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*and*

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GEMMOLOGICAL ASSOCIATION
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# GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

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INCLUSIONS IN SANDAWANA EMERALDS

*Lines of parallel fissures.*

*Typical "splashes."*

*Tremolite fibres.*

*Tremolite fibres.*

*Flat liquid film.*

*Brownish garnet with halo.*

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# EMERALDS FROM SANDAWANA

*By E. J. GÜBELIN, Ph.D., C.G., F.G.A.*

IT is most pleasant and gratifying that even in this atomic age of sophistication and technique, which seems to foresee everything by means of reason and computation, the realm of gemstones has not lost its nimbus of romance and adventure and that now and then new gems or new gem localities are found.

In October, 1956, the prospectors, Laurence Contat and Cornelius Oosthuizen, who had been attracted by the advantageous offers made to prospectors by the Rhodesian Government, happened to investigate the rocks near the valley of Sandawana in the Belingwe district of Southern Rhodesia together with their " prospecting boys" —native helpers—trained to look for unusual rock yields. Having a good knowledge of geology, Contat and Oosthuizen decided to concentrate on a small area showing the most favourable conditions for the occurrence of large pegmatites. They were not disappointed. Within ten days after their arrival they discovered the first emeralds and they ordered their boys to fan out in a more intensified search, but it was seven months before they struck the second deposit— a rich one this time.

The first samples were taken to Mr. A. E. Phaup of the Geological Survey Office at Gwelo, who confirmed the gem's nature.

The Department of Mines was then informed, but the Southern Rhodesian Government was not very much interested in this find until they heard that Contat and Oosthuizen had sent emeralds worth about US$15,000 to New York. An ordinance was then passed in February, 1958, by which all precious stones in Rhodesia were subject to the same control regulations as those in South Africa. At first the rumours mentioned a diamond find, but when the law was gazetted on 25th April, 1958, it was known everywhere that emeralds had been found.

The writer was then asked to investigate these newly found emeralds in order to find out their local peculiarities and other typical characteristics that would distinguish them from emeralds from the already known sources which have been thoroughly examined and are known to well-informed gemmologists. An initial lot of 92 stones was submitted to him and it appeared appropriate to carry out an extensive study so that comparison could be made between these new emeralds and those of other provenance with the hope of ascertaining some locally typical features which might differentiate them from others.

## Occurrence

The emerald occurrence of Sandawana is in very isolated country on the south side of the Mweza Range of mountains and so far only little geological and petrological investigation has been carried out. The position is roughly longitude 29° 56′ east and latitude 20° 55′ south. The Mweza Range is composed of very old pre-Cambrian rocks extending for some 45 miles (72 km.) east-north-east in a huge area of granitic rocks that are also of pre-Cambrian age. The range is two to three miles wide (3 to 5 km.) and rises about 500-800 ft. (150 to 200 m.) above the surrounding country.

The metamorphic rocks forming the range belong to the Bulawayan System of Southern Rhodesia and are probably 2,700 to 3,100 million years old. They have been tightly folded into a complex structure with a general direction east-north-east and very steep, almost perpendicular. On the flanks of the range the rocks are basaltic lavas and dolerites that have been metamorphosed into greenstones and epidiorites composed of amphiboles (chiefly hornblende), sodic feldspar and clinozoisite. The core of the range is a variety of banded sedimentary rocks that have been metamorphosed and now contain micas, almandine garnet and various amphiboles, including grunerite. They consist of banded ironstones, phyllites, sericite-quartz schists and quartzites. Very long, narrow sills of peridotites were intruded into these older rocks and have been altered into serpentine and related rocks.

The rocks forming the range were folded, metamorphosed and intruded by granitic rocks at the end of the Bulawayan times and again at the end of Shamvian times about 2,650 million years ago. A batholitic mass of granitic rocks extends for over 20 miles (32 km.) in all directions from the range and small stocks were intruded into the schists of the range and the gneissic granite contact around it. The emeralds have been found associated with the pegmatite dykes in the tremolite schists. The majority of the dykes probably belong to the end of the Shamvian System and contain beryl, lepidolite, petalite, spodumene and tantalum-niobium minerals. The intrusion of the granitic magma into the tremolite schists caused contact metamorphosis of the two rocks through which new minerals were formed, the most valuable of which is the emerald. It is most instructive to study the formation of emerald as shown by this particular deposit, which seems to have much in common with the emerald-bearing rocks at Tokowaya (Ural), Transvaal, Ajmer in India and the Habachtal in Austria. There, same as here, the circumstances of formation and the chemical composition of the various rocks explain the formation of the emerald. The beryllium is an element that emerges from the granite. The tremolite schists do not carry any beryllium. The granite has also brought free silica, while chromium, which acts as a pigment, under favourable conditions accompanies basic rocks of the gabbro group, which are poor in silica ; it is present in minute quantities in the altered serpentine rocks and was carried up from great depths by the peridotite. In the course of the numerous successive intrusions, alterations and re-formations, the chromium got into the process of contact-metamorphosis, thus becoming responsible for the superb colour of the Sandawana emeralds.

## Appearance

Up to the day of writing these notes, no clearly and well developed crystals could be obtained from the new mine, but a report from Sandawana mentioned that well developed, euhedral crystals are extremely rare and that most of the crystals found are so thickly encrusted with limonite that no clear crystal faces nor their combinations could be observed, let alone measured. Therefore, the present examination of Sandawana emeralds could not include a study of the crystal habit and its possible local peculiarities. Of the 92 cut specimens received for carrying out the study, all displayed a superb verdant emerald green with a brightening yellow glint that renders the stones very vivid. To the naked eye the gems appear amazingly clean and only in a few specimens denser concentrations of inclusions altered the colour into a more bluish green hue.

Unfortunately the majority of the rough material is so badly broken or occurring as small crystals only, that most of the Sandawana emeralds reaching the market of cut gems will be below 1/4 carat in weight, although larger gems may appear as the exploitation of the vast deposit progresses. The largest Sandawana emerald obtained to date weighs 1·56 carat as a cut gem. It is, however, welcome news to the jeweller that even small calibre sizes, weighing only a few points, retain the unrivalled beauty of colour, which seems to be the outstanding virtue of the Sandawana emeralds.

## Chemical Composition

A small amount of rough material made it possible to analyse the chemical composition, which was determined jointly by a chemical as well as a spectrographic analysis. On account of the tiny quantity at the writer's disposal, the three main components had to be determined with a piece weighing as little as 50 mg., which somewhat impaired the accuracy to be expected. (It may be mentioned that even with normal quantities of 0·5-1·0 gm. the analysis of beryl is no easy task.) The chemical analysis supplemented by the spectrographic examination gave the following result :—

| | | |
|---|---|---|
| $SiO_2$ | 65% | (67%) |
| $Al_2O_3$ | 14·2 | (19%) |
| BeO | 13·6 | (14%) |
| $Cr_2O_3$ | 0·5 | |
| $Fe_2O_3$ | 0·5 | |
| MgO | 3·0 | |
| $Na_2O$ | 2·0 | |
| $Li_2O$ | 0·15 | |
| Total | 99% | |

TABLE I

| *Sandawana Emerald* | *Refractive Indices* | | | *Specific Gravity* | *Absorption* | *Dichroism* | *Chelsea Filter* | *Fluorescence* | | | *Inclusions* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ω | ε | Δ | | | | | *u-v 3650* | *u-v 2537* | *Stokes' Fluoroscope* | |
| No. 1 | 1·5949 | 1·5880 | ·0069 | 2·7496 | Blurred lines at 6830, 6800 6620, 6375 | Bluish green Yellowish green | Very faint red | Inert | Inert | Glowing pale red | System of fissures similar to Fig. 6. |
| No. 2 | 1·5955 | 1·5884 | ·0071 | 2·7414 | Normal | ,, | ,, | ,, | ,, | ,, | Two tremolite needles |
| No. 3 | 1·5948 | 1·5877 | ·0071 | 2·7525 | ,, | ,, | ,, | ,, | ,, | ,, | System of fissures and tremolite needle piercing fissures. Fig. 6. |
| No. 4 | 1·5940 | 1·5871 | ·0069 | 2·7623 | ,, | ,, | ,, | ,, | ,, | ,, | Sheaths of bent tremolite needles. Fig. 2. |
| No. 5 | 1·5925 | 1·5856 | ·0069 | 2·7570 | ,, | ,, | ,, | ,, | ,, | ,, | clean |
| No. 6 | 1·5934 | 1·5864 | ·0070 | 2·7470 | ,, | ,, | ,, | ,, | ,, | ,, | Tremolite needles long and short. Fig. 3. |
| No. 7 | 1·5877 | 1·5806 | ·0071 | 2·7525 | ,, | ,, | ,, | ,, | ,, | ,, | Healing fissures. Fig. 7 |
| No. 8 | 1·5935 | 1·5864 | ·0071 | 2·7684 | 6460 only | ,, | ,, | ,, | ,, | ,, | Splashes and patches. Figs. 4 and 5. |
| No. 9 | 1·5913 | 1·5843 | ·0070 | 2·7436 | Normal | ,, | ,, | ,, | ,, | ,, | Curiously disturbed structure. Fig. 6 |
| No. 10 | 1·5932 | 1·5861 | ·0071 | 2·7558 | ,, | ,, | ,, | ,, | ,, | ,, | Single, short tremolite needles, bundles of long tremolite needles. Fig. 1. |

The figures in parenthesis represent the theoretical values based on the formula :—

$Be_3Al_2Si_6O_{18}$

$SiO_2$ was determined by evaporating twice with HCl

$Al_2O_3$ was precipated as oxychinolate from an acetic solution

BeO was separated by means of $NH_3$ with pH 8-9

Cr, Fe, Mg, Na and Li were ascertained by means of a Jarrell-Ash Ebert plane grating spectrograph with direct current carbon arc and anodic irritation. The spectral lines used were: Cr 5204, Fe 4325, Mg 5167, Na 5688, Li 6103. The accuracy is 10-20 per cent of the result obtained. It is interesting that a relatively remarkable quantity of lithium is present, the percentage of which amounts to ·15 per cent.

PHYSICAL PROPERTIES

Of the 92 cut gems submitted, ten specimens of outstanding quality were selected, so that the greatest possible constancy of data was guaranteed. Table I shows the individual data obtained and comparison with the individual figures shows how minute the variations are.

The refractive indices were determined with an Abbé-Pulfrich total reflectometer which enables four decimals to be read. The readings are collected in Table I and it may be noticed that they vary individually between the extreme values of 1·5877-1·5949 for $\omega$ and from 1·5806 to 1·5884 for $\varepsilon$ with a slightly varying birefringence from ·0069 to ·0071.

With the intention of receiving even more reliable constants and simultaneously measuring the dispersion, the optical properties of a small, clear crystal prism were measured by means of the method of minimum deviation. A one-circle goniometer was set up in combination with a monochromator. The crystal prism was extraordinarily euhedral and displayed very flat and smooth prism faces, so that values of high accuracy could be expected. First the medium birefringence was determined from a series of measurements which showed little variation only and the arithmetical average was found to be ·0071. Then the mean value of the various individual measurements of $\omega$ and $\varepsilon$ was determined for each of the five wave-lengths that had been used and these values were then balanced with the average birefringent constant. This procedure resulted in the optical data compiled in Table II (the figures have been rounded off to the third decimal).

TABLE II

| *Line* | *B* | *D* | *E* | *F* | — | *Dispersion* |
|---|---|---|---|---|---|---|
| Wavelength | 687 | 589 | 527 | 486 | 455 | 687–455 |
| $\varepsilon = n\alpha$ | 1·583 | 1·586 | 1·589 | 1·592 | 1·594 | ·011 |
| $\omega = n\gamma$ | 1·590 | 1·593 | 1·596 | 1·599 | 1·601 | ·011 |
| $\Delta$ | 0·007 | 0·007 | 0·007 | 0·007 | 0·007 | |

None of these average figures differs by more than $\pm$·0002 from those actually measured. Hence the variation is very small. Perhaps one ought to have reckoned not only with a dispersion of the refractive indices ($n$), but also of the birefringence ($\Delta$). However, since no systematic alteration of the $\Delta$-values according to the wave-lengths could be observed, an effect of this kind (if any at all) may be too small to be noticed. Consequently, it may be assumed that the adjustment of the birefringence to ·0071 over the whole spectrum will hardly cause any mistake. Thus the most reliable figures for the optical data of emeralds from Sandawana can be given as :—

$$n_\omega = 1{\cdot}593\ ;\quad n_\varepsilon = 1{\cdot}586\ ;\quad \Delta = {\cdot}007$$

From Table II the reader may also derive that the relative dispersion B-F of this new emerald amounts to ·009. Comparison with Table I shows a rather good concurrence of these R.I. values with those of specimens Nos. 5, 6, 8 and 10. For further comparison emerald No. 5 was also examined by the method of minimum deviation and a similarly good agreement was obtained as the following figures were measured for the D-line :—

$$n_\omega = 1{\cdot}592\ ;\quad n_\varepsilon = 1{\cdot}586\ ;\quad \Delta = {\cdot}006$$

with a relative dispersion B-F of ·0085. At this place it may be interesting to compare the optical values of the Sandawana emeralds with those of other important sources as registered by Ph. Vogel, who probably carried out the most thorough study on the optical properties of emeralds from the main sources known then. In Table III the refractive indices of the Rhodesian Stones are the highest for all wavelengths. The emeralds from the Habachtal, the Ural, Transvaal, Colombia and Brazil follow with degrading values. The same diminution occurs with the birefringence. While the progress of the dispersion remains identical through all the wave-lengths for the emeralds from different sources, the numerical amount of the relative dispersion (B-F) varies in being similar for emeralds from Rhodesia, Colombia, Brazil and the Habachtal on one side and for those from the Ural and Transvaal on the other.

