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OF GREAT BRITAIN

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INVESTIGATING THE VISIBLE SPECTRA OF COLOURED DIAMONDS

By KENNETH SCARRATT, F.G.A.

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INTRODUCTION

There have been some interesting developments in recent years in the methods used to detect and the information compiled on natural and artificially coloured diamonds. Most of these developments have involved in some way the absorption and/or emission spectra. This paper will deal solely with this aspect. The identification of irradiated diamonds is sometimes a difficult and controversial subject and as such should only be attempted by an experienced spectroscopist with a great deal of background knowledge. It is hoped that the following will provide for some of the latter: the former may only be obtained by hard work on the part of the individual. Some time ago in this laboratory it was decided to initiate a fresh study and to correlate the known facts and problems involved. The investigation is over an extended period of time: stones of all colours have been and are continuing to be examined.

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We have received a considerable amount of practical help from the solid state physics research group at King's College, London, from the recognized laboratories on the European and North American continents and from the father of gemmological spectroscopy, B. W. Anderson.

THE INVESTIGATION

At the outset the most pressing problem was the positive identification of the very few treated yellow Type Ia diamonds which at room temperature have no indication of the 'diagnostic' absorption line at 594nm. This line is induced into the spectrum of an irradiated diamond after the stone has been annealed, as are the lines at 504 and 497nm and many others. If the stone is annealed at temperatures above 1000 °C the 594nm line, unlike the lines at 504 and 497nm, disappears(1) even when the spectrum is examined with the stone at 77K.* After such treatment all that may remain in the spectrum to give an indication of artificial coloration could be the lines at 504 and 497nm and any 'cape' lines which had been present before irradiation. Neither the 504 nor the 497nm line unfortunately is uncommon in the spectra of naturally coloured yellow or yellow/brown diamonds. It would therefore seem that the answer lies in our ability to differentiate between the naturally occurring 504 and 497nm lines and those induced by artificial irradiation and annealing.

In the past some authorities have noted a difference in the relative strengths of these lines when they occur naturally to when they are induced.(2) We have run a survey on a number of known treated and known naturally coloured yellow and yellow/brown diamonds, paying particular attention to the relative strengths of the 504 and 497nm lines. A sample of 32 known irradiated stones were checked. Figure 1 shows that in ten stones the 504 was the stronger, in thirteen stones the 504 and 497 were of similar strength and in nine stones the 497 was the stronger.

These findings are best explained in a paper by Davies and Summersgill.(3) Briefly—in irradiated and annealed Type Ia diamonds the strengths of the 504 and 497nm lines are dependent upon the strengths of the nitrogen induced A and B absorption bands in the infrared. (The A form with peaks at 1282 and

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*K (kelvin): see J. Gemm., 1977, XV, 5, 244.—Ed.

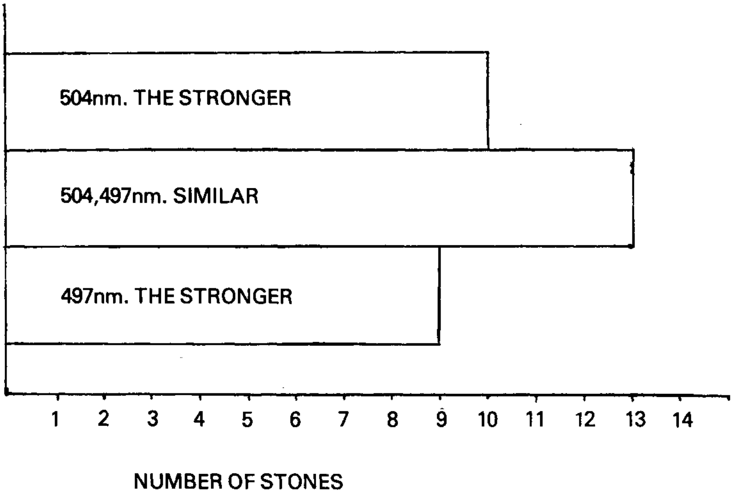

FIG. 1. In a sample of 32 irradiated yellow and yellow/brown diamonds, 10 stones had the 504nm line predominating, 13 stones had the 504 and 497nm lines of similar strength and in 9 stones the 497nm line predominated.

1206 cm^{-1} and the B form at 1172 cm^{-1}).* That is the 497 and 504 line strengths produced in a diamond by irradiation and annealing are present in a ratio proportional to the ratio of the B to A nitrogen. Either one of these infrared bands may predominate or they may be present in roughly equal proportions. It cannot therefore be stated that in a treated diamond either one or the other of the 504 or 497nm lines must predominate.

Davies and Summersgill in the same paper note that generally speaking there is a tendency for the stronger 415nm absorption to be found in a diamond with a strong B band. This confirms our observations. Figure 2 shows that in a sample of thirteen irradiated yellow diamonds in which the 415 system was very strong, the lines were of similar strength in six stones, the 497 predominated in six stones and only in one stone was the 504nm line the stronger. When the 504, 497nm lines have been observed in naturally coloured yellow stones, with strong 415nm systems, albeit very weakly in some cases, we have found the 504 either is the stronger or the lines are of similar strength. In many cases the 497 has been absent. There is a similar situation found with the naturally coloured

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*For cm^{-1} see J. Gemm., 1977, XV, 5, 247.—Ed.

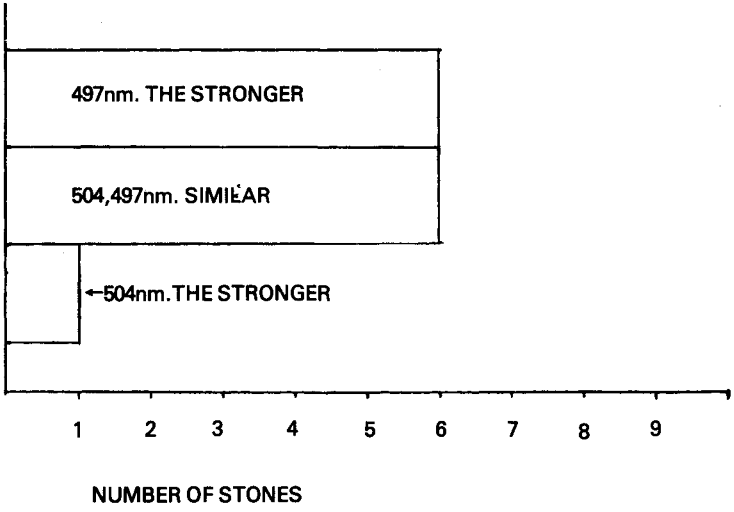

FIG. 2. In a sample of 13 irradiated yellow diamonds in which the 415nm system was very strong, the 504 and 497nm lines were of similar strength in 6 stones, the 497nm line predominated in 6 stones and only in one stone was the 504nm line the stronger.

brownish yellow stones we have examined. Those which have had the 504, 497nm lines visible have the former as the stronger partner.

It appears, as has already been noted by Collins,(1) that the naturally occurring 497, 504nm lines are in general not present in a ratio proportional to the ratio of the B to A nitrogen. This may seem to be the basis of an answer to the problem; however, the difficulties involved in measuring the B to A nitrogen concentrations in most gem diamonds make this line of investigation impracticable.(1) From the foregoing it becomes apparent that with the use of only normal gemmological techniques, the relative strengths of the 504, 497nm lines can only serve as a very general guide.

We know through the teachings of B. W. Anderson that the absorption lines in diamond are often sharpened when the temperature of the stone is lowered. This is very much the case with the 594nm line. If a stone with this line present is allowed to rise much above room temperature during examination, there is a good chance the line will disappear and only return once the stone has cooled. To counter this we have often used ice during an examination, and it was with considerable gratitude that we readily accepted an offer by Dr A. T. Collins and his colleagues to design and build for us an apparatus which would cool our diamonds to approximately 120K and keep them there during the course of a spectroscopic examination. This apparatus is now built and functioning in the laboratory. It is described in Figure 3. The theory upon which it works is surprisingly simple. Liquid nitrogen in a suitable container is evaporated by an electrical element, and the cold gas given off is then blown over the sample which is held in a glass vessel with evacuated walls.

This method not only sharpens many of the absorption lines, it also makes visible those which are not seen at room temperature. An example of the improvement achieved is produced in Figure 4. Here a known irradiated yellow stone with a very weak 594nm line (by transmitted light) was first examined at room temperature *(a)* and then at approximately 120K *(b)*. This method of observation is now helping us with the problem of the absent 594nm line. If the line has not been completely annealed out, but is not visible under normal conditions, it will be seen at low temperatures. Since the installation of this equipment we have had for examination two irradiated yellow stones in which the 504 was much the stronger of the 504, 497nm partnership. In both stones we noted that the 497 had at low temperatures resolved into a structure most easily described as a doublet, with a strong line at 497nm and a weaker line on its short wave side at approximately 496nm. (Figure 4c.) A similar structure has previously been noted by Gübelin(4) in treated yellow stones.

Collins(9) explains that when the 504nm line is strong and the 497nm line is weaker the 504 first phonon replica is produced on the short wave side of the 497nm line, thereby giving the appearance of a doublet in the area of the 497. When we first observed this structure we had not seen or heard of it recorded in any naturally coloured stones. We have since seen exactly the same structure in a naturally coloured green stone, which is to be described later.

Naturally, as yellow is the most popular and one of the easiest to obtain of the fancy colours, we are asked to examine more of this colour than any other. Following close behind are the browns. These two together make up the majority of coloured diamonds entering the laboratory. With brown Type Ia stones we have not as yet had the same problems concerning the 594nm line. It is worth

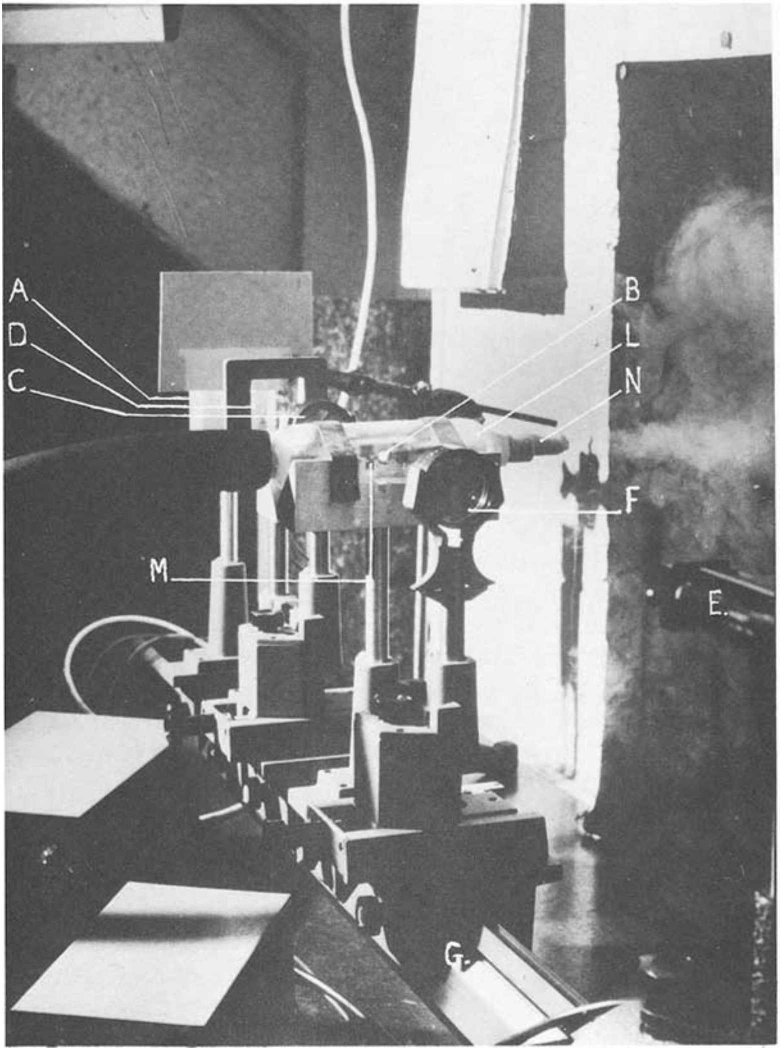

FIG. 3 (1)

FIG. 3. THE EQUIPMENT USED TO LOWER THE TEMPERATURE OF COLOURED DIAMONDS
The light from the 100 watt source *(A)* is focused on the diamond *(B)* by the lens *(C)* after passing through the heat filter *(D)*: the light after passing through the diamond is focused on the spectroscope *(E)* by the lens *(F)*: all of these being mounted on an optical bench *(G)*. The control console *(H)* is a 12 volt lamp supply unit. The liquid nitrogen is stored in the container *(I)*. The console *(J)* controls the electrical element which is inside the liquefied gas container. The cold gas travels along the insulated tube *(K)* into a glass vessel with evacuated walls *(L)* in which the diamond is held by a specially designed holder *(M)* which incorporates the exhaust *(N)*.

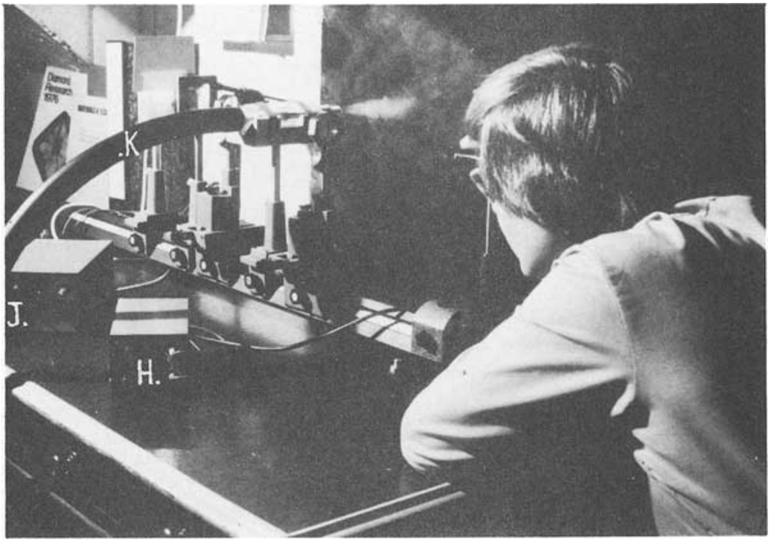

FIG. 3 (2)

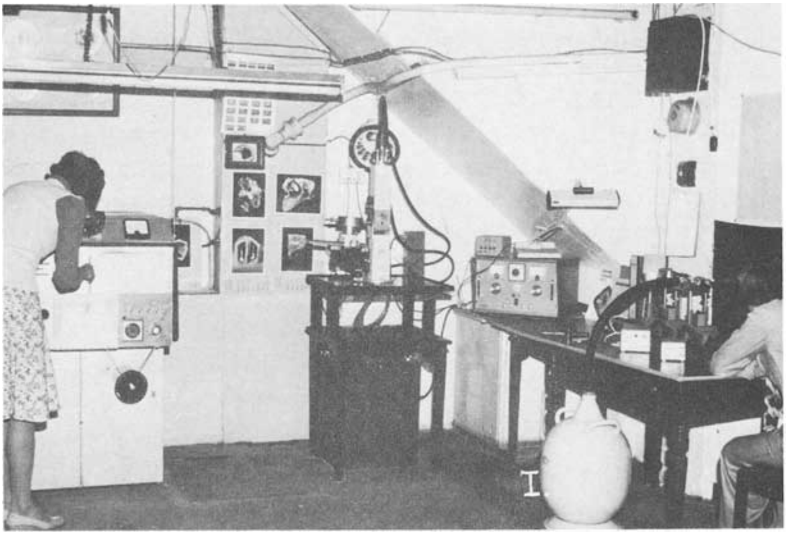

FIG. 3 (3)

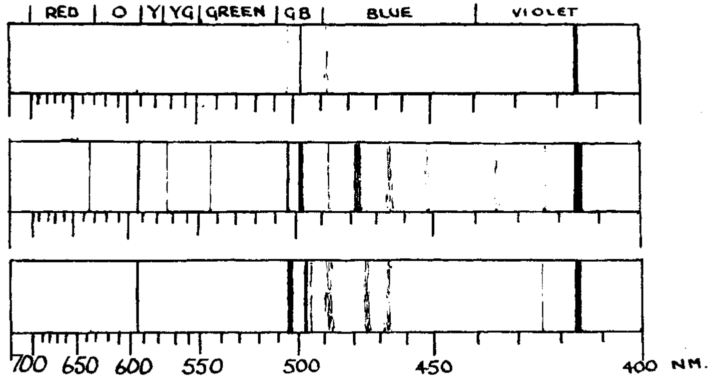

FIG. 4. The room temperature spectrum of an irradiated yellow diamond *(a)* and the low temperature spectrum of the same stone *(b)*. The low temperature spectrum of an irradiated yellow diamond in which an extra line is resolved on the short-wave side of the 497nm line *(c)*.

noting however, that in the natural brown stones so far examined which show the 504, 497nm system, either line may predominate, or they may be of similar intensity, as is found with the treated browns we have examined. We have not had the opportunity at this time to examine at low temperatures a treated brown in which the 504 predominates. Therefore we cannot say if a similar structure to that seen in the treated yellow stone at 497, 496nm exists in this colour. The room *(a)* and low temperature *(b)* spectra of a treated brown diamond are given as another example of the effectiveness of the cooling equipment in Figure 5. The 504, 497nm lines are often referred to as the 'brown lines'. This being because these lines along with those at 512 and 537nm are associated with brown or yellow/brown natural diamonds. They are often very difficult to

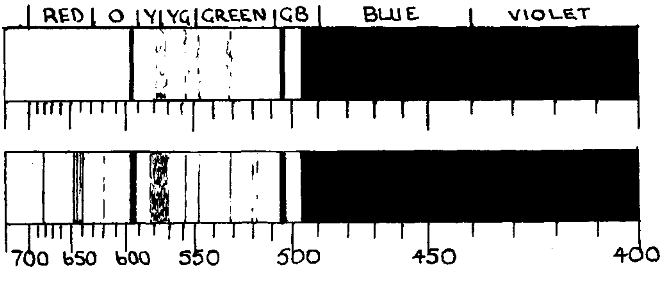

FIG. 5. The room *(a)* and low temperature *(b)* spectra of an irradiated brown diamond.

see at room temperature and are often accompanied by the line at 415nm.

