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ASSOCIATION
OF GREAT BRITAIN

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BLUE BERYLS WHICH ARE NOT AQUAMARINES

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

THE blue beryls seen recently upon the market were first tested by the Laboratory in September 1972. We reported upon the stone tested as "blue beryl". Our customers wanted "aquamarine" on the certificate, but we decided it was not an aquamarine colour. The colour of that first stone was that of fine blue zoisite or a deep-colour synthetic blue spinel. Even now, having seen quite a few, they still look wrong or, to put it a little more elegantly, not a colour which looks natural.

This is personal opinion only. In earlier days of post-diploma classes conducted by B. W. Anderson at Chelsea Polytechnic and later at Northern Polytechnic, he, B. W. Anderson, would put in among the stones to be tested some blue beryls from Madagascar. These did not look like aquamarines but were put in to check student reaction to such a blue-colour stone having beryl indices. Since most of our post-diploma students were trade people none put down their results as aquamarine—all put blue beryl. The trade knows and understands what is meant by aquamarine and the colour thereof.

From information given by members of the Laboratory to us on the eventual disposal, i.e. selling and re-selling, of the blue beryl we reported upon, it seemed that some doubts had been raised on the Continent regarding colour. Were they naturally occurring heat-treated beryl or had they been irradiated?

We are fortunate in the Laboratory, in that we have friends on the Continent and in America—friends, that is, gemmologically, and friends such that they are concerned in helping to establish good relations and not trying to vie one with the other or to score points. Needless to say we are all proud of our own particular establishment and each of us has certain strong points. We in Britain owe a tremendous debt to people such as C. J. Payne, Robert Webster and B. W. Anderson, for furthering the knowledge, teaching and science of gemmology.

Among the many useful specimens collected by B. W. Anderson is a piece of pale blue rough material known as "Maxixe Beryl" from the Maxixe Mine (Minas Gerais, Brazil). This particular specimen was donated to B. W. Anderson in 1936 by G. O. Wild, who claimed it as a new mineral in 1933. The Maxixe Mine was then a recent discovery. The figures regarding this material are given as follows: Ordinary ray 1·5920 (cobalt blue), Extraordinary ray 1·58442 (colourless), S.G. 2·805 (B. W. Anderson gives 2·797); and it is stated that the colour fades to yellowish. It is well to remember that stones which fade easily will also be susceptible to treatment and will respond to re-heating or re-irradiating. Zircons which fade to a poor blue can sometimes be improved by heating; pale amethyst can be heat-treated to turn to a permanent golden brown.

The chemical analysis of the Maxixe material was given as:

SiO_2 = 62·52
Al_2O_3 = 18·08
BeO = 11·30
Fe_2O_3 = 0·03
MgO = 0·25
CaO = 0·22
CuO = trace
Li_2O = 0·98
Na_2O = 1·28
Cs_2O = 2·80
B_2O_3 = 0·39
Ignition = 2·20

Since doubts had been expressed upon the nature of the colour in these blue beryls which are now appearing upon the market it was decided to make enquiries. Once a new material or apparently new material arrives, it is not long before interested parties, i.e. stone-merchants and gemmologists, both amateur and professional, begin to converse, contact and cross-reference each other. B. W. Anderson, who is now in retirement, was asked for his old specimen of Maxixe beryl by Robert Crowningshield of the G.I.A. Laboratory, New York. He, Crowningshield, had received blue beryls to test and he made use of fellow scientists Kurt Nassau, Ph.D., and D. L. Woods, Ph.D., of Bell Laboratories, Murray Hill, New Jersey, U.S.A.

The findings from the researches of these two scientists and notes on "Colour centres" are published verbatim (on pages 296–301 below) by kind permission of the Gemological Institute of America, whose New York director, Robert Crowningshield, speedily sent us all the information he could.

It is interesting to note at this stage that the first blue beryl tested by our Laboratory for a London Chamber of Commerce member started the ball rolling. It is not a betrayal of confidence at this juncture to state that our present Chairman of the Precious Stone Trade Section has recently had blue beryls tested by us. It is also interesting to note that the vendor of the blue beryls was the original vendor of our first blue beryl tested in September 1972. He, the vendor, made a personal visit to the Laboratory and I made tests upon several very fine blue beryls belonging to him. He states categorically that his stones are *not* irradiated and that they are mined in that colour. We saw one piece only of rough material, which obviously was not cuttable but looked reasonably like the cut material. When we placed cut specimens and the rough piece under our short-wave lamp, the cut specimens gave a greenish blue fluorescence and the rough piece did not.

We have tested quite a few blue beryls since September 1972. Recently, because of statements by scientists and mine-owners, we are wording our reports in a manner such that people will be afforded a fair observation upon blue beryls. One other slightly puzzling item is that the Brazilian owner of the Blue Beryl mine also told me that no one (presumably in Brazil) knew the whereabouts of the Maxixe Mine.

Following on from this preamble of Blue Beryls is the account of investigations conducted for the G.I.A. by the Bell Laboratories scientists. Our own findings of the blue beryls are 1·580–1·586 with a strong absorption band at about 6850Å. This line is easily seen by hand spectroscope but not easily measured.

EXAMINATION OF MAXIXE-TYPE BLUE AND GREEN BERYL

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ABSTRACT

Blue Maxixe beryl, kept in the dark since 1917, and current blue and green beryl (see R. Crowningshield, Gems and Gemology, Vol. 14, #4 Winter 1972) showing similar characteristics have been examined by absorption spectroscopy, gamma-ray spectroscopy, chemical analysis, and light, heat, and irradiation treatments. All three show an anomalous dichroism (the ordinary ray is more blue than the extraordinary ray, while in aquamarine the reverse is true) and an unusual narrow-band spectrum in the red and yellow regions. In all three cases the colour is bleached by exposure to daylight or on heating and can be recovered by neutron or gamma-ray irradiation. A colour-centre not involving a transition metal such as Fe, Co, Cu, etc. is indicated. Examination of 23 faceted "sapphire"-blue beryl gemstones by gamma-ray spectroscopy indicates that three had definitely been coloured by neutron irradiation; the others may or may not have been treated by irradiation.

INTRODUCTION

About 1917 blue beryl was found in the Maxixe mine in Minas Gerais, Brazil, which had the following unusual properties: it showed a strong anomalous dichroism, a narrow-band absorption spectrum for the ordinary ray which produces a pronounced "sapphire" or "cobalt" blue (distinctly different from the blue of aquamarine beryl); and the colour faded on exposure to light.* These and other properties were reported in 1933 and 1935.(1,2,3) We consider any beryl to be "Maxixe-type" beryl if it shows these three unusual properties: dichroism with blue in the ordinary ray; narrow-banded absorptions in the ordinary ray spectrum; and bleaching on exposure to light or heat. Some recent material of this type has become available, and our attention was drawn to the unusual absorption spectrum by Mr. R. Crowningshield.

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*After a brief period of "a lively trade"(1) "there resulted much unpleasantness"(2) (authors' translation).

EXPERIMENTAL

We have examined in detail the following: a piece of the original Maxixe find that has been kept from extended exposure to light since 1917, courtesy of Mr. B. W. Anderson; 23 specimens of currently commercially available deep blue faceted stones (ranging from four to ten carats in weight) as well as blue rough, from an unspecified locality said to be in Brazil; and three dark green stones and some dark green rough, possibly from the same current locality. All exhibit the three properties just mentioned. Although there were some minor differences, all these specimens showed pronounced blue/colourless, blue/pale pink, or green/yellow dichroism with a similar characteristic ω spectrum in the 5000 to 7500 Å region as shown in Fig. 1.

Permission was obtained to expose to light four current deep-blue stones, current deep-blue and green rough, and part of the old Maxixe rough (either to daylight with intermittent sun or to a 100-watt frosted tungsten light bulb at a distance of six inches in an air-conditioned room). After one week all had faded significantly, ending with only about half of the original colour or less. The bleaching was then completed by heating to a maximum of 235°C. (450°F.) for 30 minutes, resulting in a yellow or pale pink colour. By comparison, aquamarine is customarily heated to a much higher temperature (400°C.-750°F.) to improve the colour, which remains stable to light.(4)

Examination of all the specimens by gamma-ray spectroscopy using a lithium drifted germanium detector indicated in three of the faceted stones the presence of a small amount of Caesium-134, a radioactive species with a half life of 2 years. This is absent in nature, but produced by neutron irradiation of natural Caesium-133 in the specimens. These stones must therefore have been treated by neutron irradiation. The other specimens did not show this behaviour and have probably not been irradiated with neutrons. On heating one of the partially bleached cut stones to 150°C. for 30 minutes there was no significant further change in colour. However, after 30 minutes at 200°C. (about 400°F.) only a very pale pink colour remained. Neutron irradiation (15 minutes at 10^{13} neutrons/cm^2/sec) now returned the stone to a blue colour even deeper than its original colour. Another similar stone (blue/pale pink dichroism), when heated by Mr. R. Crowningshield, bleached completely to pale pink in less than 30 minutes at 95°C. (200°F.). This stone was exposed to gamma-rays (2×10^7 rads from Cobalt 60) and also turned deep blue. This gamma-ray irradiation does not leave any evidence of treatment, producing the usual characteristic ω spectrum. As expected from the ease of heat bleaching, this stone also bleached very rapidly in light (significantly in only 15 hours).

The green material, when bleached to a deep yellow by sunlight, could be returned to green by neutron irradiation, to a weak blue/green by X-rays, but was hardly changed by gamma-rays from Cobalt 60. The re-coloured material (both blue and green) could be bleached again by light. The green could also be changed to yellow by a 30 minute heat-treatment at 150°C., while heating to 400°C. removed the yellow colour as was previously noted in an ordinary yellow beryl(5); neutron irradiation returned this colourless material to green.