TABLE III

| *Locality* | | *Refractive Indices* | | | | *Dispersion* $B-F$ | *Birefringence* $\Delta_D$ |
|---|---|---|---|---|---|---|---|
| | | $n_B$ | $n_D$ | $n_E$ | $n_F$ | | |
| Sandawana | ω | 1·590 | 1·593 | 1·596 | 1·599 | ·009 | ·007 |
| | ε | 1·583 | 1·586 | 1·589 | 1·592 | ·009 | — |
| Habachtal | ω | 1·5859 | 1·5893 | 1·5925 | 1·5954 | ·0095 | ·0066 |
| | ε | 1·5794 | 1·5827 | 1·5856 | 1·5885 | ·0091 | — |
| Ural | ω | 1·5846 | 1·5881 | 1·5915 | 1·5946 | ·0100 | ·0066 |
| | ε | 1·5783 | 1·5815 | 1·5845 | 1·5880 | ·0097 | — |
| South Africa | ω | 1·5814 | 1·5850 | 1·5884 | 1·5914 | ·0100 | ·0063 |
| | ε | 1·5752 | 1·5787 | 1·5820 | 1·5846 | ·0094 | — |
| Colombia | ω | 1·5730 | 1·5762 | 1·5797 | 1·5825 | ·0095 | ·0056 |
| | ε | 1·5675 | 1·5706 | 1·5739 | 1·5767 | ·0092 | — |
| Brazil | ω | 1·5677 | 1·5712 | 1·5742 | 1·5772 | ·0095 | ·0049 |
| | ε | 1·5628 | 1·5663 | 1·5693 | 1·5720 | ·0092 | — |

With regard to the other optical properties, the Sandawana emeralds do not seem to show any anomaly or local peculiarity but appear to behave very similarly to their relatives from other deposits. Dichroism is distinct—displaying yellow-green for ω and bluish-green for ε. When viewed through the Chelsea colour filter the gems appear very weak red.

In the absorption spectrum the normal absorption lines show clearly at 6830, 6800, 6620, 6460, and 6370Å, as well as the characteristic band extending from 6300-5800Å with its absorption maximum near 6125Å, while the minimum is in the region of 5050Å. The absorption lines at 6370 and 6460Å usually just form the stronger border lines of the band extending between them. In one stone only the line at 6460Å was observed.

Although Sandawana emeralds do not react in the least when excited with u.v. light of short or long waves, it may easily be noticed that the stones are remarkably less transparent in short u.v. rays, and indeed examination with the u.v. absorption spectroscope revealed that they transmitted u.v.-light only down to 3200Å where complete absorption set in with a sharp cut off. As far as this phenomenon is concerned Sandawana emeralds behave like those from India. In the Stokes' fluoroscope (two-filter method) all specimens tested displayed a distinct fluorescence of glowing pale red colour.

The figures of the specific gravity were ascertained by means of the hydrostatic method, immersing the stones in ethylene dibromide and weighing very carefully with a semi-automatic Mettler balance Although all the stones examined were rather small, the remarkable freedom from any influential amount of inclusions ensured a rather good consistency of constants between the extreme values of 2·744 and 2·768 with a mean figure of 2·756. Thus the specific gravity of Sandawana emeralds ranks among the highest density figures known for emeralds and stands in conformity with the high refractive indices and great birefringence.

### Internal Characteristics

All the properties described above, though ranging among the highest ones for emeralds—are not sufficiently individual to serve

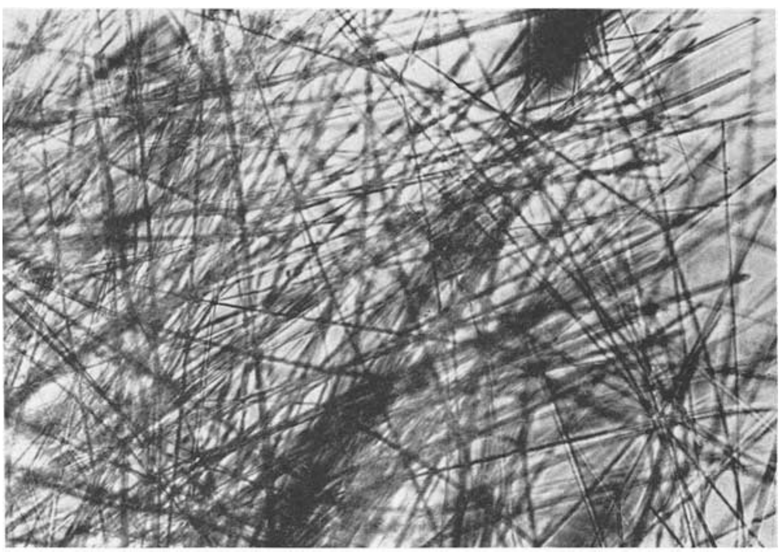

Fig. 1. *Dense accumulation of fine tremolite needles.* 125 ×.

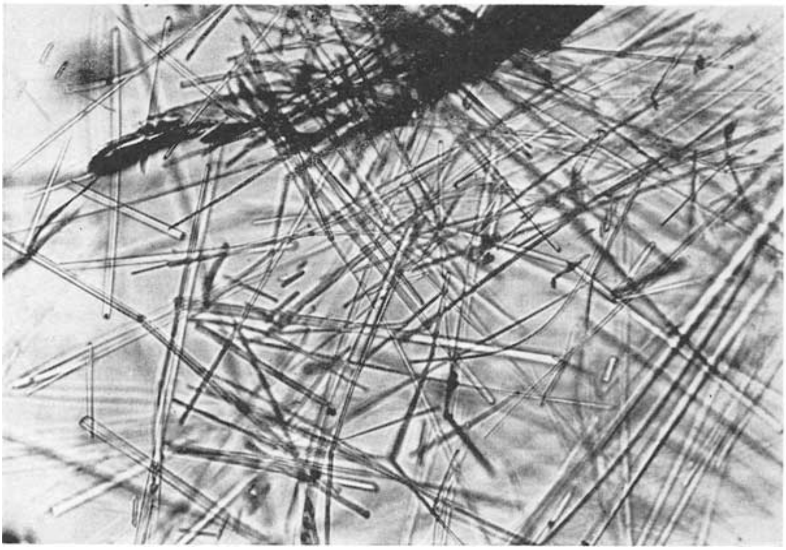

FIG. 2. *Long and short acicular rods of tremolite.* 125 ×.

as marks of identification of Sandawana emeralds or to distinguish them clearly from those of other localities. The constants of emeralds overlap in border cases, rendering it impossible to determine the origin of a given specimen, were it not for the unique internal birth-marks which in most cases point infallibly to the place of formation.

It was mentioned before that the Sandawana emeralds resulted from contact-metamorphosis between granitic magma and tremolite schists, and, as a matter of fact, acicular tremolite inclusions yield the most characteristic feature of their internal paragenesis. The gems of inferior quality teem with dense masses of short and long slender needles (Fig. 1), while in those of good quality the tremolites occur either as short pins lying criss-cross, or as very fine long fibres assembled as dense bundles or masses without any definite orientation at all (Fig. 2). Sometimes the short pins are brownish but usually all the tremolite needles are bluish-green, throwing upon the host emeralds a slight bluish cast when present in great quantities. Quite often these fibres are curved and sometimes they run through several disc-like cleavage fissures, leaving the impression of tiny flakes being threaded on silk.

The phenomenological picture of these tremolite inclusions resembles somewhat that shown by the emeralds from the actinolite schists in the Habachtal, and to those seeing it for the first time it may be most confusing. In Sandawana emeralds, however, the tremolite fibres are much finer, the occurrence of dense masses is rare and there are always short pins present (Fig. 3). Indeed, in the Rhodesian stones the tremolite fibres rather form bundles and are usually so fine that they may be compared with the well-known byssolite fibres in demantoid.

Already considerably more vivid and beautiful by nature than the emeralds from the Habachtal, the Sandawana emerald will always excel by its superior splendour and greater transparency since the tremolite needles as well as other inclusions are much rarer. The deposit in the Habachtal is almost exhausted and has never thrown many stones of good quality on the gem market, so that in future emeralds containing tremolite needles may with the greatest safety be considered as Sandawana emeralds because no other important emerald source is known to have its precious products teeming with tremolite fibres.

The tremolite needles are usually associated with other endogenetic minerals of minor importance. The most frequent and

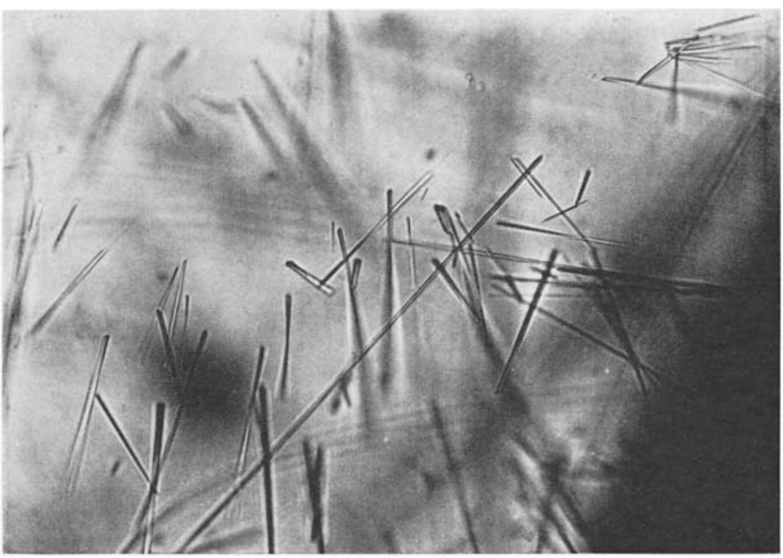

FIG. 3. *Tremolite needles of varying lengths.* 125 ×.

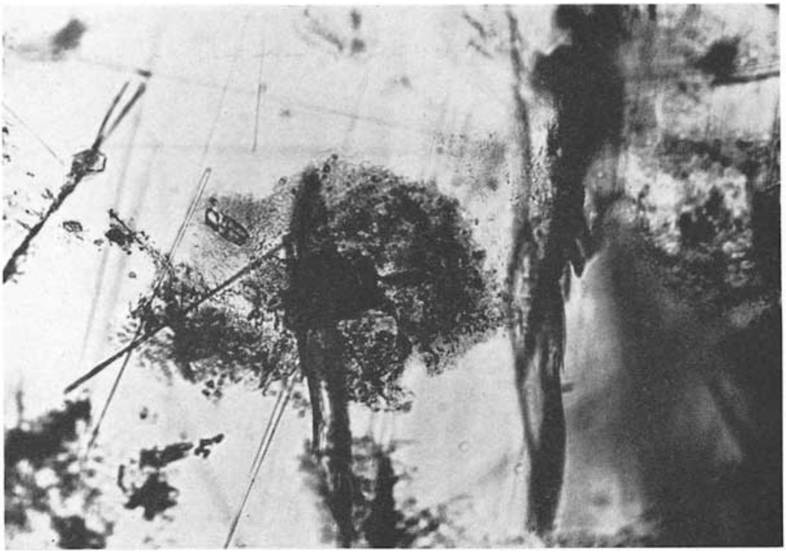

Fig. 4. *Strongly resorbed garnet crystal surrounded by a brownish, dusty halo.* 125 ×.

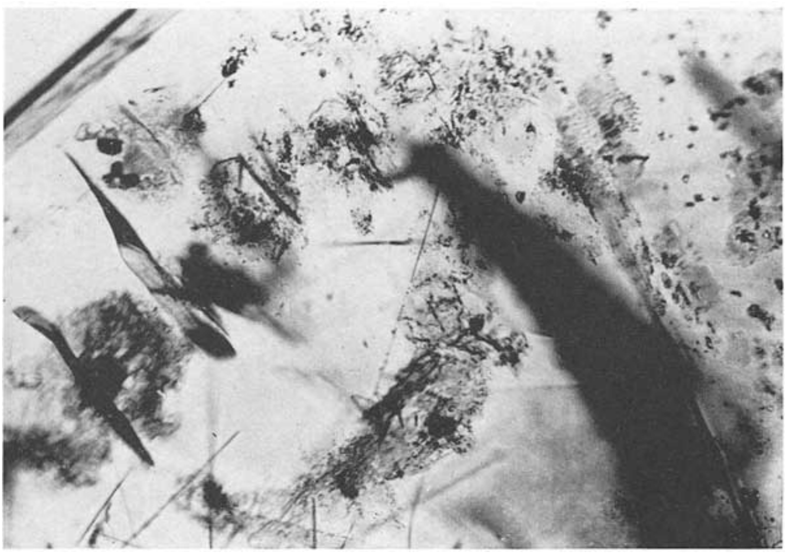

Fig. 5. *Numerous " splashes " consisting of ultra-minute liquid drops, sometimes forming a halo around a resorbed garnet.* 75 ×.