These are not, however, the only lines to be seen in natural brown stones. We have recently recorded unusual spectra in six naturally coloured brown stones, four of which were a strong brown colour and two a dirty yellow/brown. Four of these, including the yellow/brown stones, consisted of two pairs—from the absorption spectra and other properties we have concluded that they were cut from two crystals. Both yellow/brown stones at room temperature recorded a strong full cape spectrum—415, 478nm, etc. At low temperatures the spectra had additional strong sharp lines at 471.8 and 558.5nm and two further very weak lines at approximately 540 and 548nm. At the time the other four stones were examined we did not have the facility for cooling diamonds. At room temperature the first of the single stones had an absorption spectrum with a very strong line at 415, sharp lines at 478 (not the cape series line) and 562nm and two fuzzy lines, one at 546 and the other at approximately 554nm. Note the similarity of the spectra seen in these first three stones. The fluorescence properties are also very similar.

The pair of deep brown stones gave absorption spectra with sharp lines at 504 and 497 plus two further sharp lines at 466 and 471nm. The last of this group revealed a sharp line at 504nm and a weaker but still sharp line at approximately 470nm. There was a very weak fuzzy band in the region of 465nm. The similarity of the spectra of these last three stones is also quite striking. The fluorescence properties are also very similar. It is tempting to assume that if the latter three stones were examined at low temperatures a group of lines in the yellow/green and green similar to those in the first three stones, may be resolved. However, this is speculation and we may never have the opportunity to prove or disprove the theory.

A problem we are currently facing concerns what may be Type Ib brown stones. We have examined three such stones recently and know of one other which is being examined on the continent. The first of the three stones we have examined has at low temperatures a strong sharp line at 637nm and weak diffuse bands at 616 and 596nm approximately. There is also a weak but sharp line at 504nm. The second stone at low temperatures has lines at 635 and 631.5nm and a weak fuzzy area at approximately 592nm. In both these stones the bands at 637 and 635nm respectively are visible at

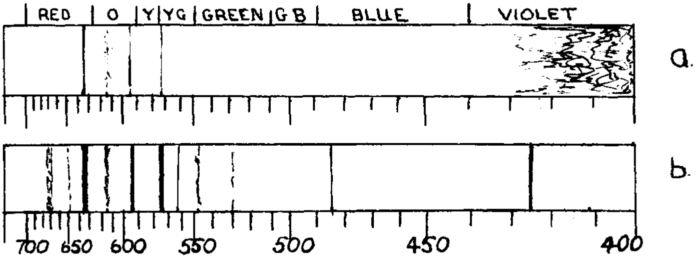

FIG. 6. The room *(a)* and low temperature *(b)* spectra of an irradiated pink diamond. The line at 573.5nm may be seen in absorption or fluorescence. There is a further fluorescent line on the short-wave side of the absorption line at 548.5nm at approximately 548nm.

room temperature. The third stone at room temperature shows only a general absorption of the violet, but at low temperatures a line at 634.5nm, sharp and clear, is resolved.

This is the type of absorption spectrum we would expect to see in Type Ib irradiated and annealed diamond.(3) The treated pink stones have a similar spectrum—the 637nm line is usually very much stronger. There is a strong possibility that this type of spectrum could appear naturally in brown stones but we have found no record of it. Until we are able to examine similar stones with the same spectrum and of a known history, the cause of the colour in these stones must remain in the grey area. The room *(a)* and low temperature *(b)* spectra of a treated pink diamond are recorded in Figure 6. A cursory glance at the low temperature spectrum could lead one to believe that the stone was a Type Ia with a strong 415nm line. This is because the line at 426nm has a similar appearance. Davies and Summersgill(3) have reported that the line at 636 appears to be associated with isolated substitutional nitrogen—Type Ib. Crowningshield has reported(5) a 415nm absorption in treated pinks with the 636nm system. Here the possibility is a mixture of Ia and Ib.

The absorption spectrum of natural pink stones at room temperature seen in the course of this investigation in the main consists of a 415nm line or no absorption lines at all. In one stone the fluorescence spectrum recorded by Anderson(6) was observed, consisting of a strong fluorescent line at 575 and three weaker fluorescent lines at 585, 598 and 620nm approximately. This spectrum was obtained by filtering the incident light through a copper sulphate solution. We have examined three natural pink stones at low temperatures, two showed no absorption. The third,

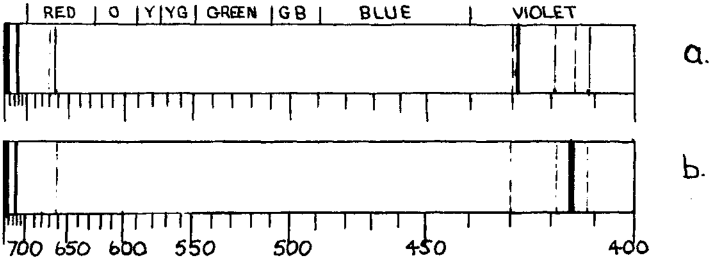

FIG.7. The low temperature spectra of two irradiated blue diamonds.

the same stone which revealed the fluorescence spectrum, had a fine absorption line at 572.6nm, This stone in every way emulated the two reported by Anderson.

We have examined at low temperatures the spectra of two natural and two irradiated blue stones. The natural stones conducted electricity and the treated stones were insulators. This would seem to be a simple enough test to enable us to distinguish between the two. We must however take into account the possibility of a naturally occurring blue stone being other than Type IIb. The natural blue stones showed no absorption in any part of the visible spectrum. At room temperature one of the treated stones had no absorption lines, while the other had a very strong 415nm line. At low temperatures both stones revealed similar spectra (Figures 7a and 7b respectively).

In the violet the spectra differed a little but both formed basically a similar pattern. The first stone (7a) had a strong line at 428.5 and weaker lines at 430, 419, 415 and 413nm. The second stone (7b) had a very strong line at 415 and then weaker lines at 430, 418 and 413nm. The lines in the red end of the spectrum in both stones were very interesting. Both had a fine sharp line at 662nm. One stone (7a) had another line on the long-wave side of this at approximately 670nm.

Both stones had two strong lines in the deep red. There was some difficulty in measuring these two lines, therefore the resulting values can only be considered as approximations. The stronger was at 742nm and the weaker at 720.6nm. The line at 742nm is probably the one referred to by physicists as the GR 1 (general radiation 1). An earlier reference in the gemmological texts to what are probably these lines is given in a paper by Anderson(7). A similar spectrum is also reported by Schiffmann⁽⁸⁾. If the line at 742nm is the GR 1, with the aid of the cooling apparatus the problem of identifying irradiated unannealed green stones with only the use of the hand spectroscope would be made that much simpler. The GR 1 band is induced by artificial irradiation and as such is present in all irradiated stones but is destroyed during the annealing process.⁽¹⁾

Four irradiated green stones have been examined at low temperatures. The absorption observed in the spectrum of one of the four consisted of the full 'cape series' plus a very weak band on the short-wave side of the 415nm line (Figure 8a). The remaining three (8b, c, d), whilst differing in wavelengths shorter than 650nm, had virtually identical patterns in the red and deep red, the two most prominent lines in the deep red having the same values as those in the irradiated blue stones. At room temperature as with the irradiated blue stones only those with the 415nm system revealed any absorption, this consisting of a weaker version of the cape lines recorded at low temperatures and nothing else. All other lines are only visible at low temperatures.

The lines at 471 and 560.8nm recorded in 8c form a pattern very similar to those recorded in the brown stones previously mentioned. This may be taken as yet another warning to step

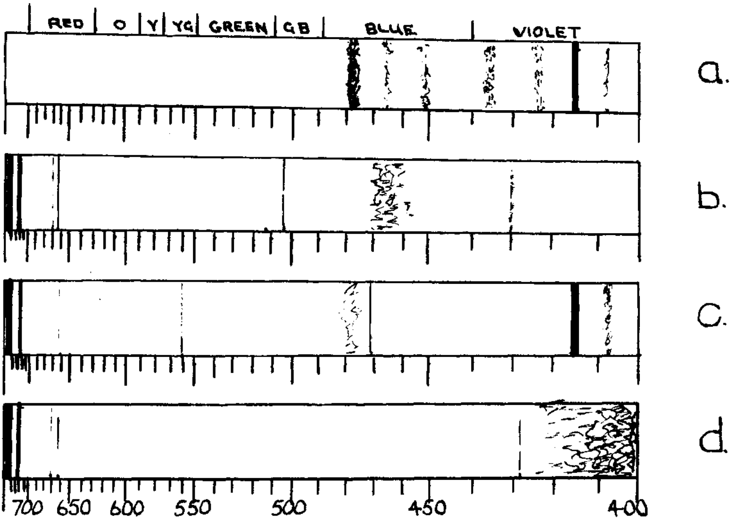

FIG. 8. The low temperature spectra of four irradiated green diamonds.

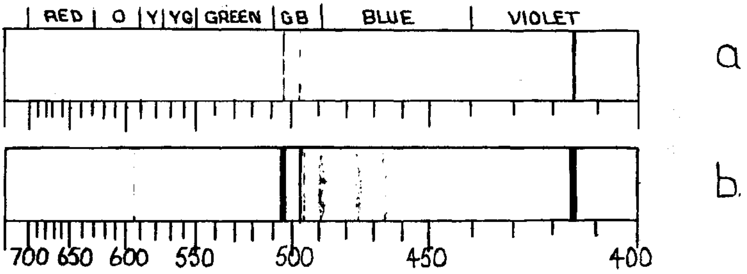

FIG. 9. The room *(a)* and low temperature *(b)* spectra of a *natural* light green faceted diamond. The low temperature spectrum reveals the line at 594nm which is normally indicative of a treated stone.

cautiously when examining coloured diamonds. Many lines which are induced by artificial irradiation may also be produced naturally. Another example is the line often referred to as the 'treated line' at 594nm. Whilst this line is seen in the greater majority of irradiated stones which have been annealed at temperatures between 300 and 900 °C, it has previously only been observed naturally in a very few uncut crystals.(7)

We have during the course of this investigation now seen the 594nm line in a naturally coloured faceted light green stone. There can be no doubt of this stone being naturally coloured. This being a statement of some importance we will record here a full description of the stone concerned.

The room and low temperature spectra may be seen in Figures 9a and 9b respectively. The 594nm line becomes visible only at low temperatures. Three absorption lines are seen at room temperature; they are at 504, 497 and 415nm. The 504 and 497nm lines are fine and sharp, the former being the stronger. The 415nm is strong and sharp. At low temperatures their strength is greatly increased. The 497 is resolved into a kind of doublet and three vague bands are seen on the short-wave side of this. By reflected light at room temperature, in certain directions, three fluorescent lines appear in the region of the blue/green boundary. The stone is old cut and cushion shaped, weighing 0.95 ct. The dimensions are: width 4.9mm, length 5.7mm and depth 4.1mm. Under x-radiation there is a bright fluorescence consisting of a mixture of yellow and blue, with a phosophorescence. Under both long-wave and short-wave ultraviolet radiation the stone is a fluorescent green. The effect is brighter under long-wave.

Five other stones of a similar colour have been examined recently. All were naturally coloured. Four of the stones were examined before the low temperature apparatus was operational. We were able, however, to examine the fifth stone in this manner. No 594nm line was seen. All five stones had absorption spectra similar to that in Figure 9a. In one stone the 504 and 497nm lines were of approximately equal strength with the possibility of the 497 being fractionally stronger. The other four stones had the 504nm line as the prominent member. We have only seen one stone of this exact colour, which has been reported upon by several laboratories as being treated. It has not been examined at low temperatures. The 594 line is seen with difficulty by reflected light only, at room temperature. Other lines noted were a weak 415 and 504, a strong sharp 497 and a weak line on the short-wave side of this in the region of 490nm.

There has been of late some commercial interest shown in black diamonds. It follows that the people concerned have required a laboratory examination of their stones. Those naturally-coloured black diamonds we have examined owe their colour almost entirely to masses of black graphite-like inclusions. The only absorption spectrum seen has consisted of a solitary 415nm line. The irradiated black stones, when a thin section is examined, are in fact very deep green. Obtaining a spectrum from such stones has its difficulties. When it has proved possible the spectrum illustrated in Figure 10 has been the result. The lines at 504 and 497nm are extremely strong.

The foregoing information is but a pin-prick compared to the wealth of information provided by earlier researchers. There is still much to be learnt about the peculiarities of the absorption and emission spectra of diamond. Research is being carried out at all levels and I have no doubt that this will be so for many years. Any

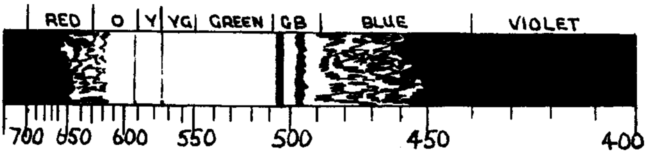

FIG. 10. The room temperature spectrum of an irradiated black (very deep green) diamond.

further developments on the topics discussed in this paper will, we hope, be published at a later date in this *Journal.*

The author acknowledges the ready help given by his colleagues in gathering the information for this paper and the help given by members of the trade in supplying the samples on which the majority of the work was carried out. To Dr A. T. Collins and his colleagues the laboratory owes a special note of thanks. The photography for Figure 3 was kindly carried out by the Institute of Geological Sciences.

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[*Manuscript received 1st February, 1979*]

MORE DATA ON VIOLET GEM SCAPOLITE, PROBABLY FROM EASTERN AFRICA

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INTRODUCTION

In the beginning of this year (1978) a parcel of violet cut stones was sent in for identification by a gem-cutter in Holland. The stones were offered to him as scapolites originating from Eastern Africa.

Many papers dealing with scapolites, especially from East African countries, have been published recently. Strunz and Wilk (1976) describe violet Mg-rich marialite with refractive indices ε 1.559 and ω 1.563 and a density of 2.64 to 2.67. In a paper of Dunn *et al.* (1978) the lowest properties mentioned are ε 1.545 and ω 1.558 for a pink marialite from Burma. Zancanella (1977), finally, was surprised to find ε 1.541 and ω 1.550 for a violet scapolite, which could easily be confused with amethyst on the basis of its properties.

We thought it would be of interest to add the results of our investigation to these data as none of them gave the properties of scapolites as we found them with the above mentioned stones.

PROPERTIES

The colour of the stones has some resemblance to that of amethyst and therefore it is conceivable that a wrong conclusion might be drawn after a quick test, as the properties are almost equal to those of amethyst. In Table 1 the properties for ten faceted violet scapolites are given.

The refractive indices have been measured on a refractometer provided with a prism consisting of synthetic Yttrium Aluminium Garnet, as designed by the author. The specific gravity of the stones was measured by using a hydrostatic balance and ethylene dibromide. From these data it may be concluded that these scapolites have extremely low refractive indices. Their densities, too, are low, the average is 2.589. These low properties do already indicate a marialite-rich scapolite.

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TABLE 1

Properties of ten violet scapolites from East Africa.

Sample no.	Weight in carats	Size in mm	ε	ω	D	Remarks
—	4.16	11.5× 9.0×7.0	1.532	1.539	2.586	oval mixed cut
—	3.23	10.1×10.1×5.8	1.534	1.540	2.592	mixed cut
—	2.93	11.9× 7.9×5.3	1.532	1.539	2.587	oval mixed cut
—	2.06	9.7× 7.4×4.8	1.531	1.539	2.587	oval mixed cut
RGM 151802	1.44	7.3× 7.3×5.0	1.534	1.540	2.595	mixed cut
RGM 151803	0.86	6.6× 6.6×3.8	1.534	1.540	2.592	mixed cut
RGM 151804	0.71	5.5× 5.2×3.4	1.534	1.540	2.593	trap cut
RGM 151805	0.46	5.5× 5.5×3.0	1.534	1.540	2.586	mixed cut
RGM 151806	0.60	5.4× 5.4×4.0	1.534	1.540	2.590	mixed cut
RGM 151807	0.49	5.1× 5.1.×3.7	1.534	1.540	2.586	mixed cut

All stones have a strong dichroism with ω colourless and ε violet. The absorption spectrum is not very diagnostic; weak didymium lines in the yellow part may be observed together with faint lines in the blue at 4955, 4880 and 4500Å.

Short-wave ultraviolet light causes a distinct pink fluorescence in all stones. Under long-wave conditions they are inert.

The stones are surprisingly free from inclusions. Some of them contain elongated needles parallel with n_o, that is with the *c*-axis.

Besides these cut stones, two crystal fragments were available for investigation. They were used to prepare x-ray and microprobe analyses.

In all, four x-ray powder photographs were made. In Table 2 the results of photograph RGM 202130, made from scapolite RGM 164268, are given. These data agree best with those from a yellow marialite-rich scapolite RGM 107194, from Tanzania, described by the author (Zwaan, 1971).