Analysis showed a high iron-content in the green material (about 0·2%), but essentially none in the old Maxixe sample (0·000X%). This is consistent with the spectral evidence that the deep yellow component is due to Fe^{3+} in the octahedral Al site(5), and indicates that Fe is not involved in the narrow-banded ω spectrum. Other transition metals such as Co, Cu, etc., are essentially absent. Since the blue material can be bleached by exposure to light or quite low temperatures and recovered by irradiation, a colour centre(6) (see Appendix) not involving a transition-metal ion is indicated. The minor differences in the spectra in Fig. 1 may well be associated with differences in the total alkali content, the old Maxixe being high (about 2%), the green low (less than 0·1%).

Neutron irradiation was also tried on several of the beryl specimens used in our previous study.(5) One of these, a colourless beryl (#451 of Ref. 5) showed a faint blue colour after irradiation, and on examination showed a weak ω spectrum of the Maxixe-type. Accordingly it appears that not any beryl can be irradiated to give a Maxixe-type colour, but neither does it appear to be necessary to have material from a unique location. Investigation on this point is continuing.

CONCLUSIONS

There is some variation in spectrum, iron content, alkali content, colour, and rate of bleaching by either light† or heat. Nevertheless, in contrast to the many ordinary varieties of beryl known over the centuries, these specimens show sufficient similarity to merit a common designation, and we have used the term "Maxixe-type" based on the first reported occurrence.(1,2,3) At present there is not enough information to decide if this type of material originates from one or several localities. It appears that the colour of some of this material may be as originally found, although some material has definitely been neutron irradiated either to form the colour, to improve the colour, or to return colour which has been bleached by exposure to light or to heat. Some or all of the rest may have been coloured by gamma-rays.

Based on the observations here reported we believe that any blue or green beryl (particularly if the blue colour is of the "sapphire" type) showing anomalous dichroism with the blue colour in the ordinary ray and sharp absorption bands for the ordinary ray in the 5000 to 7500 Å region (Fig. 1 and Ref. 7) should be designated as "Maxixe-type". Such a beryl will fade, either on exposure to light or on heating. Such a beryl may or may not have been irradiated with neutrons or with gamma-rays. It is in fact not possible to determine whether a given stone has been treated or how fast it will fade.

In the words of Mr. Crowningshield "... potential buyers should be alerted to the possibility that any stone of this type, which they consider, may fade too rapidly to be a satisfactory jewellery stone".

Our investigation is continuing and a detailed report will appear in the Lapidary Journal, together with colour illustrations.

ACKNOWLEDGMENT

We are grateful to B. W. Anderson of the Laboratory of the London Chamber of Commerce, England, for the original Maxixe specimen; to R. Crowningshield of the Gemological Institute of America, New York City, for arranging for the loan of the faceted blue stones, for helpful discussions, and for obtaining for us the green rough and stones from Mr. H. Rubin of the Gemset Co. of New York City, as well as to S. S. Voris for the gamma ray and Miss B. E. Prescott for the optical spectroscopy.

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†A large intensely coloured gemstone may need more than a week in bright sunlight (or 150 hours at 6 inches from a 100-watt frosted light bulb) to show pronounced fading.

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APPENDIX: *A Note on Colour Centres*

Most of the colour in gems and minerals is caused by unpaired electrons in major ingredients such as the copper in malachite and turquoise, or in impurities such as the chromium in ruby and emerald or the iron in aquamarine and citrine. Alternatively there is colour caused by physical structure, as in opal and labradorite (the optical diffraction-grating effect).

But in some materials, where there is no such colour-causing ingredient or physical structure present, it is possible for "colour centres" to cause a variety of colours. Colour centres have been studied intensively, but only few have been understood. Frequently this involves a vacancy (omitted atom) or some other type of defect (sometimes an impurity) which can hold (but does not of itself possess) an unpaired electron.

Examples of colour centres occur in halite or sylvite (made purple to black by various treatments), fluorite (green, purple, etc.) and smoky quartz. A frequent characteristic of colour centres is that exposure to light or to relatively low temperatures may permit the unpaired electrons to pair off, thus removing the colour. Irradiation by X-rays, neutrons, or some other form of penetrating radiation may cause the colour to return by unpairing the electrons again. An unusual, only partly understood colour centre is involved in the amethyst form of quartz which also contains iron as an impurity. Amethyst is turned yellow or green by heat, and can be recoloured with X-ray irradiation. However not just any quartz coloured green or yellow with iron will go to amethyst with irradiation—some specific defect must still be associated with the iron impurity. Synthetic quartz containing iron must be grown in one specific direction to produce this specific colour centre and enable amethyst to be produced on subsequent X-ray irradiation. The colour of amethyst is unusually stable for a colour centre, although it will fade over a period of many years or in hours at

400 to 600°C. The relative ease with which the colour is produced by X-rays is consistent with this stability to light and to heat.

In the case of the deep-blue beryl there does not seem to be any specific impurity present. It is likely therefore that a vacancy is involved which can hold an unpaired electron. The relative ease of fading implies that the electrons pair off readily, and the difficulty of returning the colour is consistent with this instability.

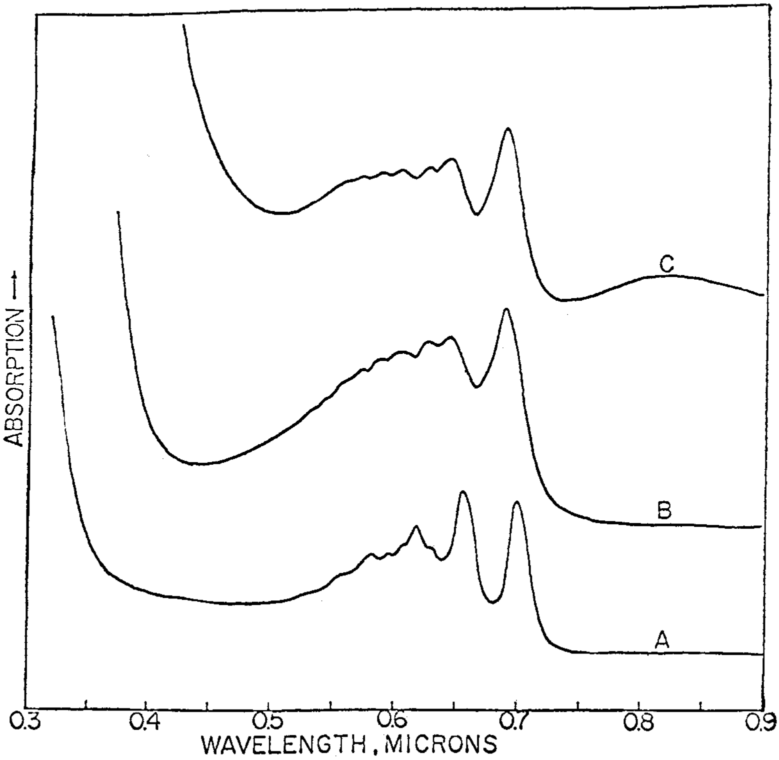

Fig. 1. Absorption spectra of Maxixe-type beryls: (A) 1917 Maxixe specimen; (B) current blue faceted stone; (C) current green rough. Ordinary ray only; extraordinary ray lacks any absorption in the 0·5 to 0·75 micron (5000 to 7500A) region.

SAPPHIRE MINING IN CHANTABURI (THAILAND)

By J. A. L. PAVITT

THAILAND, or Siam as it was formerly named, is a well known source of sapphire, ruby, star-sapphire and zircon, and over the years the skill of the Thai lapidaries has advanced to a very high degree, making Bangkok, the capital city, an important centre for the supply of cut gemstones.

There are a number of gem mining localities in Thailand, many of them in remote areas, but the mines at Chantaburi (also known as Chantabun), 200 miles from Bangkok, can be reached by car in five and a half hours, and soon after our arrival in Thailand in 1971 my wife and I made our first visit to Khau Ploi Waen, or "Hill of the Sapphire Ring", as this mining area at Chantaburi is named. I have since made further visits, the most recent in January 1973 with Mr. Kenneth Parkinson during his two week visit to Thailand.

Chantaburi has a very special place in the history and culture of the Kingdom of Thailand. Situated near the coast, only thirty miles from the border with Cambodia, its inhabitants, although loyal and proud Thai nationals, have ethnic origins connecting many of them with the diverse civilizations which existed thousands of years ago between the borders of China and the Mekong Delta. These origins are still evident in the customs, skills, religions and dialects to be found among the people of this fertile eastern region of the Kingdom.

It was at Chantaburi that King Taksin marshalled his forces after the fall of the ancient city of Ayuthya, and finally defeated and drove out the Burmese invaders. Close to the sapphire mines one can see the rusting cannon and remains of the fortress of King Rama III (1787-1851).

The gem-bearing deposits at Khau Ploi Waen are about six miles south of the town of Chantaburi, near the village of Ban Kacha. Past records indicate that in 1850 the Shans and Burmese were extracting sapphires here and that in 1895 a British Company obtained a lease but failed to make a success of the venture. In 1919 the Siam Mining Act came into force and since then mining has been solely in the hands of Thai nationals.