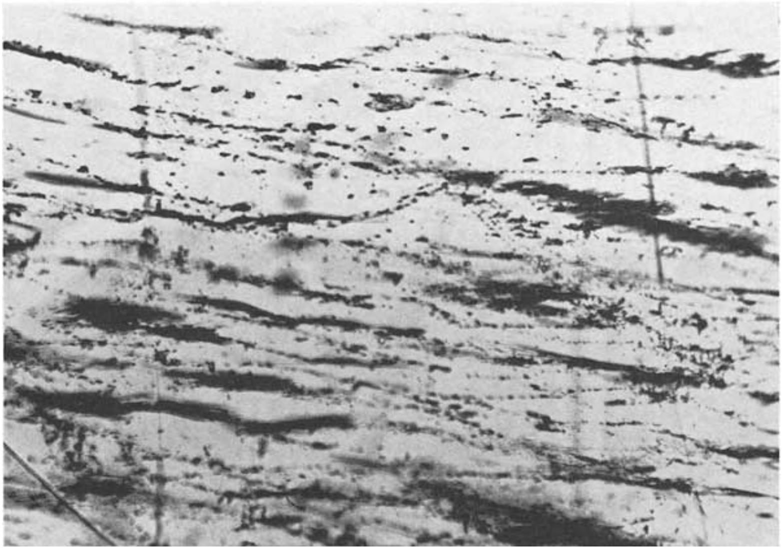

FIG. 6. *Parallel pattern of " shadows " caused by a system of fissures running parallel to the basal plane.* 125 ×.

typical companion is a brown, limonitized garnet which usually sits in cracks near the surface of the host gem (Fig. 4). The cracks are in most cases filled with limonite, which is quite common and also coats the surface of the emeralds. In association with garnets it often forms brownish, patchy halos, which also seem to be a local characteristic, yet considerably rarer than the tremolite needles. Apart from these, other rare inclusions consist of hematite tablets, decomposed plagioclase feldspar and dots of magnetite. Anthophyllite is present in the wall rock neighbouring the emerald-bearing matrix, so that it is possible for anthophyllite needles to occur as inclusions, but none have so far been seen in the gems tested.

Yet the interior of the Sandawana emeralds is not only typified by solid inclusions—two most individual kinds of inhomogeneities add to its character. One gives the impression of being splashes of a dust-like appearance, oriented parallel to the C-axis. Normally they seem to be green but sometimes they may be limonitized and then assume a brownish tint (Fig. 5). Occasionally it is impossible to distinguish these splashes from the brownish halos surrounding the garnet inclusions. Just as strange as these are sheets consisting of irregular, interrupted lines and strokes running

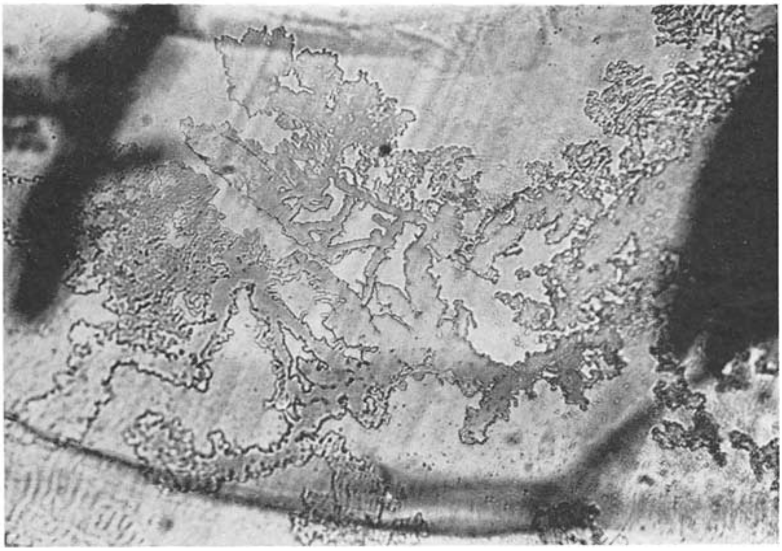

FIG. 7. *Interesting design of a film of residual liquid in a healing crack.* 125 ×. Photographed with phase contrast photo ocular 12·5 ×. Achromatic objective $Ph_2$ 10/0·25.

more or less parallel (Fig. 6). They represent systems of very fine cleavage fissures lying parallel to the basal plane. Although resulting from exactly the same cause of origin—a deficiency of cohesion between the sheets of $(SiO_3)_6$ rings—as those well known and characteristic planes of disc-like fissures which are so abundant in emeralds from the Urals, the pattern of these cleavage fissures is distinctly different and should not lead to confusion. In Russian emeralds they appear like silvery fish-scales lying in flat or curved layers, while in the Rhodesian stones they resemble irregular strokes with a brush.

One specimen displayed beautiful, lace-like patterns of liquid films which have remained " undigested " in healing fissures (Fig. 7). One single occurrence of such formations does not justify a generalization of the observation and, indeed, it may not be a typically local feature, but it should be noted and may serve as a valuable reference for future investigations of Sandawana emeralds.

It will be interesting for the reader to get acquainted with Sandawana emeralds ; he will not find it difficult to recognize their locally typical inclusions and to distinguish them from the emeralds of other occurrences.

The author wishes to express his gratitude to Mr. A. E. Phaup of the Geological Survey Office at Gwelo for his explanations of the geological conditions, to Prof. R. L. Parker for the determination of the R.I.'s by the minimum deviation method, and to Dr. M. Weibel for the chemical analysis.

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# ASCERTAINING THE NATURE AND EXTENT OF DAMAGE OR INHERENT FLAWS IN GEMSTONES

*By G. ROBERT CROWNINGSHIELD*

THE Gem Trade Laboratories of the Gemological Institute of America are frequently called on to render opinions regarding the nature of cracks and flaws in many varieties of stones. Most often, the question is whether a crack is inherent, partly inherent and extended, or due to damage that occurred after the stone was polished. It is my purpose here to set forth the methods used by the staff of the laboratories in arriving at an opinion based on careful microscopic observations.

It is common knowledge that insurance companies do not require very much information about jewellery before issuing policies and collecting premiums. Most jewellers have experienced cases where this practice has been troublesome, if not embarrassing.

Few jewellers make a detailed diagram of inherent flaws in stones they sell or appraise, other than perhaps in diamonds, since insurance companies do not demand it. Therefore, stones with inherent fractures are frequently insured that may later be mistaken for damage, causing an unnecessary and time-consuming settlement.

Let us reconstruct a hypothetical case in which an insured customer first believes he has damaged a stone. One day the insured trips and falls and believes that he has struck his star-sapphire on the concrete floor. His first thought, after seeing that no bones are broken, is to inspect his star-sapphire. For the first time the stone is examined carefully, perhaps with strong transmitted light. Sure enough, there is a crack ! The insurance company and an adjuster are notified, and he sees the crack. The jeweller is notified. He inspects the stone with his loupe and admits that he sees a crack too. All too often the insurance company pays off, but not before considerable time and effort have been expended.

Much too frequently the supposed damage is an inherent fracture or even a characteristic fingerprint inclusion or repeated twinning, especially in star-sapphires and some star-rubies. This could have been proved by the proper use of a microscope and direct reflected light.

How is this done ? If the flaws (cracks) come to the surface and were present at the time of last polishing, the act of polishing invariably leaves tell-tale evidence. This is usually in the form of polishing drag marks originating from the trailing edge of the crack. Bits of the leading edge break off and score the polished surface for varying distances from the crack. If the polishing direction happens to parallel the crack, these polishing drag marks will not be evident, of course. Instead, there may be undercutting along the crack, although in this case, especially in diamonds, there may be no visible evidence.

To observe both the polishing drag marks and the undercutting, a source of light other than the dark field of the Diamondscope or Gemolite is needed. In some cases, the ordinary overhead light attachment of the latter instrument is sufficient. With diamond, however, a more distant source of light is usually necessary. The light should be direct, not diffused. In addition, the magnifications needed are 60 × and 120 ×, the higher power principally for diamonds. With 120 ×, polishing lines can frequently be detected on all facets of a diamond, but not with equal ease. Occasionally, an extraordinarily well polished diamond may show no polishing marks even under 120 ×. But this same diamond with an inherent crack may show the polishing drag marks mentioned above.

Another clue that may be helpful in determining whether a crack is inherent or due to damage is the presence of foreign material within the crack. Considerable caution must be exercised here, because what may appear as a stain may be a brownish nondescript interference of light caused by air in the crack, possible in both old and new cracks. Of course, if the crack can be proved to terminate or originate in a definite fingerprint inclusion, then it must be concluded that at least part of the effect seen is inherent.

A frequent cause for concern and trouble is the fact that many coloured stones, particularly flawed specimens of emerald, star-sapphire and ruby, are oiled to help conceal the inherent fractures and flaws. It is shocking to learn that some merchants actually believe that this oiling is necessary in order to replace the " natural oil " of the stone lost in lapping ! This fraudulent practice is engaged in quite openly ; in fact, members of the staff have observed emeralds soaking in oil in sunny windows of firms that otherwise have fairly good reputations. The oils used vary considerably : from 3-in-1 penetrating oil to whale oil and even mineral oil. An oil that will " set " upon standing is preferred, since subsequent changes are slower in coming about.

Unfortunately, the presence of penetrating oils cannot always be detected, although gentle warming of a suspected stone may produce an oozing of the oil from the cracks. At the Laboratory in New York we have seen star-rubies " weep " red oil and emeralds " weep " green oil. After several years, depending on the treatment the stones received meanwhile, the oil tends to dry out and cracks become more visible. For this reason, oiled stones more frequently appear in necklaces and pins than in rings.

The retailer who sells oiled stones is more than likely not aware of the oil. Hence, when the customer complains in a year or two that the stones are cracked (and she can usually recall some occasion when the piece was dropped or some other occurrence to which she can lay the blame) the jeweller goes along with the story. A microscopic examination of the surface termination of the cracks may not reveal any evidence of damage whatsoever, but instead, prove that the cracks were present at last polishing. This unfortunate situation has arisen more than once at the New York Laboratory involving firms of the highest integrity.

Most insurance policies insuring for damage (all-risk policies) do not allow for ordinary wear and tear nor for inherent weakness. The possibility that an inherent slight fracture or cleavage may extend due to wear and tear, a blow, temperature change, pressure from uneven prong tension, etc., always exists. After all, a crack in a stone can be seen only when air is allowed to enter and form a reflecting or interference plane. It is conceivable that many cracks are actually much larger than assumed, even when observed under the most favourable microscopic conditions. It requires only an extremely slight change of the thickness of the crack to allow air to enter and thus allow the crack to be seen.

Not all suspected damage is actually inherent, of course. One of the indications of actual damage is one or more chips from which fresh cracks radiate indicating a blow, cracks that do not show polishing drag marks or undercutting. Another indication is a raised flake at the point of intersection of two fresh cracks or under a prong. The raised condition indicates that it could not have left the polishing wheel in that condition. One unexpected incident that gave us a clue that the sapphires in a bracelet had been mistreated, probably by heat during manufacture, was the presence in two of the stones of " exploded " negative crystals that had pushed the surface up, much as a mushroom pushes up the ground above it.

Much disagreement about damage in diamonds originates from a lack of ability to recognize *naturals*. Some crystal surfaces actually form re-entrant angles and may appear very much as a chip. We have encountered several brilliants that have turned in their settings and thus exposed *naturals* that were originally hidden by the prongs. A study of the surface under high magnification may reveal the difference between the natural surface and the fresh cleavage or cleavage-fracture combination that is characteristic of broken diamonds. At times, it has been the experience of the Laboratory that no conclusion can be reached, since a *natural* with octahedral orientation can be confused with a cleavage nick, which, of course, has the same orientation.

A further word about the set-up necessary for observing drag marks, particularly in diamonds, is in order. As expressed above, high magnification is frequently required to observe drag marks in diamond. When observing the surface of the stone in search of drag marks originating at the crack, one may see no evidence of them for much of the distance along the crack. The polishing marks may be seen to cross the crack unmodified by the crack. However, at slight zig-zags in the crack one may see drag marks. The presence of even one distinct polishing line originating at the crack is considered proof of the existence of the crack before last polishing.

Note that I have used the phrase " last polishing." This wording is used because the presence of polishing drag marks, or even some of the other clues discussed, do not necessarily prove inherence of the crack in the original crystal. We have seen cabochon sapphires in which there was evidence that the stones had been polished in their settings; whether this was an attempt to remove a setter's slip or not is unknown. Another case involved an emerald that had been broken in setting and then had been removed and repolished without the owner's permission. Since all cracks had polishing drag marks, it could not be determined which were due to recent damage and which were inherent.

May I suggest that readers practice with some star-sapphires, which are rarely without some inherent fractures. One can gain much information about the nature of undercutting and polishing drag marks from these stones. Note that cabochons are polished in many directions, unlike faceted stones, particularly diamonds, in which the polishing marks are usually all in one direction. In cabochons, since the inherent cracks are almost certainly crossed by one or more of the directions, drag marks will almost certainly be seen. An exception to the rule might be stones that have been repolished in this country by certain very meticulous lapidaries who specialize in this work.

When observing star-sapphires and rubies it is well to become acquainted with the appearance of repeated twinning. The recently imported very dark purple-red star-rubies from India are almost invariably twinned in a rhombohedral direction, a condition which may give rise to three series of parallel lines around a " bulls'-eye " centre zone. Of course, the zoning may not be well developed in all three directions. In black star-sapphires note the almost universal development of the basal repeated twinning planes, which may show up as bright " fractures " parallel to the girdle of the stone. These kinds of twinning in corundum are frequently mistaken for damage.

When repeated twinning in corundum is recognized, the alert jeweller will bear it in mind when setting, sizing or otherwise subjecting the stone to any forces. We once encountered a very large star-sapphire that had been split neatly into three sections because it had not been removed from the setting. The ring had been slipped over a steel mandril while the jeweller attempted to enlarge the shank by hammering ! To be sure, the stone had possessed well developed rhombohedral twinning.

One final observation comes to mind. Much of the actual damage in both diamonds and coloured stones has been observed in stones with " knife-edge " girdles. Although the tendency in diamond-cutting is toward too thick a girdle instead of too thin, because of the factor of weight recovery from the rough, a sufficient number of thin-girdled stones are encountered to make it imperative for the jeweller to consider rejecting these stones or using safe mountings. After all, the consumer frequently believes a diamond cannot break because it is the hardest thing in the world. Since not all consumers can be educated to the *truth*, it is well that he not learn the truth on his own stone !

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# SYNTHETIC EMERALD

*By W. F. EPPLER*

An important series of articles, *Synthetischer Smaragd*, has been abstracted from the Deutsche Goldschmiede-Zeitung, 1958, Vol. 56, Nos. 4-7. The illustrations accompanying the abstract appear by the courtesy of the Deutsche Goldschmiede-Zeitung.

