Vol. 10 No. 4 October, 1966

THE JOURNAL OF GEMMOLOGY

and

PROCEEDINGS OF THE
GEMMOLOGICAL
ASSOCIATION
OF GREAT BRITAIN

GEMMOLOGICAL ASSOCIATION
OF GREAT BRITAIN
SAINT DUNSTAN'S HOUSE, CAREY LANE
LONDON, E.C.2

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

(Originally founded in 1908 as the Education Committee of the National Association of Goldsmiths, reconstituted in 1931 as the Gemmological Association)

Past Presidents:
Sir Henry Miers, D.Sc., M.A., F.R.S.
Sir William Bragg, O.M., K.B.E., F.R.S.
Dr. G. F. Herbert Smith, C.B.E., M.A., D.Sc

OFFICERS AND COUNCIL

President:
Sir Lawrence Bragg, F.R.S.

Vice-President:
Edward H. Kraus, Ph.D., Sc.D.

Chairman:
Norman Harper, F.G.A.

Vice-Chairman: **P. W. T. Riley, F.G.A.**

Treasurer: **F. E. Lawson Clarke, F.G.A.**

Elected Fellows:
T. Bevis-Smith
W. C. Buckingham
E. H. Rutland, Ph.D.
E. R. Levett
Miss I. Hopkins
R. Webster
C. T. Mason, O.B.E., F.R.I.C., M.A.
J. M. McWilliam (co-opted)
M. Asprey (co-opted)
D. J. Ewing
W. Stern

Examiners:
G. F. Claringbull, B.Sc., Ph.D.
B. W. Anderson, B.Sc., F.G.A.
J. R. H. Chisholm, M.A., F.G.A.
A. J. Allnutt, M.Sc., F.G.A.
S. Tolansky, D.Sc., F.R.S.

Instructors: **R. K. Mitchell, F.G.A., Mrs. V. Hinton, F.G.A.**

Curator: **R. Webster, F.G.A.**

Librarian: **H. Wheeler, F.G.A.**

Secretary and Director of Examinations:
G. F. Andrews

Offices:
Saint Dunstan's House, Carey Lane, London, E.C.2
(By Goldsmiths' Hall)
Telephone: **MONarch 5025/26**

Affiliated Associations : **Gemmological Association of Australia**
Canadian Gemmological Association
Rhodesian Gem and Mineral Society

THE JOURNAL OF GEMMOLOGY

AND PROCEEDINGS OF THE
GEMMOLOGICAL ASSOCIATION
OF GREAT BRITAIN

Vol. 10 No. 4 OCTOBER 1966

TRANSPARENT GREEN GROSSULAR—A NEW GEM VARIETY; TOGETHER WITH OBSERVATIONS ON TRANSLUCENT GROSSULAR AND IDOCRASE

By B. W. ANDERSON

ALTHOUGH during the past sixty years there has been an astonishing number of new minerals discovered which can lay some claim to be gem materials (two of which, indeed, were at first only known as cut gems) one has to admit that these stones are still regarded only as collector's items, and have made no impact at all on the jewellery trade.

There are several reasons for this; one being the extreme conservatism of the trade itself, which limits the number of gem species to be seen in the average jeweller's window to a mere dozen or so, even at a time when supplies of the more notable precious stones are woefully short. Another (to be honest) is the lack of real beauty or durability in the newly-discovered materials, which rely rather heavily on the third and least reputable quality required in a gemstone—rarity—to be worth the high prices asked for them. And a third reason is that very rarity which makes it sought after by collectors. That lovely stone benitoite (first discovered in 1907) which has the brilliant blue admired in sapphire added to a fire equal to that of diamond, is a case in point here.

Found only in one locality, and virtually extinct in, so to say, the wild state, it is just not available to the enlightened designer of fine jewellery, who would otherwise surely have come to prize it as he has learned to prize the fire and colour of demantoid garnet.

Demantoid garnet, as gemmologists will know, is a special variety of andradite, the calcium-iron garnet which in its black opaque form is known as melanite. The purpose of the present article is to signal the appearance of another transparent green garnet, in this case belonging to the calcium-aluminium species, grossular. Transparent grossular of brownish-orange colour has, of course, been well-known in jewellery for centuries, under the name "hessonite" or formerly "cinnamon stone". In later years translucent massive grossular in shades of green or pink have also become fairly well known as one of the jade substitutes, and I shall have something to say about this material later in the article.