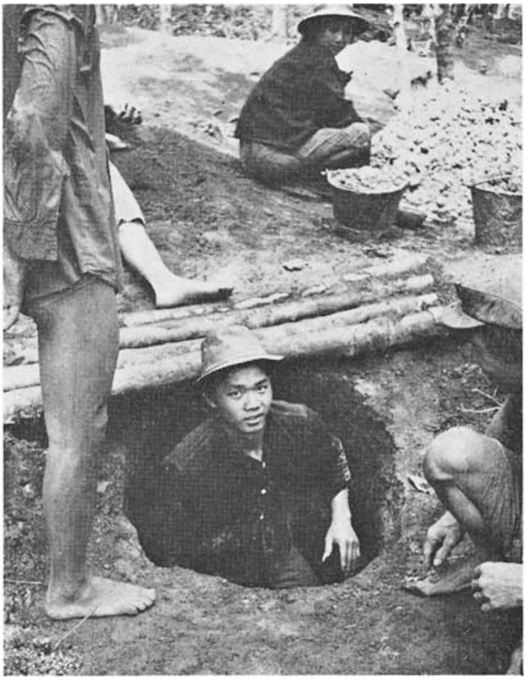

FIG. 1. Typical sapphire mine shaft at Khau Ploi Waen.

The mining area is privately owned and has been cleared of primary growth and planted with rubber trees, although it is obvious that an income from rubber tapping is of minor importance. A lease to dig for gemstones over an area of one "rai" (approx. 0·4 acre) for one year is granted by the landlords for a fee which may be as high as Baht 300,000 (£6,000) for high yield areas which have not previously been worked. A lease area is usually shared by groups or families and there are said to be some 2,000 people mining around Khau Ploi Waen.

The method of extracting the stones is very primitive, as are the tools—a pick, a spade and a rattan basket. A vertical shaft of about four feet in diameter is dug in the red/brown clay soil, in between the rubber trees (see Fig. 1). These vertical shafts sometimes go as far as thirty feet deep and each basketful of soil is lifted to the surface by a crude, but effective, crane arrangement consisting of two bamboo legs and a long bamboo derrick arm with a rope and

FIG. 2. A bamboo crane used for lifting soil from the mine shafts.

basket at one end and a counterbalance of large stones tied to the other end (see Fig. 2).

When a gem-bearing stratum is reached each basketful of soil is placed to one side at the top of the shaft, to be washed and sorted. In some instances a horizontal shaft will be dug to follow the gem-bearing stratum, but as no wooden props or tunnel shores are used the length of these horizontal tunnels is limited by the courage and tenacity of the digger, not to mention his ability to breathe in the tomblike atmosphere. No ladders are provided in the vertical shaft, and entry and exit are effected by bracing the back and hands against one wall and the feet against the opposite side, at the same time exerting the body in a motion that would do credit to James Bond in his tightest spot!

There is no natural supply of water for washing the extractions, so the miners pay for this to be brought from the nearby village by water-tank lorries. A small pond about ten feet in diameter and

FIG. 3. A washing pool.

three feet deep is formed near the shaft and the baskets of soil are washed and broken up by members of the group sitting in the pond (see Fig. 3). As and when the gemstones are found, these are placed in small plastic bags around the perimeter of the pond.

This particular area produces a fair quantity of corundum, most of the crystals being in the form of repeated lamellar twinning. In this form some of the stones can be cut en cabochon to exhibit fine golden six-rayed stars on a dark brown to nearly black background, and on my first visit I met Khun Saengroong, a local dealer and cutter, who had just bought a magnificent hexagonal lamellar crystal of star-sapphire material weighing 1720 carats. This is of course a rare exception and the average size seldom exceeds 15 carats, and even then only very few of the stones will, when cut, show a well centred star without the disfiguration of the prominant zone-lines which are a feature of the stones from this mine.

The local "test" for rough star-sapphire material is to place a drop of water on the stone and to view it from an overhead single light source. In a suitable crystal the "star" will show up clearly when the drop of water is placed in the right position. As is to be expected, a very great proportion of these opaque corundum crystals show a very poor, or no, star-effect, and these fetch very low prices.

In quantity, the second main gem production of this area is green sapphire, followed by blue/green, yellow/green and more rarely fine blue and yellow sapphire. The hexagonal zoning is easily detected under the lens in a large majority of these stones.

Also associated with the corundum are pyrope garnet (R.I. 1·745 to 1·750) and a fairly large quantity of opaque black stones which take a high polish and are sold both faceted and en cabochon as "Thai Jet". Kenneth Parkinson took ten of these back to the U.K. and has since written to tell me that seven of these have a S.G. of between 4·1 and 4·2 and with a R.I. just visible at the very end of the standard refractometer it seems fairly certain that they are black almandines. The other three stones proved to be black diopside (no star or cat's-eye) with a clear double refraction 1·68-1·71. Although this is slightly higher than the normal 1·67-1·70, Webster (Gems, 2nd Edition, page 264) notes that the R.I. may rise when the material is so dark as to be virtually hedenbergite.

Many jewellers and gem-dealers in Bangkok will inform their customers "These stones come from our own mine at Chantaburi", but it is very doubtful whether any of them actually engage in mining themselves, as those who have taken a lease and employed people to dig for them have usually found that somehow their area seems to produce only low-grade stones. The best-quality stones will find their way into the market, but not through the lease-holder. The local expression is "employ someone to dig and your stone will fly".

Dealers and middlemen gather at a small group of wooden coffee-shops at the fork of two roads leading into the mining area and it is here, in the late afternoon, that the miners bring their daily production for sale (see Fig. 4).

The existence of these sapphire mines and others in the area producing ruby and zircon, has created a flourishing cutting and setting centre in the town of Chantaburi (see Fig. 5). The standard of work is high, and, compared with western prices, cutting costs are very low. A skilled Thai lapidary will be paid about 20 pence for faceting and polishing a zircon of one carat. These low cutting-costs have prompted many of the local dealers to import rough gem-material for cutting in Thailand and eventual export to the major markets in Europe and the U.S.A. When Kenneth Parkinson and I were in Chantaburi we were shown a parcel of fine blue sapphire crystals recently purchased in Australia. One could not help thinking of the expression "bringing coals to Newcastle".

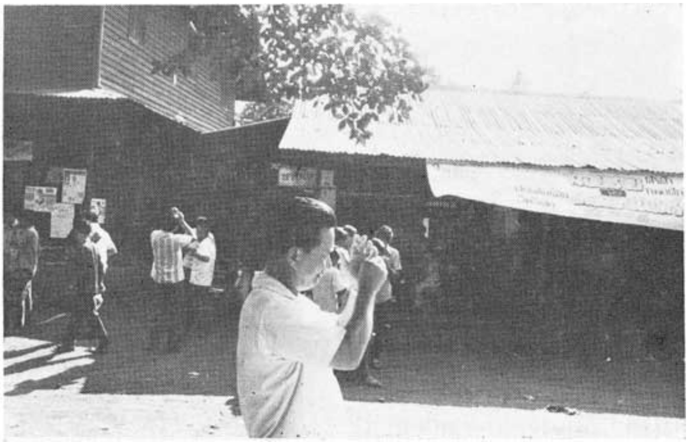

FIG. 4. Dealers examining stones at the village near Ban Kacha.

Although sapphire, ruby and zircon are the principal materials cut at Chantaburi, opal, emerald and other rough is imported for cutting. It is perhaps inevitable that half boules of synthetic corundum are to be seen in many of the gem-cutting shops, and, although the majority of dealers will not offer synthetics as anything but what they are, one suspects that a few will be sorely tempted when selling to some of the gullible foreign tourists who are now starting to visit this area.

FIG. 5. One of the many lapidary shops in Chantaburi.

STAR-DIOPSIDE AND LABRADORITE AS PARAMAGNETIC MINERALS

By DAVID KENT, F.G.A. and ROBERT WEBSTER, F.G.A.

IN 1953 B. W. Anderson(1) referred to some experiments with a pocket magnet which he had carried out. His method entailed using a sensitive balance and a small mathematical calculation, and the scheme was found to have some practical value. In this paper some experiments using a small 'Eclipse' horse-shoe magnet and/or a compass are considered. These experiments indicated that paramagnetic inclusions can cause a non-magnetic mineral to be attracted to a magnet.

One of us (D. K.) was told by an American friend, Mr. Antonio Bonanno, of Washington, D.C., that he had noticed that a black four-rayed star-diopside was attracted to a magnet and, indeed, questioned whether the stone was a true diopside or a magnetite. The second author (R. W.) was approached to find out whether this effect had previously been reported. Another specimen of such a stone was then examined and this too was found to be paramagnetic in that it could be attracted to a magnet. As a precaution green diopsides from Madagascar and from Sljudanka (Baikal, U.S.S.R.), a diopside cat's-eye, small green crystals from Georgetown (California), a large crystal which probably came from Piedmont (Italy) and a piece of rough material of yellow colour from Three Rivers (Quebec, Canada) were tested and found to be all non-magnetic.

The next question was "Why are these star-diopsides magnetic?". It was considered that the answer might lie in the inclusions which produce the asterism and that these inclusions might well be magnetite, a mineral which is well-known for its magnetism. This led to reference to the writings of the two best-known experts on inclusions in gemstones, Professor W. F. Eppler and Dr. Edward Gübelin.

It was known that Professor Eppler had written a paper(2) on star-diopside and star-enstatite soon after these stones appeared on the market, and this article was looked up. These were early days and Dr. Eppler after discussing the star effect stated—"The nature of these particular inclusions is not yet known". Dr. Martin's work(3) published shortly afterwards threw no further light on this matter. Dr. Gübelin's work on inclusions(4) was then consulted and here we found an answer, for Dr. Gübelin wrote as follows—"H. J. Schubnel reports(5) that by using the microprobe analysis he has been able to identify as primarily unmixed magnetite the black needle-shaped inclusions responsible for the asterism in the Indian star-diopside". Later Mr. Anderson referred us to the article by Dr. Ponahlo of Vienna(6) who had found the inclusions in these star-diopsides to be magnetite and after the material had been powdered-up for X-ray analysis that the particles were magnetic.