## Nacken Synthetic Stones

Apart from the scientific interest in the work of Hautefeuille and Perry (*Comptes rendus*, 1888, 22, 237, and 1889, 107, 786), the first successful synthesis of emerald was that of E. Nacken around 1928 (G. van Praagh, Synthetic Emeralds, *Science News*, 3, 1947). The second process was developed by I. G. Farbenindustrie, Bitterfeld, Germany, in 1930 and improved around 1935, when the stones, named Igmerald, were first marketed (E. Schiebold, Comparison between natural and synthetic emerald crystals, *Zeitschr.f.Kristallographie*, A 92, 435-473). The third variety of synthetic emeralds was produced some years later by C. F. Chatham, San Francisco. These stones appeared on the market in 1941 and have been regularly produced since 1951. To-day they are the only synthetic emeralds of commercial importance. This series of articles is a report on extensive microscopical investigations showing interesting differences as well as connexions between synthetic emeralds produced by the three methods. The first instalment is concerned with Nacken's synthesis and photomicrographs show inclusions of this particular variety of synthetic emeralds. The production of synthetic emerald crystals is described briefly and the author warns that this description might be a misleading analogy to Nacken's synthesis of quartz. "Tie-pin" inclusions seem to be present in all the Nacken synthetic emeralds and only in them. Tiny emerald crystals formed between stages of growth of the host crystal form the heads of the "tie-pins." The pin itself is a tapering hollow tube arranged parallel to the *c*-axis. Other typical inclusions are very small phenakite crystals, which are smaller than the more developed phenakite crystal inclusions in the Igmerald and Chatham emeralds. In common with all other synthetic emeralds, the Nacken stones show the typical twisted veil-like feathers which are not found in natural emeralds.

### Igmerald

After a short description of the production method (diffusion melt), the differences and similarities of Igmerald and other synthetic and genuine emeralds, as revealed under the microscope, are enumerated. Igmerald, like other synthetic emeralds, shows twisted veil-like feathers, but they are somewhat coarser and bigger than those of the Nacken synthetics. Both Igmerald and the Chatham synthetic stones show phenakite crystal inclusions due to a local deficiency of aluminium oxide in the melt (solution). Emerald is a beryllium aluminium silicate and phenakite a beryllium silicate. Typical of Igmerald are small synthetic emerald inclusions and spotted areas, which are liquid inclusions with very small doubly refractive particles (probably phenakite).

### Chatham's Synthetic Emerald

Although this is the only synthetic emerald which is produced and marketed regularly at present, no reliable information has been published about its production method. Microscopical examination, however, shows so many inclusions similar to those of Igmerald that it would be surprising if Chatham's method varies fundamentally from that of the former I.G.Farbenindustrie. Naturally, this does not exclude the possibility of certain variations regarding concentration, temperature during formation, purity of the raw material, and possibly use of different crystallizers. This is indicated by small differences between the inclusions of the two varieties of the synthetic emerald. On the other hand the similarity of the inclusions is so striking that the probability is that both methods are identical. This means that Chatham's synthetic emeralds like Igmeralds are almost certainly made by the same melt-diffusion method.

The following descriptions of inclusions show these similarities and at the same time point to the small differences between the two varieties.

Veil-like liquid inclusions occur in all three varieties of synthetic emerald. These veils show greater similarities with those of Igmerald than those of Nacken's product. The veils of Chatham's synthetic emerald show certain peculiarities. These are occasional long-drawn two-phase inclusions.

A further peculiarity is shown in Fig. 1. These liquid inclusions form a regular pattern similar to that shown in Igmerald

(Fig. 2). In Chatham's product, however, the inclusions are connected with each other, whereas they remain individuals in the Igmerald. If one studies the angles of the pattern, those of 120° stand out and correspond to the angles of the hexagonal prism. It can be assumed, therefore, that most probably these inclusions are former crystals which have been resorbed. At first they were attached to the basic plane of the seed crystal. Their former liquid inclusions, which were concentrated near the outer zones, are still indicating their former position and size.

Still greater conformity with the Igmerald is shown in Figs. 3 and 4. The formation of these inclusions has not yet been explained. In both varieties the inclusions are arranged parallel to the basic plane of the host crystal ; different only is the agglomoration of small phenakite crystals which surround the described inclusions in Chatham synthetics. The phenakite crystals are characterized by their double refraction and their barely indicated hexagonal forms.

A further similarity with Igmerald, which approaches conformity, is shown in Fig. 5. These angular and interconnected liquid inclusions in Chatham synthetics resemble largely a veil form in Igmerald shown in Fig. 6. Different, however, are solid doubly refractive inclusions within the liquid inclusions of the Chatham emerald. These are presumably phenakite crystals due to a surplus of the phenakite component in the raw material, or, amounting to the same thing, to a slightly smaller percentage of the aluminium oxide which facilitates formation of the phenakite.

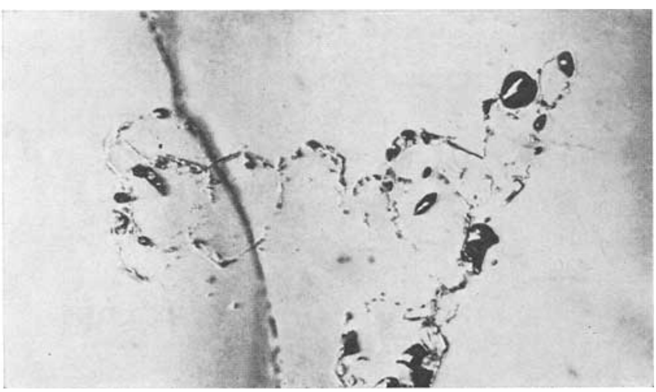


FIG. 1. *Pattern of liquid inclusions in Chatham synthetic emerald parallel to basal plane of host crystal.* 120 ×

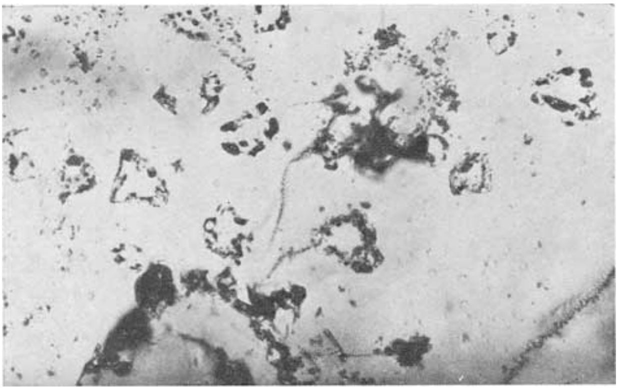


Fig. 2. *Irregularly arranged liquid inclusions in Igmerald, parallel to basal plane of host crystal.* 120 ×

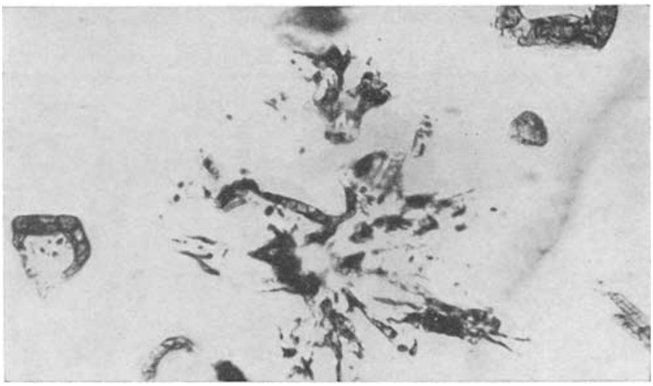


Fig. 3. *Chatham's synthetic emerald. Irregularly arranged liquid inclusions, parallel to basic-plane of host crystal ; to the left and right agglomeration of small phenakite crystals.* 120 ×

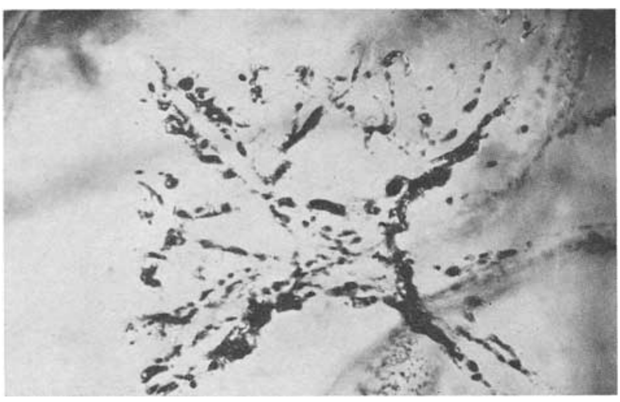


Fig. 4. *Igmerald. Irregularly arranged liquid inclusions, partly two-phase inclusions parallel basic plane of host crystal.* 120 ×

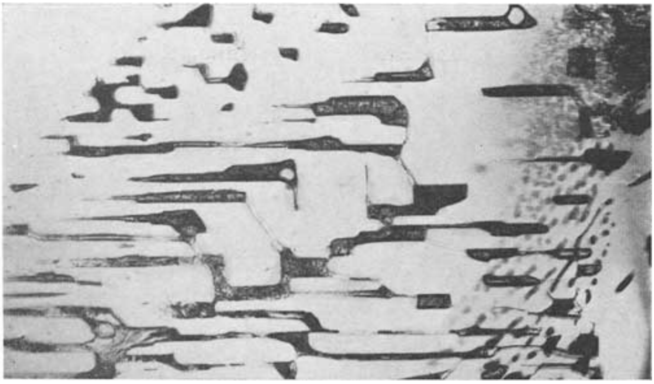


FIG. 5. *Chatham's synthetic emerald. Part of inter-connected veil of liquid inclusions. Some inclusions contain solid doubly refractive matter, presumably phenakite.* 120 ×

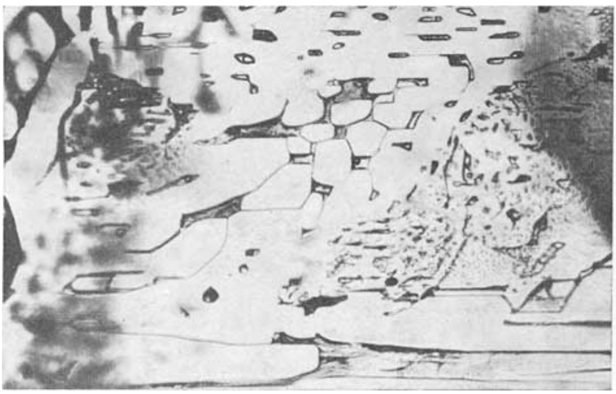


FIG. 6. *Igmerald. Veil of liquid inclusions, partly interconnected.* 120 ×

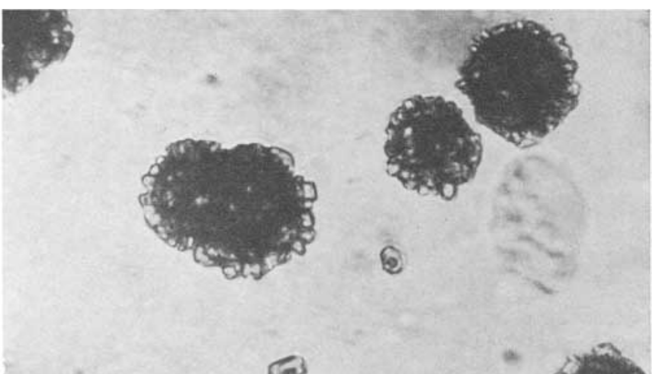


FIG. 7. *Chatham's synthetic emerald. Rounded groups of phenakite crystals.* 320 ×

Among the liquid inclusions of Chatham synthetic emeralds occur occasionally long drawn ones parallel to the *c*-axis of the host crystal. They may form veils or occur individually. Frequently they are three-phase inclusions, the solid matter presumably being phenakite. The two other varieties of synthetic emerald do not show these inclusions, which differ also from the tubular two-phase inclusions in Nacken's product. In Chatham's synthetic emerald, phenakite crystals are mostly arranged in small groups of rounded patterns (Fig. 7) which resemble phenakite inclusions in Igmerald (Fig. 8) in spite of their different size. Other phenakite

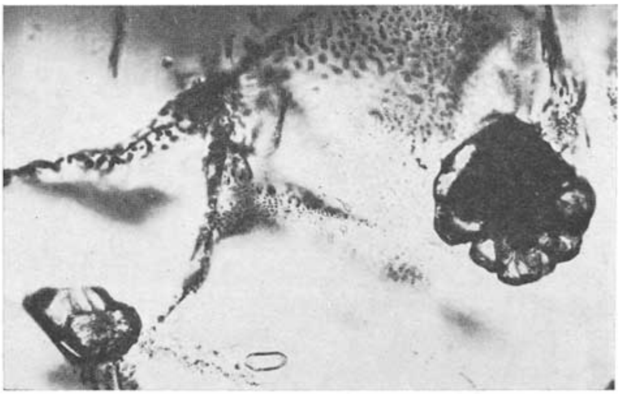


FIG. 8. *Igmerald. 2 inclusions of phenakite crystal groups and strongly twisted veils of liquid inclusion.* 120 ×

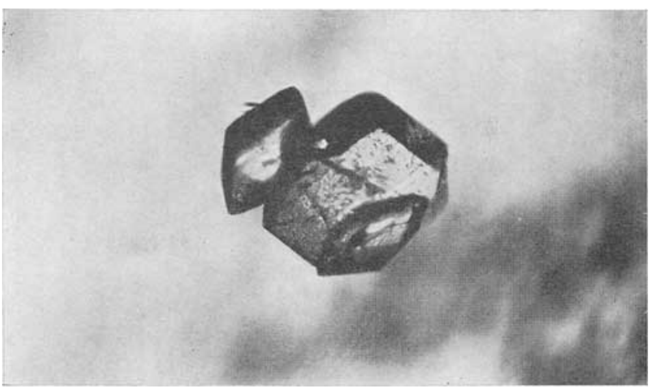


FIG. 9. *Chatham's synthetic emerald. Inclusion group of phenakite crystals.* 120 ×