Several microprobe analyses were kindly carried out by Dr P. Maaskant of the Institute of Earth Sciences of the Free University at Amsterdam. Dr Maaskant is a member of the WACOM, a working group for analytical geochemistry subsidized by the Netherlands Organization for the Advancement of Pure Research (ZWO) at Amsterdam. Standards used were albite feldspar and jadeite (Na), corundum, albite and jadeite (Al), diopside, albite and jadeite (Si), orthoclase feldspar (K), diopside (Ca), hematite (Fe), barite (S) and halite (Cl). The scapolite was found to be homogeneous, as far as the chemical composition is taken into

TABLE 2

X-ray powder diffraction data for violet scapolite RGM 164268

$d_{obs.}$	I	h k l	$d_{obs.}$	I	h k l
8.50	3	1 1 0	1.741	3	5 0 3
6.44	4	1 0 1	1.700	4	7 1 0
6.07	2	2 0 0	1.671	3	6 4 0
4.42	½	2 1 1	1.610	2	4 0 4
4.25	3	2 2 0	1.555	4	7 1 2
3.80	8	3 1 0	1.507	3	5 4 3
3.56	3	3 0 1	1.459	5	7 3 2
3.45	10	1 1 2	1.417	5	3 0 5
3.05	9	3 2 1	1.397	1	7 2 3
3.00	4	4 0 0	1.379	5	3 2 5
2.83	2	2 2 2	1.363	6	8 2 2
2.72	2	4 2 0	1.343	5	6 2 4
2.68	7	3 1 2	1.327	1	7 5 2
2.54	1	4 2 1	1.313	5	9 2 1
2.36	1	5 1 0	1.282	5	5 0 5
2.29	5	5 0 1	1.179	2	9 5 0
2.20	1	4 2 2	1.167	3	6 3 5
2.13	5	4 4 0	1.156	4	10 0 2
2.07	1	5 3 0	1.146	3	4 2 6
2.01	4	5 1 2	1.123	2	7 2 5
1.948	½	6 1 1	1.081	2	10 4 2
1.907	7	0 0 4	1.061	2	8 8 0
1.813	4	5 3 2	1.031	3	10 6 0
1.776	½	6 0 2			

account. In Table 3 the average of several microprobe analyses is given.

It should be noted that the contents of MgO, MnO, TiO_2, V_2O_3 and CO_2 have been omitted. They were all found to be very low and therefore could be neglected. The total iron was calculated as FeO. The calculation of the marialite content on the basis of

$$\frac{Na}{Na + Ca}$$

gives the result of 89.2%, which is a very high percentage indeed.

TABLE 3

Microprobe analysis of violet scapolite RGM 164268

	ox.%		el.%	numbers of ions on the basis of 24 (O)	
SiO_2	60.64	Si	28.35	Si	8.48
Al_2O_3	19.56	Al	10.35	Al	3.22
Fe O	0.06	Fe	0.05	Fe	0.008
Ca O	2.66	Ca	1.9	Ca	0.40
Na_2O	12.29	Na	9.1	Na	3.32
K_2O	0.90	K	0.75	K	0.16
SO_3	0.18	S	0.07	S	0.02
Cl	3.9	Cl	3.9	Cl	0.92
	100.19				
0=Cl	0.88				
Total	99.31				

CONCLUSIONS

The scapolites described in this paper have refractive indices and densities lower than ever before measured by the author in members of this group of minerals. The marialite content is higher than ever mentioned in the literature.

In fact this type of scapolite is unique in that it seems to be the purest marialite ever found. It is hoped, therefore, that the origin of this material will become known in due course.

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THE BLUE COLOUR OF SODALITE

By P. E. PAULIN, B.Sc., F.G.A.

During the summer of 1977 I had the great pleasure of meeting Dr Adil Hassib from the University of Khartoum, Sudan. At the time Dr Hassib was doing research on sodalite—work that is still going on—in order to try and establish, among other things, the true cause of the colour in the blue variety. As Dr Hassib is an ESR-expert, Electron Spin Resonance was used as the main instrument in a series of experiments at the University of Uppsala, Sweden, where I had the opportunity of following some of them in detail.

Sodalite, a cubic mineral with the chemical composition $Na_8(Al_6Si_6O_{24})Cl_2$, does mainly appear in nature coloured blue, often with white and darker blue irregular bands. As it had been suggested that the blue colour was due to sulphur, a regular part of the variety hackmanite, the specimens used were carefully analysed for sulphur content but none was found, at least not down to the detection level of 0.01 per cent.

Significant clues as to the nature of the colouring came forward after a series of experiments with heat, x-ray excitation and daylight exposure. Blue sodalite when heated loses its colour and becomes a greyish-white in appearance. Tests showed no structural change after heat treatment. A short (about 3 minutes) x-ray irradiation period caused a fairly strong pink coloration rapidly fading in about the same duration of time in daylight or tungsten light, the pink colour now replaced by a very light blue. Repeating this cycle, x-ray irradiation followed by daylight exposure resulted in a gradually deepening blue colour, until after about 20 cycles no more pink can be induced and the material stays blue of the same hue as the original, i.e. before the heat treatment.

During all phases of this experiment Dr Hassib obtained ESR-spectra as a basis for evaluation of results. First of all, spectra of untreated blue sodalite in single-crystal form show an isotropic centre, i.e. one resonance line that does not shift position with varying orientation of the crystal. Heating sodalite powder in steps shows that this isotropic line gradually diminishes in intensity to

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disappear completely at a temperature slightly above 600 °C. This is also the point where all the blue colour has disappeared. On the other hand transparent, colourless and naturally occurring crystals of sodalite did not show the isotropic feature until after heat treatment and subsequent x-ray and daylight induced blue colour. These crystals did not regain their transparency.

This connexion then—strong blue colour and an isotropic line in the ESR-spectrum—was the first clue. The second clue is rather technical. It has to do with the saturation of the resonance signal when the microwave power is varied, or rather with the non-saturation in the case of sodalite.

Earlier research (Portis 1953) has shown that the non-saturation behaviour of the isotropic line intensity excludes the resonance from being due to trapped electrons i.e. F-centres. Furthermore Hodgson *et al* (1967) and McLaughlan and Marshall (1970) have shown that the pink colour induced by x-ray irradiation

FIG. 1. Thin plate of blue sodalite viewed in transmitted light. (63 ×)

is due to the generation of F-centres. The sequence in the experiment mentioned above—

x-ray irradiation —— pink coloration
Tungsten or daylight exposure —— bleaching of pink colour
and gradual deepening of the blue colour with repeated cycles—

indicates that annihilation of the pink F-centres and the immediately following formation of metallic sodium colloidal particles is the mechanism that produces the blue colour of sodalite. Such a sequence is similar to what other researchers have found to be responsible for generating colloids in alkali halides and the well-known silver colloids of photography.

The structure of sodalite may be regarded as Na—Cl units in an alumino-silicate cubic framework with the sodium ions along the cube diagonals and the chlorine ions at the corners and in the centre. This is a probable structure for allowing the formation of colloidal particles of a size necessary to produce the blue colour in sodalite by the Tyndall scattering effect which also explains the blue colour of the sky. Optical examination by microscope of a thin section of blue sodalite did show the Tyndall effect. The presence of clustered matter is quite obvious when a thin plate is viewed in transmitted light (Figure 1). The darker parts are the most intense blue ones and the clustered nature is evident.

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TRANSPARENT BLUISH-GREEN KORNERUPINE FROM EAST AFRICA (KENYA AND TANZANIA)

By Dr K. SCHMETZER, Dr J. OTTEMANN, Prof. Dr H. BANK
and Dr H. KRUPP

Since 1972 bluish-green and blue kornerupines (Bank & Berdesinski 1974, 1975; Webster 1974) from Kenya and Tanzania have arrived at gemmological laboratories. These stones are distinctly different in their optical features from the green kornerupine crystals from the Kwale District, Kenya (Schmetzer *et al.* 1974; Girgis *et al.* 1976). The samples which are described here are mainly cut stones which could be partly detected in lots of other minerals (green tourmalines or green garnets). Partly they had been offered as single stones under other names (e.g. sillimanite). In the last few months, we have been able to obtain bigger lots of rough cuttable material of these bluish-green kornerupines for investigations. Therefore we publish here some of our results, though we have not yet been able to clarify comprehensively the especially interesting correlation between their crystal chemistry and colour.

The kornerupines mentioned above differ especially in their expressive pleochroism (Table 1) from those of the Kwale District, Kenya, and also from the brown-green crystals of the historic occurrences in Ceylon and Madagascar. They show, on observation in polarized light parallel to the crystallographic *c*-axis, an intense emerald-green colour. Perpendicular to the *c*-axis, there can be seen

Table 1

Pleochroism of kornerupine from different localities.

	Ceylon and Madagascar	Kwale District, Kenya	Kenya and Tanzania, various localities, somewhat different due to contents of trace elements		
X	yellowish-brown	intensely green	emerald-green	emerald-green	
Y	brown	slightly green	bluish-grey	reddish-purple	Y and Z show only small differences
Z	greenish	greenish-yellow	reddish-purple	bluish-grey	

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a slightly weaker blue colour which may differ from crystal to crystal (sometimes more reddish-purple, sometimes more bluish-grey). The colour itself varies in natural unpolarized light in various stones from green through bluish-green to blue and purple. This colour corresponds to the colours along the directions of X, Y and Z (colours parallel to the crystallographic axes *a, b,* and *c* of the orthorhombic mineral kornerupine) and eventually a mixture of these three colours appears on viewing at any angle other than these directions. A similar pleochroism is present for different colours of all varieties of optically anisotropic minerals, but only in very few minerals are they distinctive. It has been described by Rösch (1970) for blue zoisite as an example.

Though polarized absorption spectra of the kornerupine crystals from Kenya and Tanzania could not yet be interpreted in detail, it can be stated with certainty, as the result of chemical and spectroscopical investigations, that the colour is caused by traces of the elements iron, chromium and vanadium (Table 2). In the case of blue samples, it was possible to determine a distinctive content

Table 2

Chemical analysis of kornerupine (microprobe analysis)

locality	colour	Fe	Cr	V
Madagascar	brown or green	0.83	0.02	0.01
Ceylon		3.82	—	0.02
Burma		1.05	0.02	0.01
Kwale District, Kenya	green	0.03	0.03	0.15
Kenya and Tanzania, various localities	green	0.08	—	0.04
	green	0.05	0.04	0.17
	bluish-green	0.14	0.06	0.07
	blue	0.11	0.10	0.02
	blue	0.18	0.39	0.53

— = not found

of Cr_2O_3 analytically, whereas chromium-free kornerupines and samples with little chromium and much vanadium showed green colour shades in varying intensity. Chromium will possibly be present as Cr^{3+} in the Mg-Al-silicate kornerupine whereas the valency stated of iron (Fe^{2+} and/or Fe^{3+}) and vanadium (V^{3+} and/or V^{4+}) could not yet be determined. The lattice positions of these ions, which theoretically may occupy five different lattice points in the crystal structure of kornerupine, could also not yet be determined.

The refractive indices of the optically biaxial negative kornerupine crystals vary for the various determined samples within narrow limits. Due to the small optical angles, n_y and n_z do not show big differences.

n_x	1.662-1.663
n_y	1.673-1.674
n_z	1.674-1.675
$2V$	6-11°
n_z-n_x	0.012-0.013

Until now, we have only been able to recognize that the kornerupine crystals come from occurrences in Kenya (district of Namanga) and Tanzania (southern part of the Usambara Mountains or Daluni in the Umba Region). More localities of blue kornerupines will most probably be discovered in Eastern Africa.

We thank Prof. Dr E. Gübelin, Lucerne, Switzerland, and Mr H. W. Lorenz, Idar-Oberstein, Germany, for providing research material from Ceylon, Madagascar and Burma from their collections.

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OPAL—THE UNLUCKY 'LUCKY' STONE

By S. B. NIKON COOPER, B.D., F.G.A.

The early Sanskrit writers were nothing if not straightforward in their approach to gem-names. How better to describe an emerald than by its greenness?—so: marakata to maragda→*σμάϱαγδος* (smaragdos)→esmeraude→emeraud, to our emerald. Or, the blood-red colour of a ruby: rudhira (='blood') → ἐϱεύθϱος (ereuthros) → ruber → rubith → rubis → rubie, to our ruby. Even the word meaning 'untameable': adamya (*α*–privative + 'dam' (=to 'subdue'), the 'unsubdued'), which passed to *ἀδάμας* (adamas) → adamans → adamant → adyamont → diamonde, to our diamond.

But there was one word they used with a meaning just of 'jewel' alone. A 'precious stone', upala. It is tempting to read more into this than can be justified—that this is, in fact, 'our' opal. However, all that can be said with certainty is that the word was the root-form of the Greek *ὀπάλλιον* (opallion), which in turn was the source of Pliny's 'opalus' (de Opalis; Book 37, Chs 21, 22).(1) He tells us that the stone comes from India. It would be more correct to say the name came from there. And yet, of all his descriptions, this ties up more completely than any other with a modern gem: '...of all precious stones, it is opal that presents the greatest difficulties of description, it displaying at once the piercing fire of carbunculus (i.e. ruby), the purple brilliancy of amethystos and the sea-green of smaragdus (i.e. emerald), the whole blended together and refulgent with a brightness that is quite incredible...' (Ch. 21). He is surely referring to the play of colour in our opal. But India...? The Romans knew opal well enough. The deposits in what is now Czechoslovakia were already in production. It was a favourite stone with them. Again, with Pliny as our authority (Ch. 23), '...of the highest rank.' Could it be that Pliny is falling into the trap of a practice which obtained until not so long ago of designating all the really 'precious' stones as 'coming from the East' or 'oriental'? An 'oriental' opal must be more precious than the relatively local product... There is a suggestion of this in the first two lines of Ch. 21. 'India, too, is the sole parent of these precious stones (i.e. opals), thus completing her glory as being the great producer of the most costly gems.' As an example of the latter

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point he cites the—then—well-known opal of Nonius, valued at a small fortune of two million sesterces.

One other significant fact: so well known and well loved was this gem that it even had a nickname: 'paederos', poetically translated by Gübelin(2) as 'a child, lovely as Love'. Cross-referencing to the 'paederos' entry (Ch. 46) we learn one more fact: the paederos (opal) was a 'white' stone, named—says Isidore (Lib.XVI:X:2)(3)—for its preeminence of beauty.

The next source to mention opal is Marbode(4), taking us to the Middle Ages, to a time when every really 'precious' gem had its own 'virtue'—the ability to confer this or that benefit on its fortunate owner. That of optallius—his name for opal—is given. It was the stone for all eye-troubles ('Avertens oculis morbos').

One virtue might be thought as good as another, but why would eye-troubles be mentioned specifically? This is answered from a source of the next century: Albertus Magnus,(5) who describes (Book 2, Ch. 13) a gem named ophthalmus, whose 'colour is not stated, perhaps because it is of many colours...' Ophthalmus...? Of course, ὀφθαλμός = the 'eye'; and, if a gem were called after the eye, it follows, parallelism being what it is, that it must be 'good' for the eyes. The only trouble with this is that there was already a stone of virtue for the eyes—the emerald. Right then, to avoid confusion, some extra virtue must be claimed for the new contender. So the assertion (Ch. 13) (the entry stems largely from that of Marbode) that it is said not only to be good for all diseases of the eyes but also to 'dim the sight of those near by. And therefore it is known as the protector of thieves, for those who wear it are, as it were, invisible.'

Truly a remarkable gem indeed! Surely, one of the 'luckiest' of all to possess! We doubt though that it was able to maintain its claim to confer invisibility for long, because no other author after the 13th century repeats the claim. But no matter; it still had the virtue of protecting one from diseases of the eyes. The same stone, with variant spellings (olthamus—13th century; apthalme—15th century) still retains its curative powers. We particularly like the Peterborough(6) (late 15th century) reference: '...he kepeth & saueth yene, & kepeth him cler & scharp & withowte greuance.' Peterborough, by the way, is the one who nearly restores the modern spelling ('Optalio' (elsewhere 'opatallio') 'is a stone that is cleped opalus.')

Turning to Leonardus Camillus(7) (16th century) we see two entries. One, for 'opalus' or 'opal', the other for 'obtalius' or 'obtalmius.' It is obvious that both refer to the same gem. Both are of 'many colours': both have virtue over eye-diseases. Referring to its talismanic nature he says: '...it cannot be improper to attribute to it so many Virtues, since it partakes of the Nature and Colour of so many Stones.' One point, by the way: in retelling Pliny's account of Nonius's opal, the value is now given as twenty thousand sesterces. We are obviously in a period of deflation!

A final entry with Agricola(8) (Book 6) gives us not only, once again, Pliny's description of opal's play of colour but, of interest, the current 16th century popularity ratings for gemstones; from which we see the order is: diamond, pearl, emerald and opal—opal in preference, therefore, to ruby and sapphire. Elsewhere he contradicts himself and says opal is more valuable than emerald, putting it third in order of favour.

So, a gem truly to be prized. Both valuable and beautiful; but above all, a stone of 'virtue'—a 'lucky' stone. It had a history, as we have tried to show, all through the Middle Ages of one that could confer desirable gifts on its fortunate owner.

'The belief in the unlucky character of opal is not, I think, earlier than Scott's "Anne of Geierstein"...' So says Joan Evans in her *Magical Gems.*(9) And we cannot even blame Sir Walter Scott for this. It is doubtful that he ever intended to malign the opal; only that its play of colour interested him, and that he made use of it in his plot. In briefest detail, a certain lady named Hermione wore one in her hair (incidentally, a good setting for a gem of such relative softness!) It was a charmed stone and changed colour according to the mood of its wearer. When she was happy, it flashed gay and bright; when she was angry, it glinted redly; and so on. The story goes on to tell how a few drops of Holy Water were sprinkled on the opal—immediately its fire was quenched and Hermione fell in a swoon. Taken to her bed, next day nothing was found save a small heap of ashes. (Incidentally again, we note that 'water' has a deleterious effect on opal!)

That was in 1829, and on such slender grounds are reputations born. So, the opal is 'unlucky'—after all, who wants to suffer the fate of Hermione! It took all of Queen Victoria's judicious patronage, through her gifts, in popularizing the newly-discovered opal fields of Australia, to bring the so-beautiful gem back into favour. The emergence of the black variety of opal, from Lightning Ridge and Andamooka, has completed the process, until in recent times opal has once again regained the first rank of precious stones that it held in Roman times.

But something of its 'unlucky' character still remains... We are not superstitious, yet we cannot help but recall our feelings after cutting a particular fire opal. Every precaution had been taken; care in dopping the stone; more in its grinding; still more in polishing it. The finished result proved the worth of these measures—a lovely orange-red gem, truly worthy of the care that had been taken in its fashioning. And then the disappointment, on inspecting it again some days later, to see the same gem—but now a travesty of itself, with cracks and surface crazings marring its beauty. Picture the same, seemingly inexplicable, transformation happening a hundred years ago, and we come to what must have seemed a reinforcement of the 'unlucky' tag. Today, it can be explained; in earlier times it would have been proof of undeserved ill-fortune; a stone, therefore, to be avoided; but it is so beautiful...