Dr. Ponahlo did not infer in his article that the whole stone could be influenced by a magnet so the authors felt that it should be put on record. Further, this led to the consideration of other gem materials which might behave similarly. It is fairly well known that the labradorite variety of feldspar contains inclusions of magnetite, so a number of specimens of this variety of feldspar were examined. Using a hand-held magnet it was found that many of the stones did show paramagnetism, and this gave further evidence that inclusions might produce the magnetic effect.

It is clear that something should be recorded of the actual experiments carried out. As all the stones examined were cabochon cut they were laid, with the domed top surface downwards, on a smooth surface—a sheet of glass or plastic, or a table-top with a good surface—and the magnet was gradually brought near to the stone, which, according to the strength of the magnetism, began to rotate or oscillate and eventually 'fly' to the magnet. In the case of the star-diopsides it was noticed that the stone was attracted to the magnet at a point midway between the arms of the star. It seems, therefore, to show that this effect is due to a resultant of the two forces of attraction produced by each of the two series of inclusions giving rise to the star. There also seems to be some degree of polarity. In general magnetite is not an 'active' magnet; it is only the variety *lodestone* which acts as a magnet. This is clearly stated by Dana/Ford(7) which says—"Ordinary magnetite is attracted by a magnet but has no power of attracting particles of iron itself. The property of polarity which distinguishes the *lodestone* is exceptional".

Several cabochon-cut labradorites, including specimens of the so-called 'black moonstone', were examined and were found to be weakly magnetic, and also appeared to be polar. The magnetic effect is, however, not very strong and only fairly high cabochons will have so little friction between the stone and the table surface as to move readily. The effects may be summed up as follows: the star-diopsides show the effect strongly, the 'black moonstones' much less so, and the more common greyish type of labradorite gave the least response to the magnet. The question of the polarity was less easily disposed of. Although there was certainly some degree of polarity shown, with the apparatus available there was no conclusive proof of this having a *north* and *south* pole. In the case of the labradorites the attraction was found to lie between two sets of inclusions and again may be a resultant of forces.

The results obtained with the above experiments led to trials with a compass needle—a small charm compass, a four-armed button compass and a Service marching compass being used for the experiments. Using the small compass, it was found that each ray of the star-diopsides was polar, one end being *south* and the other *north*. This polar effect was also seen with the large compass, but owing to the shape of the casing of the compass this was more difficult to assess. By placing the stone on the glass cover of the compass over the pivot of the needle, the ring dial being set at the north point, the needle moved to a steady position half way between the arms of the star, and on turning the stone the needle moved through an arc of about 100 degrees.

With the specimens of labradorite the results obtained with the small compass were not so helpful, due perhaps to a lack of sensitivity and the shortness of the needles and to the weak magnetism of the labradorite. Very little movement of the needle could be seen, but when the large marching compass was used there was, in most cases, some movement of the compass needle to be seen, the 'black moonstone' types giving a total swing of about 10 to 15 degrees, while the greyer types only showed a needle movement of about 3 degrees. In some cases, and these were mostly rough unpolished pieces, no precise movement could be seen.

It is clear from these experiments that profuse inclusions of a magnetic mineral can produce response to a magnet even when they are embedded in a host mineral which is itself non-magnetic.

Further, it is apparent that the needle-shaped crystals forming the inclusions in the stone are polar, or under the influence of a magnet can be made so. While the weak response given by labradorite would not provide a satisfactory test, for labradorite is so easily identified by mere inspection, the much stronger magnetism of the star-diopside may have real value in confirming the nature of the stone.

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4. Gübelin, E. *On the nature of mineral inclusions in gemstones.* Journ. Gemmology, 1969 XI, 5, 166-167.
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6. Ponahlo, J. F. R. *Inclusions in black star pyroxene.* Journ. Gemmology, 1968, XI, 1, 12-15.
7. Ford W. E. *Dana's Text Book of Mineralogy.* 1948, Chapman & Hall, London, 491.

GILSON SYNTHETIC TURQUOISE: More Notes

By F. S. H. TISDALL, F.G.A.

AFTER reading Robert Webster's interesting and informative article on Gilson synthetic turquoise,* and being prompted by the hope that he expresses in his final sentence that others would continue to examine these stones, I wrote to Messrs. Gilem S.A. and requested a specimen from them; they very helpfully sent one: a 12 × 10 mm. oval cabochon weighing 5·13 cts.

Mr. Webster's description applies equally to my stone, i.e. the colour tended to be on the pale side, and not the deeper, finer blue of turquoises from Persia. Comparison with an American stone showed a close colour resemblance. The Gilson is, nevertheless, a pleasing stone and has a high degree of polish, superior to that of the natural, and whatever the problems with which they may confront gemmologists one cannot withhold from Messrs. Gilson credit for producing an attractive synthetic. The first impression is, simply, that the stone is "too good to be true"—a feature of most synthetics. The base of the stone is neatly ground to a flat surface with a slightly bevelled edge to assist the setter. There is, of course, an entire absence of limonite or any other form of inclusion. Now that one knows these stones are on the market, this last feature together with such perfect regularity of cut should excite suspicion.

Merely for the sake of confirming Mr. Webster's findings I carried out a hydrostatic S.G. test and obtained the figure 2·70. A "distant vision" R.I. reading on a Dialdex refractometer yielded approximately 1·6. Both constants are characteristic of turquoises from America, so that no diagnostic help is given by these figures.

Not feeling that the use of spectroscope or ultra-violet lamps would prove fruitful I next made a careful examination of the stone's surface under a binocular microscope, the illumination being directed down on to the stone from above; it was this examination which, in my view, led to a clear differentiation between the Gilson and the natural turquoise. In no natural turquoise have I seen a pattern of surface markings like that on the Gilson stone. Mr. Webster describes the surface as "made up of small dark blue

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*Webster R. *More Notes on Gilson Synthetic Turquoise,* Journal Gem. 13 (5), 157-160, Jan. 1973.

angular particles . . . buried in a whitish groundmass". That description I cannot better.

Examination of the surface of a 12 × 10 mm. cabochon American turquoise did, in fact, disclose small-scale patchiness of colour, but nothing resembling the almost honeycomb-like mosaic on the Gilson; the polish of the natural stone was much inferior.

Powerful illumination of the surface of the Gilson with a 500-watt photoflood lamp so positioned that light fell at an angle of about 45° disclosed that the whitish groundmass had in many places been etched or polished away, leaving a network of very minute cracks quite unlike anything I have ever seen on a natural turquoise.

The above examination was carried out at a magnification of 35 × ; at 87 × the structure was more easily seen, and also the surface appeared translucent. After removing the stone from the microscope I found that I could just discern the mosaic structure with a 20 × loupe, though not with a 10 × ; keener eyes might do so.

Summarizing: the Gilson stones are a pleasing lightish blue and have a very good polish; there is no sign of inclusions of any kind, and the base is neatly and evenly ground flat. If placed on the stage of a microscope and illuminated from above (a 60-watt pearl bulb will serve) the surface structure as described will be seen and will designate the stone as a Gilson synthetic turquoise.

Not having facilities for chemical analysis it is not possible for me to say whether the composition corresponds to that of a natural turquoise. It is to be noted that Messrs. Gilson do not use the gemmologically preferred description "synthetic" but describe their product as "Gilson created turquoise".

GADOLINIUM GALLIUM GARNET

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

YET another garnet-type synthetic material originally made for the electronics industry is reported to be offered in a cut form in the United States. I am indebted to Dr. Kurt Nassau, of Bell Telephone Laboratories, Murray Hill, New Jersey, for specimens of red, green and colourless material.

Examination of the red and green crystals showed well-developed dodecahedron faces, modified by those of the icositetrahedron. The red stones, according to the manufacturers, are coloured by manganese, and the green by cobalt. Neither stone, however, displayed any marked absorption spectrum.

The colourless stone, in the form of a truncated cone, might be said to be a very pale straw-colour. Although no absorption spectrum can be seen by daylight or tungsten light, a fine fluorescence spectrum is displayed both under short-wave ultra-violet light and X-ray radiation. A strong absorption in the red is accompanied by an emission line; the sodium doublet shows as an emission; there are two distinct bands in the green and two in the blue. The stone fluoresces very pale straw under long-wave, and a peach-colour under short-wave ultra-violet light. Under X-rays the fluorescence is lilac, resembling that of YAG. There is no phosphorescence.

The chemical composition is $Gd_3Ga_5O_{12}$, thus fitting in with the general formula for garnet-type synthetics. The density, at 7·09, is very high for a gem material; the density of gadolinium, a rare earth of the lanthanide group, is 7·88; that of gallium 5·90. The refractive index ascertained by Robert Webster, using the real and apparent depth method, was in the region of 1·92 and the hardness just over 6.

Industrially these garnets are used in microwave filters, where gadolinium may substitute for yttrium.

I am indebted to Alec Farn for placing the X-ray set at the Gem Testing Laboratory at my disposal.

A FURTHER NOTE ON DIAMONDS, REAL AND IMITATION, IN THE ROMAN PERIOD

By J. M. OGDEN, F.G.A.