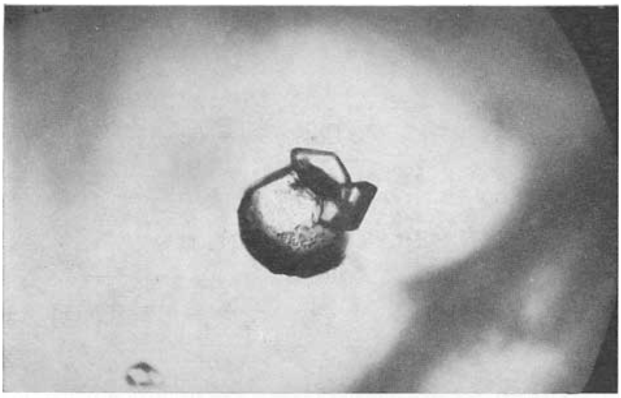


FIG. 10. *Igmerald. Typical inclusion, phenakite crystal group.* 90 ×

FIG. 11. *Chatham's synthetic emerald. Inclusion of phenakite crystal of prismatic shape.* 120 ×

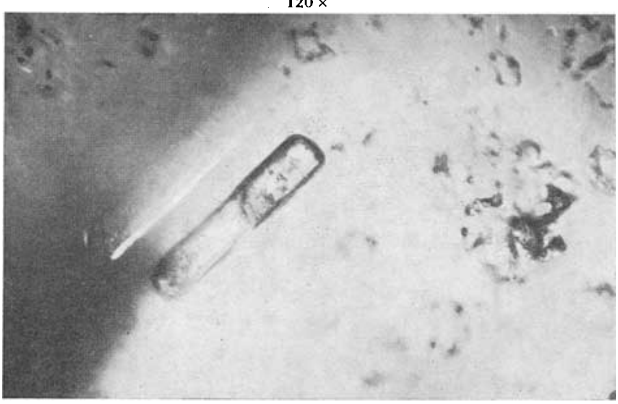


FIG. 12. *Igmerald. Phenakite inclusion of prismatic habit. To the left weak reflection of prism caused by polished facet.* 120 ×

inclusions show typical habits (Fig. 9) similar to those encountered in Igmerald (Fig. 10).

Finally, phenakite crystals in Chatham synthetics were also observed in the shape of elongated prisms (Fig. 11) comparable with the inclusions shown in Igmerald in Fig. 12.

## Summary

All three varieties of synthetic emerald (Nacken's, Chatham's, and Igmerald) have typical veil-like inclusions consisting of small and very small liquid droplets. No satisfactory explanation has yet been found regarding the formation of these veil forms, and the following theory is offered for discussion.

Experiments with easily crystallizing substances have shown phenomena which can only be called "healing cracks." It has been observed that these "healing cracks" developed during the growth of the crystal without any outside influence. Often they were started by a growth disturbance the cause of which has not yet been found. An example is shown in Figs. 13 and 14. Alum was crystallized from aqueous solution at room temperature. After removing the crystal from the mother liquor it showed on an octahedral plane a growth disturbance consisting of a rough spot on and under the surface from which emanated a crack which was in the process of healing. During the growth of the alum crystal the crack must have developed and it must have been subject to a healing process. The crack could be healed completely

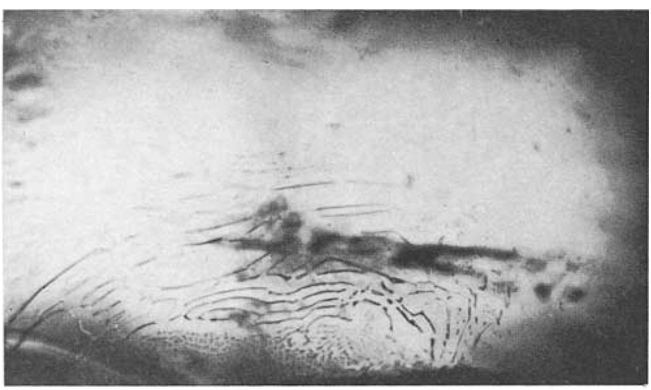


Fig. 13. *Alum crystal. A healing crack emanates from the growth disturbance. The healing crack developed during growth of the crystal, but is not oriented. It can be compared with secondary healing cracks in many precious stones.* 50 ×

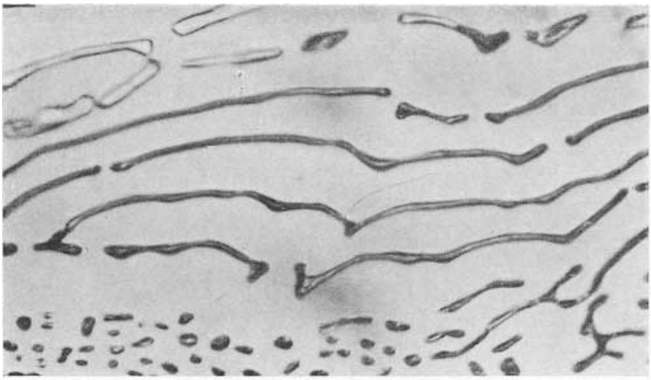


FIG. 14. *Alum crystal ; healing crack, section of Fig.* 13. 240 ×

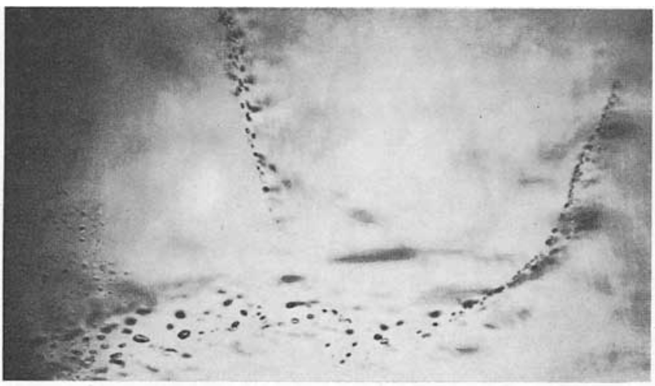


FIG. 15. *Crystal of magnesium aluminium sulphate. Two strongly twisted healing cracks.* 90 ×

when the crystal was re-placed in the mother liquor. Artificially inflicted cracks could be healed in the same way. Experiments with magnesium-aluminium sulphate produced healing cracks (Fig. 15) which showed a certain similarity with those in synthetic emeralds. It seems likely, therefore, that the typical veils in synthetic emeralds also represent healing cracks. The author deals with a few points which could be raised against the validity of his theory and concludes the series of articles by illustrations showing the similarities and differences between Chatham's synthetic emerald and Igmerald.

Summarizing, the author states that Nacken's synthetic emeralds were most probably produced by a hydro-thermal method; Igmeralds by a melt-diffusion method. It seems by a conformity of inclusions that Chatham's synthetic emeralds are produced by a similar method to Igmeralds, although small specific differences exist. All three varieties show the typical veil-like feathers. The author thanks Messrs. B. W. Anderson, H. Espig and E. Gübelin for the loan of specimens.

W.S.

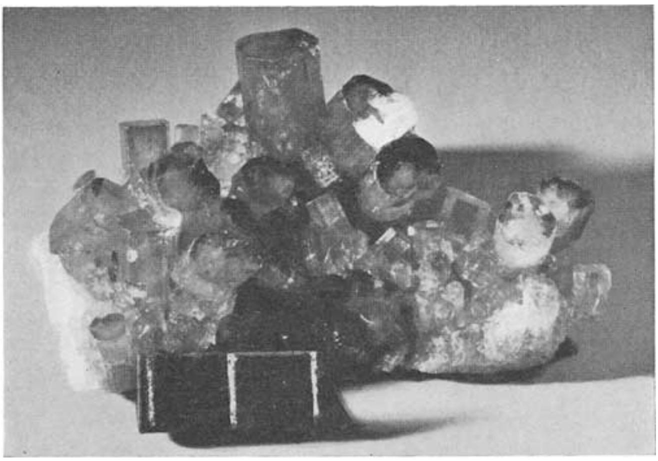


FIG. 16. *Group of synthetic emerald crystals (Chatham) formed by uncontrolled growth. The group shows that the crystals grew (downwards) from pieces of quartz which floated on the molten mass. From this it appears that the production of synthetic emerald by Chatham is very similar to that of the earlier German synthetic, the so-called Igmerald.*

# NOTE ON THE HOPE DIAMOND

For the second time in less than ten years, the Hope Diamond has been shown at the Canadian National Exhibition, in Toronto, Canada. The largest blue diamond in the world, the Hope was closely examined by Mr. Dean S. M. Field, F.G.A., Director of the Gem. Lab. Research Division of H. Forth & Company Limited, Toronto.

Mr. Field describes the Hope Diamond as follows :

It is quite unlike the glass replicae commonly displayed by jewellers and in museums. The shape is more oval than anything else, one side being slightly shorter than the other, indicating that it may have been cut from a larger pear-shape stone. The colour is slate grey-blue and bears no resemblance whatsoever to a sapphire. The only other gems that might resemble it in colour are the blue-grey spinels from Ceylon.

The diamond was measured in the vaults of the Imperial Bank of Canada's Head Office, and the dimensions were found to be approximately : length, 25 mm ; width, 22 mm ; depth, 14 mm. No flaws nor inclusions were visible under a ten-power glass, but several of the facets were not quite symmetrical in relation to the others.

Rather surprisingly, Mr. Field found that the diamond had a faceted girdle, a feature not supposed to have been developed when the Hope Diamond was cut in its present form.

The culet is small in relation to the size of the stone, which is shallow and appears to be much heavier than it really is. Nevertheless, the brilliancy is good for a coloured diamond, and the cutting, generally, is much more modern than one might expect in such an old stone.

The diamond is now owned by Mr. Harry Winston, well-known New York diamond broker, who acquired it from the estate of the late Evelyn Walsh MacLean, of Washington.

# Gemmological Abstracts

BARRON (E. M.). *The gem minerals of Mexico.* Lapidary Journ., XII, 1, pp. 4-16, 1958.

A concise account of the gem localities of Mexico and useful notes about marketing. Banded and other agates are discussed in detail and there is a reference to a location of fine danburite at San Luis Potosi. Gems found in the country, apart from the well known opal and agates, include garnet, topaz, apatite, orthoclase, and amethyst. Gem-grade tourmaline has also been found, but the locality is not disclosed.

S.P.

WILSON (G.). *Nephrite jade discovered in Wisconsin.* Lapidary Journ., XII, 1, p. 76, 1958.

A report of an occurrence of nephrite in Marathon County, Wisconsin, in an area of primarily dolomitic rocks. A near white sample gave a specific gravity of 2·96, with refractive index of 1·62.

S.P.

CARRARO (F. L.). *A Identificação das Gemas Preciosas pela Difração de Raies-X.* Identification of precious gems by X-ray diffraction. Gemologia 9, pp. 1-4, 2 illus., 1957.

A brief account of X-ray diffraction identification as applied to mineral specimens, including the latest apparatus whereby the diffracted rays are fed via a geiger counter to an automatic register which delivers the result in graph form for easy and rapid identification.

R.K.M.

UNTERMAN (J.). *Os Filtros de Luz na Identificação de Gemas.* Light filters in gem identification. Gemologia 9, pp. 17-24, 1957.

A discourse on the use of light filters in gemmology, describing the beryloscope and the Chelsea Filter ; with a list of residual colours under the latter, reprinted from Webster's Gemmologists, Compendium. The writer goes on to describe a series of 12 filters known as ABG filters (after the Assoc. Brasiliera de Gemologia) which he has compiled. These are mainly intended for use in identifying emerald, Chatham synthetic emeralds and synthetic blue spinels and apparently they do these jobs with varying efficiency. The most interesting appears to be ABG12, which is a very dark filter absorbing all visible light up to 7500Å. Used with a very strong light source green stones placed on a white background are visible as black outlines, with the sole exception of the Chatham synthetic emerald which fluoresces and appears almost invisible against the background.

R.K.M.

MENDES (J. C.). *Pérolas : Gemas de Origem Biológica.* Pearls : gems of biological origin. Gemologia 10, pp. 1-8, 4 illus., 1957.

A general account of the pearl, its cultivated form and its imitations. The writer includes a schematic diagram of a cross section of a pearl which perpetuates a misconception of the structure of oriental pearls. The section shows the pearl with concentric regions of nucleus, conchiolin, prismatic layer and nacreous layer. This sequence is true of mother-of-pearl, if we omit the nucleus, but it conveys a false picture of the pearl, which is almost entirely nacreous material with a fine interlacing of conchiolin acting as a " mortar " between the nacreous crystals.

R.K.M.

GÜBELIN (E.). *Diamant, Echt Oder Synthetisch ?* Diamond, Natural or Synthetic ? pp. 14, 5 illus.

A pamphlet printed in German and French for Swiss readers. It is written as an answer to possible loss of faith in natural gem diamond following the announcement of the production of the American synthetic. Gübelin points out that the material produced by G.E.C. is of minute size and contains many flaws and impurities ; that it is being primarily produced for its industrial abrasive value rather than as a forerunner to production of synthetic gem diamond. Even if the obviously immense problems which prevent the making of large single crystals of gem quality were ever surmounted, the synthetic origin of the resultant gem would be detected.

R.K.M.

SLAWSON (C. B.). *Hardness of synthetic diamonds.* Amer. Min., Vol. 42, pp. 299-300, 1957.

