 51-3, 1981.

The ideal proportions of the brilliant-cut for diamonds are illustrated. M.O'D.

GERUVOL (M. T.), ALKHAZOV (V. Yu.), YURGENSON (G. A.). *Mineralogy of pegmatite productive mineral complexes with precious stones in Nuristan (Democratic Republic of Afghanistan).* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 63-70, 1980. (In Russian, with English abstract.).

Brief details, including refractive indices, are given for various Nuristan gemstones which occur in the magmatic to hydrothermal stages of pegmatite bodies. Those described are beryl (aquamarine, vorobievite), tourmaline (schorl, indicolite, verdelite, achroite, dravite, uvite), and spodumene (kunzite, hiddenite, nuristanite). There is a wide development of cleavelandite, and veins and crusts of pink cookeite with spodumene and green tourmaline are indicative of the presence of gem varieties. R.A.H.

GRUTTMANN (K.). *Diamanten-gradierung.* (Diamond grading.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 49-51, 1 fig., 1979.

Brief scheme for diamond grading. M.O'D.

GÜBELIN (E. J.). *Neue Mikrosonden-Analysen von Mineral-Einschlüssen einschliesslich eines Rubins im Diamant.* (New electron microprobe analysis of mineral inclusions, including that of a ruby in diamond.) Z.Dt.Gemmol.Ges., **31**, 1/2, 23-40, 17 figs (16 in colour), 2 tables, bibl., 1982.

The mineral inclusions of nine diamonds are described. Two methods of exposure were used. In the first, the diamond host was crushed and the inclusion sorted out; in the second the diamond was cut down until the inclusion was exposed to the surface. In both cases the inclusions were analysed by means of an electron microprobe. In the first, mineral inclusions were subjected to further examination by x-ray, for instance for the determination of their structure. The results are described and with some samples the genetic significance of the inclusions is discussed. E.S.

GUNAWARDENE (M.), MERTENS (R.). *Die Edelsteine Thailands.* (The gems of Thailand.) Z.Dt.Gemmol.Ges., **31**, 3, 151-6, 8 figs in colour, 1 map, bibl., 1982.

Article on the occurrences of corundum in Thailand which can be subdivided into eluvial, alluvial and coluvial. The most famous occurrences are listed and mining methods used are shortly described. There seem to be about 200 000 lapidaries working in Thailand, mainly in Bangkok and Chanthaburi, not only working gem materials found locally, but also imported material from Sri Lanka, Colombia, Australia and Brazil. Synthetic stones are also worked, of some danger to the tourists, although lately some gemmological knowledge is being introduced to the Thais. E.S.

HÄNNI (H. A.). *Zur Erkennung diffusionsbehandelter Korunde.* (Identifying heat-treated corundums.) Z.Dt.Gemmol.Ges., **31**, 1/2, 49-57, 7 figs in colour, 1 table, bibl., 1982.

When dealing with heat-treated corundum, it is important to establish whether any foreign material has been added. In normal heat treatment no additional components are added to affect the colour. In diffusion heat treatment, trace impurities are inserted to stain the stone. Normal heat treatment results in a more or less even colour throughout the stone, while diffusion heat treatment results in a surface stain along a thin layer of approx. 0.2 mm depth. Repolishing can remove this layer. Heat treated and diffusion treated corundums can be distinguished by characteristic inclusions and surface features. The first signal to test is a dark circle along the girdle visible with the naked eye: this is where the stone is thinnest and the effect of the diffusion treatment strongest. E.S.

HÄNNI (H. A.). *Perlendiagnose mit Laue-Aufnahmen.* (Investigation of pearls with the help of diffraction x-ray patterns.) Z.Dt.Gemmol.Ges., **31**, 3, 131-42, 18 figs, bibl., 1982.

An English version of this article was published in J.Gemm., 1983, **XVIII**, 5, 386-400, under the title *The Influence of the Internal Structure of Pearl on Lauegrams.* E.S.

HÄNNI (H. A.), GUNAWARDENE (M.). *Untersuchungen an Titanit, einem für Sri Lanka neuen Edelstein.* (Investigations into titanite, a new gemstone in Sri Lanka.) Z.Dt.Gemmol.Ges., **31**, 1/2, 65-70, 2 figs in colour, 4 tables, bibl., 1982.

Generally sphenes from different sources do not show significant differences in content of major elements, but they can be distinguished by their different optical constants. The recently found brown to yellowish-green material from Sri Lanka has distinctive inclusions characteristic for this source. E.S.