SINCE the brief note on Roman imitation diamonds by the writer was published in the Journal of Gemmology(1) two fine Roman rings, both set with interesting stones, have been available for study. The first (Fig. 1 *a.* and *b.*) has an attractive openwork-sided setting in which is set an octahedral stone. This stone was at first glance taken to be a rock crystal of the type considered by the writer to be a Roman imitation of a natural diamond crystal. Closer inspection of the stone however revealed the typical surface decomposition characteristics of glass and the stone was, in fact, a yellowish white glass (the term "paste" would be wrong here, as technically this should only refer to those glasses with high refractive index and brilliancy). The writer knows of other instances of rings set with glass octahedra, and these, like the rock crystals, might be taken to be imitations of diamond crystals. It might be argued that any reasonably knowledgeable Roman could have told glass from the "invincible" diamond, but one would expect that these copies of diamond crystals were more in the nature of moral frauds; in other words they would have been worn by those to whom the diamond was, for reasons of economy or rank,

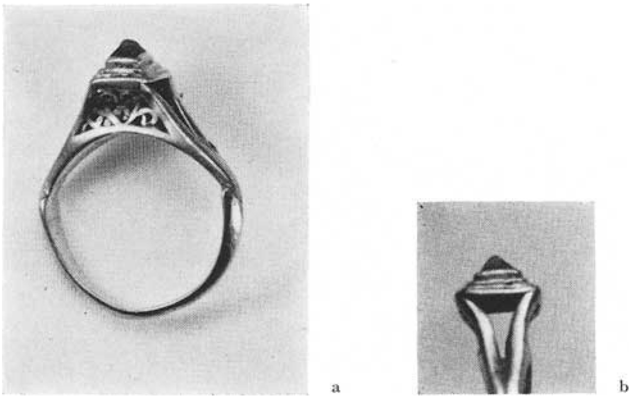

Figure 1a and b

out of reach. A similar state of affairs can be seen earlier in the Roman period when only free-born citizens were allowed to wear gold rings; slaves and others made do with wearing gilt bronze rings.(2)

The second ring is extremely interesting and possibly even unique, as it is set with a brown diamond. This stone, larger than any other Roman diamond known to the writer, is in the form of rough natural twin octahedra: the general appearance can be seen from Fig. 2 *a.* to *d.*, and in fact it is similar to diamond twin octahedra illustrated by Bruton.(3) Alec Farn of the Gem Testing Laboratory very kindly examined and tested this stone and found it to be a brown-series diamond: two lines, at 4980Å and 5040Å, were visible in the spectrum, and there was a blue fluorescence under X-rays. The weight of the stone was difficult to gauge, but it must have been about 7 carats. The majority of Roman diamonds known to the writer do not have recorded weights, but they generally would seem to weigh under a carat. This large stone under discussion was by no means obviously a diamond from colour or appearance, except to one versed in crystallography; so other stones of a similar nature

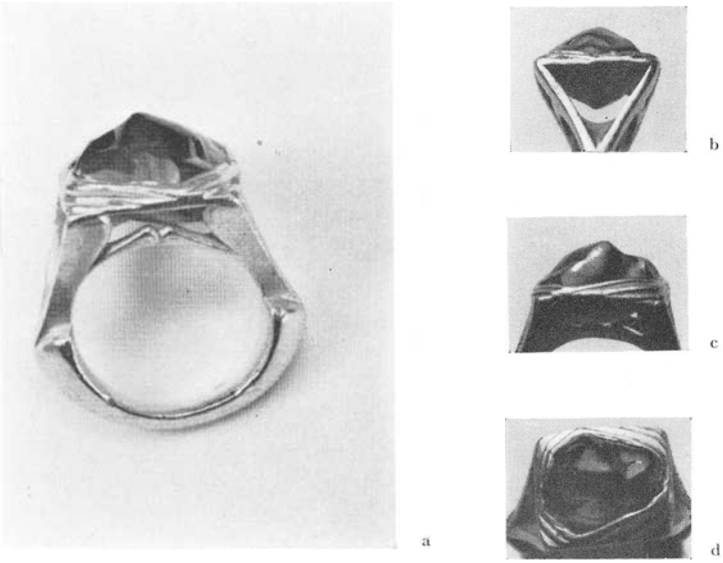

Figure 2a b, c and d

might exist, unrecognized, in museum or private collections. In its recent history the stone in this ring has been described in a multitude of ways, most recently as "Topaz." This fine ring is of a similar type to the first ring mentioned above, although it is sturdier and its size would indicate that it was definitely a man's ring. Both these rings were originally in the collection of Count Henri de Clercq Boisgelin, a well-known collector whose ancient jewellery included some of the finest specimens known. There is no cause to doubt that both these rings are genuine, and that they date from the late Roman period (c. 3rd–4th century A.D.). Close examination by the writer revealed no evidence that the stones were not originals: indeed the ring holding the diamond had quite obviously been made for that stone and none other. The colouration, surface appearance under strong magnification and the general "feel" of the gold in both cases would show that the settings were as old as supposed.

No provenance is recorded for either of these rings, though it would seem likely that they were made in Italy or in one of the Eastern Roman centres such as Asia Minor or Egypt. The exact area of origin for the diamond is not known, but it would be likely that it was traded "loose" from India, possibly via Alexandria.

The writer is indebted to Robin Symes, London, for permission to study, photograph and publish these rings.

NOTES

1. Journal of Gemmology, Vol. 13, No. 5 (January 1973), pp. 179–180.
2. The wearing of gold rings in the Roman period is discussed by Marshall in the "Catalogue of the Finger Rings, Greek, Etruscan and Roman, in the Department of Antiquities," British Museum, 1968.
3. Eric Bruton, "Diamonds," London, 1970 fig. 17.18, p. 287.

Gemmological Abstracts

BANK (H.). *Durchsichtiger albit aus Madagaskar und den Alpen.* (Transparent albite from Madagascar and the Alps.) Z. Dt. Gemmol. Ges., 1973, 22, 2, 53-54.

A colourless, transparent stone found in Madagascar and also in the Alps, especially in Austria, was found to be albite. Physical and chemical properties are given.

E.S.

BANK (H.). *Plagioklas-mischkristall a andesin als 'Madagaskar-mondstein'.* (Plagioclase-type crystals of andesine known as 'Madagascar moonstone'). Z. Dt. Gemmol. Ges., 1973, 22, 2, 55-57.

A stone from Madagascar, known as 'Madagascar moonstone' as well as 'precious labradorite from Madagascar', was examined and found to be a plagioclase-feldspar, in particular andesine, which is a mixed crystal between oligoclase and labradorite; these stones show the typical effect of labradorite, a plagioclase rich in calcium. A graph illustrates the R.I.s of a series of plagioclase-feldspars.

E.S.

BANK (H.). *Klar durchsichtige labradorite (plagioklas-feldspate) aus Oregon, U.S.A.* (Transparent labradorites (plagioclase-feldspars) from Oregon, U.S.A.) Z. Dt. Gemmol. Ges., 1973, 22, 2, 58-59.

This article deals with clear transparent labradorite from Oregon, U.S.A. These crystals show less of the characteristic optical properties of labradorite but have a similar effect to that of aventurine.

E.S.

BANK (H.). *Ein neues smaragdvorkommen in Zambia (Miku-deposit).* (A new emerald find in Zambia (Miku deposit).) Z. Dt. Gemmol. Ges., 1973, 22, 2, 60-61.

A new emerald deposit in Zambia, the Miku deposit, is recorded, and the geographical find described, as are also some physical properties.

E.S.

BANK (H.). *Bleiantimonspiessglanz als haarförmiger einschluss in quartz aus Brasilien.* (Hair-like inclusions of a lead-antimony mineral in quartz from Brazil.) Z. Dt. Gemmol. Ges., 1973, 22, 2, 62-64.

This article deals with needle-like inclusions in quartz from Bahia, Brazil, which were first thought to be rutile needles, but later found to be boulangerite, the iron-free form of lead-antimony. In fact the mineral consists of lead, antimony and sulphur, and was found in a large rock-crystal weighing 650 kg exhibited in the local (Idar-Oberstein) museum.

E.S.

BARIAND (P.). *Lapis Lazuli from Afghanistan.* Min. Digest, 1972, 4, 6-14. 10 colour photos.

A brief history of lapis lazuli from the mines in the Kokcha Valley, Afghanistan, is accompanied by colour photographs, some of them illustrating lazurite crystals in marble and showing dodecahedral form. The lazurite is accompanied by nepheline, sodalite, pale blue cancrinite (afghanite), pyrite, phlogopite, forsterite, diopside, green apatite, and scapolite. The sulphur for the feldspathoids is said to be derived from iron sulphates (magnesiocopiapites).

R. A. H.

BRADT (R. C.), NEWNHAM (R. E.) & BIGGERS (J. V.). *The romance of jade.* Earth & Min. Sci. (Pennsylvania State Univ.), 1973, 42, 29-30. 2 figs.

Fracture strengths of several varieties of nephrite and jadeite have been measured at around 30,000 and 15,000 lb/in^2 respectively, thus exceeding that of most commercially available ceramics (about 10,000 lb/in^2). The average fracture energy for a number of Russian and Alaskan nephrites is 225,000 ergs/cm^2, an exceptionally high value; Burmese jadeites have yielded 120,000 ergs/cm^2. Jade is thus about an order of magnitude tougher than most ceramic materials. The high fracture energy and fracture strength are not related directly to the atomic structure but to the microstructure and the restrictions which this imposes on the propagation of cracks.

Jadeite fracture surfaces seen by scanning electron microscope show a very high proportion of transgranular cleavage fractures; the elongated nature of some of these cleavage steps strongly suggests that fractures occur parallel to the pyroxene chains, on the (110) and ($\bar{1}$10) planes. It is this extensive transgranular cleavage fracture mode that imparts toughness to jadeite. Nephrite has a different fracture topography, with a random orientation of individual fibres, leading to interlocking with an increase in fracture strength. Cleavage planes are parallel to the fibre axis, so cleavage occurs lengthwise and is slowed or stopped when crossing over to a second fibre.

R. A. H.

Burridge (A. D.). *A quarter century of diamond research.* Gems & Gemology, 1972, XIV, 3, 66-76. 4 illus.