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NEW FORMS OF SYNTHETIC GEM MATERIALS: TWO BRIEF NOTES

By MICHAEL O'DONOGHUE, M.A., F.G.S., F.G.A.

I

SYNTHETIC OPAL BY GILSON

The black and white opals manufactured by Pierre Gilson S.A. of France are now on the market as preformed rough sections which can be cut by lapidaries to any desired shape. Two pieces in my collection have been examined. The white section measures 11 × 8.5 × 3mm and shows on the top face a fine play of colour, which is echoed to a lesser extent on the other faces due to sawing. Individual colour patches are large and evenly sized; some red, orange and yellow shows quite clearly by transmitted light. As in other products of this firm, dark or neutral patches show at all angles of viewing; at some angles a red blush sweeps across the whole surface. The play of colour is very strong and even in diffused light (daylight) is sufficiently visible to make the gem-potential very high: the pieces examined are presumably first quality, since I have seen many finished stones with a far less prominent play of colour and with a pronounced milkiness. No luminescence or phosphorescence could be seen. The colour patches do not extend over any of the edges, but there is a distinct impression, when looking from the top, that the play of colour begins a little way below the rather glassy surface.

The black opal measures 11 × 11 × 1mm and is also very spectacularly coloured. Colour patches are again large and relatively even in size; the thinness of the piece suggests that its use in a composite stone would be profitable. Viewed at different angles the surface tends to take on various shades, not too different, of the one colour, mostly green or red. No luminescence or phosphorescence could be seen. More interestingly, in this piece, on some of the edges, colour patches visible on the surface can also be seen with the same dimensions, looking as if the patch is distinctly three-dimensional. Viewed at a distance from the light source, glassiness (as in the white piece) can easily be seen and is not at all like natural opal: in fact there should be no possibility of confusion with either piece.

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SYNTHETIC ZIRCONIA

Zirconium oxide has now been on the scene for a little while and is also known in colour as well as in white forms. At least one firm is marketing various coloured varieties and I was fortunate enough to be able to acquire a superbly-coloured crystal section on a recent visit to Moscow. The colour is instantly reminiscent of padparadschah-coloured (orange) sapphire. Examination of the absorption spectrum showed that only the red, orange, yellow and part of the green were unabsorbed—there was no sign of chromium which might just have been expected. Fire opal would not have allowed so much of the green to pass, but there is really very little likeness between the two since fire opals have so low a hardness.

II

'REGENCY EMERALD': A NEW SYNTHETIC FROM THE U.S.A.

Through the kindness of Mr Walter E. Johansen and of Mr John B. Mandle, I have recently received a crystal and a cut stone of 'Regency emerald', produced by Vacuum Ventures, Inc., of Pompton Lakes, New Jersey and of Sunnyvale, California. The cut stone weighs 0.33 ct and the crystal 5.02 ct.

In the hand-out sent with the stones the SG is given as 2.67-2.69, RI as 1.570-1.576 with a birefringence of 0.005-0.006 and dispersion as 0.014. Hardness is 7½-8 and toughness is fair to poor depending on quality. The fluorescence is stated to be bright red, and there is said to be no transparency to x-rays, nor do they cause any luminescence. The stones are said to glow bright red through the colour filter and to have a similar absorption and infrared spectrum to the natural material.

I examined the two specimens sent by the manufacturers. The presence of platinum wires and a seed of slightly lighter colour, together with typical cuneate growth-tubes with two-phase contents stemming from phenakite crystals, indicate a hydrothermal origin for the product; if this is the case, it may reinforce the manufacturer's statement that the infrared spectrum does not differ from that shown by natural emeralds. Stones manufactured by the hydrothermal (but not flux-melt) process will show bands due to water in the IR spectrum as do many natural stones. It is also possible to see numerous phenakite crystals taking up linear positions on a previous growth plane, and they can also be seen pointing in the growth direction from the seed. The crystal and the cut stone show wisps (in the cut stone they appear to be in several parallel planes) and several irregularly-shaped structures resembling water-lily leaves with some unidentified spot occupying the centre.

Both specimens show a distinct red under the colour filter and under long-wave ultraviolet light both show a distinct red—this is quite rare for emerald, whether natural or synthetic. The RI is as the makers state—the SG was not tested. The absorption spectrum was most interesting. A sharp and prominent line in the light blue (477.4nm) could be seen in one direction as quoted by Anderson* and the windows beside the lines at 662.0 and 646.0nm were easily seen. Observations were made with the Eickhorst 'Kaltlicht' spectroscope light source with Zeiss spectroscope fitted with blue filter and polarizing attachment for the various readings.

There should be no difficulty in recognizing this product; the colour is a fine bluish-green and is comparable to other stones presently in production. It is possible that this new emerald is a continuation of that commenced and later abandoned by Union Carbide, whose patents they are said to be using under licence. On a visit to San Diego a Union Carbide spokesman told me that the emerald had been discontinued due to the difficulty of obtaining crystals sufficiently thick to be cut as gemstones, and a specimen in my collection seems to bear this out. The present 'Regency' crystal is much thicker and would cut with no difficulty.

**Gem Testing*, 8th edn, 1971, p.156.

[*Manuscripts received 12th December, 1978, and 24th May, 1979.*]

J. Gemm., 1979, XVI, 7

REPORT ON THE GEM DIAMOND PEN

By P. G. READ, C.Eng., M.I.E.E., M.I.E.R.E., F.G.A.

The Gem Diamond Pen, marketed by Gem Instruments Corporation, is the latest in a series of instruments designed to distinguish between diamond and its simulants. Like the grease tables and belts which are still in use at some diamond mines, the Diamond Pen depends for its effectiveness on diamond's unique surface characteristics (i.e., its low water contact angle). The instrument is similar in construction to a draughting pen, and has the same type of dispensing head and ink reservoir. The Diamond Pen, however, uses a specially formulated test liquid. This liquid is a non-drying viscous fluid containing inert chemicals and a blue dye to make it easily visible.

The complete test kit (Figure 1) consists of the pen, a pair of stainless steel locking tweezers, a quantity of polishing powder, a

FIG. 1. The Gem Diamond test kit.

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felt cleaning pad and a plastic bottle containing a supply of the test liquid. Detailed instructions for the use of the pen are also included together with explanatory sketches.

The stone to be tested is first cleaned by placing a small quantity of the polishing powder on the felt pad and rubbing the table facet of the stone back and forth on the powder. When cleaning a large unmounted stone the tweezers are used to hold the stone round the girdle. A small unmounted stone can be held by placing the hole in the end of the tweezers over its pavilion. When the stone is thoroughly clean, it is wiped with a tissue to remove any excess powder. The stone is then held table facet uppermost, and the tip of the pen is pressed down vertically onto the facet and drawn slowly across its surface. If the stone is a diamond, the pen will draw a continuous line of test liquid across the facet. However, if the stone is a simulant, the liquid will not flow in a continuous line but will break up into a series of droplets.

During repeated tests with the pen it was possible to identify, without ambiguity, a diamond from a selection of three diamond simulants (cubic zirconium oxide, GGG and strontium titanate). Typical results obtained from these tests can be seen in Figures 2-5. When testing the diamond sample, it was sometimes necessary to make two or three attempts before the test liquid could be persuaded to flow. With the simulants, however, it was even more difficult, and on a few attempts only a single droplet was left on the surface as the pen was lifted off.

Two things were of prime importance to the success of the test; one was the thorough cleaning of the stone (reminiscent of a similar need with reflectivity meters), and the other was the priming of the pen before application. The instruction leaflet advises that the pen should be shaken gently to start the 'ink' flowing after filling. However, it is helpful to repeat this just before each test, and to check for ink flow by touching the tip of the pen on a piece of paper.

A cautionary note in the instructions warns that the test should be regarded as a strong indication rather than a positive identification of diamond. The instruction leaflet also warns that anomalous results can occur with stones whose refractive indices are below 1.80. This was confirmed with further tests on paste, quartz and spinel, all of which resulted in a continuous line of liquid being drawn across the facet. However, the ease with which

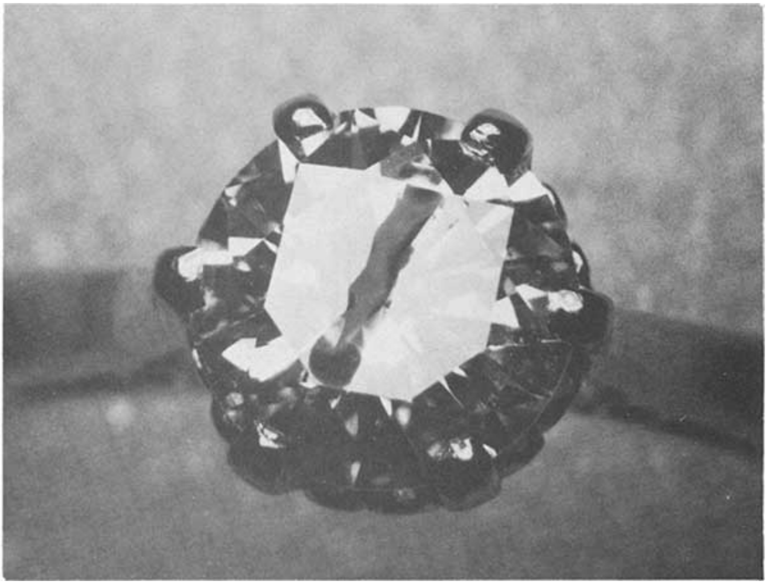

FIG. 2. Diamond.

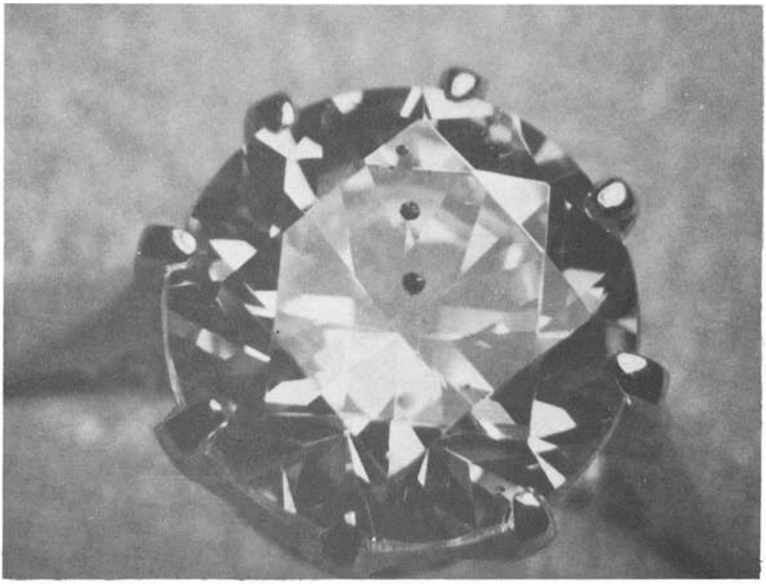

FIG. 3. Cubic zirconium oxide.

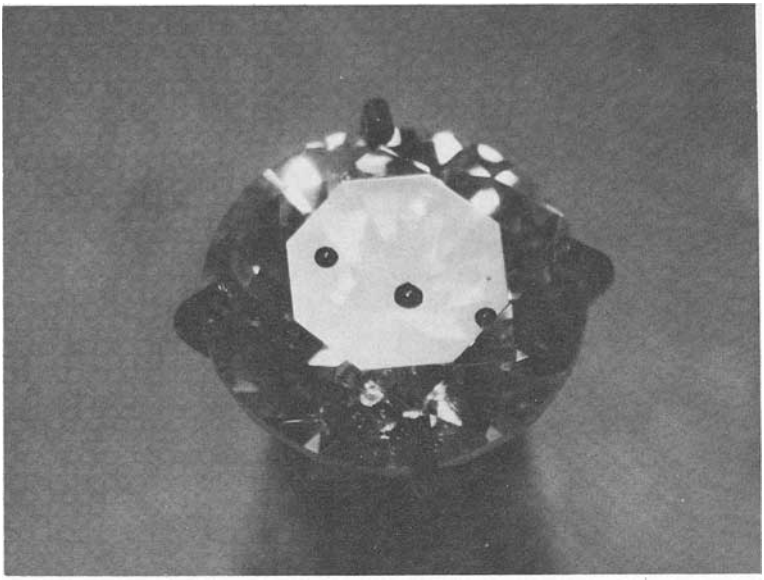

FIG. 4. Strontium titanate.

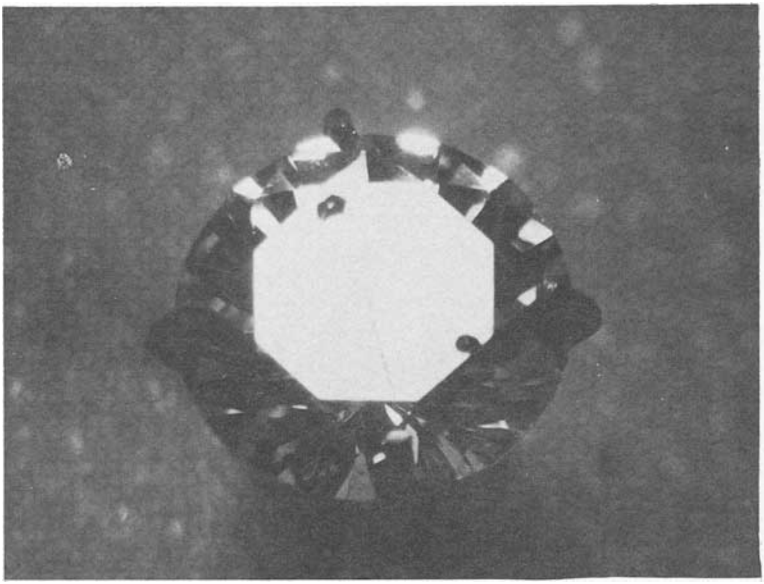

FIG. 5. Gadolinium Gallium Garnet.

the line was started (compared with the slight reluctance encountered when testing diamond) did provide some discrimination even with these stones.

A note on simple tests for detecting cubic zirconium oxide which appeared in the December 1978 issue of the trade magazine 'Canadian Jeweller' suggests using a felt-tip pen in the same way as the Diamond Pen. To verify this possibility, my tests were repeated using three different types of felt-tip pen in place of the Diamond Pen. The results were found to be both unreliable and confusing, and this was probably because of variations in the grease content of the inks and the difficulty in controlling its flow. In comparison, the success of the Diamond Pen is no doubt due to the consistency of the test liquid and the fine degree of control in its application.

With unmounted stones which approximate to the ideal proportions of the brilliant cut, a more conclusive test for diamond is to check the stone's girdle diameter against the weight of the stone. With mounted stones, however, the Gem Diamond Pen could be usefully combined with other simple procedures, such as the 'light spill' test,* to provide a reliable indicator for diamond.

The Gem Diamond Pen is available from Gemmological Instruments Limited. The approximate price in the U.K. is **£21**.

[*Manuscript received 23rd February, 1979*]

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*P. G. Read, Close up on C.Z., *Diamond News and S. A. Jeweller.* **44**, 3, 28-30, December1978.
P. G. Read, The diamond simulants: how to spot them, *Canadian Jeweller,* pp.10-12,September 1978.
E. Bruton, *Diamonds,* 2nd edn, p.472,N.A.G. Press.
P. G. Read, *Gemmological Instruments,* p.154, Newnes-Butterworths.

GEMMOLOGICAL ABSTRACTS

BALL (R. A.). *A note on the structure of fire agate.* Australian Gemmologist, **13**, 7, 210-11, 3 figs, 1978.

A very brief note on the subject, made obscure by use of terminology which will leave the average gemmologist unenlightened. R.K.M.

BANCROFT (P.). *La benitoite, Californie, USA.* (Benitoite from California, U.S.A.) Le Monde et les Minéraux, **11**, 258-61, 7 figs (1 colour), 1976.

A sketch-map of the location, with notes on the mineral and its recovery, is accompanied by a fine colour photograph of benitoite with neptunite on natrolite. M.O'D.

BANCROFT (P.). *La fluorite.* (Fluorite.) Monde et Minéraux, **24**, 746-8, 4 figs (3 in colour), 1978.

Describes the various types and occurrences of fluorite with illustrations in colour. M.O'D.

BARIAND (P.), POULLEN (J. F.). *The pegmatites of Laghman, Nuristan, Afghanistan.* Mineral. Record, **9**, 5, 301-8, 15 figs in colour, 1978.

Minerals of gem quality found in this area include kunzite, green spodumene, elbaite and morganite. Three pegmatite deposits, Nilaw, Mawi and Kurgal, are situated near the Alingar River, the area as a whole lying in the north-east of the country. M.O'D.

BETTETINI (E.). *Au coeur des gemmes.* (In the heart of gemstones.) Le Monde et les Minéraux, **07**, 155-7; **08**, 183-5; **09**, 216-17, 8 figs (4 in colour), 1975.

Illustrates typical inclusions in blue sapphire, demantoid garnet, emerald and ruby. M.O'D.

BROWN (G.). *The identification of some rare organic materials.* Australian Gemmologist, **13**, 7, 238-9, 1978.

Summary of a paper read before the G.A.A. at Perth. Deals briefly with ivories, vegetable ivory, stag horn, corals, copal resins, keratoproteins (various horns, tortoiseshell and hornbill casque) and wood. R.K.M.

BROWN (G.). *Kauri gum.* Australian Gemmologist, **13**, 7, 225-31, 6 figs, 1978.

Attempts to distinguish this recent resin from other copal gums. Kauri-gum is comparatively rare today and occurs only in New Zealand. Author describes early recovery methods and subsequent overproduction leading to present moribund state of the industry. Distinction between kauri and other copals is difficult since they are essentially similar except in the trees from which they come. Distinction from amber, which *is* important, relies largely on the relative insolubility of the latter in ether. Part of the paper seems to be missing. Illustrations have not reproduced well. R.K.M.

BROWN (G.). *Commercial gemstone production in Australia.* Canadian Gemmologist, **2**, 4, 2-11, 5 figs, 1979.