HÄNNI (H. A.), KLEIN (H. H.). *Ein Smaragdvorkommen in Madagaskar.* (An emerald occurrence in Madagascar.) Z.Dt.Gemmol.Ges., **31**, 1/2, 71-7, 6 figs in colour, 1 table, 1 graph, bibl., 1982.

The new emerald mine Ankadilalana lies in the south-east of the island. Stones are found in mica schist and are similar to Zambian emeralds in colour (blue-green) and optical constants. There are some minor chemical differences, and they can also be identified by their inclusions, which can be brown biotite, muscovite, apatite, haematite, goethite, quartz, ilmenite, tourmaline, two-phase inclusions; there is also often some colour zoning. The mine is at present worked sporadically and with primitive technical means. E.S.

HAYNES (S. J.). *Turquoise color and supergene environment, Sar Cheshmeh, Iran.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.*, (see Book Review p.575 below), 105-10, 2 figs, 2 tables, 1980.

Turquoise occurs locally in the Sar Chesmeh porphyry copper deposit, where it is associated with a 20 cm wide quartz pebble dyke at the boundary between the supergene oxide and enrichment zones in the andesitic host rocks. Both blue and green varieties are found. The blue turquoise has H.5 with CuO 7.51, total Fe as

FeO 2.93%; whereas the green variety has H.6, CuO 6.51, FeO 6.86%. The green variety was partly due to the replacement of Cu by ferrous sulphate; the origin of the phosphate was probably the breakdown of apatite. R.A.H.

Ivanov (V. G.), Samoilov (V. S.), Sapozhnikov (A. N.), Kashayev (A. A.), Vinogradov (A. P.). *Mineralogy of lazurite deposits of the USSR.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review p.575 below), 97-104, 1980. (In Russian, with English Abstract.)

The mineralogy of the lazurite deposits of the near-Baikal region has been studied in detail. These rocks were produced by metasomatism at the contact between magnesian marbles and aluminosilicate rocks (syenites, nepheline syenites, etc.) in alkaline conditions at 520-605 °C. Chemical analyses and optical properties are given for lazurite (4), triclinic lazurite (2), hackmanite, afghanite and 'sulphide cancrinite'. The mineralogy of the cancrinite group is reviewed, and a division is proposed into (a) the cancrinite-vishnevite group with the formula $A_{6-8}B_{12}O_{24}X_{1-2}.nH_2O$, and (b) the afghanite group with fromula $A_{6-8}B_{12}O_{24}X_3.nH_2O$. From a crystal-chemistry viewpoint the afghanite group is intermediate in the feldspathoids between the sodalite and cancrinite groups. Analysis of triclinic lazurite gave SiO_2 31.84, Al_2O_3 27.41, Fe_2O_3 0.05, MgO 0.14, CaO 6.01, Na_2O 18.40, K_2O 0.51, SO_3 11.41, S 1.70, Cl 0.20, CO_2 1.50, H_2O 2.14, less O = Cl, S 0.90, = 100.41; RIα1.503, β1.509, γ1.509; SG 2.43; *a* 9.08, *b* 12.85, *c* 25.70Å. The 'sulphide cancrinite' gave SiO_2 31.1, Al_2O_3 24.4, Fe_2O_3 0.4, MgO 0.2, CaO 5.7, Na_2O 14.0, K_2O 1.5, SO_3 13.4, S 7.8, Cl 1.5, CO_2 1.56, H_2O 2.74, less O = Cl, S 4.2, = 100.1; RIω1.578, ε1.655; SG 2.56; *a* 12.85, *c* 10.69Å. R.A.H.

Korago (A. A.), Kalikov (V. N.), Golubev (B. F.). *New data on the composition of pearl found in the northwest of the USSR.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review p.575 below), 116-21, 2 figs, 1980. (In Russian, with English Abstract.)

Quantitative spectral analyses of freshwater pearls from NW. U.S.S.R. reveal microimpurities of Mg (0.01-0.12%), Mn (0.004-0.400%), Sr (0.1-0.3%), Ba (0.03-0.08%), Si (0.03-0.10%) and Al (0.01-0.03%). These microimpurities are found to be localized in the organic cement. R.A.H.

Lind (Th.), Schmetzer (K.). *Infrarotspektroskopie geschliffener Edelsteine, dargestellt am Beispiel von echten und synthetischen Amethysten.* (Infrared spectroscopy of cut gemstones shown using the example of natural and synthetic amethysts.) Z.Dt.Gemmol.Ges., **31**, 3, 143-50, 5 figs, bibl., 1982.