The transparent green grossulars so far seen were only three in number: they were sent from Pakistan in the hope that they might be emerald. In appearance they did indeed resemble emerald, though not of quite the same colour, and with distinctly more fire. In their fire they were reminiscent of demantoid, but the colour was less yellowish-green. Thus, so far as appearance went, the stones were distinctly puzzling—and, being so attractive, distinctly exciting also. In their properties they matched very closely the hessonite variety of grossular, having refractive index 1·738 and density 3·63. Their absorption spectrum was clearly due to chromium, thus accounting for their almost emerald-green colour. There was a doublet and a number of other narrow lines in the red end of the spectrum, but these were faint and difficult to measure: there was also a broader, diffuse band in the orange-yellow.

The whole effect was very reminiscent of a chrome-rich grossular which had been tested about a year previously. This stone had been sent to this country as "Pakistan emerald", and was in the form of a green broken crystal in which some dodecahedral faces could be recognized, striated parallel to their longer diagonal. On this specimen, measurements of some of the chromium lines were possible though perhaps not very accurate. The usual strong chromium doublet was represented by a line at 6970 A; this was followed by several weaker lines and a more prominent line at 6300 A; a diffuse band was centred near 6050 in the orange, and another in the blue-green at 5050 A. The density of this specimen was 3·62 and the refractive index (measured on a polished flat) was 1·742.

There could thus be little doubt that the three transparent green specimens were in fact a new form of gem grossular, but as a final check Dr. G. F. Claringbull kindly obtained for me an X-ray powder photograph from traces scraped from the edge of one of the stones. This showed a pattern typical of nearly pure grossular.

The inclusions of the stones were interesting; in one case showing a large and well-developed crystal, possibly of actinolite (Fig. 1), and in others liquid feathers rather in the spessartite manner (Fig. 2): but it would be rash to draw general conclusions from so few samples.

The dispersion for grossular garnet is 0·027 for the B-G range: much lower, of course than for demantoid (0·057), but much higher than for emerald (0·014). The new stones thus have a distinctly lively appearance, and they should prove readily saleable if they become available in reasonable quantity and at a reasonable price. Nomenclature may prove tricky. The misuse of the term "olivine" or "olivene" in the trade for demantoid garnet seems fortunately to have died out, and demantoid is either referred to as such or as green garnet. The grossulars just described can hardly be denied the appellation "green garnet", and confusion with demantoid might well ensue unless the term "grossular" be added.

Massive Grossular and Idocrase

Nomenclature has already proved difficult in a range of massive green grossular garnets which were first mined in South Africa near Pretoria, and were offered as ornamental stones under the misleading term "Transvaal jade". The grossular from this locality has also been found in attractive shades of pink. Recently pieces of translucent material of the same general nature but resembling jadeite much more closely have been sent to this country from a source said to be in Western Pakistan. In testing a number of samples of this kind, it was found that some of them had undoubtedly properties more appropriate to the "californite" variety of massive idocrase then to grossular garnet, and it became clear that in others there was a complete mixture between the two minerals.

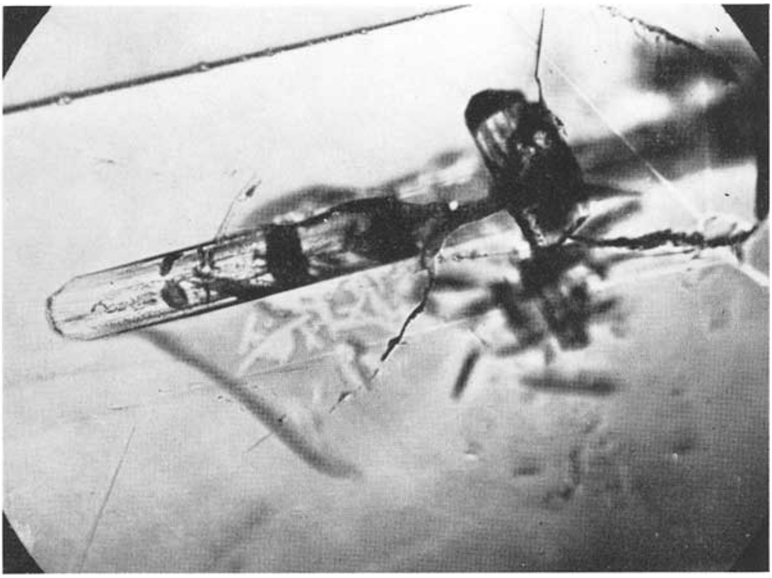


FIG. 1. *Actinolite(?) inclusion in transparent green grossular.* (× 25).