The commercial importance of the gemstone resources of Australia is steadily growing. Over 22 million dollars' worth of opal and over 13 million dollars' worth of sapphires were traded in 1975. The value of chrysoprase slightly declined compared to previous years. Details of the mining of these materials are given. M.O'D.

CASSEDANNE (J.). *Une exploitation primitive: les gîtes d'améthyste de Brejinho (Bahia-Brésil).* (A primitive working: Brejinho's amethyst deposits in Bahia, Brazil.) Bull. Assoc. Franç. Gemmologie, **31**, 14; **32**, 7-9, 11 figs, 1972.

Brejinho is in the central south-west of the state of Bahia, Brazil, about 430 km west-south-west of Salvador. Amethyst is recovered from galleries and marketing carried out through Idar-Oberstein, West Germany. Citrine is also found. M.O'D.

CASSEDANNE (J.), CASSEDANNE (J.). *Les diamants du Guaniamo (Venezuela).* (Diamonds from Guaniamo, Venezuela.) Le Monde et les Minéraux, **16**, 444-5; **17**, 465-9, 9 figs (2 in colour), 1977.

Guaniamo is 320 km west-south-west of Ciudad Bolivar and 450 km south-south-east of Caracas. The diamond-bearing zone extends over the whole basin of the Cuchivero River. Diamonds are recovered from gravels and frequently contain inclusions of forsterite, enstatite and pyrope. M.O'D.

CASSEDANNE (J.-P.), CASSEDANNE (J.-O.). *La pegmatite à quartz rose du Alto Feio.* (Rose quartz-bearing pegmatite at Alto Feio.) Revue de Gemmologie, **57**, 11-14, 6 figs (2 in colour), 1978.

Alto Feio lies in the north of the Brazilian state of Paraiba, in the north-east of Brazil. Alto Feio is a small hill with a pegmatite carrying beryllium and tantalum, contacting schist and granite. Rose quartz shows no crystal faces; morion and citrine have also been found. Other minerals from the area include tourmaline (black), beryl (pale blue or green), zircon and garnet. M.O'D.

CASSEDANNE (J.), CASSEDANNE (J.). *La pegmatite de Limoeiro et ses minéraux.* (The Limoeiro pegmatite and its minerals.) Le Monde et les Minéraux, **14**, 354-6; **15**, 403-5, 7 figs (1 colour), 1976.

Limoeiro is north-west of Virgem da Lapa in the north-east of Minas Gerais, Brazil. Topaz, either yellow or blue, tourmaline, black, green or red, herderite and apatite are the chief minerals of interest recovered from the pegmatite in the locality. M.O'D.

CECCUZI (B.). *Considerazioni sull'uso del rifrattometro.* (Considerations on the use of the refractometer.) La Gemmologia, **4**, 1, 9-14, 1978.

A general review of refractive index and its measurement with examples of how various authorities differ in published figures. M.O'D.

CHAKRABORTY (D.), LEHMANN (G.). *Infrared studies of x-ray irradiated and heat treated synthetic quartz single crystals.* Neues Jahrbuch für Mineralogie Monatshefte, **7**, 289-98, 1 fig., 1977.

It was found that irradiation produced formation of smoky quartz centres and rearrangement of hydrogen defects. Destruction of smoky centres by x-ray irradiation is faster than the restoration of the original hydrogen defects. Heat treatment for 24 hours at 550°C caused milkiness but did not alter the infrared spectrum. M.O'D.

DANBOM (E.A.). *Some 'new' angles on faceting.* Gems & Gemology, **xvi**, 3, 88-91, 8 figs, 1978.

Some suggestions for improved cutting angles for coloured stones. Fig 2 is confused in its angles. Author's strange suggestion to off-set crown mains to fall between pavilion mains might produce a 'busier' stone but not one readily acceptable in Western markets. Interestingly, this paper originates from Sri Lanka, not the world's best centre of stone cutting. May the author prevail in his home country! R.K.M.

ESCOBAR (R.). *Geology and geochemical expression of the Gachalá emerald district, Colombia.* Economic Geology, **73**, 7, 1391, 1978.

Features of the area suggest a close relation between evaporitic sequences and the emerald deposit, since the evaporites supply some of the ions needed to give the metasomatic alteration of the host formation and the mineralization. M.O'D.

FALTER (M.), LIEBERTZ (J.). *Rasterelektronenmikroskopische Untersuchungen von synthetischem Opal.* (Raster electron microscopic examination of synthetic opal.) Z.Dt.Gemmol.Ges., **27**, 3, 134-43, 12 figs, 1978.

The article discusses the crystal structure of synthetic opals emphasizing the faults in the lattices. The opals examined were Gilson opals and some produced by the authors. Article is illustrated by 12 beautiful photomicrographs. E.S.

FIEREMANS (C.). *Het voorkomen van diamant langsheen de Kwango-rivier in Angola en Zaïre.* (Diamond occurrences along the Kwango river in Angola and Zaire.) Mém. Acad. Roy. Sci. Outre-Mer, Cl. Sci. Natur. Méd., Brussels, n.ser., **20**, 1, 29, 2 pl., 1 map. French summary.

A historical review is given of diamond exploration along the Kwango river and information provided about the geology, tectonics, diamond deposits, and their origin. A systematic increase of the size of diamond crystals from north to south, related to a variation of accompanying minerals (ilmenite, pyrope, diopside), may indicate an approach to the primary pipes. R.V.T.

FISCHER (J. C.). *L'ambre jaune. Roche biologique.* (Yellow amber—a biological rock.) Monde et Minéraux, **22**, 670-80, 3 figs (2 in colour), 1978.

Gives a general account of the occurrences and types of natural amber with a map of world deposits. M.O'D.

FISCHER (K.). *Verfeinerung der Kristallstruktur von Benitoit.* (Refinement of the crystal structure of benitoite.) Zeitschrift für Kristallographie, **129**, 222-43, 1 fig, 1969.

Discusses the crystal structure of benitoite on the basis of powder and single-crystal diffractometer data. M.O'D.

FRANCESCONI (R.), SVISERO (D. P.), VALARELLI (S. V.). *Minerais de elementos raros no distrito pegmatítico de São João del Rei, Minas Gerais.* (Rare-element minerals from the pegmatite district of São João del Rei, Minas Gerais.) Gemologia, **22**, 43, 53-63, 1 fig, 1978.

Optical microscopy and x-ray diffraction have identified a number of rare-element minerals as well as zircon, beryl and spodumene from the pegmatite at São João del Rei, Minas Gerais, Brazil. M.O'D.

FRUTOS MARTÍNEZ (M. I.). *Características generales de los elementos de transición.* (General characteristics of transition elements.) Boletin del Instituto Gemológico Español, **18**, 5-11, 2 figs, 1978.

An explanation of the importance of transition elements in the coloration of gemstones. M.O'D.

FUJIKI (Y.). *Growth of ZrO_2 single crystals using V_2O_5-NaF flux.* Collected papers of National Institute for Researches in Inorganic Materials (Japan), **3**, 207-8, 2 figs, 1975.

Crystals grown with a flux of V_2O_5-NaF were lemon yellow from V^{5+}. Localized cooling methods were the most successful. M.O'D.

FUJIKI (Y.), ONO (A.). *Growth of ZrO_2 crystals by localized cooling method using $Na_2B_4O_7$-KF flux.* Collected papers of National Institute for Researches in Inorganic Materials (Japan), **3**, 53-4, 1 fig, 1975.

Crystals grown fall into two classes; those showing tabular and those showing prismatic form. Many prismatic crystals are twinned. M.O'D.

FUJIKI (Y.), SUZUKI (Y.). *Flux growth and surface observations of ZrO_2 single crystals.* Journal of Crystal Growth, **24/25**, 661-5, 7 figs, 1974.

Monoclinic ZrO_2 crystals were grown by a localized cooling method with various fluxes. Growth and etch patterns were observed by EPMA on the {100} surfaces and by differential interference microscopy. M.O'D.

FUJIKI (Y.), SUZUKI (Y.). *Growth process of baddeleyite (ZrO_2) in PbF_2 flux.* Mineralogical Journal, **6**, 6, 477-85, 8 figs, 1972.

Crystals show both prismatic and tabular form and polysynthetic twinning is observed. M.O'D.

FUJIKI (Y.), SUZUKI (Y.), ONO (A.). *Preparation of baddeleyite (monoclinic ZrO_2) using PbF_2 flux.* Collected papers of National Institute for Researches in Inorganic Materials (Japan), **2**, 273-7, 5 figs, 1973.

Crystals of high quality were obtained by the localized cooling method using PbF_2 as a flux. Crystals, of tabular form and showing {100}, {110}, {111} and [011] faces are typical of the better qualities obtained; less good quality crystals are twinned with development of {110} with composition planes (100) and (110). Polysynthetic twinning is also found in these crystals. M.O'D.

Gill (J.O.). *A study of colored diamonds.* Jewelers' Circular-Keystone, June, 83-86; July, 131-2; Aug., 71-2, 74; 3 coloured figs, 1978.

This writer is the compiler of a comprehensive index to journals, articles and books related to gems and jewellery and published by the G.I.A. Here he has apparently collected into three papers most of the published gemmological facts on coloured diamonds. The first paper covers naturally coloured stones; the second, foiled, painted and irradiated ones, the latter continuing in the third paper. Despite rather poor colour plates and an unfortunate misprint which converts Abbé Haüy to 'Abbie Haüy', the papers are well written and contain a lot of information on a comparatively rarely considered subject. R.K.M.

Gill (J.O.). *Water melon diamonds.* Jewelers' Circular-Keystone, Aug., 106, 108, 1978.

A further short paper listing such oddities as particoloured natural diamonds and others which change colour in different lights or which change after being stored in the dark. Opalescent (cloudy) diamonds may very occasionally be found with play of colour. R.K.M.

Goldman (D. S.), Rossman (G. R.), Parkin (K. M.). *Channel constituents in beryl.* Physics and Chemistry of Minerals, **3**, 225-35, 8 figs, 1978.

Examines the electronic absorption spectra in non-Cr beryls with particular reference to the behaviour of Fe^{2+}. Some dark blue beryls have an absorption band at 700 nm which may arise from an Fe^{2+}/Fe^{3+} intervalence interaction. Channel iron strongly influences colour when beryl is subjected to heating or irradiation. M.O'D.

Gorelikova (N. V.), Perfil'ev (Yu. D), Babeshkin (A. M.). (Distribution of iron ions in the structure of tourmalines according to Mössbauer spectroscopic data.) Zap. Vses. Min. Obshch., **105**, 418-27, 5 figs, 1976. (In Russian; abstract from note by L. Bulgak.)

Mössbauer spectroscopy was used to study the distribution of Fe ions in cation sites in tourmalines. M.O'D.

Graziani (G.), Guidi (G.). *Hydrous gem magnesian cordierite with inclusions of hydroxyapatite, dolomite and rutile.* Mineralog. Mag., **42**, 481-5, 3 figs, 1978.

Cordierite from Madagascar, pale blue in colour, has RIα1.528, β1.522, γ1.537 with a DR of 0.009. Using a probe, dolomite, hydroxyapatite and rutile inclusions were identified. M.O'D.

Greenspan (J.). *Charoite, a spectacular new cutting material.* Lapidary Journal, **32**, 9, 1942-3, 4 figs, 1978.

Charoite's constants are given as SG 2.68, RI 1.55 and hardness 5-6. Hints on fashioning are provided. M.O'D.

Greenspan (J.). *Diamond tools in the lapidary arts.* Industrial Diamond Review, Jan., 12-14, 1979.

Amateur lapidaries in the U.S.A. have found that bonded diamond wheels and discs produce better and faster results than the more conventional tools which use silicon carbide abrasive. These new diamond tools employ nickel plating to bond a single layer of blocky synthetic diamond grit to the working surface of the steel rings and discs. Even diamond compounds have been found to produce a better finish, with less 'undercut' (particularly with gem minerals such as jadeite and nephrite), when used with the appropriate lap. P.G.R.

GÜBELIN (E.). *Saphirblauer Euklas—ein Sammlerstein.* (Sapphire blue euclase—a stone for collectors.) Z.Dt.Gemmol.Ges., **27**, 3, 145-50, 1978.

Up to a year ago euclase was found in pale colours, from colourless to light blue and green to yellow green and green blue. Then sapphire blue euclase was found in Miami in Rhodesia, in the south-west corner of a beryl and muscovite bearing gneiss field (map reproduced). It was shown that trivalent iron was the cause of the blue colour. Physical constants are given. The blue stones are not as clean as the colourless specimens often are, but show irregular flaws. E.S.

GÜBELIN (E.J.). *The tears of the Heliades.* Gems & Gemology, **XVI**, 3, 66-76, 3 maps, 21 figs. in colour, 1978.

An account of amber, its origins and particularly its fossil insect and flora inclusions which are very beautifully illustrated. Text is a little laboured, occasionally obscure and difficult to follow, with some errors, e.g. vertebrae for vertebrates; geni for genera; quiver-flies and day-flies are better known in English as caddis and may-flies or lace-wings, but this is still a serious account of a rather neglected subject. R.K.M.

HASSAN (F.), LABIB (M.). *Induced color centers in a-spodumene called kunzite.* Neues Jahrbuch für Mineralogie, **134**, 1, 104-15, 6 figs, 1978.

Lilac and green colours in kunzite are produced by ionizating radiation acting upon impurity-related precursor centres. Lilac is thought to be due to a hole centre trapped on a Mn^{2+} ion substituting for Si^{4+} in the tetrahedrally coordinated site. With exposure to radiation these centres trap other holes altering the Mn to the Mn^{4+} state. Electrons released in this reaction are trapped by adjacent Fe^{3+} ions in the Al site. The bluish colour acquired by kunzite on irradiation is due to a combination of these activities. On heating crystals up to 500°C all centres were destroyed and the crystals rendered colourless. M.O'D.

HECKMAN (M. W.). *La formation gemmologique en Angleterre et en Allemagne.* (Gemmological structure in England and Germany.) Revue de Gemmologie, **57**, 15, 1978.

Gemmological education in Great Britain and in the Federal Republic of Germany is reviewed; the British system is thought to leave the identification of stones to the initiative of the individual student whereas in Germany all courses are residential and identification is supervised. The German course is expensive. No mention is made of local classes in the U.K. M.O'D.

HOMMA (S.), IWATA (M.). *X-ray topography and EPMA studies of synthetic quartz.* Journal of Crystal Growth, **19**, 125-32, 10 figs, 1973.

Lang diffraction topography and EPMA studies combined to show characteristic growth patterns on as-grown surfaces of hydrothermally grown quartz. Al, Fe and Na were detected as impurities. M.O'D.

KOMATSU (H.), LANG (A. R.). *The growth condition of a natural diamond.* Mineralogical Society of Japan, Special Papers, **1**, 35-41, 6 figs, 1973.

An octahedral diamond from South Africa was studied by surface microtopographical methods; internal microstructures were also studied. Features observed lead to the conclusions that the crystal grew into octahedral form conserving bundles of dislocations generated at early stages of growth and that it was later subjected to strong shear stress giving an incomplete crack along an octahedral plane, the crack later being filled on further growth. M.O'D.

LALLEMENT (A.). *Fievre à Governador Valadares (Minas-Gerais, Brésil).* (Fever at Governador Valadares, Minas Gerais, Brazil.) Monde et Mineraux, **25**, 804-5, 1 fig in colour, 1978.

Rubellite of exceptional quality has been discovered at the Itataia mine 5 km east of Conselheiro Pena, Minas Gerais, Brazil. A specimen is illustrated. M.O'D.

LIDDICOAT (R. T.), KOIVULA (J. I.). *Synthetic cubic stabilized zirconia.* Gems & Gemology, **XVI**, 2, 58-60, 7 figs (6 in colour), 1978.

A résumé of known facts about, and test for, this comparatively new diamond simulant. Colour plates show inclusions (which are normally avoided in stones cut for market purposes), also the rich colour range available apart from the white stones commonly used as the diamond simulant. R.K.M.

LOKHOVA (G. G.), RIPINEN (O. I.), BUKIN (G. V.), VEIS (M. E.), SOLNTSEV (V. P.). (Quantitative evaluation of the colour characteristics of natural emeralds.) Zap. Vses. Min. Obshch., **106**, 704-7, 3 figs, 1977. (In Russian.)

The spectral transmission characteristics were measured for five specimens of emeralds from the Urals, ranging yellowish green to bluish green in colour. Their contents of Cr (0.04-0.38%), Mn (0.004-0.016%), Fe (0.21-0.50%), and Ti (tr.-0.016%) are tabulated. The greenish colour is caused by Cr^{3+} replacing Al; the presence of active Mn chromophores does not affect the colour. R.A.H.

LÜSCHEN (H.). *Mineralogische Märchen.* (Mineralogical stories.) Mineralien Magazin, **1**, 19-22, 5 figs (4 in colour), 1979.

A general summary of legends connected with minerals includes a fine full-page photograph of rough diamonds in colour. M.O'D.

MCCAULEY (J. W.), GIBBS (G. V.). *Redetermination of the chromium position in ruby.* Zeitschrift für Kristallographie, **135**, 453-5, 1972.

Least-squares refinement using a three-dimensional single crystal x-ray diffraction shows that Cr is disordered in the cation site of the corundum, displaced about 0.03Å toward the nearest cation along c. The displacement is not significant. M.O'D.

McCawley (E. L.). *How, where and why hardness varies in gem minerals.* Lapidary Journal, **32**, 5, 1090-1105, 6 figs, 1978.

A full account of the structure of minerals shows how variation in hardness comes about and how this affects the lapidary. M.O'D.

Manson (D. V.). *Plastic impregnated opal.* Gems & Gemology, **XVI**, 2, 49-57, 22 figs (14 in colour), 1978.

A paper dealing with the broad field of opal and opal simulants introduces two new plastic imitations with sub-microscopic sphere structures similar to those of natural opal. RIs are within natural opal range but SG (1.17) is much lower. Principal information is on plastic-impregnated (stabilized) Brazilian opal, sometimes with added black dye to imitate fine black opal. Specimens from which all opal was dissolved by hydrofluoric acid retained form, polish and some play of colour although they then consisted entirely of a network of the polymer plastic known as *n-butyl methacrylate.* Treated stones said to be undetectable by ordinary gemmological means. R.K.M.