An English version of this article was published in J.Gemm., 1983, **XVIII**, 5, 411-20, under the title *A Method for Measuring the Infrared Spectra of Faceted Gems such as Natural and Synthetic Amethysts.* E.S.

Maschmeyer (D.), Lehmann (G.). *Ein Strahlungsdefekt als Ursache der Färbung bestimmter 'Rosenquarze'.* (A defect in radiation as cause of coloration in certain rose quartzes.) Z.Dt.Gemmol.Ges., **31**, 3, 117-24, 3 figs, bibl., 1982.

A radiation defect with an unpaired electron on an oxygen bridging between one substituted aluminium and phosphorus, each has been identified by electron paramagnetic resonance measurements as the cause of coloration of certain rose-coloured quartzes. No sign of lower stability compared to the smoky quartz centres was found. E.S.

METALIDI (S. V.), ZARITSKY (A. I.), TSYMBAL (S. N.), POTEBIYA (M. T.), KVASNITSA (V. N.), SLYSH (R. A.), YASVINSKY (B. I.). *Pervaya nakhodka almazov v konglomeratakh verkhnego proterozoya na territorii Vostochno Evropeiskoi platformy.* (The first discovery of diamonds in upper Proterozoic conglomerates on the East European Platform.) Mineralogicheskii Zhurnal, **4**, 3, 20-9, 6 figs, 1982. (In Russian, with English abstract.)

A description is given of the crystal morphology and physical properties of diamonds discovered for the first time on the south-western margin of the East European Platform [not more specifically located] in upper Proterozoic conglomerates which had formed during the 1500-1100 m.y. interval. Colourless or yellow-tinted crystals of octahedral habit predominate; colourless dodecahedral and cubic-dodecahedral crystals play a minor role, and crystals of cubic habit and intensely worn grains of ellipsoidal shape are very rarely encountered. From their physical characters, these diamonds are Type Ia, and only isolated grains are Type IIa. In colour, crystal morphology, and physical properties, these diamonds are indistinguishable from those quantitatively predominant in the kimberlites of other regions, for instance, Yakutia. The bedrock sources of the diamonds in the conglomerates examined were kimberlites with an age greater than 1100-1200 m.y.

D.A.B.

PETRUSENKO (S.), ARNAUDOV (V.). *Emeralds from desilicified pegmatites in Bulgaria.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.*, (see Book Review on p. 575 below), 74-9, 2 figs, 1980. (In Russian, with English abstract.)

The properties and paragenesis of beryls (including emeralds) in various pegmatites of the NW. Rhodope massif are described. The zonal desilicified pegmatites cutting ultrabasic rocks contains some 50 mineral species, including fuchsite, emerald, chrysoberyl, allanite, cyrtolite, apatite, garnet, fluorite, chromite and various sulphides. Beryl is commonly associated with quartz, apatite and garnet in the plagioclase-phlogopite zone; it ranges from light blue to green and emerald-green. Analysis of an emerald gave SiO_2 66.63, Al_2O_3 15.95, Cr_2O_3 0.04, Fe_2O_3 0.48, BeO 13.10, MgO 1.00, CaO 1.53, Na_2O 0.90, K_2O 0.07, Rb_2O 0.02, Cs_2O 0.06, H_2O^+ 1.16, H_2O^- 0.21, ign. loss (900 °C) 1.39, =99.54; RI ϵ 1.572-1.575, ω 1.572-1.580; SG 2.690-2.694. R.A.H.

PSCHICHHOLZ (D.). *Edelsteine Nordamerikas.* (North American gemstones.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 40-3, 5 figs, 1979.

Brief review of the major stones found on the North American continent.

M.O'D.

RAJARAMAN (S.). *A short note on the Williamson diamond mines, Mwadui, Shinyanga Region, Tanzania.* Indian Minerals, **33**, 1, 52, 1979.

A brief account of the diamond bearing body is given. M.O'D.

ROGOVA (V. P.). *Formation conditions of charoite rock—new stones for jewellery and carving.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 79-86, 1980. (In Russian, with English abstract.)

The occurrence of charoite-bearing rock in the K-rich alkaline syenites of the Murun massif in the Aldan region is described. K-Ca metasomatism has affected the igneous rocks, locally accompanied by the introduction of Fe, Ti, Ba, Sr, F and H_2O, which gave tinaksite, charoite, canasite and pectolite. Chemical analyses are reported for charoite (3), canasite and tinaksite. R.A.H.

ROSSOVSKY (L. N.), KONOVALENKO (S. I.). *Gemstones in the pegmatites of Hindukush, Southern Pamyrs and Western Himalayas.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 52-62, 1980. (In Russian, with English abstract.)