The article tells the history of the Diamond Research Laboratory at Johannesburg, South Africa. The laboratory was started on the 21st of April, 1947, and then consisted of one building—the buildings now occupy a nine-acre site. It was primarily designed for research into the problems of the use of industrial diamonds, such as for drills, saws, grinding-wheels etc. Since 1958 experiments at the laboratory have considerably improved the growth of synthetic diamonds, and studies have been made of the best shapes of crystals to use for various industrial applications. The "cladding" of diamond crystals with metal has been investigated, and a number of specialized machines have been devised and built for experimental purposes; some of these are now in operational use in the diamond mines themselves. Much work has been carried out on the physical properties of diamonds and gem diamonds have not been left out of the research projects. New recovery methods have been worked out and apparatus designed. These include scintillation and X-ray fluorescence separators for use in the diamond mines. Investigations into the thermal, electrical and hardness properties of various kinds of diamonds have led to the use of diamonds as 'heat sinks' and semiconducting devices. It is said that controlled heating in diffuse light of electron-irradiated diamonds induces a colour change, but when these so-called 'chameleon' diamonds are exposed to sunlight they revert to their original colour. It is clearly emphasized that irradiation cannot change a brown or yellow diamond to white, nor make a bad diamond into a good one.

R.W.

CASSEDANNE (J.). *Le diopside de Malacacheta, Bresil.* (Diopside from Malacacheta, Brazil.) Bulletin de l'Association Française de Gemmologie, 35, 5-7.

Diopside, some transparent, is found in the area of the small town of Malacacheta, in the State of Minas Gerais. The material is found in association with quartz, attaining in some cases the size of 30 × 8cm. Perfect crystals are rare, due to the difficulty of extraction. The colour is a dark green, the specific gravity 3·33 and hardness 5½. The refractive indices are 1·705, 1·674 with a DR of 0·031. Although 0·3% of chromium is present, it has little effect on the colour, which is due to iron. M. O'D.

CROWNINGSHIELD (R.). *Developments and Highlights at G.I.A.'s Lab. in New York.* Gems & Gemology, 1972, XVI, 3, 82-86. 9 illus.

A strongly radio-active green diamond is mentioned and so are some 'treated' diamonds examined. These latter included an intense yellow round brilliant-cut stone of some 20 carats and a number of brilliants of an intense blue colour somewhat like the best colour of 'fired' blue zircons. The problems in identifying 'buried' jades is referred to. The effect of heat on some nephrite discs, which caused the strengthening of the 4980Å line and associated lines, absorption lines which were not seen in the unaltered discs, is mentioned. The use of paraffin oil treatment to cracked jades is referred to and some emphasis is given to the danger of such oiling masking cracks so that in setting they are not noticed and breakage occurs. A necklace of pearls, natural white sapphires and uncut (or only partially faceted) crystals of red spinel is illustrated. There is a discussion on a smoky quartz and the report concludes with the mention of a diamond with an octahedral inclusion. R.W.

DERN (H.). *Die Herstellung synthetischer Diamanten im Spiegel der Patentliteratur.* (The production of synthetic diamonds in the patent literature.) Z. Dt. Gemmol. Ges. 1973, 22, 2, 65-75.

The article lists patents referring to the synthesis of diamonds from 12 countries, the earliest being a British patent dated 1930, the latest mentioned a Belgian patent dated 1972. The list mentions 162 separate patents. The article also points out the main differences between the most important patents. E.S.

ELBE (M. G.). *Die rechnerische Ermittlung der optimalen Brillanz von Brillanten.* (The mathematical calculation of the optimal brilliance in brilliants.) Z. Dt. Gemmol. Ges. 1973, 22, 2, 80-82.

It is shown that the equation by Johnsen (submitted to the Journal by Eulitz) is equal to the equation by Elbe.

E.S.

GÜBELIN (E.). *Inclusions in gemstones.* Australian Gemmologist, 1972, 11, 8, 3-14. 42 figs.

The nature and origin of inclusions in gemstones is described. Examples of solid, liquid and gaseous inclusions are illustrated.

D. R. H.

HAMLIN (A. C.). *The emerald.* Min. Digest, 1972, 3, 17-32. 8 colour photos.

An excerpt from *Leisure hours among the gems*, published in 1884, is illustrated by colour photographs of emeralds from Chivor and Muzo, Colombia, including the 632 carat 'Patricia' uncut emerald crystal from Chivor mine, now in the American Museum of Natural History, New York.

R. A. H.

HASSAN (F.). *Amethyst.* Min. Record, 1972, 3, 221-225. 8 figs.

The colour of amethyst is shown to be due to creation of Fe^{2+} and Fe^{4+} absorption centres by irradiation. Permanent loss of colour can be effected by heating amethyst to above 400°-450°C. Detailed study of amethyst occurrences might lead to a useful geothermometer. The occurrence, habit, and physical (structural and optical) features of amethyst are summarized.

J.A.

HEARNES (V. J.). *What is this thing called hardness?* The Australian Gemmologist, 1973, 11, 9, 16-17.

Discusses the different scales of hardness and questions whether a different more accurate system than that of Mohs could be devised and yet not require expensive equipment. Wisely the author states that first an acceptable definition of the term 'hardness' must be made, for the various systems mentioned operate on the measurement of different types of hardness.

R.W.

JONES (R. W.). *Arizona minerals in retrospect.* Lapidary Journal, 1973, 27, 1, 122-134.

Among the less well-known ornamental minerals from Arizona are variscite from Bisbee, fine wulfenite from the Rowley Mine near Theba, cerussite from the Flux Mine, Patagonia Mountains, and turquoise in matrix from Kingman. These specimens are illustrated in colour.

M.O'D.

KATZ (M. B.). *On the origin of the Ratnapura-type gem deposits of Ceylon.* Econ. Geol., 1972, 67, 113-115. 2 figs.

The detrital gem deposits appear to be derived from cordierite gneisses and associated rocks located in the surrounding highlands.

A.J.E.

LENZEN (G.). *Vorher – Nachher.* (Before – After.) Z. Dt. Gemmol. Ges., 1973, 22, 2, 76-79.

The article is illustrated by five photomicrographs showing the removal of two black inclusions in a brilliant by laser beams. The removal of the black spots and especially their reflection improves the stone greatly, but the hole caused by the beam is easily seen. It is suggested that the seller always mentions that the stone has been so treated and a correct definition in the described case history should read: '2nd piqué, laser bored'.

E.S.

LIDDICOAT (R. T.). *Developments and Highlights at G.I.A.'s Lab. in Los Angeles.* Gems & Gemology, 1972, XIV, 3, 86-94. 19 illus.

Two examples of turquoise matrix are described. The first was found to be natural turquoise containing white metallic areas consisting of pyrites and black areas consisting of zinc blende. The second stone was again not treated as such but gaps in the turquoise had been filled in with black plastic containing flecks of pyrites. Other items mentioned were a dark green 'aventurine glass' with spangles consisting of specular iron ore, calcite crystals in quartz and a 'feather' in a spinel which looked very much like a human fingerprint. A 'star quartz' in which a dark star is formed by a concentration of dark red inclusions in stellate arrangement is mentioned. Some effects shown by diamonds which had suffered burning and the lazer drilling of diamonds are discussed. A new source of opal—in Arizona—is referred to and there is some discussion whether to describe a greyish-blue cabochon of tremolite as nephrite or not. This stone showed an absorption line at 4370Å, which is the position of the jadeite line. A sapphire which showed a fluorescence under short-wave ultra-violet light but did not show the 4500Å line was found to be genuine. A Colombian emerald was seen to show a diamond-shaped solid in a three-phase inclusion, while another stone from the same country contained a plane of small pyrites crystals. A yellow cat's-eye jadeite is described, and the article concludes with references to insects enclosed in amber.

R.W.

MACFALL (R. P.). *The Hall of Jade and what it means.* Lapidary Journal, 1973, 27, 1, 18-45.

An account of the reconstructed Hall of Jades in the Field Museum of Natural History, Chicago. The two distinct minerals to which the name jade is given are reviewed and the major exhibits in the new display illustrated.

M.O'D.

MALES (P. A.). *Lightning Ridge nobbies and the 'Chinaman's hat'.* Australian Gemmologist, 1972, 11, 7, 17-18.

Irregular-shaped opal nodules of uncertain origin are described from Lightning Ridge, New South Wales.

D.R.H.

MALES (P. A.). *Inclusions in opal.* Australian Gemmologist, 1973, 11, 9, 15-16.

Describes a specimen of Lightning Ridge opal potch which had unusual inclusions. The inclusions may be gypsum.

R.W.

NASSAU (K.). *The Hoquiam ruby story.* Lapidary Journal, 1973, 27, 1, 26-32.

The first Verneuil-type synthetic rubies were made in the United States in 1903-1904 by two lumbermen at Hoquiam in the state of Washington. They were assisted by an associate of Verneuil. Examination of the few known boules made at that time shows that the feed powder was made from quite pure alum recrystallized several times from distilled water. Ground natural ruby was not used. The chromium content of the Hoquiam boules varies from 0·24 to 0·56 and the iron from 0·0040 to 0·0062.

M.O'D.

NORWOOD (J. E.). *Rubies of Wake County, N.C.* Rocks & Minerals, 1972, 47, 645-648. 2 figs.

Small ruby crystals are associated with chromite in dunite bodies near Bayleaf, Wake County, North Carolina. Notes on the geology and history of the area are included.

R.S.M.

OUGHTON (J. H.). *Diamond, YAG and other simulants.* Australian Gemmologist, 1972, 11, 8, 15-18.

The physical characteristics and methods of recognition are given for natural and synthetic gems used to simulate diamond.

D.R.H.

OUGHTON (J. H.). *Some archaic instruments in present day use.* Australian Gemmologist, 1973, 11, 9, 4-13. 10 illus.