Manson (V.). *Genèse des tourmalines de Pala (California).* (Origin of tourmaline from Pala, California.) Le Monde et les Minéraux, **12**, 302-5, 3 figs, 1976.

General notes are given, with a sketch-map, of the tourmaline-bearing pegmatite located in the Pala Valley, San Diego County, California. M.O'D.

Mehta (K.). *Gemstones of Rajasthan.* Gem World, **5**, 6, 33-6, 1978.

Emerald, garnet (mostly almandine), ruby, aventurine, aquamarine, amethyst, serpentine, tourmaline, rock crystal and chrysoberyl are found in the state. Emeralds from the Kalaguman area are said to be of first class deep green colour: those from Rajgarh are said to excel Colombian stones in colour. M.O'D.

Michele (V. de). *Le collezioni mineralogiche del Museo Civico di Storia Naturale di Milano attraverso 140 anni di storia.* (The mineralogical collections of the Civic Museum of Natural History in Milan over 140 years of its history.) Atti della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano, **119**, 1, 3-58, 18 figs, 1978.

The collections now number 22500 specimens and over the past 15 years considerable reorganization has taken place. Training of amateur mineralogists is carried out by the Museum. Italian type locality material is kept in a special section. M.O'D.

Milashev (V. A.). (Toward a theory of the prediction of bedrock diamond potential.) Geologiya i Geofizika, **18**, 4, 9-17, 1 fig, 1977. (In Russian with English abstract.)

Many geologic and petrographic surveys of possible diamond-bearing deposits have been unreliable owing to uncertain predictions; new criteria are suggested for the study of kimberlite regions. M.O'D.

Miles (E.R.). *Laser reflection patterns in diamond and diamond substitutes.* Gems & Gemology, **XVI**, 3, 77-84, 22 figs, 1978.

Laser reflection 'finger-prints' obtained from diamond and its simulants with

Gemprint, an Israeli invention. Some earlier techniques are outlined. Suggestions made for further uses for this somewhat expensive piece of equipment. Interpretations might present problems in non-scientific circles. (Use of circular transparent film instead of square paper would make matching easier if it is to be used to identify individual stones). R.K.M.

MOSELE (G.). *Una nuova rubrica: gemme e inclusione tipiche.* (A new rule—gems and their typical inclusions.) La Gemmologia, **4**, 1, 18, 4 figs in colour, 1978.

Examples are shown of curved striae in a Verneuil-growth sapphire; elongated gas bubbles in a similar stone; colour zoning in a sapphire from Sri Lanka; and zircon haloes in another Sri Lanka sapphire. M.O'D.

MUMME (I. A.), BALL (R. A.). *On the genesis of volcanic opal at Houghlahan's Creek near Teven-Tintenbar, New South Wales.* Australian Mineralogist, **8**, 33-5, 6 figs, 1977; also Australian Gems & Crafts Mag., **21**, 1977.

Precious opal, together with common opal, chalcedony, and quartz, occurs in amygdales in the upper part of a Tertiary basalt flow. Adjacent and overlying beds of diatomite are belived to have been a source of silica-rich solutions for opal formation. D.R.H.

NASSAU (K.). *The history and present status of synthetic diamond.* Lapidary Journal, **32**, 1, 76-96; **32**, 2, 490-508; 24 figs (9 in colour), 1978.

A description of the processes involved in the manufacture of diamond with notes on the history of the experiments carried out in order to produce it. References to man-made gem-quality diamond show that a blue colour is caused by boron and a yellow colour by nitrogen. Both parts of the paper include a list of references. M.O'D.

NASSAU (K.). *A test of the Ceres diamond probe.* Lapidary Journal, **32**, 9, 1970-3, 2 figs, 1978.

The Ceres diamond probe is able to identify diamond by means of its unique thermal conductivity; the probe, copper tipped, is placed against the stone to be tested for about three seconds; where the stone is diamond an indication is given to the operator. Stones as small as 3 points could be satisfactorily checked and no commonly used materials are likely to cause confusion. M.O'D.

NAUMOV (V.B.), KOVALENKO (V.I.), IVANOVA (G.F.), VLADYKIN (N.V.). *Genesis of topaz according to the data on microinclusions.* Geochemistry International, **14**, 2, 1-8, 2 figs, 1977.

Shows that topaz crystallizes at temperatures in the range 1000-3000°C and that it can form from melts, brines and solutions. Specimens from a number of regions are listed according to the types of inclusion present. M.O'D.

NICHOL (D.). *Amazonite deposit near Koppio.* Min. Resrcs. Rev., South Australia, **141**, 110-14, 2 figs, 1977.

A lensoid amazonite-bearing pegmatite transects Cleve metamorphic rocks of

Lower Proterozoic age near Koppio, South Australia. The amazonite megacrystals are light blue-green coloured, constitute about 30% of the pegmatite, and are associated with quartz and plagioclase. The proportion of gem quality material is less than 5%. The deposit contains at least 400 tonnes of amazonite. W.A.F

NIKOLSKAYA (L. V.), TEREKHOVA (V. M.), SAMOILOVICH (M. I.). *On the origin of natural sapphire color.* Physics and Chemistry of Minerals, **3**, 3, 213-24, 9 figs, 1978.

The optical spectra of natural sapphire, together with EPR and infrared spectra, have been examined to see whether Fe^{2+}/Fe^{3+} ratios could be the cause of colour. Charge compensation in $Fe^{2+} \rightarrow Al^{3+}$ isomorphism is discussed. M.O'D.

O'DONOGHUE (M.). *Scandinavian rock hunt. Part 1.* Gems, **11**, 1, 43-5, 1979.

The author led a party of mineralogists to Norway, Sweden, Finland and the U.S.S.R. in the autumn of 1978. This first part describes visits to various locations in Norway (Landsverk, Flåt, Larvik), Sweden (Långban) and Finland (Outukumpu). At the last-mentioned place very fine uvarovites were obtained.
(Author's abstract) M.O'D.

O'DONOGHUE (M.). *A tour of mineral sites in Eastern Europe.* Lapidary Journal, **32**, 9, 2056-61, 4 figs, 1978.

In 1976 a party left the U.S.A. under the guidance of the author and others to visit sites of mineralogical importance in Poland, Czechoslovakia, Austria, Hungary, Yugoslavia, Greece and Turkey. At several places tour members were able to collect for themselves. Notable places visited included Karlovy Vary (the former Carlsbad), Trepça and Laurium. (Author's abstract) M.O'D.

ONO (A.). *Syntheses of monoclinic and tetragonal ZrO_2 at high temperatures.* Mineralogical Journal, **6**, 6, 442-7, 1 fig, 1972.

Single crystals of ZrO_2 were grown by flux methods; a tetragonal crystal was transformed into a monoclinic twinned phase on cooling. Equilibrium temperature of the monoclinic and the tetragonal phases is 1145 ± 10°C. M.O'D.

OTOTAKE (H.). (Historical development of cultured pearl industry in Japan.) J. Gemm. Soc. Japan, **3**, 14-16, 114-16, 165-8, 1976; **4**, 13-15, 1977. (In Japanese with English summary.)

Development of cultured pearl industry in Japan is reviewed chronologically. It is divided into seven stages, and events are described in some detail. I.S.

PERTHUISOT (V.), GUILHAUMOU (N.), TOURAY (J.-C.). *Les inclusions fluides hypersalines et gazeuses des quartz et dolomites du Trias évaporitique Nord-tunisien.* (Hypersaline fluid and gaseous inclusions in quartz and dolomite from the evaporitic Trias of northern Tunisia.) Bulletin de la Société Géologique de France, 73 ser., **20**, 2, 145-55, 9 figs, 1978.

Among various inclusions noted in a study of quartz and dolomite crystals from the Trias of northern Tunisia were halite, sylvine, hematite, various carbonates, liquid CO_2, gaseous CO_2 and nearly fresh water. Study of the inclusions made it possible to distinguish between late quartz of vein crystallization under hydrostatic conditions in a high geothermal gradient and early quartz and dolomites grown in a lower geothermal gradient. M.O'D.

POVARENNYKH (A. S.), CLARK (A. M.), JONES (G. C.). *The infrared spectrum of painite.* Mineralog. Mag., **42,** 518-19, 1 fig, 1978.

The formula of painite can be written $CaAl_9ZrO_{15}(BO_3)$; this takes into account the very high vibration frequency of the $(BO)^{3-}$ radical; this shows a narrow and intense absorption band at 1360-1310cm^{-1} and bands with maxima at 792 and 760cm^{-1}. M.O'D.

POVONDRA (P.), CECH (F.). *Sodium-beryllium-bearing cordierite from Haddam, Connecticut, U.S.A.* Neues Jahrbuch für Mineralogie, Monatshefte, **5,** 203-9, 1978.

Reports a cordierite found in a pegmatite at Haddam, Connecticut. Some of the cordierite is of gem quality and is dark blue to purple. M.O'D.

PRESCOTT (B. E.), NASSAU (K.). *Black elbaite from Corrego do Urucum, Minas Gerais, Brazil.* Mineralog. Mag., **42,** 357-9, 2 figs, 1978.

A black tourmaline from Corrego do Urucum, Minas Gerais, Brazil, showed blue, green and pink areas when cut into sufficiently thin slices. Two distinct growth stages are postulated. Iron is believed to account for the blue and manganese for the pink coloration. M.O'D.

RANKIN (A. H.). *Macroscopic inclusions of fluid in British fluorites from the mineral collection of the British Museum (Natural History).* Bulletin of the British Museum (Natural History), Geology series, **30,** 4, 297-307, 14 figs (8 in colour), 1978.

Twenty-one specimens of Weardale fluorite from the collections of the British Museum (Natural History) were examined for macroscopic fluid inclusions. All are primary in origin and show no signs of leakage. Further work is needed to establish their chemical nature. M.O'D.

RISLING (M.). *The diagnostic inclusions of quartz.* Canadian Gemmologist, **2,** 3, 2-7, 8 figs, 1978.

Describes and illustrates some of the typical inclusions to be found in amethyst, aventurine and other varieties of quartz. M.O'D.

ROBINSON (D. N.). *The characteristics of natural diamond and their interpretation.* Min. Soc. Eng., **10,** 55-72, 9 figs, 1978.

Consideration of the characteristics of natural and synthetic diamond and current ideas on conditions prevailing in the interior of the Earth, lead to the belief that most terrestrial diamond probably crystallized just within its thermodynamic stability field from the parent liquids of peridotitic and eclogitic rocks. Such diamond has been brought to the surface as xenocrysts in kimberlite, the only igneous rocks originating from sufficient depths (>150 km) to have frequently tapped diamond-bearing regions. All known meteoritic diamonds show characteristics indicating a shock-induced origin. The inclusions and surface textures of diamonds are reviewed briefly and the conditions of crystallization of terrestrial diamond are discussed; carbonado may have a much lower temperature of origin. R.A.H.

ROGOVA (V. P.), ROGOV (Yu. G.), DRITS (V. A.), KUZNETSOVA (N. N.). (Charoite, a new mineral and jewellery stone.) Zap. Vses. Min. Obshch., **107**, 94-100, 7 figs, 1978. (In Russian; abstract from note by L. Bulgak.)

Charoite is given the formula (Ca, Na, K, Sr, $Ba)_3Si_4O_{10}(OH,F)$ with 0.5-1.0 H_2O. Lilac material is found associated with dark green aegirine and honey-yellow tinaksite in the central part of the course of the Charig River, Siberia. Both charoite and tinaksite, together with other K-Ca minerals are found at the contact between potassium feldspar-bearing metasomatic rocks and limestone. RI is given as 1.550, 1.553 and 1.559. It can be polished and has considerable tenacity. M.O'D.

SACHANBINSKI (M.). *Edelsteinvorkommen in Polen.* (Gem occurrences in Poland.) Z. Dt. Gemmol. Ges., **27**, 3, 156-8, 1978.

The article is a reprint from a monthly magazine 'Polen-illustrierte Monatszeitschrift' (Poland-Illustrated monthly magazine). Chrysoprase is found in large quantities in Silesia; this source has been mined since 1740 and produces very beautiful green stones. Together with these one sometimes finds a milky opal. Before 1906 Jordanow was the only European source of nephrite; in 1899 the American gemmologist Kunz acquired a piece weighing two tons which is to be found in the Metropolitan Museum in New York. A number of beautiful quartzes are found in Silesia, mainly smoky quartz, morion, rock crystal and amethysts; the chalcedony found in Karkonosce is especially colourful and occurs in all rainbow colours. Serpentine is also found and used mainly for vases, ashtrays, etc. In small quantities one can find fluorite, tourmaline, garnet and even ruby and sapphire.
E.S.

SAMOILOVICH (M. L.), TSINOBER (L. I.), DUNIN-BARKOVSKII (R. L.), LISITSYNA (E. E.), KHADZHI (V. E.). (The third type of citrine colour of natural quartz.) Zap. Vses.Min.Obshch, **105**, 223-7, 7 figs, 1976. (In Russian; abstract from note by L. Bulgak.)

Dark brown colours in one variety of quartz are caused by interstitial ions of Fe^{2+} and Fe^{3+}. In another a smoky colour is related to hole centres due to radiation effects on oxygen tetrahedra where Si ions are replaced by Al. A third variety can be decolorized by heating at high temperature during gamma-ray irradiation. M.O'D.

SCHMETZER (K.), BANK (H.). *Blaugrüner Zoisit aus Merelani, Tansania.* (Blue-green zoisite from Merelani in Tanzania.) Z.Dt.Gemmol. Ges., **27**, 3, 151-2, bibl, 1978.

The optical and crystallographic data for the blue-green zoisite do not differ from the values for the blue zoisite. The absorption spectrum shows the lines of the vanadium-containing zoisite from Merelani as well as those of the chrome-containing green zoisite from Longido. Chemical analysis confirmed that these zoisites contain roughly the same amount of vanadium as of chromium. E.S.

SCHMIDT (W.), ROSLER (H. J.). *Zur Nutzung der Harteanisotropies des Diamanten am Beispiel von Ritzwerkzeugen.* (Making use of diamond's anisotropic hardness taking as an example a scratch tool.) Z. Geol. Wiss., **6**, 813-20, 9 figs, 1978.

Experimental data are used to demonstrate that there is a relation between the abrasion resistance of industrial diamonds and the anisotropic hardness properties of diamond crystals, with the position of the cleavage surfaces of the diamond towards the abrasive base acting as a controlling factor. The mineralogical properties of diamond crystals exert an influence on the efficiency of industrial diamonds which needs further investigation. P.Br.

SCHUBNEL (H.-J.). *Le diamant et l'URSS.* (Diamond and the U.S.S.R.) Revue de Gemmologie **57**, 7-10, 9 figs (2 in colour), 1978.

Describes and illustrates some of the specimens of diamond, both cut and rough, in the Diamond Fund of the U.S.S.R. in Moscow. The Siberian localities for diamond are shown on a map. M.O'D.

SHAUB (B. M.). *Notes on the origin of the Biggs jasper.* Rocks & Min., **53**, 56-62, 12 figs, 1978.

Jasper, from a locality south of Biggs Junction, Oregon, exhibits intricate configurations of thin dark-brown lines on a lighter brown matrix. Dendritic black manganese stains also often are present. In the field the jasper is sandwiched between two successive basalt lava flows. The quartz rock probably was derived from the hydrothermal alteration of clays formed from volcanic ash. Factors relating to this origin are considered in detail, and associated rocks and fossils are described. Some lapidary uses of the picturesque rock are illustrated. R.S.M.

SHAW (R.). *The new gem diamond pen.* Gems & Gemology, **XVI**, 3, 92-95, 3 figs, 1978.

An introduction to the diamond pen which is claimed to distinguish diamond from its imitations and simulants. Nassau's list of contact angles for water on various gems is quoted and a connexion implied between this and the liquid used in the pen. But the latter is evidently not plain water. On diamond it gives a continuous line; on highly refracting simulants the coloured liquid beads into droplets. Stones must be clean and free from artificial coating before testing. A polishing pad, which could damage softer stones, is provided. The test, although empirical, proves diamond but does not distinguish between the different simulants. R.K.M.

SMITH (G.). *A reassessment of the role of iron in the 5000-30 000cm^{-1} region of the electronic absorption spectra of tourmaline.* Physics and Chemistry of Minerals, **3**, 343-73, 9 figs, 1978.

Polarized optical spectra of blue-green tourmalines were measured at a variety of temperatures. Some green stones were heated at 750-800°C in air and hydrogen. Absorption at 7900 and 13 800cm^{-1} are ascribed to Fe^{2+} in the b-site. Bands at 9000 and 13 400cm^{-1} are ascribed to Fe^{2+} in the c-site. Heat treatment shows that the band at 18 000cm^{-1} can be assigned to the charge transfer $Fe^{2+} + Fe^{3+} \rightarrow Fe^{3+} + Fe^{2+}$. Broad absorptions found in the 22 000 and 25 000cm^{-1} regions in some green and brown tourmalines are attributed to $Fe^{2+} + Ti^{4+} \rightarrow Fe^{3+} + Ti^{3+}$ charge transfer. It is suggested that on heating green tourmalines in air and hydrogen Fe^{3+} cations in b- and c-sites are reduced. Further heating in air and hydrogen oxidizes $Fe^{2+} \rightarrow Fe^{3+}$ and generates bands near 19 000 and 21 600cm^{-1}. These are assigned to Fe^{3+}–Fe^{3+} pairs. M.O'D.

Smith (G.). *Evidence for absorption by exchange-coupled* Fe^{2}–Fe^{3} *pairs in the near infrared spectra of minerals.* Physics and Chemistry of Minerals, **3**, 375-83, 1 fig, 1978.

It was found that by heating tourmaline in hydrogen Fe^{3+} is reduced to Fe^{2+} and that the absorbance of the bands at 9000 and 13 800cm^{-1} is lessened. This appears consistent with the *d-d* origin of the bands; in sapphire spin-forbidden bands are intensified by Fe^{3+} -Fe^{3+} exchange-coupling. Bands at about 10 000 and 11 500cm^{-1} in blue sapphire may be of spin-allowed exchange type. M.O'D.