The pegmatites in this area include rare-metal pegmatites of medium depth which may contain kunzite, tourmaline, aquamarine and vorobievite (Cs-bearing beryl); the more deep-seated pegmatites yield sapphire, ruby and dravite. The gemstones in these rare-metal pegmatites were formed at the last stage of pegmatite formation by direct crystallization from pegmatite melt-solutions. Finds of deep blue, violet and pink corundum crystals are reported from the SW. Pamyrs; they are similar to the Himalayan sapphire deposits. R.A.H.

SACHANBINSKY (M.). *Mineralogy of chrysoprases from the deposits of Lower Silesia.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 128-40, 13 figs, 1980. (In Russian, with English abstract.)

Chrysoprase from the Skliary deposit and from the magnesite deposit at Vira, near Vroclav (Wroclaw), have been studied. At Skliary chrysoprase occurs in veins and druses in serpentinite; it ranges from opaque light green masses to uniformly fine-grained translucent dark green: *n* 1.447. NiO is the chromophore and amounts to 0.03-1.30%; mineralogically it consists of α-quartz with a minor amount of α-tridymite. The chrysoprase from Vira occurs as thinner veins and is somewhat lighter in colour; it has ω 1.543, ε 1.552, and x-rays show it to consist of chalcedony with NiO 1%. In both these Silesian chrysoprases the Ni is in the form of pimelite.
R.A.H.

SAVKEVICH (S. S.). *New developments in amber and other fossil resins: mineralogical studies.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review on p. 575 below), 17-28, 4 figs, 1980. (In Russian, with English abstract.)

Museum samples and recent finds of amber have been investigated by IR; many samples designated as amber (succinite) are not amber in the strict sense and are of no value for jewellery. However, fossil resins possessing good mechanical and decorative properties, fit for jewellery, occur in Sakhalin and the Transcaucasus; these are rumanite analogues. Geochemical conditions for the fossilization of resins and the formation of succinite, rumanite and schraufite are outlined. Further mineralogical work is necessary to reclassify museum collections of amber and other resins. R.A.H.

SCHMETZER (K.). *Absorptionsspektren und Farben Vanadium- und Chromhaltiger Minerale.* (Absorption spectra and colours of minerals containing vanadium and chrome.) Z.Dt.Gemmol.Ges., **31**, 3, 125-30, 6 graphs, bibl., 1982.

The position of the absorption maxima of V^{3+} and Cr^{3+} in silicates and oxides is mainly dependent on the crystal field parameter in the vanadium-oxygen and chromium-oxygen octahedron respectively. A decrease of this parameter as well as a shift of the absorption bands to smaller wavelength numbers (greater wavelengths) is caused either by lattice expansion or by a contra-polarization effect. The colour of vanadium and chromium containing minerals (green and blue or green and red) is explained by the position of the absorption maxima of V^{3+} and Cr^{3+} in the visible region. E.S.

SCHMETZER (K.). *Ein ungewöhnlicher Granat aus dem Umba-Tal, Tansania.* (An unusual garnet from Umba Valley, Tanzania.) Z.Dt.Gemmol.Ges., **31**, 1/2, 59-64, 3 figs (1 in colour), 2 tables, bibl., 1982.

An English version of this article was published in J.Gemm., 1982, **XVIII**, 3, 194-200. E.S.

SCHMETZER (K.), BANK (H.). *Untersuchungen an Exemplaren der 'Smaragd-Vollsynthese' von Lechleitner.* (Investigation of specimens of the Lechleitner fully synthetic emeralds.) Z.Dt.Gemmol.Ges., **31**, 1/2, 79-80, 1 table, bibl., 1982.

The chromium content of the synthetic Lechleitner emeralds was found to vary between 0.84-0.40% Cr_2O_3, much lower than that of the synthetic emerald coat grown on colourless beryl seeds by the same producer. The fully synthetic stones had RI between 1.566-1.562 and 1.562-1.559. E.S.

SCHMETZER (K.), BANK (H.). *Gelbgrüner Grossular aus Ostafrika.* (Yellow-green grossularite from East Africa.) Z.Dt.Gemmol.Ges., **31**, 1/2, 81-4, 1 fig in colour, 1 graph, 2 tables, bibl., 1982.

The yellowish-green grossularite from East Africa was found to consist of 94.6% grossularite, 2.3% pyrope, 2.3% andradite, 0.7% spessartine and 0.1% goldmanite. The colour was caused by V^{3+}, Fe^{3+} and Mn^{2+}. RI 1.740; SG 3.68; a_o 11.858Å. E.S.