It has long been realised by mineralogists that grossular and idocrase are very closely related, both chemically and structurally. The analyses of grossular and of vesuvianite (idocrase) given below will show how little difference there is between them chemically.

	Idocrase	*Grossular*
SiO_2	37·70	39·30
Al_2O_1	19·30	21·93
Fe_2O_3	0·85	0·80
FeO	0·37	0·28
MgO	2·45	trace
CaO	38·30	37·10
Density	3·322	3·506

Analyses of other specimens show wider differences, but those quoted above were from white (and thus presumably unusually pure) specimens, and both were taken from veins in serpentinite in Georgetown, California.

That the structure of the two minerals is also closely related was early realised by Warren and Modell, who carried out the X-ray investigation in 1931. The cube edge of grossular is 11·85 A in pure material, while the corresponding c axis spacing in idocrase is almost the same (11·79 A).

It is not surprising that the two minerals can and do occur as intimate mixtures; and to obtain even an approximate estimate of the proportions in which they are present is no easy task for the gemmologist, confined as he is to methods which are non-destructive and not too time-consuming.

Density determinations and a careful study of the absorption spectra provide useful clues. The most that one can hope to do (and really all that one *needs* to do) is to be able to label those with a considerable preponderance of one mineral "grossular" or "idocrase" as the case may be, and to acknowledge intermediate types to be mixtures of the two.

The density of pure grossular can be taken as 3·60, and that of idocrase is considerably lower, perhaps 3·32—though in coloured crystals 3·40 is a not uncommon figure. The density of minerals in the massive state is generally lower than in single crystals, and 3·50 may be taken as good average figure for a fairly pure massive grossular, and 3·30 for californite (massive green idocrase). Robert Webster(1) carried out density measurements on an extensive range of green and pink jade-like grossulars from the well-known Transvaal locality, and found a surprisingly wide range from 3·36-3·57, with a few pieces even beyond this extensive span. My own determinations on Pakistan material gave a rather similar range: 3·28-3·52.

The chief feature in the absorption spectrum of green idocrase is a strong and well-defined band in the blue at 4610 A, due to iron, and there is a much weaker band in the green near 5300 A. In the case of green grossular the colorant is mainly chromium, and the absorption band most easily seen is a rather broad one in the orange at 6300 A which has a sharp edge on the green side.

It was noticeable that when Pakistan "greenstones" were arranged in order of increasing density, stones with the higher values showed the 6300 chromium band with little or no sign of the idocrase bands at 5300 and 4610 A, while those with low density showed these idocrase bands clearly and no trace of the 6300 chrome-grossular band. The conclusion drawn from these simple

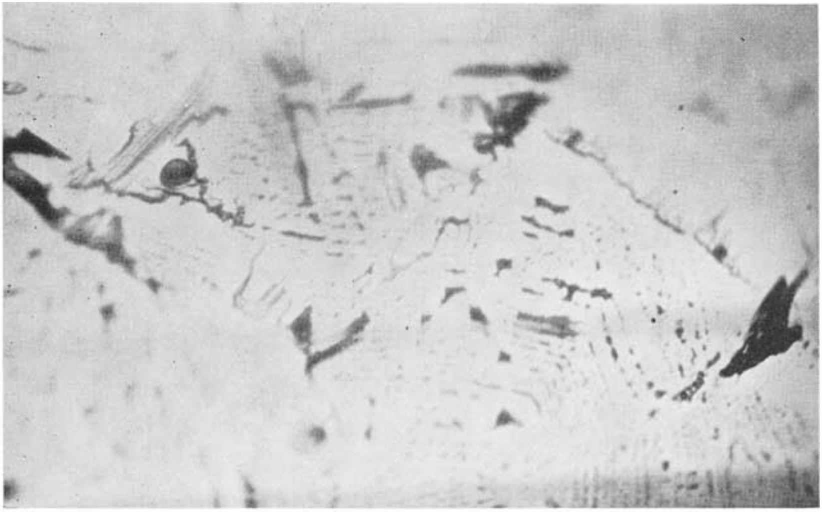


FIG. 2. *Liquid feather in transparent green grossular.* (× 25).

gemmological tests, that we have an almost complete range from nearly pure grossular to nearly pure idocrase has been very kindly confirmed for me by Dr. Claringbull, not only by X-ray powder photographs but also by examining thin sections of suitable specimens.