Stepanov (I. S.), Sychkin (G. N.). (On evaluating the reliability of certain diamond finds.) Geologiya i Geofizika, **18**, 10, 73-9, 1 fig, 1977. (In Russian with English abstract.)

A summary of diamond finds in magmatic rocks and clastic deposits of Paleozoic and Proterozoic age in the Ural Mountains of the U.S.S.R. Much of the existing data is considered unreliable owing to the poor interpretation of results, identification of specimens and disregard for possible contamination of testing devices. M.O'D.

Strunz (H.), Wachsen (G.). *Perlen aus dem Fichtelgebirge.* (Pearls from the Fichtelgebirge.) Aufschluss, **29**, 379-95, 20 figs (2 in colour), 1978.

Freshwater pearls from the Fichtelgebirge (in Bavaria, north-east of Bayreuth) are found in sizes rather less than 1 cm across. The history of their recovery is given, together with notes on their structure and formation. M.O'D.

Suhner (B.). *Das Goniometer in der Gemmologie-Möglichkeiten und Grenzen.* (The goniometer in gemmology—possibilites and limits.) Z.Dt.Gemmol. Ges., **27**, 3, 121-33, 1978.

The determination of the refractive index and dispersion of faceted stones according to the minimum deviation method is the most accurate and generally accepted method for isotropic stones. In the case of anisotropic minerals it is only an exception when the main indices can be read, with the exception of the ordinary ray. Dispersion can always be determined, especially in the case of weak double refraction, as the dispersion alters only slightly with the direction of the rays. Although limited in the case of anisotropic minerals, the author argues his case for the application of the goniometer. The article is illustrated and examples are given.

E.S.

Takenouchi (S.). (Basic knowledge on studies of fluid inclusions in minerals, parts 2, 3 and 4.) Journ. Gemm. Soc. Japan, **2**, 2, 66-73, 14 figs, 1975; **2**, 3, 110-21, 17 figs, 1975; **2**, 4, 21-8, 7 figs, 1975. (In Japanese.)

The second part of the survey introduces principles of fluid inclusion geothermometry and discusses the relationship of formation temperature and filling temperature of fluid inclusions. Heating-stage microscope and decrepitation methods are described. Part 3 introduces the use of the freezing-stage method in fluid inclusion study. There are discussions of the formation of liquid CO_2 and CO_2hydrate in cooled CO_2-bearing fluid inclusions and the pressure-specific volume-temperature and pressure-composition-temperature relations of binary systems of H_2O-NaCL and H_2O-CO_2 in hydrothermal conditions. Part 4 reviews the destructive methods of analysis of fluid inclusions with particular remarks on possible contaminations of samples. M.O'D.

TAXER (K. J.), BUERGER (M. J.). *The crystal structure of rhodizite.* Zeitschrift für Kristallographie, **125**, 423-36, 4 figs, 1967.

Ideal formula is calculated as $CsBe_4B_{12}Al_4O_{18}$ with space group $P\bar{4}3m$. Cell edge is a = 7.319±0.001Å. M.O'D.

VACHER (A.). *Étude du processus d'étranglement des cavités intracristallines.* (Study of the strangulation process of intracrystalline cavities.) Revue de Gemmologie, **56**, 3-4, 5 figs, 1978.

Epigenetic inclusions in quartz are examined. The formation of two-phase inclusions allows stages of growth to be studied with particular reference to intracrystalline cavities. M.O'D.

VASIL'EV (V. I.), PRUGOVA (I. V.). (New minerals in Siberia and the Soviet Far East.) Geologiya i Geofizika, **18**, 12, 60-72, 1977. (In Russian with English abstract.)

A list, arranged in chemical classification, includes several varieties of garnet, chromiferous kyanite, strontioapatite and pyroxene of the diopside-jadeite-chromochlore series. M.O'D.

VOILEAU (A.). *Thaïlande. Le rubis de Chanthaburi.* (Thailand. Ruby from Chanthaburi.) Le Monde et les Minéraux, **09**, 202-6, 7 figs (1 in colour), 1975.

The recovery of ruby is illustrated and notes given on the commercial aspects of mining in the region. M.O'D.

VOILEAU (A.). *Thaïlande. Le saphir de Kanchanaburi.* (Thailand. Sapphire from Kanchanaburi.) Le Monde et les Minéraux, **10**, 230-3, 6 figs (1 in colour), 1976.

Gives brief but unspecific notes on the region; sapphires are sold locally as well as in Bangkok. M.O'D.

VOILEAU (A.). *Minéraux de Namibe, Afrique du sud-ouest.* (Minerals from Namibia, South-West Africa.) Monde et Minéraux, **26**, 832-6, 1978.

Among the gem minerals to be found in Namibia are red tourmaline, pink smithsonite, rhodochrosite and azurite-malachite. M.O'D.

WACHSEN (G.). *Weisser Opal aus dem Fichtelgebirge.* (White opal from the Fichtel mountains.) Z.Dt.Gemmol. Ges., **27**, 3, 153-5, 1978.

Milky opals were found in the mountains in north-east Bavaria, a well-known occurrence of hyalite. Physical constants are given. E.S.

WERDING (G.), SCHREYER (W.). *Synthesis and crystal chemistry of kornerupine in the system $MgO\text{-}Al_2O_3\text{-}SiO_2\text{-}B_2O_3\text{-}H_2O$.* Contributions to Mineralogy and Petrology, **67**, 247-59, 13 figs, 1978.

Synthesis of micron-sized crystals of kornerupine showed that the total number of cations per formula unit increases beyond the ideal number of 14.0 with increasing boron content. The Mg:Al:Si ratio may remain constant with increasing boron content. M.O'D.

WILKS (E. M.). *Optical methods to select diamonds of very high lattice perfection.* Nature, **262**, 570-1, 1 fig, 1976.

Criteria for selecting strain-free diamonds include minimum birefringence, freedom from trigons on natural faces and from rectangular markings on polished cube faces, and the ability to produce polarized photons when used as a synchrotron target. F.B.A.

WILSON (A. F.). *The refractory metamorphic gemstones of Australia.* Australian Gemmologist, **13**, 7, 203-9, 1978.

A mineralogical account of various infusible (refractory) minerals and their formation. From details of actual occurrences listed it is evident that there are many potential gem sites as yet unexplored. Hopeful parallels are drawn between Australian localities and known gem areas in other parts of the world. The uncertainty of results from prospecting hinders development. R.K.M.

WOOD (M. M.), WEIDLICH (J. E.). *Diopside 'jade' from the Eel River, Mendocino County, California.* Lapidary Journal, **32**, 7, 1532-5, 6 figs, 1978.

Some jade-like boulders found in the Eel River, Mendocino County, California, have proved to contain diopside in whole or in part. Tests are described. M.O'D.

ZEITNER (J. C.). *The big sky sapphire.* Lapidary Journal, **32**, 6, 1244-54, 13 figs, 1978.

A rough blue sapphire from Montana weighed 24ct and yielded a faceted stone of 12½ct. Mining methods in the Missouri River area of Montana are described. M.O'D.

ZEITNER (J. C.). *The gem investment boom.* Lapidary Journal, **32**, 6, 1372-8, 14 figs, 1978.

Gemstones have increased in price so rapidly over the past few years that many species formerly obtainable at low prices now attain price levels that only a few buyers can reach. M.O'D.

ZEITNER (J. C.). *Sri Lanka, isle of gems.* Lapidary Journal, **32**, 8, 1668-98, 16 figs in colour, 1978.

A general survey of Sri Lanka with notes on the gemstones found there and an account of tours made to the island. M.O'D.

Boletim de preços, bens minerais e produtos metalúrgicos. (Bulletin of prices, fin minerals and metallurgical products.) Boletim de Preços, **5**, 25, 1-43, 1978.

This number includes a section giving the prices of rough and cut diamonds and of various Brazilian gemstones; Rio Grande citrine is said to be heat-treated amethyst; green spodumene is labelled hiddenite; emerald is given a separate table.

M.O'D.

Lista de preços e demais especificações técnicas de materiais gemológicos. (List of prices and technical details of gem materials.) Gemologia, **22**, 45, 65-78, 1978.

This price list is extracted from the Boletim de Preços of the Departmento Nacional de Produção Mineral, **3**, 14, Sept/Oct 1976, and lists prices asked for rough and cut Brazilian and other gemstones. M.O'D.

The Headley Museum, Lexington, Kentucky. Rocks & Min., **53**, 28-31, 9 figs, 1978.

This private museum was founded in 1968 by artist-designer George Headley. It houses jewelled bibelots, including numerous items made from rare and precious stones. Large faceted gemstones are also exhibited, and there is a Shell Grotto containing rare and unusual specimens. R.S.M.

NOTE: Le Monde et les Minéraux became Monde et Minéraux with issue no. 22.

BOOK REVIEWS

AMELINCKX (S.), GEVERS (R.), VAN LANDUYT (J.). *Diffraction and imaging techniques in material science.* 2nd edn. North-Holland Publishing Co., Amsterdam, 1978. 2 vols, pp.847. Illus. in black-and-white. $(US)109.75.

This new edition of a standard work brings up-to-date the work on various types of surface study, with particular reference to different types of electron microscopy. SEM and TEM are described and examples given of the uses in which they are competent. Those wishing for descriptions of the principles and methods of operation of these instruments are recommended to this book. M.O'D.

BALDOCK (J.W.), HEPWORTH (J.V.), MARENGWA (B.S.I.). ***Resources inventory of Botswana: metallic minerals, mineral fuels and diamonds.*** Mineral Resources Rept No. 4, Geol. Survey Dept, Botswana, 1977. pp.xi, 69. 3 figs, 7 pls, 8 geol. maps (in pocket). P4.

There is an 8-page section on diamonds, including details on the history of prospecting, geological setting, kimberlite petrology and geochemistry, and the grade and quality of the diamonds. In the Orapa-Letlhakane region 29 kimberlite pipes have been found, the largest in area being Orapa (110 hectares) yielding 2.2-2.5

carats/m³, of which only 10% are gem quality. Seven pipes have also been discovered in the Jwaneng region. Most of these pipes have a highly altered upper part derived from kimberlite and capable of being worked opencast to a depth of 37 m. R.A.H.

BARIAND (P.), CESBRON (F.), GEFFROY (J.). *Les minéraux, leurs gisements, leurs associations.* (Minerals, their occurrences and associations.) Minéraux et Fossiles, Meung-sur-Loire, France, 1977. 3 vols, pp.489. Illus. in black-and-white and in colour. Price on application.

Although the first part of this book is concerned with didactic mineralogy, the bulk of it deals with the better-known minerals, arranged in order of the main chemical constituent (reminiscent of the Handbook of Geochemistry). The most useful parts are undoubtedly the section for each mineral which give considerable details of occurrence and associated minerals so that the student can get some geological relationships as a background to determinative mineralogy. The photographs (by Nelly Bariand) are of high quality—some have already been published elsewhere. The reviewer noted the lack of a bibliography and, more seriously, of an alphabetical index. Species can only be found from a contents list so that the reader must know the composition of a particular specimen in advance. M.O'D.

BOSCH FIGUEROA (J.M.), MONES ROBERDEAU (L.). *Diamantes.* (Diamonds.) Editorial Entasa, Madrid, 1979. pp.648. Illus. in black-and-white and in colour. 3000 pesetas.

This large and attractively produced book will immediately become the standard Spanish text on the diamond. It deals with the origins of the stone, including a number of maps and photographs of working sites, how it is cut (again with numerous illustrations), how diamonds are classified, identified, synthesized and imitated. Each chapter has its own short bibliography and at the end of the book is a section illustrating (in colour) the grading system used for clarity assessment, the actual system being in this case the Scandinavian Diamond Nomenclature. Highly recommended for those with a fair knowledge of Spanish and even for those without. M.O'D.

DEER (W.A.), HOWIE (R.A.), ZUSSMAN (J.). *Rock-forming minerals.* Vol. 2A. 2nd edn. Longmans, London, 1978. pp.viii, 668. 1 fig. in colour. £25.00.

Since the first edition of this standard series was published in 1963 the amount of information added to the literature has been so great as to necessitate the splitting up of the original volume dealing with the chain silicates into two; this one deals with single-chain silicates. As the authors say in their preface, the growth of electron microprobe work, of crystal structure determination and of experimental petrology, has increased the amount of information available so that the student has, as never before in the earth sciences, to keep constantly in touch with journals. This book will serve for a time to reduce the labour spent in these searches.

The most important minerals covered by the present volume are the pyroxenes; these include augite, the diopside-hedenbergite series, jadeite, rhodonite, bustamite and spodumene among others less likely to be sought by gemmologists. Each mineral has an introduction, diagram of a characteristic crystal, followed by notes on the chemistry, experimental work including synthesis, optical and physical properties, distingushing features and paragenesis, concluding with a list of references, brought for the most part up-to-date for 1976 and the early months of 1977. There are many more phase diagrams than in the first edition, thus reflecting the work done since then, and many analytical tables. This volume is quite expensive but should find a place in the library of every serious student, most of whom will welcome the appearance of the series in parts! M.O'D.

MEDENBACH (O.), WILK (H.). *Zauberwelt der Mineralien.* (Magic world of minerals.) Sigloch Edition, Künzelsau, W. Germany, 1977. pp.204. Illus. in colour throughout. Dm49.

This is not just another collection of beautiful mineral pictures; although the illustrations are of superb quality, there is also an accompanying text of considerable authority. The introduction to the study of minerals is accompanied by full-page facing pictures so that the reader is impelled to learn just how these beautiful things come about. The introduction is not too complicated, confining itself to a description of the crystal systems, optical properties, hardness and specific gravity. This takes up a few of the early pages. After this, however, the minerals themselves take over, and for the remainder of the book all the text is devoted to descriptions of the specimens illustrated—text and picture face each other as in all good books. Specimen size, too, all too often omitted, is given. But it is the sheer beauty of the pieces which makes this book essential to the private collection of anyone caring for natural beauty. They are quite easily the best that this reviewer has ever seen—readers with an interest in gems should look for the green tourmaline crystal on page 185, the hessonite on page 177, the red beryl from Utah on page 197 and the emerald group on page 193. These are only some of the gem varieties illustrated but are typical of the standard of the rest. There appear to be very few errors—one misprint is the incorrect spelling of the Wah Wah mountains in the caption to the red beryl picture, but even this is of relatively small account. Over the years I have accumulated many hundreds of mineral books but this is easily the best illustrated. M.O'D.

METZ (R.). *Visage des minéraux et des pierres précieuses.* (The face of minerals and gemstones.) Librairie du Muséum, Paris, 1978. pp.187. Illus. in colour. Fr185.

This beautifully illustrated work was first published in 1964; this new issue contains a preface by H.-J. Schubnel. It is possible that an English translation may appear at some time in the future. The book follows a pattern almost traditional with mineral books; early chapters deal with crystals and their symmetry, the physical properties of minerals and some general geology. After this, chapters cover mineral origins and there is a special section on minerals from Alpine clefts. Ten pages of general notes on gemstones are unaccompanied by plates other than those depicting minerals not of gem quality. There is a very short bibliography. M.O'D.

MIKA (J.), TÖRÖK (T.). *Analytical emission spectroscopy.* Butterworths, London, 1974. pp.529. £9.00.

A useful and fairly exhaustive guide to the whole area of emission spectroscopy, this book would be useful for those wishing to learn more about those aspects of the subject pertaining to minerals and gemstones. M.O'D.

MYERS (H.P.). *Colour classification of sapphires from Sri Lanka.* Institute of Physics, Göteborge Universitet Chalmers Tekniska Högskola, Sweden, 1978. pp.16. 6 figs. Price on application.

A method of appraising the value of blue sapphires from Sri Lanka involves comparison of their colour with a series of agreed standards, in this case a set of solutions ranging from dark to light blue. M.O'D.

READ (Peter G.). *Gemmological Instruments.* Newnes-Butterworths, London, 1978, pp.227, 146 figs. £8.50.

It might be supposed that all aspects of gemmology had by now been adequately covered by the literature, which has been particularly prolific during recent years, but Peter Read has shown in his book 'Gemmological Instruments' that the increased production and variety of specifically gemmological instruments has by now created a useful place for a work giving information on these products and where to obtain them. The author was formerly Technical Manager to the Diamond Trading Company and he brings to the subject the skill and knowledge as to 'how things work' gained as a trained engineer and expert in electronics. He has also acquired enough knowledge of gemmology to give very capable and succinct summaries of those properties of gemstones which the instruments are designed to observe and measure.

The book is well organized, and packs a great deal of information into the space of its 227 pages, much of which is taken up with illustrations. After an introductory section on the characteristics and constants of gems the second chapter deals with supersonic baths (whose value is dubious in this context and highly dangerous to many gemstones) and such humble but essential accessories as tweezers, shovels and stone-papers. Chapter 3 covers the enormously important inspection aids ranging from pocket lenses and head-loupes to elaborate binocular microscopes which have been found most suitable for the examination of gems whether mounted or unmounted. Sources of illumination are also included in the same chapter. The next chapter covers colour (including pleochroism) and colorimeters, while Chapter 5 copes with refractive index, refractometers, polarizers and (one is glad to see) table spectrometers.

The new reflectivity meters are the subject of a separate chapter and diagrams of their construction given. These instruments have become available just at a time when the manufacture of high-index diamond substitutes has become a serious nuisance to the legitimate trade. Chapter 7 treats with specific gravity, while the next, entitled 'Spectra', briefly covers the absorption spectra of gemstones and the spectroscopes (both prism and grating types) most suitable for viewing them. It is good to see several spectroscopes here which dispense with the added complication and cost attendant on having a wavelength scale attached. This is followed by a chapter on luminescence and a very short one on hardness.

In the eleventh chapter the author abandons his descriptions of instruments and surveys the pressing problem of identifying synthetic gemstones and other forms of simulant, with potted descriptions of each. Chapter 12 concerns itself with diamond grading—on which Mr Read should write with special authority—and the descriptive part of the book ends with a survey of some of the expensive and elaborate equipment which may be of value in specialized research laboratories.