SHATSKY (V. S.), LEBEDEV (A. S.), KLJAKHIN (V. A.). *Micromorphology of crystals of synthetic hydrothermal emerald.* In: Inhomogeneity of Minerals and Crystal Growth; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Sidorenko (A. V.) *et al.*, Academy of Sciences of the USSR, Leningrad, 255-61, 6 figs, 1980 (In Russian, with English Abstract.)

The micromorphology of emerald crystals grown in hydrothermal conditions was investigated. The crystals have the following faces: $000\bar{1}$, $10\bar{1}0$, $11\bar{2}1$, $11\bar{2}0$, and $10\bar{1}1$. The flaky-spiral mechanism of growth is characteristic of all the faces of the crystals studied and is in agreement with the data from microcrystallomorphological investigations. The centres of spiral generation are shown to be microcrystals of beryl or foreign particles adhering to a face. It is noted that there is no essential difference between the growth mechanisms of natural and synthetic beryls. P.Br.

SINGH (K. N.). *On the occurrence of semi-precious tourmaline in the crystalline formation of Dudhatoll District Pauri, and Chamoli, Uttar Pradesh.* Indian Minerals, **32**, 2, 28-33, 4 figs, 1978.

Pale-yellow transparent to translucent tourmaline has been found in a muscovite schist and a darker, yellowish-brown variety in a pegmatite. Mode of occurrence of dravite is discussed. M.O'D.

STANEK (J.). *Two types of beryllium pegmatites with gemstones in Northern Moravia, Czechoslavakia.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.*, (see Book Review p.575 below), 70-4, 1980. (In Russian, with English Abstract.)

Syntectonic pegmatites in this area contain albite, quartz, muscovite and sillimanite but are lacking K-feldspar; chrysoberyl occurs, but beryl is rare. The post-tectonic pegmatites contain beryl of two generations; early beryl forms large yellowish crystals associated with K-feldspar, whereas the later beryl is smaller and occurs as aquamarine associated with sugar-like albite. Bertrandite, bavenite, euclase and milarite have also been found in this type of pegmatite, but chrysoberyl is very rare. R.A.H.

SUPERCHI (M.). *Gemmology as a master academic science, not a part of mineralogy: general principles and concepts.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.*, (see Book Review p.575 below), 140-50, 1 fig., 1980.

A syllabus for a course in gemmology is outlined. Chromaticity diagrams are discussed, and it is suggested that the best scheme of arrangement for gemstones in a museum display is by colour. R.A.H.

SUTURIN (A. N.), ZAMALETDINOV (R. S.), LETNIKOV (F. A.), SEKERIN (A.P.), BURMAKINA (G. V.), SUTURINA (T. A.), PLATONOV (A. N.), BELITCHENKO (V. P.), VOKHMENTSEV (A. Ya.). *Mineralogy and genesis of nephrites in the USSR.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.*, (see Book Review p.575 below), 87-97, 2 figs, 1980. (In Russian, with English Abstract.)

The nature of the colouring and quantitative estimates of the colour (in *xyz* CJE co-ordinates) of nephrites from a wide range of localities have been investigated by optical transition and reflection spectra and Mössbauer, IR and EPR spectroscopy. Chemical analyses are reported for nephrites from 14 deposits and determination of the chromophoric trace elements (Cr, Ni, Co, V, Ti) are tabulated for 12 specimens. The colour of nephrite is due to Cr^{3+} and Fe^{2+} ions occupying distorted octahedral positions instead of Mg^{2+}. Nephrite commonly forms as a result of infiltration-diffusion Ca-metasomatism, along antigorite serpentinite fibres at the contact with gabbroic or granitic rocks. R.A.H.

TAKUBO (H.), KITAMURA (Y.), KUME (S.), KOISUMI (M.). *Preparation of star-ruby containing large crystals of rutile. Preliminary investigation.* In: Inhomogeneity of Minerals and Crystal Growth; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Sidorenko (A. V.) *et al.*, Academy of Sciences of the USSR, Leningrad, 305-9, 2 figs, 3 photos, 1980.

A method for preparing rutile-bearing ruby crystals is described in detail and the results of microscopic and x-ray observations of the synthetic crystals are presented. It is concluded that if appropriate controls on *T* variation and Ti-concentration are maintained, it will be possible to make synthetic star-ruby similar in both external and internal appearance to a natural star-ruby of first grade. P.Br.