The cutting and polishing by a fine powder of synthetic diamond of a natural diamond close to the octahedron face is described. A facet was cut within 1° 23′ of parallelism with the octahedron and it is concluded that there is no difference in the actual hardness of natural and synthetic diamonds.

G.A.

WYART (J.) and ŠĆAVNIČAR (S.). *Synthèse hydrothermale du beryl.* (Hydrothermal synthesis of beryl). Bull. Soc. franç. Minér. Crist., Vol. 80, pp. 395-396, 1957.

Notes of the hydrothermal synthesis of beryl. A mixture of SiO, AlO and BeCO, with addition of water, was used with a pressure varying from 400 to 1500 bars. Beryl in the form of fine white powder appeared at 400°C. and at 600°C transparent crystals were obtained showing form, together with small amounts of phenacite and chrysoberyl. When a small amount of chromium replaces part of the Al of the starting material, phenacite, quartz, chromium oxide and faintly green beryl are obtained. This green colour may be due to inclusions of chromium oxide or to replacement of Al by Cr in the beryl structure.

G.A.

SCHALLER (W. T.) and HILDEBRAND (F. A.). *A second occurrence of the mineral sinhalite.* Amer. Min., Vol. 40, pp. 453-457, 1955.

A contact metamorphosed limestone in Warren County, New York, was found to contain sinhalite.

G.A.

WEBSTER (R.). *Amber, Jet and Ivory.* Gemmologist, Vol. XXVII, No. 321, pp. 65–72. April, 1958.

The continuation of the series on organic gems. The inclusion of flies in amber is discussed and the types of amber imitations which may be encounted are mentioned. A description of jet including its properties and he localities where it is found are given. The imitations of jet are mentioned. Ivory from the elephant and the mammoth is discussed. The nature of ivory and the types of elephant ivory are mentioned.

6 illus. P.B.

ANDERSON (B. W.). *More news of man-made diamonds.* Gemmologist, Vol. XXVII, No. 321, pp. 59–61. April, 1958.

Dr. Grenville-Wells and Prof. K. Lonsdale of University College have examined by rotation X-ray photography specimens of synthetic diamonds made by The General Electric Company of Schenectady. The photographs showed a comparatively strong reflection from " 200 " planes hitherto not seen in natural diamonds. This and other irregular features are explained as each man-made diamond consists of a matrix of normal diamond with a lattice constant of 3·567Å within which occur islands of a different face-centred cubic structure with spacing 3·54Å lying closely parallel with the diamond matrix. An analysis of some G.E.C. diamonds by Messrs. Johnson Matthey showed traces of Si, Al, Fe, Mn, Mg, Na, K, Ti, Ca, Cr, Cu, and B, with also significant quantities of nickel to which the extra spots on the rotation X-ray photograph are ascribed. Examination of samples of these synthetic diamonds by the author (B.W.A.) shows that the grit-like particles are mostly aggregates of tiny diamond crystals. They are mostly interpenetrant octahedra or in parallel growth. Cube forms were not infrequent and these faces are remarkable for their smoothness. Flattened " hopper " crystals are particularly noticeable. Fluorescence is hardly observable, but a few showed the typical blue, green or yellow glow. Some of the particles were found to be magnetic.

1 illus. R.W.

REEVE (V. J.). *Gem hunting in Australia.* Gemmologist, Vol. XXVII, No. 321, pp. 62–63. April, 1958.

A report on a visit to Lightning Ridge and other areas where gems are found. A visit to the Turon goldfield is described and some of the activities of the Lapidary Club of New South Wales are mentioned.

R.W.

MAHAJAN (B. S.). *Birthstones—an Indian interpretation.* Gemmologist, Vol. XXVII, No. 319, pp. 21-23. Feb., 1958.

The article tells of Indian beliefs of astrology and astral medicine, and the ancient beliefs in the medicinal qualities of gems, The Indian aspect of birthstones is discussed.

R.W.

EPPLER (W. E.). *Particularidades sobre durezea.* (Details of hardness.) Gemologia, No. 12, pp. 1–14. 1958.

A translation of the article which appeared in Journ. Gemmology, Vol. 5, No. 5, 1956.

R.K.M.

KELLER (J. E.). *The lapidary of the learned king.* Gems and Gemology. Vol. IX, No. 4, pp. 105-110 and 118-121. Winter 1957/58.

In the Escurial near Madrid the library contains a book known as the *Lapidario* said to have been written by Alphonso X el Sabio (the Learned). This article describes the book and comments on the caligraphy and the illumination. Mention is made of the difficult times which occurred in Spain during the period in which it was written and subsequent happenings at the Escurial. Three hundred and sixty gems are listed, many of which are described as having fantastic and extraordinary properties. Much of the book relates to the older conceptions and fables of gemstones, especially the medico-mysticism and the lore of precious stones. 4 illus.

R.W.

CROWNINGSHIELD (G. R.). *Spectroscopic recognition of yellow bombarded diamonds and bibliography of diamond treatment.* Gems and Gemology, Vol. IX, No. 4, pp. 99–104 and 117. Winter, 1957/8.

Colours of bombarded diamonds which are commercially available are various tones and intensities of yellowish-green to bluish-green, brown to orange-brown, and yellow to brownish-yellow. Blue and greenish-blue stones have been reported and a few brownish-red tones have been seen but are not available commercially. Unless green *naturals* are present on a dark green diamond (an indication of green-skinned stones from Venezuela or Bahia) few dealers accept as natural any dark green stones. Radium treatment is suspected if the stones show blackish surface discoloration and if they " take their own picture " when exposed to a photographic film for 12 to 36 hours. Cyclotroned stones, which have only surface coloration, show, if the top of the stone has been treated, dark bands in the crown facet reflections; or, if the bottom of the stone has been treated, a star-shaped zone of colour will be seen at the culet. Pile treatment by neutrons causes through-

out coloration of the stone and no visual features are apparent. The yellow and brownish-yellow diamonds which owe their colour to pile treatment and subsequent heat treatment but show no signs of irradiation are a greater danger and pose problems in identification. The darker the original colour of the " dark Cape," the darker the result of treatment. A fine white stone will take the best colour, whether green or yellow. The diamond trade has not yet reached the point where the artificial coloration is accepted, like that of citrine, aquamarine or zircon. Extensive study of the absorption spectra and fluorescence has been carried out and some correlation made. The "Cape" spectrum, the brown diamond spectrum and the luminescence shown by each of these groups are referred to. The finding of an absorption line at 5920Å in a bright yellow diamond and the subsequent recognition of this line in nearly every yellow to golden yellow treated diamond and in some of the brown treated stones are reported. Observation on some twenty stones before and after pile treatment showed that the bombardment and subsequent heating had induced the 5920Å line as well as, in some cases, the 5040Å line. It is remarked that treated diamonds tend towards a brownish-yellow and not towards a greenish-yellow, and that 1950 is set as the arbitrary date after which any yellow diamond is suspect. An important article which ends with a useful bibliography.
4 illus. R.W.

Custers (J. F. H.). *Minor elements in diamonds and their effect on diamond colours.* Gems and Gemology, Vol. IX, No. 4, pp. 111–114. Winter, 1957/8.

Diamond colours resulting from the presence of minor elements are highly stable even at temperatures up to 500°C. Heating a diamond to this temperature will verify if the colour, if present at all, was introduced after the diamond was crystallized. Two types of diamond colours are known to change on moderate heating. One is introduced artificially either by bombardment with neutrons from a nuclear reactor or electrons from a high-voltage electron-source or by irradiation with sufficiently energetic gamma rays. The resulting colour is green, blue and greenish-blue respectively. The other type is the natural green diamond frequently found in Sierra Leone. All these diamonds turn to a light brown or yellow on heating to 450°C. Such coloration is due to a fraction of the carbon atoms being displaced from their original position. This is the so-called "radiation damage." Experiments on the absorption spectra of coloured diamonds by light absorption curves using an absorption spectrophotometer are reported. The results obtained by the author, and by other workers are mentioned. It is established that the colour of pink and mauve diamonds is most probably due to one element, namely manganese. An absorption band with a maximum at 5500Å was found in all pink and mauve diamonds, and some brown diamonds also show this band. Manganese was found as a minor element contained in diamond, with silicon, calcium, magnesium and aluminium. In the mauve and pink diamonds it is suggested that it is the manganic ion which is responsible for the colour. Nearly all semi-conducting diamonds are steel blue in colour, but a few pale brown stones were also found to be semi-conducting. Much technical information given.

1 illus. R.W.

SHIPLEY (R. M.). *Electronic colorimeter for diamonds.* Gems and Gemology, Vol. IX, No. 5, pp. 136–143. Spring, 1958.

A full description of an electronic colorimeter built specially for the colour-grading of diamonds. The use of an optical colorimeter, its defects and limitations are commented upon. The design construction and working of the latest electronic colorimeter are described. The colour assessment is made numerically on a meter by electronic means. The limits of accuracy of the machine are given.

1 illus., 4 graphs. R.W.

WEBSTER (R.). *Ivory, bone and horns ; vegetable ivory and tortoiseshell.* Gemmologist, Vol. XXVII, Nos. 322 and 323, pp. 91–98. May and June, 1958.

The continuation of a series. Mammoth, hippopotamus and walrus ivories are discussed. The "horn" of the rhinoceros is not ivory but a packed mass of hairs, and has a low density of 1·29. The structure of teeth is commented upon and the detection of ivory by examination of the peelings is described. The nature of the vegetable ivories, their structure and testing factors are given. Tortoiseshell is obtained from a turtle. The properties of the material and its imitations are discussed.

12 illus. P.B.

Steiger (A. J.). *Russian diamonds.* Gemmologist, Vol. XXVII, No. 323, pp. 108–111. June, 1958.

The Russian diamond area of the Siberian taiga forests is situated on what is termed the Siberia plateau and extends over 1,000 miles from Krasnoyarsk to Yakutsk between the Lena and Yenisol rivers. The geology is said to resemble that of the South African and Indian regions. The right bank of the Vilyui, a tributary of the Lena, is the centre of the richest find—a diamond pipe. Some history of the geological endeavours leading to the finding of diamonds is given. The first diamonds were found in 1947 in the Upper reaches of the Nizhnaya Tunguska river. The finding of pyropes in 1953 in the region of the Upper Markhi river led to the finding of the kimberlite pipe. A new design X-ray separator working on the principle of the X-ray luminescence of diamond crystals is used to separate the diamonds from the run-of-the-mine rock.

1 illus. R.W.

Anderson (B. W.). *Synthetic gemstones and their detection.* Gemmologist, Vol. XXVII, No. 322, pp. 79–85. May, 1958.

A report of a lecture given to the West of Scotland branch of the Gemmological Association. Reconstructed rubies were remarked upon and synthetics and the difficulties which may be encountered in their detection discussed. The use of the spectroscope as an aid to the detection of some synthetics explained. Various other " special " synthetics, such as the synthetic star stones and the new red synthetic spinels, are mentioned. Some remarks on the synthetic emerald and on other synthetics were made by the lecturer.

6 illus. R.W.

Bowden (F. P.). *Polishing diamond.* Gemmologist, Vol. XXVII, No. 322, pp. 86–90. May, 1958. Extracted from *Adhesion and friction,* Endeavour, January, 1957.

An elegant article explaining experiments carried out on high-speed polishing. The diamonds are rubbed against a rotating metal ball held and rotated in a vacuum by magnetic means. Polishing does not occur at speeds over 250 metres per second for at high speeds the high temperature caused by the friction causes softening and melting of the ball, or metal lap, to take place without

abrasion of the diamond, whereas at speeds just below this, diamond is polished, even on the octahedral faces which are difficult to polish by conventional means.
6 illus. R.W.

WEBSTER (R.). *A new imitation turquoise from Germany.* Gems and Gemology, Vol. IX, No. 4, pp. 115–117. Winter 1957/8.

A further report on imitation turquoise made in Germany (*cf.* Steinwehr, Journ. Gemmology, Vol. VI, No. 5, p. 220.) A short review of older turquoise imitations is given and the new material is compared with the so-called "Viennese turquoise," and with the American plastic-bonded types of imitation turquoise. The new material has a hardness of $3\frac{3}{4}$ (Mohs's scale) ; the refractive index is near 1·55 and the density about 2·4. Like some of the other turquoise imitations a spot of hydrochloric acid turns yellow when placed on the surface of the specimen, a test which if carried out on the base or an inconspicuous part of the stone leaves little or no damage. The new imitation does not show the turquoise spectrum and under the long-wave ultra-violet lamp a bluish glow pin-pointed with bright blue spots is seen.

P.B.

BATCHELOR (H. H.). *Gem fields of Australia are finished.* Gemmologist, Vol. XXVII, No. 325, pp. 153–154. August, 1958.

Owing to the drought and lack of water most of the miners have left Lightning Ridge and it is said that the black opal is a thing of the past. All the opal fields are deserted except Coober Pedy and Andamooka where a few old pensioners are scratching over the old workings. The sapphire fields are said to be worked out except Willows where a couple of prospectors are getting some small yellows and greens. A few diamonds are found in nearly all States, the largest a 12 carat black crystal. The only minerals sought after are silver, lead and uranium. Gemstones are not in demand in Australia, the people being quite satisfied with synthetics. R.W.

VAN LEUVEN (E. P.). *The virtues of bloodstone.* Gemmologist, Vol. XXVII, No. 325, pp. 155–156. August, 1958.

An article recounting the legends and the supposed medicinal properties of the quartz mineral called bloodstone or heliotrope.
R.W.

WEBSTER (R.). *Coral, shell and operculum.* Gemmologist, Vol. XXVII, No. 319, pp. 28–29. Feb., 1958.