There are some valuable appendices, in the first of which are given the names and addresses of suppliers of the instruments described in the text. These are listed in alphabetical order and amount to no fewer than 100 names, compilation of which must have cost the author considerable trouble, for which we should be grateful. There follow comprehensive tables of constants (obligatory in any serious book on gem identification), notes on the most typical inclusions in natural and synthetic gemstones, and a good index.

The nature of the subject matter has tempted the publisher to include some relevant advertisements in the end pages of the book. Though slightly 'infra dig', these give in some cases useful information as to the cost of the instruments advertised. This, for most readers, most important matter is, for obvious reasons not even hinted at in the text. What the author might consider doing in a future edition is to indicate groups of items of essential equipment recommended for (*a*) a student, (*b*) a professionally involved or keen amateur F.G.A. and (*c*) a small trade laboratory, with a broad indication as to total cost in each case. A chapter might well be added on photography in the service of gemmology, with suggestions and descriptions of the most useful types of camera.

Where it is not directly concerned with the descriptions of individual instruments Mr Read's text is largely an intelligent condensation of standard works. This is frankly acknowledged by the author giving a list of references at the conclusion of each chapter. In this context it was pleasant to observe in the chapter on the spectroscope a reference going as far back as 1859, to Bunsen's original work on the spectra of the elements.

A few errors were noticed, some of which may be mentioned for the sake of future editions. On page 2 the author maintains that metallic lustre is due to 'the type of very high surface finish associated with metals'. This is quite untenable: a rough piece of galena or pyrites, for instance, needs no polish to reveal itself as having an undoubtedly metallic lustre. Also in the first chapter, 'cabouchon', 'waxey' and 'hackley' are not spellings favoured by the dictionaries. Rose quartz shows a 6-ray, not a 4-ray star: the definition of prism is incorrect, and the terms pinacoid, twinning, and parallel growth should be added to the list of definitions. On page 13 only two of the three pleochroic colours of iolite and zoisite are given, and alexandrite deserves a place in the short list of notables in this connexion, while on page 17 moonstone is for some reason substituted for orthoclase in Mohs's hardness scale.

In Chapter 5 it seems as though the author has perpetuated a common misconception in implying that the dispersion of a gemstone can be measured on a refractometer simply by taking shadow-edge readings in suitably filtered red and blue light and subtracting one from the other, whereas things are much more complicated, readings being dependent on the relative dispersion of the (highly dispersive) lead glass of the refractometer prism and that of the stone being tested. The *higher* the dispersion of the stone, the *narrower* the colour-fringe in white light. Further, in the diagram 5.1, the rays R6 and R7 are surprisingly refracted *towards* instead of *away from* the normal, giving the drawing a very odd appearance!

In Chapter 8, the credit for being the first spectroscopist to employ a collimating lens between the light-source and the prism of the instrument is given to Fraunhofer. This enormously important advance in design is usually ascribed to Zantedeschi in 1846: an exact reference to Fraunhofer's use of the device would be welcome, and would add yet one more 'Oscar' to those he earned for his wonderful work on the spectroscope.

In the notes on artificially coloured diamonds (page 157), those coloured by neutron bombardment are said to show an umbrella pattern round the culet, whereas this effect is seen only in stones which have been bombarded by charged particles from a cyclotron, and lastly it might be suggested that in the list of gem materials which show characteristic fluorescent effects under x-rays the orange glow shown by grossular should be mentioned.

None of the above points are of radical importance, and they do not seriously detract from the value of what to gemmologists should prove a very useful compilation. B.W.A.

WEBSTER (B.). *Mineral collector's field guide, Connecticut.* B. Webster, Wallingford, Connecticut, 1978. pp.39. Sketch maps in black-and-white. Price on application.

This small guide describes how to get to some of the best known collecting areas in Connecticut. Especially well known is the Haddam area, now closed, which has produced tourmaline and aquamarine, and several other places have pegmatites where interesting minerals may be found. Up-to-date information on access and sketch-maps are given. There is a short bibliography. M.O'D.

YOGEV (Gedalia). *Diamonds and coral.* Leicester University Press, Leicester, and Holmes & Meier Publishers Inc., New York, 1978. pp.360. £8.50.

This well produced book is a scholarly record of research based on the author's Ph.D. thesis. The title, however, may be somewhat misleading: it is not a book about diamonds and coral as such—its subject is better indicated by the subtitle 'Anglo-Dutch Jews and Eighteenth Century Trade'—though indeed many of the merchants participating in the coral-diamond trade were Portuguese Jews driven out of Portugal by the fires of the Inquisition.

After 25 pages taken up by the title page, table of contents, acknowledgments, Foreword and a brief Introduction, the text is divided into three Parts—a 'General Survey' of four chapters (pp.25-77), 'The Diamond and Coral Trade, 1660-1800' (chapters 5-9, pp.81-180) and 'The House of the Prager Brothers (Levin Salomons) and the Anglo-Dutch Trade, 1760-1796' (chapters 10-12, pp.183-274)—followed by a page of Abbreviations, Notes (pp.276-330), eleven Appendices (pp.331-40), a copious Bibliography (pp.341-8) and Index (pp.349-60).

The third part and the appendices have only a minimal connexion with gemmology except for some particulars in Chapter 12 of the Anglo-Dutch diamond trade (London merchants supplying Brazilian and Indian rough diamonds to Amsterdam for cutting), but there is much in the first and second parts and their notes for the gemmologist who takes an interest in the history of the gem trade. Some excerpts follow.

'The jewellery trade between India and Europe has always been a two-way business. India supplied Europe with diamonds, garnets, rubies and eastern pearls, and Europe exported to India coral and amber: later Europe also exported emeralds and western pearls from South and Central America. After the early sixteenth century diamonds were the main item in jewellery exports from India, and coral took first place in exports to the East . . . . The western Mediterranean was the only source of red coral, the kind needed for the Indian market. Marseilles, Leghorn, Genoa and Naples were centres of coral fishing and coral industries . . .' (pp.102-3), but it was shipped from London. 'The diamond mines were spread over a large area, north and south of Madras. Stones were found in the river beds of the Penner, the Kistna, the Godavari, and the Mahanadi, and in the neighbouring areas. In the middle of the eighteenth century a new source was discovered further north, in the vicinity of Panna in Bundelkhand.'

I was particularly interested to find a number of references to emeralds being supplied from Europe to India but none to any movement of emeralds in the reverse direction and this seems to back up the late Robert Webster's statement[1] that a source of true emerald in India was not known until a much later date (viz. 1943).

The great number of diamonds from Brazil reaching Lisbon from 1728 onwards of course affected the Anglo-Indian diamond trade, but Dr Yogev considers Dr Lenzen's estimate[2] that the discovery of diamonds in Brazil caused an approximate eight-fold increase in the supply to Europe of rough diamonds to be grossly exaggerated (Note 42, p.294): a comparison of the data concerning sales of Brazilian stones during 1775-88 given by W. L. Eschwege[3] with the diamond imports from India[4] for the same period tend to show that the diamond imports from India were generally larger: but smuggling must not be forgotten—the official figures both for Indian and for Brazilian diamonds do not represent the total value of imports.

Towards the end of the eighteenth century import of diamonds from India by way of trade was adversely affected when men who had made great fortunes in India (such as Clive and Warren Hastings) found an easy way to remit their wealth to England was by buying diamonds in India for sale in London: these large purchases in India created a typical sellers' market there, which greatly disadvantaged the merchants engaged in the Anglo-Indian diamond trade, and from the late 1780s the trade was entering the stage of its final decline. By 1823, as reported by Mawe[5] Brazil was almost the only supplier of diamonds to Europe. J.R.H.C.

International directory of micromounters. 9th edn. Baltimore Mineral Society, Balitmore, U.S.A., 1978. pp.34. $1.25.

Lists micromounters by country and state, then alphabetically. M.O'D.

Precious stones newsletter. Precious Stones Newsletter, Thousand Oaks, California 91359, U.S.A., 1978. $104.00.

The first issue of a monthly journal aimed at those intending to obtain gemstones as an investment. Market trends are observed and analysed. M.O'D.

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[1] *Gems, their sources, descriptions and identification,* Newnes-Butterworths, London, 3rd edn. 1975, pp.94-5.

[2] *History of Diamond Production and the Diamond Trade,* (1970), p.121.

[3] *Brasilien, die neue Welt,* (Braunschweig, 1830), I, 112.

[4] according to the General Cash Journals of the East India Company.

[5] *Treatise on Diamonds and Precious Stones,* (2nd edn, 1823).

ASSOCIATION NOTICES

NEWS OF FELLOWS

Mrs Sheila J. Lewis, F.G.A., and Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., gave a second course on 'Synthetics Simplified' at Harrow College of Further Education on 9th March, 1979. As before, a wide variety of set pieces and new possible gem materials were shown, including some rare-earth germanates, synthetic zircon and dysprosium gallium garnet.

On 1st May, 1979, the Worshipful Company of Goldsmiths held a Symposium on 'Synthetic Stones in Jewelry' at Goldsmiths' Hall, with Mr Ivan Tarratt, F.G.A., (past Prime Warden) in the Chair, and Mr M. J. O'Donoghue, M.A., F.G.S., F.G.A., was one of the principal speakers.

On 23rd May, 1979, Vice-President Mr B. W. Anderson, B.Sc., F.G.A., and Mr Alan Hodgkinson, F.G.A., appeared in the third instalment of the BBC2 television series 'The Genuine Article' (dealing with discrimination between the true and the false, the genuine and the fake). Mr Anderson recalled his Laboratory's demonstration of the different transparency to x-rays of zircon and diamond in a Court case where a man was prosecuted for having fraudulently passed off zircons as diamonds, and Mr Hodgkinson with two collaborators showed how to distinguish natural and synthetic rubies by their inclusions and how to recognize doublets by immersion in liquid.

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to the following for their gifts:

Mr D. Inkersole, F.G.A., London, for a piece of dendritic opal rough, referred to as 'Seascape Opal', from Peru.

Mr M. J. Keegan, Wulguru, Queensland, Australia, for two specimens of prehnite with native copper and chrysocolla inclusions.

MEMBERS' MEETINGS

London

On 3rd April, 1979, at the Central Electricity Generating Board Theatre, London E.C.1., the films 'Gem Fun and You' and '7000 Years of Gold Jewellery' were shown.

Midlands Branch

On 10th May, 1979, at the Society of Friends, Colmore Circus, Birmingham, Mr C. Hicks gave an illustrated talk on crystals and minerals. The meeting also included the Annual General Meeting of the Branch, when Mr C. L. Hundy, F.G.A., and Mrs J. S. Leek, F.G.A., were re-elected Chairman and Secretary respectively.

North-West Branch

On 26th April, 1979, at Church House, Hanover Street, Liverpool, a film show was held, covering an introduction to gem collecting, gem-making tools available for cutting and polishing stones, and how they are used.

South Yorkshire and District Branch

On 3rd May, 1979, at Sheffield Polytechnic, Mr P.G. Read, C.Eng., F.G.A., gave a talk on 'Colour in Diamonds'.

PRECIOUS STONES OF THE FUTURE FROM THE LABORATORY

(A report on M. Pierre Gilson's talk)

On the 11th October, 1978, a talk was given to members of the Association by M. Pierre Gilson on 'Precious Stones of the Future from the Laboratory' in the Geological Museum Cinema Theatre, South Kensington. The theatre was full when the proceedings were opened and the speaker was introduced by the Vice-Chairman, Mr David Callaghan, F.G.A., who said M. Gilson produced the very best that man could produce and was able to do in a relatively short time things which Nature took very much longer to achieve: his talent and the vast range of materials that he was producing were quite fantastic.

M. Gilson's talk then took the form of a running commentary on the hundred or so slides which he showed during the evening and he left few people in doubt about the progress made in the last fifty or sixty years. He reminded the audience that Verneuil was the first to make synthetic ruby and sapphire at the beginning of the century: with his relatively simple method he was able to produce a boule in one of several colours in a matter of three hours or so, and his synthetic corundum was soon used to make the jewels in watches.

In contrast, M. Gilson's company takes as long as nine months to grow synthetic emeralds. They start with a seed—synthetic material of the highest quality—and grow it as a non-stop process for nine months. A continuous supply of electricity is essential, because it is important to allow crystallization to take place at a constant temperature if good crystals are to be grown. Accordingly arrangements have been made to ensure that the company is guaranteed a supply of electricity privately in case there should be a failure in the public supply due to breakdown or perhaps a strike.

But it is not just a matter of having the right equipment and know-how: experimentation also is necessary. Before success in making synthetic turquoise was achieved, thirty different phosphates had to be crystallized.

The equipment now used in the Gilson laboratories is very sophisticated and quite advanced. In order to study the size and formation of the tiny 'beads' which make up such gemstones as emeralds an electron microscope is used. A spectrophotometer is another essential piece of equipment, because it is important to be able to control absorption to within one part per million.

With synthetic emeralds M. Gilson has found it beneficial to cut at a specific angle in relation to the seed crystal on which the new material has been grown. He used slides to explain that the main difference between synthetic and natural emerald lies in the nature of the inclusions. In the synthetic material the 'veil' is twisted, whereas in the natural stone it is straight. He added that Nature produced only one good emerald for every million crystals formed: in the laboratory it was essential to have a very much higher success-rate. Emerald production in the Gilson laboratory takes precisely nine months, since, if you wait any longer, crystallization may have stopped. A simple—but impractical!—test to distinguish between natural and synthetic emerald was mentioned: if you heat it to one thousand degrees and it turns white when it cools, you know it is natural. He added that the hardness of emerald was affected by the extent of inclusions in a given stone.

Opal was next discussed. Opal is pure silica: it acts like a prism and the colours which can be seen are pure spectral colours. Gilson synthetic opals contain more pure colours than natural material because they contain more pure constituents. Laboratory production of opal calls for a very high temperature: natural opal is no longer being created because temperatures are not high enough. Even in the laboratory it is impossible to produce two identical opals. Production starts with the production of millions of tiny 'beads', each about 0.3 microns in diameter, and these eventually form the finished material. M. Gilson's most recent improvements involve the removal of all traces of water from synthetic opals, and this gets rid of cracks and helps to avoid some of the hazards associated with the natural material. With natural opals, it is interesting to note that material found at a depth of more than six metres is often noticeably better than stones found near the surface.

Natural turquoise contains iron, and in some cases customers are disappointed when the iron turns green after a year or two. 'Our own stones are pure turquoise, so this problem doesn't arise'—but a process has now been developed so that iron can be introduced to the surface of synthetic turquoise.

With lapis, although pyrites (its inclusion) can be synthesized, M. Gilson uses natural pyrites. 'Each day nine hundred tons of natural pyrites are mined: I cannot compete with that!' He is now successfully synthesizing coral and uses calcite which is now being mined in France.

In answer to a question whether he could suggest any methods of testing stones to tell the difference between real and synthetic specimens, he said: 'We work on

FIG. 1. Chinese style carving in Gilson synthetic lapis-lazuli.

Fig. 2. Gilson synthetic emerald—crystal group.

FIG. 3. Gilson synthetic black opal—rough.

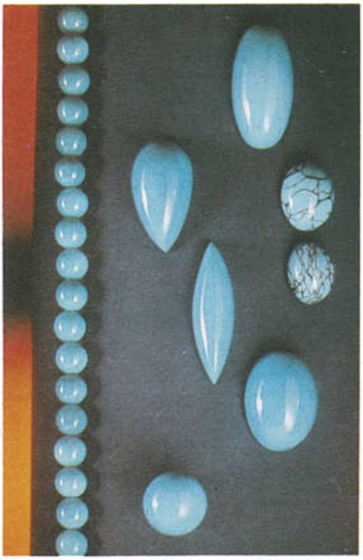

FIG. 4. Gilson synthetic turquoise—beads and cabochons.

FIG. 5. Gilson synthetic emerald crystals being removed from furnace after nine month's growth.

FIG. 6. Gilson synthetic black opals.

FIG. 7. Gilson synthetic turquoise—cabochons and rough.

developing new scientific products, but when it comes to identification you are the experts.' Asked whether it was his intention to produce stones so similar to the natural product that they could not be detected, he replied: 'We are not competing with Nature but merely trying to improve on it by producing more pure stones—more beautiful ones for the jeweller to work with.'

Mr Alec Farn, F.G.A., (L.C.C. Gem Testing Laboratory) asked if M. Gilson had produced any emeralds without chromium but with the additon of vanadium, and M. Gilson replied that he had not—and even if it was done, could the result be described as emerald? 'If people want chromium in emerald, then why shouldn't we give it to them?'

Offering a tip for improving opals, M. Gilson said that if soaked over night in ethyl alcohol all moisture in the stone would be driven out and the colour improved—but it was essential not to do this if the stone was a triplet! And in reply to an enquiry whether he had carried out any experiments on the jadeite family, he smiled and said: 'Yes, we are working on this problem.'

When asked how long he had been trying to make synthetic stones before he had his first success, he said he took fifteen years to succeed with emerald, ten years with opal, and eight years with turquoise: and because of slow reactions and the length of time it took to grow a single crystal before it was known whether or not the experiment was a success, research was becoming more difficult and expensive. Some members of the audience were surprised when M. Gilson mentioned that his main business was not the production of synthetic gemstones but the manufacture of about nine tons of ceramics each month for industrial use.

Mr Alan Jobbins, B.Sc., F. G. A., (Institute of Geological Sciences) proposed a vote of thanks to M. Gilson, which was passed by acclamation.

(Text based on report in the Retail Jeweller by courtesy of the Editor: illustrations reproduced from his slides by permission of M. Gilson)

CORRIGENDA

On p.385 above, in the 'References' *s.v.* Dunn P. J., for 'microbe' read 'microprobe'.

On p.410 above, line 7, for 'show' read 'shown'.

On p.417 above, line 20, for 'four of five' read 'four or five'.

In J.Gemm., 1976, XIV, 3, on p.146, *s.v.* Takenouchi (S.), for '1975, 2, 4, 165' read '1975, 2, 1, 165'.

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