TOMBS (G. A.). *Heat treatment of Australian blue sapphires.* Z.Dt.Gemmol.Ges., **31**, 1/2, 41-8, 24 figs in colour, 1982.

The author discusses the difficulty of distinguishing untreated and heat-treated sapphires. In cut and polished heat-treated stones the main identifying feature (if present) is (1) the presence of vacant tubes under dark field illumination, (2) sharpness of zonal banding combined with the contrast of areas almost vacant of colour between coloured zones and (3) slight loss of dichroism as compared to untreated specimens of Australian blue sapphire which is almost always strong blue-green. In some heat-treated Ceylon sapphires one finds occasionally a gas bubble in association with a residual inclusion. E.S.

VAKANYATZ (B.), ZARIĆ (P.). *Gemstones in Yugoslavia.* In: Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, ed. Bukanov (V. V.) *et al.,* (see Book Review p.575 below), 44-52, 1980. (In Russian, with English abstract.)

Yugoslavian gem minerals occur in various types of rock: (1) pegmatites (beryl, aquamarine, spodumene, zircon, amethyst, citrine, morion, rose quartz and amazonite), (2) metamorphic complexes (ruby, garnet, amethyst, kyanite, citrine, jasper), (3) volcanogenic complexes (opal, amethyst, agate, jasper), (4) ultrabasic rocks (chrysoprase, serpentine), and (5) other occurrences (vesuvianite, garnet, epidote, rhodonite, onyx). R.A.H.

WILD (K. E.). *Das Edelsteingraveurgewerbe in Idar-Oberstein.* (Gemstone carving in Idar-Oberstein.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 31-9, 7 figs, 1979.

Details of gemstone carving in the town of Idar-Oberstein are given. M.O'D.

Bodenschätze sibiriens. (Siberia's mineral wealth.) Veröffentlichungen aus dem Naturhistorischen Museum Wien, neue Folge, **20**, illus. in colour, 1982.

Some gemstones found in Siberia are described and illustrated. M.O'D.

Diamantgewinnung in der Premier Mine. (Mining at the Premier Mine.) Diebeners Goldschmiede- und Uhrmacher- Jahrbuch, 44-8, 1 fig., 1979.

A brief history of the Premier mine and of some of the stones recovered from it. M.O'D.

Gem & jewelry fact sheets. American Gem Society, **2**, 1, 1982.

A specimen issue of this series was examined. The contents were market orientated with comments on pearl (considerable demand, stable prices), on coloured stones and precious metals. No great detail is given and in this respect readers would be better served by the commercial section of *Jewelers' Circular-Keystone.* M.O'D.

BOOK REVIEWS

BUKANOV (V. V.), SIDORENKO (A. V.), SOBOLEV (V. S.), RUNDKWIST (D. W.), SHAFRANOWSKY (I. I.), SAVKEVICH (S. S.), eds. *Gem Minerals; Proceedings of the XI General Meeting of IMA, Novosibirsk, 4-10 September, 1978.* Academy of Sciences of the U.S.S.R., Leningrad, 1980. pp.152. 37 figs, 14 photos. Price 70 k.

This book contains 18 papers presented to the I.M.A. Working Group on Gem Materials. Many are in Russian, but all except one have abstracts in English. Abstracts of each paper appear in Gemmological Abstracts. R.A.H.

GAY (P.). *An introduction to crystal optics.* Longmans, London, 1982. pp.ix, 262. £6.95.

First published in 1967, the present text is a re-issue with small modifications including a minimal up-dating of the bibliography. Designed for students of mineralogy, the general level is above that necessary for the adequate testing of gemstones, but diligent students will not find the concepts and applications too difficult should they wish to pursue their studies into the wider world of mineralogy. Diagrams are clear and the text lucid. I should certainly recommend this work both for those reasons and for the modest price. M.O'D.

SCALISI (P.), COOK (D.). *Classic mineral localities of the world: Asia and Australia.* Van Nostrand Reinhold, New York, 1982. pp.xvii, 226. Illus. in black-and-white and in colour. £25.10.

This is to be the first of a series intended eventually to cover the mineral deposits of the world, or rather those deposits which include materials of importance to the collector as well as to the economic geologist. Japan, India, Burma and the U.S.S.R. are among the countries covered by this volume, and in each case the chief deposits are described with profuse illustrations of characteristic crystal forms. Most of these are reproduced from Goldschmidt's *Atlas der Krystallformen,* published for the first time in 1913 and now, in its complete form of 9 volumes, virtually unobtainable. Though there is a short list of references to each chapter and a fairly short general bibliography, there is something lacking from the work in that many of the descriptions are sketchy and clearly reproduced from other work, in some cases from an original of some age. This prevents the reader from knowing exactly how up to date the descriptions are and also how scholarly is the criticism and selection employed on so vast a mass of original data. Though most readable and attractively produced the general air given is that of the amateur collector rather than the scholar; far more attention should have been paid to the presentation of detail, especially with respect to dates. But none the less it is very good to have such material, albeit in a somewhat imperfect form and we look forward to further volumes in the series. M.O'D.