The continuation of the series reported in Abstracts, Journ. Gemmology, page 268, April, 1958. The objects known as " shell " or " Chinese cat's-eyes " are discussed. Correctly termed operculum, the pieces have no optical chatoyancy but have eye-like markings. The pieces are the lid or door which shuts in certain shellfish when they retire into their shell. Most of these objects come from the snail-like animal *Turbo petholatus.* The density of such pieces lies between 2·70 and 2·76 and the hardness is $3\frac{1}{2}$. They are found in the Pacific Ocean along the shores of many of the islands. Fossil ammonites are mentioned as having been mounted in jewellery.

2 illus. P.B.

MAYERS (D. E.). *The Sandawana emerald discovery.* Gemmologist, Vol. XXVII, No. 320, pp. 39–40. March, 1958.

The report of a discovery of emerald in Southern Rhodesia. The deposit was found by two field geologists, who promptly reported their find to the Southern Rhodesian Government. The emeralds occur in schist, bordering a pegmatite; The occurrence resembles that of the Gravelotte emeralds of Northern Transvaal. The crystals are not impressive, are distributed over a large area and the bulk of the stones are worthless for gem purposes.At one spot they occur in superb quality and are of a deep green colour. Fine stones have been cut from the good quality rough, but as the material is badly flawed only calibre sizes under a quarter of a carat can be obtained as cut stones.

R.W.

MUIR (R. E.). *Is it a diamond ?* Gemmologist, Vol. XXVII, No. 321, p. 77. April, 1938.

A report on the appearance of, and the response by jewellers to, a three-stone ring set with strontium titanates. Most jewellers considered it to be a " deceit," but not in all cases were the stones spotted as not being diamonds. Those who thought it wrong could not name the stones. It is suggested that price will keep the synthetic strontium titanate from the hands of the unscrupulous.

R.W.

WEBSTER (R.). *Amber and jet.* Gemmologist, Vol. XXVII, No. 320, pp. 50–55. March, 1958.

A full description of the various ambers and the localities where they are found is given. Mention is made of the varieties and the commercial classification. " Sun spangled " amber and the inclusion of insects in amber are discussed. The various imitations and their detection completes the article.

P.B.

BROWN (J. C.). *Sapphires of Burma.* Gemmologist, Vol. XXVII, Nos. 318/319/320, pp. 1–6, 24–27, 41–44. Jan./Feb./Mar., 1958.

A very complete survey of the occurrence and recovery of the sapphires found in Burma. Burma sapphires were for long unjustly classed as inferior to those from Thailand, Cambodia, Ceylon and Kashmir. The history of the negotiations with Streeter, after the annexation of Burma by the British forces in 1886, which formed the basis of the ruby regulations and the formation of the Burma Ruby Mines Ltd. Comment is made on an unsatisfactory clause in the agreement with the company. The recovery of the gems during the 37 years the Burma Ruby Mines Ltd. were in existence is discussed, and the value, weight and percentages of the rubies, sapphires and spinels mined are given. The company went into voluntary liquidation in 1925 but a skeleton staff carried on small scale mining until 1931 when the Government of Burma assumed supervision of the industry. The method of licensing by the Burma Government and the financial return to the Government from the different methods of licensing are mentioned. This state of affairs ended when the Japanese erupted into Burma and mining was not recommenced (and then only on a small scale) until 1945, this post-war mining being hampered by the insurrection and political unrest and difficulties of communication. The weight and value of the rubies, sapphires and spinels officially recovered in Burma for the ten years 1945 to 1955 is told. The grading of Burmese sapphires into six groups, excluding the star-sapphires and the fancy-coloured sapphires is explained. Yellow, purple and colourless corundums are fairly common while violet and deep amethyst are rare and green sapphires almost unknown. An " alexandrite "-coloured sapphire exhibiting a change of colour has been reported. The ethnographical connexion of the Bur-

mans with the Shan States of Siam is discussed, and reference made to the trading of Burmese sapphires to Bankok in Siam giving the impression that stones emanating from Burma were Siamese sapphires. The mines of the Phailin deposits were discovered by the Shans from Burma and were mined by them. Some notes on the history of the mining sapphires from Siam and Cambodia are given. The blood-red colour of Mogok rubies is described as the colour of a living pigeon's eye. Comparison is given of the colour of the blue sapphire from Siam as against that of the stones from Burma. The writer mentions that the provenance of a stone may not always be possible to determine. The chief mining centres for Burma sapphires are at Kathe, Kyaungdwin and Gwebin.
4 illus. R.W.

EHRMANN (M. L.). *A new look in jade.* Gems and Gemology, Vol. IX, No. 5, pp. 134–135 and 158. Spring, 1958.

A factual report on the staining of jade. Whitish-grey jadeite cabochons are heated over a charcoal burner until they turn to a glossy opaque finish. After cooling the stone is placed in a dye solution for a short time (48 hours in practice) after which they are rinsed in alcohol and dried on a towel. Two acid-based dyes are used, a yellow and a blue, which are mixed in pure alcohol. The stones are finished by placing in melted wax, after which they are thoroughly dried. A salt-based dyestuff with distilled vinegar will also produce the desired colour. The formation of jade triplets is also discussed. In these the centre piece of jadeite is coloured with a jelly-like dye and this is inserted into the hollow top and the bottom piece is then glued on.
1 illus. R.W.

WEBSTER (R.). *Imitation pearls—their manufacture and properties.* Gems and Gemology, Vol. IX. No. 5, pp. 144–147. Spring, 1958.

A reprint of an article published in the Gemmologist and recorded in Journ. Gemmology (Abstracts), Vol. VI, No. 6, page 268.
2 illus. P.B.

NAUTIYAL (S. P.) : MUKHERJEE (B.). *Absorption spectrum and colour of blue sapphire.* Gemmologist, Vol. XXVII, No. 324, pp. 119–121. July, 1958.

Discusses the absorption spectrum and fluorescence of blue sapphire. Comments on the finding of two absorption bands in the ultra-violet at 3750 and 3880Å, but makes no mention that these bands had been previously recorded by Anderson. Spectrographic analysis made on sapphires from Burma and Ceylon. The criticisms made of earlier workers in the field of fluorescence do not agree with the text of the actual articles.

1 diagram. P.B.

SCHLOSSMACHER (K.). *Neue Instrumente zur Edelsteinuntersuchung.* New instruments for the determination of precious stones. Zeitschr. d. Deutsch. Ges. f. Edelsteinkunde, No. 23, pp. 10–13, 1958.

The following instruments developed by E. Gübelin are described : (*a*) the precision stone spectroscope, a complete unit with light source of varying intensity, universals pecimen holder, wave-length scale and eye piece with rotating disc to bring one of several lenses in position to suit the eyes of the user, (*b*) the gemmolux, an adjustable light source of many uses for the gemmologist, (*c*) the gemmoscope, a binocular microscope with polarizing equipment, adjustable light source, specimen holder and provision for the attachment of the "perloscope" which allows examination of drilled and half-drilled pearls, (*d*) the fluoroscope, making use of a copper sulphate solution filter (Stoke's principle), (*e*) hardness plates.

W.S.

MEDENBACH (K.). *Ein Mikroskop zur Untersuchung von Edelsteinen und Lagersteinen.* A microscope for the examination of precious stones and jewel bearings. Zeitschr. d. Deutsch. Ges. f. Edelsteinkunde, No. 23, pp. 13–17, 1958.

An inverted microscope with polarizing equipment by Leitz, of Leica fame, is described (magnification 15 × to 250 ×). The microscope developed by Dr. Waldmann, Basel, is particularly useful in the determination of the crystal orientation of jewel bearings. (Wear properties depend on correct orientation.)

W.S.

POUGH (F. H.). *Now, "cultured rubies."* Jewelers' Circular, Keystone, p. 56, July, 1958.

A short account of the production of synthetic corundum by a technique similar to that used for production of synthetic quartz and emerald. The corundum is grown from a seed of synthetic corundum produced by the Verneuil method. Colourless corundum and ruby have been produced but the crystals are small. Larger crystals are possible but at the moment the experiment is of scientific rather than commercial interest.

The article refers to an argument put forward that the word " synthetic " is insufficient to describe some materials produced by man. The suggestion is made that there is need for etymological distinction between substances formed by two wholly different techniques. This seems quite unnecessary, for a ruby produced by the Verneuil method or from a seed in an autoclave is a *synthetic* to any clear thinking gemmologist.

S.P.

The Australian Gemmologist. A journal of gemstones, jewellery and minerals produced for the Gemmological Association of Australia. No. 1 of Vol. 1 appeared in July, 1958.

WIRTH (A. A.). *Gem inclusions through a* $\times 10$ *loupe.* Australian Gemmologist, 1, 1, pp. 10-12, 1958.

A short survey of the inclusions in the principal gemstones which may be recognized with a $10\times$ pocket lens.

S.P.

TOLANSKY (S.) : HOWES (V. R.). *Induction of ring cracks on diamond surfaces.* Proc. Phys. Soc., Vol. 70B, pp. 521-526, 1957.

Further work on the production of percussion marks on diamond surfaces has shown that softer materials can be used to produce pressure crack figures : tungsten carbide and sapphire balls have produced cracking on an octahedral face of diamond. The full development of a pressure crack is traced : three distinct types of cracking are associated with each percussion mark and the mechanism of each is discussed in terms of cleavage, crystallographic shatter and cracks due to shock-wave propagation.

R.A.H.

EMARA (S. H.) : TOLANSKY (S.). *The microstructure of dodecahedral faces of diamond.* Proc. Roy. Soc., Vol. 239, A, pp. 289-295, 1957.

Multiple-beam interferometry and the light-profile microscope have been used to study the microtopography of the faces of six dodecahedral diamonds. These faces show either striations or oriented network patterns, both being caused by narrow shallow ruts often less than 50Å deep. These ruts are compared with the results of etching and it is considered that dodecahedral faces are more subject to natural solution processes than are octahedral faces.

R.A.H.

## BOOK REVIEWS

SMITH (G. F. H.). *Gemstones.* Revised by F. Coles Phillips. 13th edition, 560 pp., 28 plates (4 in colour) and 138 text illustrations. Methuen & Co., Ltd. London, 1958. 50s.

Gemmologists throughout the world will be glad to know that, five years after its author's death, a new and revised edition of Dr. Herbert Smith's *Gemstones* has made its appearance.

The work of revision was entrusted to Dr. F. Coles Phillips, Reader in petrography in the University of Bristol, and author of the best modern book on crystallography. The choice has proved to be a very happy one. No small part of the book's standing as a classic has lain in the scholarly, authoritative and academic vein in which it was written, and it would have been a great mistake for revision to be carried out by someone with an entirely different style and cast of mind. Passages of Dr. Phillip's own writing differ from those of the original author in being more succinct and more easily comprehended, but the general flavour and feel of the book has not been marred in any way.

Before new matter could be added to the book an essential and rather drastic job of pruning had to be undertaken. The best issue of *Gemstones* before the present (13th) edition was the 9th edition, which appeared in 1940. In this, the author, by a great effort continuing over several years, had almost entirely rewritten the former relatively slight text, and expanded it into a formidable volume containing over 200,000 words. In a subsequent revision (1949) the book became unbalanced ; far too much space being devoted, for instance, to crystal morphology at one end of the book and to ivory at the other, while the gemmologist's most essential tool, the microscope, was still only accorded incidental mention.

Dr. Phillips has succeeded in improving the balance very effectively. Discussion of crystal morphology has been reduced to an essential minimum ; long and stringent mathematical proofs of certain formulae have been omitted or simplified ; ivory now has a suitably modest place amongst the borderline materials of gemmology and, on the positive side, a new chapter has been added, describing with admirable clarity the functions of the polarizing microscope and its application to gemmology. It is worth noting, perhaps, that Dr. Phillips has plumped boldly for *seven* crystal systems in accordance with current British practice. This is certainly more logical than making the trigonal system an appendage of the hexagonal, since with seven systems each can be related to unique features in their axes of symmetry. Thus, the triclinic system can be said to include all crystals possessing no axes of symmetry ; the monoclinic system includes all crystals possessing a single digonal axis, the trigonal system includes all crystals possessing a single trigonal axis, the hexagonal system includes all crystals which possess a single hexagonal axis . . . and so on, as shown on p. 34 of the book.

The descriptive part of *Gemstones* was always its strongest feature, and Dr. Phillips has wisely made few alterations here, except by the inclusion of newly-discovered gem materials such as sinhalite and painite, and a re-arrangement of the less important gems in alphabetical order for ease of reference.

The bibliography has also been brought up-to-date and re-arranged under such headings as " Early works," " General," " Identification," " Diamond," etc., which will probably prove useful to those in search of special information though lacking in the sheer chronological sweep of Herbert Smith's earlier arrangement. The index, too, has come in for some welcome pruning, page references being limited to those which are really useful, often with bold type to indicate the most important reference.

The whole lay-out of the book is clean and attractive, and the publishers, Dr. Coles Phillips, and his advisers are to be congratulated on producing a worthy successor to the previous editions of this famous and essential classic.

B.W.A

Schlegel (Dorothy M.). *Gem Stones of the United States.* U.S. Geological Survey Bulletin 1042G. pp. 50.

A small paper-covered book issued by the U.S. Geological Survey. The great value of the work lies in the exhaustive list of gem localities given in the second part of the book. This occupies 17 pages and lists more than one thousand gem mineral occurrences in over 650 localities under State and County headings.

The fact that the book is apparently written largely for a lay public and is about American sources only is probably responsible for the omission of refractive indices from the descriptive section, and for the relegation of zircon, peridot and spinel to " also-ran " positions in a list at the end of the book, entitled " Other Gem Stones of the United States." The book is primarily for home consumption. It is none the less a contribution to world gemmological literature out of all proportion to its size.

R.K.M.

Williamson (G.). *Sky smuggler.* Robert Hale Ltd., London, 1958. 16s.