An entertaining article describing old instruments, such as microscopes, refractometers, a goniometer (table spectrometer) and balances made in olden days, which found their way to Australia, often hidden for years in cupboards or on store shelves and now brought to light. Some of these are now used by students and gemmologists 'Down Under'.

R.W.

PERRAULT (G.) and RICHARD (P.). *L'Ekanite de Saint-Hilaire, P.Q.* (Ekanite from Saint-Hilaire, Quebec Province.) Canadian Mineralogist, 1973, 11, 5, 913-929.

Small crystals discovered in cavities in pegmatite veins associated with the Mont Saint-Hilaire intrusion in Quebec Province, which were provisionally referred to as "UK—4" pending their identification, have now been established as a variety of the radioactive thorium mineral, ekanite, which was first discovered twenty years ago in Ceylon by F. L. D. Ekanayake, after whom it was subsequently named. The density of the Quebec specimens was measured on a Berman balance and gave a low value of 2·95, the difference between this and the calculated figure of 3·32 being ascribed to the porosity of the specimens.

The refractive index for the ordinary ray was 1·573 and for the extraordinary ray 1·572, while the hardness was 350 on the Vickers scale, equivalent to a Mohs hardness of 5.

Analysis was complicated by the presence of 11·6 per cent absorbed water, but showed a composition very similar to former analyses on material from Ceylon, with two exceptions: (i) no uranium was found (Ceylon, 2-3%), (ii) sodium (3·36) and potassium (3·42) were present as essential constituents, but were missing from the analyses of Ceylon ekanites. While it is clear that ekanite is essentially a silicate of thorium, sodium, potassium and calcium, so far the proportions of the constituents have refused to conform exactly to a stoichiometric formula.

The crystals are tetragonal (space group P4/mcc) and associated minerals include analcite and aegerine. As would be expected from its heavy thorium content (28%), the mineral is radio-active, both α and β particle emissions being measured but (unlike the Ceylon variety) no gamma radiation being observable.

The lead content of these ekanite crystals was approximately 0·005 atoms per million which, supposing the lead to be due entirely to disintegration of thorium, argued an age of about 60 million years for this occurrence.

Abstractor's note

Ekanite provides one of many examples of a gem-quality mineral which, though having no commercial significance, has proved to be of extreme interest to science. Those who wish to refresh their memory of the story of its discovery by Mr. F. L. D. Ekanayake of Colombo twenty years ago, and of the protracted work on its composition and nature which finally established it as a new mineral, can refer to R. K. Mitchell's article in the *Journal of Gemmology* for July, 1961 (VIII, 3, 95-98). Very full details of the investigation and properties of ekanite can be found in a brilliant paper by Dr. Edward Gübelin in the *Gemmologist* for August and September, 1962 (XXXI, 373, 142-152, and 374, 165-169).

As found in the Ceylon gem gravels, ekanite is a green subtransparent mineral in a completely amorphous (metamict) state, the breakdown of its crystal structure being due to internal bombardment by alpha-particles emanating from its large thorium (and uranium) content during a period of 600 million years (ten times the period endured by the crystals found in Canada). Orientation of the inclusions suggested that the mineral had originally possessed a tetragonal structure and this was confirmed by X-ray powder photographs on material which had been subjected to prolonged heating.

An occurrence in Central Asia of crystallized ekanite containing alkali metals was reported by Russian workers in 1965, but was apparently overlooked by British abstractors.

B.W.A.

POUGH (F. H.). *Meet Tanzania's fancy sapphires.* Australian Gemmologist, 1972, 11, 8, 19-21.

A review is given of the occurrence of gem corundum in Tanzania, with emphasis on the fancy sapphires from the Umba River area.

D.R.H.

RIEMAN (H. M.). *Chrysoprase.* Lapidary Journal, 1973, 29, 3, 559-562.

Study of the cause of colour in chrysoprase has shown that nickel, the colouring agent, occurs as a constituent of the clay mineral pimelite rather than as a separated nickel oxide. Chrysoprase from Silesia contains 96% quartz and just over 1% pimelite. Occurrences of chrysoprase in the United States are rare, one of the best known being in Tulare County, California.

M.O'D.

SANTOS MUNSURI (A.). *Hornbill.* Boletin del Instituto Gemologico Español, 1972, 1, 3, 15-20.

An account, illustrated in colour, of the use of hornbill as an ornamental material. Greatly esteemed among the Chinese, it has a refractive index of approximately 1·54 and may be distinguished, albeit with some difficulty, from horn in which the fibres are concentric.

M.O'D.

TENHAGEN (J. W.). *Muzo emerald mine.* Gems & Gemology, 1972, XIV, 3, 77-81. 6 illus. in black and white.

Tells of a visit to the Muzo emerald mines in Colombia and of the difficulties in getting there. The mines are located in a hot and humid valley with dense vegetation around. The rock faces worked are called 'banks'. The Tequendama bank, now still being worked, was the site worked by the Spaniards some 400 years ago. At Muzo there are five or six banks (areas), of which only two are currently worked. Open-pit mining is employed, the emeralds being found in white calcite veins in a black carbonaceous shale. Owing to metamorphism the bedding planes of the shale are either vertical or twisted. The emerald-bearing strata are either dynamited or bulldozed and then broken up by hammers. The emerald-bearing strata are often washed down by water and the emeralds recovered from the residue. When found the emeralds are placed in double-locked bags which are later flown by helicopter to the bank at Bogota. Something is told of the inclusions found in Muzo emeralds.

R.W.

TENHAGEN (J. W.). *Muzo emerald mine, Colombia's hidden gem.* Lapidary Journal, 1973, 27, 1, 56-58. 6 illus. in colour.

The text of this article also appears in Gems & Gemology (see abstract above), but here it has coloured illustrations.

M.O'D.

TRUEB (L. F.) & BARRETT (C. S.). *Microstructural investigation of ballas diamonds.* Amer. Min., 1972, 57, 1664-1680, 14 figs.

Brazilian ballas consists of dense, globular aggregates of anhedral diamond crystallites with an average diameter of the order of 40 microns. The grain boundaries, which are often outlined by impurities and inclusions, are interlocked in complex sawtooth patterns and fracture is almost exclusively transgranular. The crystallites have a well developed preferred orientation, each radial direction being an axis of a [110] fibre texture.

A.P.

WEBSTER (R.). *The role of gemmology.* Australian Gemmologist, 1972, 11, 7, 7-16. 12 figs. (reprinted from Medicine, Science, and the Law, 1972, 12, 1, 31-42).

Already abstracted on p. 149 *supra.* D.R.H.

WOLLIN (J.C.). *Tigereye.* Min. Digest, 1972, 4, 97-102, 6 colour photos.

The occurrence of the golden or blue tigereye variety of quartz pseudomorphous after crocidolite asbestos in the folded Griquatown series of the Transvaal system near Prieska, Cape Province, South Africa, is described. Silicification and oxidation have affected only the upper few tens of feet, giving jasper, tigereye and hematite, overlying the main ironstone formation with shales, limestone, asbestos, chert, and magnetite. The tigereye veins are often only four inches thick and of irregular distribution. The red material is produced by heating the golden variety: the light honey colour is said to be produced by bleaching in oxalic acid.

R.A.H.

ANON. *The attraction of Agate Creek.* Rocks & Minerals, 1972, 47, 600.

Large quantities of agate occur in gravel at Agate Creek, south of Forsyth, Queensland, Australia. Also rough topaz occurs north of Mt. Surprise.

R.S.M.

ANON. *The story of Colombian emeralds.* Rocks & Minerals, 1973, 48, 36-37.

The history of emerald mining in Colombia is summarized. The Chivor, Muzo, and Cosquez mines are most important.

R.S.M.

ANON. *The* 601·25 *carat Lesotho diamond.* Min. Digest, 1972, 4, 92-96. 13 colour photos.

A brief history is given of the discovery of the world's seventh largest rough diamond in the Letsung-la-Terai area, at above 10,000 feet, of its initial sale for $302,400, and of its cleaving by the cutter Pastor Colon, *Jr.* for the Henry Winston firm of New York, the final buyer.

R.A.H.

BOOK REVIEWS

BAXTER (J. W.) and others. *A geologic excursion to fluorspar mines in Hardin and Pope Counties, Illinois.* Illinois Geological Survey Guidebook series no. 11, Urbana, Illinois, 1973. pp. 30. Price on application.

This short guide, illustrated with maps of the fluorspar-producing areas, was prepared for the Ninth Annual Forum on the Geology of Industrial Minerals held in 1973. Diagrams depict the position of the various veins and beds.

M.O'D.

BUCHESTER (K. J.). *The Australian amateur lapidary.* Ure Smith, Sydney, 1967. pp. xix. 211. Illustrated in black-and-white and in colour. £2.75.

A companion volume to the author's excellent Australian gemhunter's guide, this book covers the history of the lapidary art, how it developed in recent years in Australia and the growth of interest in gemmology. Further chapters introduce simple crystallography and pleochroism, refractive index and dispersion. The following sections of the book are devoted to the methods of fashioning stones. The apparatus used is clearly described and illustrated with black-and-white photographs. Special cutting techniques for opal, chrysoprase, amethyst, tiger's eye and rutilated quartz are described. A most useful addition to the normal matter is a review of the methods of assessing the value of gem material. Appendices contain a variety of tables and there is a bibliography.

M.O'D.

FRANCO (R. R.) and others. *Minerais do Brasil.* (Minerals of Brazil). Edgard Blucher, São Paulo, 1972. 3 vol., pp. 426. Illustrated in colour. Price on application.