ASSOCIATION NOTICES

OBITUARY

Mr V. G. Jones, F.G.A. (D.1953), London, died on 27th December, 1982.

Mr Bapusaheb Shamrao Mahajan, F.G.A. (D.1954), Bombay, India, died on 6th January, 1983.

Mr Theo Stern, F.G.A. (D.1949), London, died on 4th February, 1983.

NEWS OF FELLOWS

On 12th November, 1982, Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., gave a talk on mineral identification to the Cheltenham Mineral and Geological Society.

On 8th January, 1983, Mr Peter G. Read, C.Eng., F.G.A., gave an illustrated talk to the Wessex Branch of the N.A.G. at the Wessex Hotel, Bournemouth, based on his recent visit to the new underground workings at the Finsch diamond mine in South Africa.

On 10th January, 1983, Mr W. H. Pluckrose, R.J.Dip., F.G.A., gave a talk on gemmological instruments and the identification of gemstones to the Ulster Jewellers' Association. Four mini-laboratories were set up and everyone present had the opportunity of using the instruments.

Mr HARRY WHEELER'S RETIREMENT

A full report (with photographs) of the parties held in connexion with Mr Harry Wheeler's retirement last year will be found by members of the Association in the Annual Report for 1982 accompanying the Notice of the Annual General Meeting.

MEMBERS' MEETINGS

Midlands Branch

On 27th January, 1983, at the Society of Friends, Dr Johnson's House, Bull Street, Birmingham, Mr P. West, F.G.A. and Ms Carole Gibbs addressed the meeting on 'Turtles and tortoiseshell'.

On 24th February, 1983, at the Society of Friends, Dr J. B. Nelson, F.G.S., F.Inst.P., F.G.A., gave a talk entitled 'Colour perception and measurement of gemstones'.

North-West Branch

On 20th January, 1983, at Church House, Hanover Street, Liverpool 1, Mr A. Hodgkinson, F.G.A., gave an illustrated talk entitled 'Gemmology and the shop'.

On 24th February, 1983, at the Liverpool Museum, William Brown Street, a talk was given by Dr J. Trecise on two collections of gemstones displayed at the Museum.

South Yorkshire & District Branch

On 20th January, 1983, at the Sheffield City Polytechnic, the Annual General Meeting was held, at which Miss J. I. Platts, F.G.A., and Mr J. I. Reynolds, F.G.A., were elected Chairman and Secretary respectively. The A.G.M. was followed by an illustrated talk by Mr N. Grist, F.G.A., entitled 'History of Jewellery'.

ANNUAL REUNION OF MEMBERS AND PRESENTATION OF AWARDS

The Annual Reunion of Members and the Presentation of Awards took place at Goldsmiths' Hall on 15th November, 1982.

The Chairman, Mr David Callaghan, F.G.A., who presided, reflected on a year of change and on the development and progress of the Association. It was both a sad and a happy year; sad because Harry Wheeler, F.G.A., had reached his retirement after serving the Association for 48 years and being its Secretary since 1973, and happy because we had found his replacement in Con Lenan, F.G.A. In 1934, when Harry joined the Association, 21 students gained their Diploma and were all from the U.K.: this year 300 students from the U.K. and Overseas gained their Diplomas and 102 centres were set up in many countries of the world, where both Preliminary and Diploma students were able to sit their examination. Through his many efforts, Harry could look back on a splendid achievement in his final year.

'The Association continues to be recognized as the premier gemmological association internationally and it is our intention to perpetuate this recognition. To help expand our interests and to develop, an Executive Committee will be formed and an Education Committee has been set up.'

The Chairman then introduced Mr E. A. Thomson, President of the Coloured Stones Commission of C.I.B.J.O. and Vice-Chairman of the London Chamber of Commerce Executive Committee of the Diamond Pearl and Precious Stone Section, one of whose functions is to control the Gem Testing Laboratory. Mr Thomson thereupon presented the awards and delivered the address which is recorded in full below.

The President, Sir Frank Claringbull, then thanked Mr Thomson for presenting the awards, and the proceedings were concluded.