Describes many exploits of smuggling and the way H.M. Customs and Excise authorities have adapted their methods to compete with the difficulties encountered with the introduction of air travel. Diamonds and watches account for a large part of smuggled articles and there are many references to the various ruses and tricks attempted by would-be smugglers.

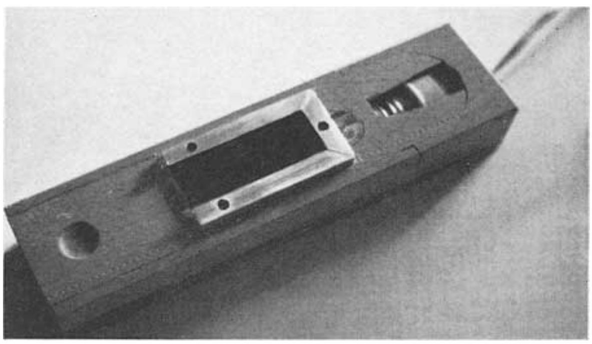
H.W.

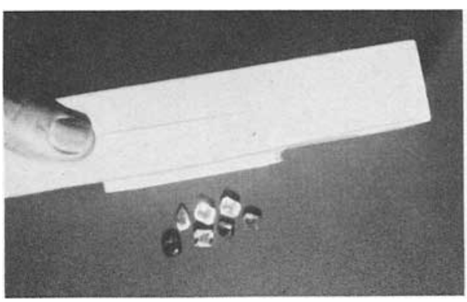
# AN INEXPENSIVE ULTRA-VIOLET LAMP

*By RUDOLF THURM*

In order to obtain an effective ultra-violet light lamp at moderate cost, I purchased a Phillips fluorescent tube and a Chance OX7 filter. The lamp was placed into a pupil's pencil box, backed with an aluminium foil from a cigarette box to act as a reflector. The lid of the box had to be cut out slightly to enable it to slide over the lamp socket. A pocket knife did all the cutting necessary.

The illustrations show some results that have been obtained with the pencil-box ultra-violet light lamp. The fluorescence of the synthetic red corundum appears rather weak in the illustration because the film used was more sensitive to blue light.





Left to right Top line

*Aquamarine*

*Synth. aquamarine-coloured spinel*

*Synth. peridot coloured spinel*

Bottom line

*Green tourmaline*

*Synth. green-tourmaline-coloured spinel*

*Red garnet*

*Synth. ruby-coloured corundum*

# ASSOCIATION NOTICES

## EXAMINATION RESULTS

In the 1958 examinations in gemmology 138 candidates presented themselves for the preliminary and 100 for the diploma examination. Upon the recommendation of the examiners the Tully Memorial medal was awarded to John G. Roach of Birkenhead.

The following is a list of successful candidates, arranged alphabetically :—

### Diploma

*Tully Medallist :* Roach, John G., Birkenhead, Cheshire.

*Qualified with Distinction*

Coakley, Brian, Manchester.
Donaldson, Robert G., London.
Fuhrbach, John R., Amarillo, Texas, U.S.A.
Roots, Jack L., Rainham.
Rushworth, Jack, Halifax.
Tungate, James B., London.

*Qualified*

Ainsworth, Michael B., Blackburn.
Aldridge, Patrick E., London.
Armstead, John M., London.
Atkinson, James C., Whitley Bay.
Baglee, Gordon, Whitley Bay.
Biggers, Willard B., London.
Black, Vete G., Spring Valley, Calif., U.S.A.
Boyd, Russell T. F., Toronto, Canada.
Callaghan, David J., London.
Clarke, Eric M., London.
Clay, John J., Leicester.
Cook, Peter B., Birmingham.
Cooke, Barrie E., Birmingham.
Delario, Anthony J., Paterson, N.Y., U.S.A.

De Silva, Lindamulage J. C. F.,
Colombo, Ceylon.
Eakins, Harry, Liverpool.
Falconer, Richard A., New Malden.
Ferguson, Charles T., Smethwick.
Francis, Barry P., London.
Greene, Patrick, London.
Gunning, Jack W., Toronto, Canada.
Henn, Elizabeth R. (Miss), Farmcote.
Hermitage, Wendy B. (Miss), London
Hill, Stanley G., Birkenhead.
Hopper, Peter J., Boston.
Huddy, George, Liskeard.
Jones, James R.,
Mortdale, N.S.W., Australia.
Lema, Audry Hayes de (Mrs.),
Colombia, South America.
Mackenzie, Enid L. Dowell (Miss),
Glasgow.
Mooney, Eugene, Edinburgh.
Ould, Thomas A., Plymouth.
Peplow, William R. H., Stourbridge.
Petterson, Bjorn W., Oslo, Norway.
Phillips, Dennis, Leeds.
Plews, William A., Edinburgh.
Reeves, Roger C., Chatham.
Reynolds, Helen M. (Miss), Ludlow.
Ritchie, Arnold J., Toronto, Canada.
Sando, Kolbjörn, E., Oslo, Norway.
Skinner, Ramon, London.
Smith, Clifford J., Walsall.
Smith, David J., Brighton.
Steadman, Ivor N., Huntingdon.
Stitt, John, Toronto, Canada.
Taylor, Joseph N.,
Newcastle upon Tyne.
Walton, Joseph H., Cirencester.
Warburton, Frederick W.,
Toronto, Canada.
Weller, George T., Tunbridge Wells.
White-Hide, Richard G., Wadhurst.
Whyte, Archibald G., Edinburgh.
Wille, Robert F., Toronto, Canada.

*Rayner Prize :* Mendelsohn, Michael, Cape Town, South Africa.

Allden, Arthur G., London.
Allemann, Susanne (Miss), Basel, Switzerland.
Bacon, Frank H., Kempston.
Battersby, Keith W., London.
Bergan, Kjartan E., Oslo, Norway.
Betts, Geoffrey N., Birmingham.
Biggers, Willard B., London.
Black, Vete G., Spring Valley, Calif., U.S.A.
Boyd, Russell T. E., Toronto, Canada
Britchfield, Charles F. J., Gravesend.
Brodtkorb, Anne K. (Miss), Hokksund, Norway.
Brousseau, Murray P., Toronto, Canada.
Buitenen, A. Th. Cr. v., S-Hertogenbosch, Holland.
Clark, Alexander, Ruislip.
Conyers, Barry, London.
Dalrymple, Angus, Canvey Island.
Delario, Anthony J., Paterson, N.Y., U.S.A.
Durrant, Anthony W., Ipswich.
Edminson, Dennis F., Toronto, Canada.
Edwin, Wilfred, Medan, Sumatra.
Engstrom, Hans, W. E., London.
Etienne, Lorette (Mrs.), Bangkok, Thailand.
Feer, Beatrice D. (Miss), Geneva, Switzerland.
Fuhrbach, John R., Amarillo, Texas, U.S.A.
Fernando, W. B. C., Mount Lavinia, Ceylon.
Fjeld, Per G., Oslo, Norway.
Griffiths, William H., Birmingham.
Gryska, Stephen, Worksop.
Gulliksen, Gunnar B., Oslo, Norway.
Gunning, Jack W., Toronto, Canada.
Hickman, John T., Bristol.

Jarvis, John C., Calcutta, India.
Jones, James R.,
Mortdale, N.S.W., Australia.
Just, Turid, Oslo, Norway.
Kay, Jonathan G. D., Woolton.
Langton, Edward G., London.
Lax, Edgar, London.
Leek, Stanley H., Toronto, Canada.
Lema, Audrey Hayes de (Mrs.),
Colombia, South America.
McCulloch, Robert, Glasgow.
Malm, Knut, Oslo, Norway.
Marshal, Michael, Cottingham.
Maund, Anne A. (Miss), London.
May, Peter G., Leicester.
Morrell, Anthony, Knaresborough.
Neil, Peter B., Glasgow.
Parker, George E., Birmingham.
Patience, Kenneth, Norwich.
Pattni, Pravinkumar, Birmingham.
Pilot, Lawrence M., London.
Ponka, Bernard, Birmingham.
Pragnell, John W., Bournemouth.
Raven, Robert H., Chelmsford.
Relwani, Arjan C., Calcutta, India.
Ritchie, Arnold J., Toronto, Canada.
Schoien, Magnus, Skien, Norway.
Shapland, Roger S. C.,
Cookham Dean, Berks.
Shotton, John J., London.
Smith, James S. A., Glasgow.
Solomons, Alexander, Guildford.
Stitt, John, Toronto, Canada.
Stocker, Philip Leslie, London.
Turner, Bernard A., Nelson.
Turner, Stanley, London.
Vlerk, Hendrik T. van der,
Schiedam, Holland.
Wheeler, Alfred, Aylesbury.
Whitehead, Helen B. (Mrs.),
Edinburgh.
Whitehead, Henry J., Edinburgh.
Wille, Robert F., Toronto, Canada.
Winter, Elspeth W. (Miss), Guiseley.
Yates, Roy Frank, Manchester.
Zegerius, Harry, Amsterdam, Holland.

## TALKS BY MEMBERS

LONGBOTTOM, W. : "Gemstones," to Yorkshire Federation of Women's Institutes, Hull, 9th September, 1958.

## NORWEGIAN GEMMOLOGICAL ASSOCIATION

The offices of President and Secretary of the Norwegian Association have changed as the result of the election of the Secretary, Mr. Gunnar Sunde, F.G.A., as President and Mr. Hans Myhre, F.G.A., as Secretary. Mr. Myhre had been President of the Association for the past four years.

The Norwegian Association has been successful in arranging a radio series on "Our precious stones." Several members have given talks on gems, pearls and testing, each broadcast taking about twenty minutes.

## MEMBERS' MEETINGS

The meeting of members held at the Medical Society of London's Hall on Tuesday, 14th October, 1958, will be reported in the next issue of the journal.

A reunion of Fellows and Members will be held in the Goldsmiths' Hall, London, E.C.2, on 11th November, 1958, between 6 and 7 p.m. The presentation of awards gained in this year's examinations will be at 7.15 p.m. Dr. F. C. Phillips, Reader in Petrology at the Bristol University, who has recently revised the thirteenth edition of G. F. Herbert Smith's *Gemstones* has kindly consented to present the awards.

## GEMMOLOGICAL ASSOCIATION OF AUSTRALIA

In July the Australian Association produced the first issue of its own journal, the "Australian Gemmologist." It will be abstracted in this Journal. The Council of the Association has sent its congratulations and good wishes to its sister organization upon its enterprise.

## GIFTS TO THE ASSOCIATION

The Council of the Association acknowledges with gratitude the following gifts :—

*The recognition of minerals* by C. G. Moor, from Mr. R. Webster. A collection of synthetic emeralds made by Prof. Nacken, from Mr. G. Wild.

An anonymous donation of £5 for the Sir James Walton Memorial Library.

## GEMSTONES AND GEOLOGY

Tutor : M. J. Frost, B.Sc., F.G.A.A., Research Fellow in Geology, University of Birmingham.

The department of extra-mural studies, University of Birmingham, has arranged a course on gemstones and geology. The course emphasis will be on the geological aspects of gemmology. It is not intended to be a vocational course. The classification, properties and occurrence of gemstones will be covered in the lectures and an approach will be made to gemstone prospecting and gem determination. Special attention will be given to the study of inclusions in both synthetic and natural gemstones as a clue to their mode of origin.

The practical work will introduce the study of natural, treated, and man-made gemstones. Participants will have the opportunity of using most of the instruments used in gemstone determination and of examining many of the more important gemstones, cut and uncut, as well as the rocks in which they are found.

Enrolments will be limited to ten. Applications must be made before the commencement of the course, accompanied by a statement of previous experience in geology.

Eleven meetings ; Mondays, 6.45–8.45 p.m., beginning October 6th. At the Department of Geology, the University, Edgbaston, Birmingham. Fee 10s.

## ASSOCIATION SUBSCRIPTIONS AND INCOME TAX

The Commissioners of Inland Revenue have approved the Gemmological Association of Great Britain for the purposes of Section 16, Finance Act, 1958, and that the whole of the annual subscription paid by a member who qualifies for relief under that Section will be allowable as a deduction from his emoluments assessable to income tax under Schedule E.

The circumstances and manner in which members may make claims to income tax relief are described in the following paragraphs.

Commencing with the year 5th April, 1959, a member who is an office holder or employee is entitled to a deduction from the amount of his emoluments assessable to income tax under Schedule E of the whole of his annual subscription to the society *provided that*—

(*a*) the subscription is defrayed out of the emoluments of the office or employment, *and*,

(*b*) the activities of the society so far as they are directed to all or any of the following objects :—

(i) the advancement or spreading of knowledge (whether generally or among persons belonging to the same or similar professions or occupying the same or similar positions) ;

(ii) the maintenance or improvement of standards of conduct and competence among the members of any profession ;

(iii) the indemnification or protection of members of any profession against claims in respect of liabilities incurred by them in the exercise of their profession ;

are relevant to the office or employment, that is to say, the performance of the duties of the office or employment is directly affected by the knowledge concerned or involves the exercise of the profession concerned.

A member of the Association who is entitled to the relief should apply to his tax office as soon as possible *after 31st October, 1958,* for form P 358 on which to make a claim for adjustment of his pay as you earn coding.

## SMITHSONIAN INSTITUTION

At the end of July the Smithsonian Institution, Washington, D.C., opened an exhibition hall in the modernized Institution which contains a most extensive collection of gems. Among the exhibits are a 316 carat star-sapphire, a 66 carat alexandrite and a 310 carat peridot. The new hall is called the hall of " Gems and Minerals " and contains examples of all the principal species of minerals. Featured among them is a large greenish specimen of smithsonite, a carbonate of zinc named after its discoverer, James Smithson, the Englishman who founded the Smithsonian Institution.

# JOURNAL OF GEMMOLOGY VOLUME VI

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## 1957-1958

*Names of authors are printed in small capitals, subjects in lower case and abstracts in italics*

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