Apart from a general introduction to mineralogy and summaries of the properties of the various mineral classes, this book consists entirely of coloured photographs of Brazilian minerals, each accompanied by its chemical formula, location and English name. Many of the commoner Brazilian species are covered by several photographs, so that emerald, for example, is depicted five times from Ferros and Teofilo Otoni in Minas Gerais and from Bom Jesus dos Meiras and Carnaiba in Bahia. There are twenty-six illustrations of tourmaline. The standard of photography of the crystals is good, that of the cut stones which are occasionally shown less so. For the importer and collector of rough material the book is invaluable and as the complete text is given in both English and Portuguese there is no difficulty in understanding the descriptions.

M.O'D.

LENZEN (G.). *Kurzgefasste Diamantenkunde.* (Concise diamond information). 2nd edition. Verlagsbuchhandlung Elisabeth Lenzen, Kirschweiler, West Germany, 1973. pp. 154. Price on application.

The second edition of the author's excellent short course on diamond appraisal, testing and grading, this book is intended specifically for students attending the short residential courses of the Deutsche Gemmologische Gesellschaft.

Additional material includes a table giving world diamond production by country, and in the table linking colour grade and price the grade of Top Wesselton is allocated 95% against the 100% of the River grade whereas the earlier edition gave the grade 90%. Some material has been rearranged.

M.O'D.

MORENZ (O.). *Wie Kauft man Diamanten, Farbsteine, Perlen, Schmuck?* (How do you buy diamonds, coloured stones, pearls and jewellery?) Third, revised edition. Econ-Verlag, Düsseldorf and Vienna, 1970. pp. 224. Coloured illustrations. DM.4.85.

A guide to assist the layman in buying jewellery, this well-produced book is particularly useful to the student of gemstone prices. In addition to its coverage of the more important gem materials the book includes details of precious metals and coins.

M.O'D.

NOTT (S.C.). *Chinese jade throughout the ages.* Charles E. Tuttle Co., Rutland, Vt., and Tokyo, 1969. pp. xx, 193. Illustrated in black-and-white and in colour. £8.95.

A reissue of a classic book on the jades first published in 1936.

Although the function of some of the artefacts is now thought to be different from the author's conjecture, the bulk of the text is authoritative and gives a full introduction to the use made by Chinese craftsmen of both jadeite and nephrite. An introductory chapter deals with the two forms of jade and later chapters are assigned to archaic jades, ritual symbols and works of art arranged in dynastic order. A chapter covers the testing of jade and its commoner simulants and there is a bibliography, including works in Chinese, the study of which is essential for an understanding of the significance to the Chinese of particular forms, symbols and inscriptions. It is now known that a number of these writings were uncritically edited in later times and that the names and descriptions given to particular artefacts are therefore probably not those which archaic times would have recognized. A work of some authority, the Chou li, dating from the third or fourth century B.C., is not included in the bibliography. There are more than 350 photographs, including 39 in colour.

M.O'D.

PEARL (R. M.). *Cleaning and Preserving Minerals.* 2nd edition (revised). Earth Science Publishing Company, Colorado Springs, 1973. pp. 86. $2.75.

During 1947 Dr. Pearl published a work "Mineral Collectors' Handbook", the first section of which dealt with 'Cleaning and Preservation of Mineral Specimens'. This section, with some revision, was republished in paper-back form in 1971 and now a further edition has been published after revision.

This booklet of 86 pages (six pages more than the 1971 edition) deals with the stability and instability of minerals to various influences and discusses the changes which may occur with unstable minerals. The reader is quickly taken on to the care of mineral specimens and their cleaning from dust and grease by mechanical methods such as brushing, blowing, suction, scraping and hand picking. Porous minerals which must not be washed in liquids are listed, and listed are those minerals which must not be treated with acid or alkaline liquids, and much information is given on how to wash mineral specimens in various liquids. Wisely notes are given on how to mix liquids, especially acids and alkalis, as some of them are a health hazard. Something is told, too, of the use of ultrasonic cleaning.

Detailed descriptions are given of the treatment of various near-surface contaminations—such as by smoke, soot, organic encrustations, etc.—and the preparation of various chemicals and chemical mixtures to use for such treatments. Various methods of lacquering specimens so as to prevent future surface attack are mentioned and the alteration of some specimens by loss of water is also discussed, some opal and turquoise being cited as examples. Temperature and humidity are also considered as factors causing damage to mineral specimens. The effects of heat on zircon, topaz and amethyst are cited; changes of temperature and the effects of light, where again a number of gemstones are referred to, are important parts of the book. References to other writers are made throughout the book. There is no index.

R.W.

SABINA (A. P.). *Rocks and minerals for the collector: the Alaska Highway, Dawson Creek, B.C., to Yukon/Alaska border.* Geological Survey of Canada, Paper 72-32, Ottawa, 1973. pp. viii, 146. Map. $2.50.

The area covered by this paper produces, in addition to numerous gold deposits, jasper, nephrite, serpentine, epidote and rhodonite. Cassiterite, locally called "Yukon diamond", is in demand for the fashioning of nugget-studded jewellery. Locations are precisely indicated with the aid of geological maps and there is an extensive bibliography.

M.O'D.

Masterworks of Chinese jade in the National Palace Museum. Taipei, Taiwan, Republic of China. pp. 92. £4.50.

A description, illustrated in colour, of 50 pieces ranging from the Shang (1766-1122 B.C.) to the Ch'ing (1644-1911) dynasties. Each item is described in English, Chinese and Japanese and there is a section dealing with the traditional shapes of ornaments. Although some jadeites are so described, other illustrations do not state the material employed. No reference is made to the possible use of the pi, a circular disk with a central hole, and the ts'ung, a rectangular tube with a hollow centre and horizontal grooving, although these two forms have been the subject of a number of recent papers. The coloured plates, printed in Japan, are of very high quality.

M.O'D.

Fluorspar in Illinois, by various authors. Circulars 385, 413 and 420 of the Illinois Geological Survey. 1965-68, Urbana, Illinois. Price on application.

Illinois is the leading fluorspar producer in the United States, most of the production coming from underground mines. The mineral is found in the extreme south of the State in Hardin and Pope Counties. Present mining operations centre around the Cave-in-Rock district. Deposits are found in inclined veins and in beds in the host limestone. In association are galena and sphalerite. The areas are illustrated by high-quality geological maps mounted in folders.

M.O'D.

ASSOCIATION NOTICES

MEMBERS' MEETINGS

Midlands Branch

At the Annual General Meeting of the Branch held on 15th June, 1973, at Regent House, Birmingham, Mrs. S. E. Hiscox was re-elected Chairman and Mr. G. S. C. Porter elected Secretary. The films "Of Jewels and Gold" and "The Magic of Diamonds" were shown during the evening.

Scottish Branch

The summer outing of the Branch was held on the 17th June, when members visited Ballater. Many specimens of pink fluorspar, purple fluorspar in veins, and groups of quartz crystals, in matrix, were found.

TIES FOR FELLOWS

An Association tie is available for Fellows. The tie, which is dark blue, bears the crest of the Association in gold, and the price (U.K. only), including postage and VAT, is £1·25. The price outside the U.K. is £1·25 by surface mail or £1·50 by air mail.

OBITUARY

Mr. Stanley S. Belcher, Johannesburg, South Africa, who gained the Association's Diploma with distinction in 1945, died in September 1973.

Mr. Charles J. Parsons, La Mesa, Calif., U.S.A., died on the 14th September, 1973. Mr. Parsons gained the Association's Diploma with distinction in 1952.

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to the Victoria branch of the Gemmological Association of Australia for first day cover of Australian gemstone postage stamps, depicting chrysoprase, agate, rhodonite and opal.

LETTER TO THE EDITOR

Dear Sir,

B. W. Anderson, in his excellent review* of the 14th and revised edition of Dr. G. F. Herbert Smith's "Gemstones", draws attention to the fact that Plate 19, a reproduction of the absorption spectra of three different zircons, is printed the wrong way round in relation to the colours indicated below the spectra, thus perpetuating an error which first occurred in the 1958 (13th) edition.

For the sake of accuracy I would point out that in the 13th edition the spectra were printed upside down. In other words the photographed part of the plate was rotated through 180° in relation to the numbers and colours around it. Thus in that edition the captions referred incorrectly to the numbered spectra.

The latest edition attempts to put things right by changing the order of the caption. This leads to the spectra being correctly named but with the absorption bands the wrong way round—as noted by your reviewer.

It is perhaps some comment on the efficiency of gemmological teaching on this subject (for which Mr. Anderson is primarily responsible) that no one has drawn attention to the original error. Anyone familiar enough with zircon absorption to notice the error would be too familiar to need to refer to the illustration under discussion.

This confused illustration does not detract in any way from the excellence of this edition so ably revised once more by Prof. F. Coles Phillips. The book remains the standard work on the subject of gems.

Yours sincerely,
R. KEITH MITCHELL

3rd July, 1973.

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*Journal Gemmology, XIII, 6, 236-239.—Ed.

MEMBERSHIP

Mrs. Christine Nemoto, Warsaw, Poland, (D.1972) was elected to Fellowship in October, 1972.

MEETINGS 1973 and 1974

1973	
19th November	Reunion of Members. Goldsmiths' Hall, London, 6.00 p.m.
	Presentation of Awards. Goldsmiths' Hall, London, 7.00 p.m.
1974	
25th February	Film Show. Goldsmiths' Hall, London, 7.00 p.m.
26th March	Meeting. Goldsmiths' Hall, London, 7.00 p.m.
25th April	Annual General Meeting, Saint Dunstan's House, London, 6.00 p.m.
9th October	Talk by Mr. B. W. Anderson. Goldsmiths' Hall, London, 7.00 p.m.
25th November	Reunion of Members. Goldsmiths' Hall, London, 6.00 p.m.
	Presentation of Awards. Goldsmiths' Hall, London, 7.00 p.m.

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