ADDRESS OF MR E. A. THOMSON, PRESIDENT OF THE COLOURED STONES COMMISSION OF C.I.B.J.O.

Mr Chairman, Ladies and Gentlemen,

Firstly, I wish to congratulate once again all those to whom I have given their Diplomas tonight and also, of course, those who have qualified and have been unable to join us. The G.A. Diploma is not a qualification obtained easily, and I do appreciate the really hard work you have done to pass this difficult test.

Secondly, I also congratulate you on deciding to study and qualify in this really exciting and colourful world of coloured stones—a world that is getting more and more difficult for the professionals as constant discoveries of new varieties of precious stones and cleverer and cleverer synthetic stones hit the market. That is why we need more and more knowledge and expertise coming into the trade at all levels.

A word of warning, however; please do not think that because you have got your Diploma you are now professional experts. You are not. But what you have got is a basic knowledge on which you can advance. Full knowledge only comes with constant practice and handling of stones. Dealing in your own office with your instruments around you is one thing, but the test is when you are outside your environment and you just have your loupe and tweezers. That is when you develop a feel and a second sense of the stones. The background knowledge you now have will be a great help, and the trade does need more knowledgeable and practical gemmologists, which I hope you all will become.

I am, as you know, President of the Coloured Stones Commission of C.I.B.J.O., that is the International Confederation of Jewellery, Silverware, Diamonds and Precious Stones. This is a controlling body for nineteen countries on the ethics of the trade, laying down the definitions, rules of application and permitted list of gemstone names. These are in our Blue Book, which lays these out in four languages, of which English is the original text. It is now in the course of publication, and I would suggest that directly it is available you obtain a copy and base your actions on it. In that way you will help our gemmology and trade both at home and internationally.

Lastly, under another hat I am at present Vice-Chairman of the L.C.C. Executive Committee of the Diamond, Precious Stone and Pearl Section, one of whose functions is the control of our British Gem Testing Laboratory. This Laboratory was the home of Anderson, Webster, Payne and Farn and is internationally respected. Now under the control of Ken Scarratt it is in the process of moving to larger and more prestigious surroundings on the corner of Greville Street and Saffron Hill. The Laboratory is a recognized C.I.B.J.O. Laboratory and not a commercial undertaking. It is and has to remain an independent and non-profit-making concern in order to make correct and unbiased judgements. It now has a highly trained, young and enthusiastic team. Please do make use of the Laboratory whenever you find that more advanced knowledge and equipment are needed to test stones with which you may have problems in the future, and in particular keep them informed of any new discoveries you make yourselves or new information that comes your way. It is vital that our national Laboratory is kept fully informed to hold its rightly esteemed position world wide.

Once again I sincerely congratulate each and every one of you, and I am sure you will permit me to give a special personal congratulation to my daughter-in-law, Jenny Thomson, F.G.A.

ANNUAL GENERAL MEETING, 1983

The Association's 52nd Annual General Meeting will be held at Kensington Town Hall on Wednesday, 4th May, 1983, at 6 p.m., followed by a buffet supper.

RESIDENTIAL WEEK-END COURSE AT CHICHESTER

A residential course for second-year G.A. Correspondence Course students, covering the use of gem-testing instruments, will be held at West Dean College on 17th to 19th June, 1983, (Friday evening to Sunday afternoon). The Course Tutor will be Mr Peter G. Read, C.Eng., F.G.A., and full particulars may be obtained from the Course Supervisor, Miss Susan Overman, West Dean College, West Dean, Chichester, West Sussex, PO18 0QZ—telephone (0243) 63301.

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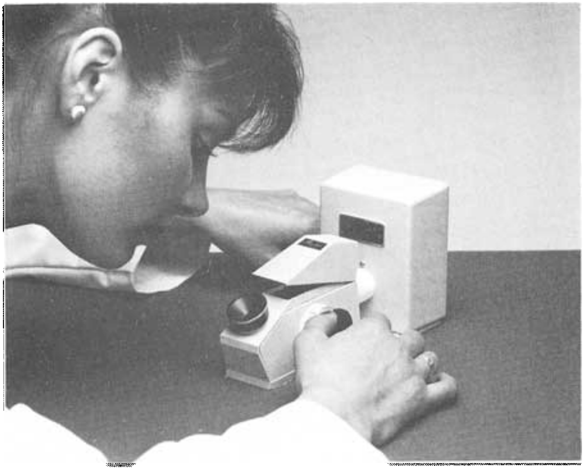

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Historical Note

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

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

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

Notes for Contributors

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

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

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

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