In Transvaal specimens the main idocrase band at 4610 A can be detected in many cases, but there seemed hardly enough chromium present even in the green varieties to register the chrome-grossular spectrum. The presence of zoisite in some of these South African grossulars has been reported, and may in part account for the density variations found in this material.

X-RAY FLUORESCENCE

The orange glow under X-rays (noted by Robert Webster), which is so striking a feature of all massive grossulars, is certainly a valuable confirmatory test for laboratory workers. It has certain drawbacks, however. In the first place the cause of the glow is not known: it does not seem to be intrinsic to grossular itself—almost all such effects in minerals are due to some specific "impurity". Viewed through the spectroscope the emission is seen as a broad structureless band of light centred in the orange-yellow, giving no clue as to its origin. A study of the trace-element content of fluorescent and non-fluorescent grossulars might suggest an answer.

In the second place, the presence of the phosphor in quite minor amounts will yield the orange glow, which can thus be seen even in some pieces presumed to be californite (idocrase)—a fact which has been recorded by G.I.A. laboratory workers in "Gems and Gemology"(2).

To sum up, the attractive jade-like greenstones from Pakistan have been found to grade from almost pure grossular coloured by chromium to samples consisting mainly of idocrase. The grossulars are marked by densities near 3·5 and by an absorption band near 6300 A in the orange: the californites by densities near 3·3, with the idocrase band at 4610 strongly marked and a weaker band at 5300 A. There are many intermediate types which can only be described (gemmologically) as a grossular-idocrase intergrowth. Almost all specimens may show an orange glow under X-rays in a strength which does not seem to vary consistently with the proportion of grossular present.

Some of this Pakistan material is very pleasing, and at first sight may resemble Burmese jadeite quite closely in appearance, especially in samples where an almost white base is dappled or streaked with patches of bright chrome-green. To market the product successfully will prove difficult unless a good selling name is available. The temptation to describe it as some form of "jade" will be very strong but must be resisted, since only jadeite and nephrite can legitimately be so described. Possibly some broad and non-commital term like "Pakistan greenstone" would prove acceptable for commercial purposes, to which could be added a more specific description for those who are gemmologically interested.

REFERENCES

1. Robert Webster, *Gems and Gemology*, 1963, XI, pp. 35-37.
2. Robert Crowningshield, *Gems and Gemology*, 1965-66, XI, p. 366.

SMARYLL—A NEW EMERALD DOUBLET

By ROBERT WEBSTER, F.G.A.

THE use of composite stones to imitate the prized emerald is no new thing. Gemmologists have known the green garnet-topped doublets for over half a century, and the "soudé emerald" with a rock crystal crown and pavilion joined together with a coloured layer across the girdle is nearly as old. In 1951 this type was modified by using synthetic colourless spinel for the two main parts of the stone(1).

This latest doublet, which the Americans would probably call a triplet, is made by the firm of Kämmerling of Idar-Oberstein, West Germany, and it consists of two pieces of colourless beryl, pale aquamarine or poor quality emerald, for the crown and pavilion. The two pieces are cemented together with a good emerald-coloured duroplastic cement. The use of real beryl in the making of soudé type doublets is no new thing. Kraus(2) illustrates such a type of stone in his book.

Through the courtesy of the Gemmological Association the writer has been privileged to examine three specimens of these new composite stones. Two of the stones were fashioned in conventional emerald-cut style and weighed 3·36 carats and 1·97 carats respectively. The third stone was cut as a round brilliant and weighed 1·02 carats. The colour is a good emerald-green and is possibly somewhat better in this respect than that of the synthetic spinel doublets. It was noticed that there were slight differences in the shade of colour of the stones.

The refractive indices obtained from the table facets of the two trap-cut stones were found to be 1·591-1·585, but the indices of the pavilion pieces were found to be slightly lower. The refractive indices of the brilliant-cut stone taken on the table facet were 1·588-1·582; the indices of the back facets were not taken owing to the small size of the pavilion facets.

All the three stones showed a green residual colour through the Chelsea colour filter and were dark when viewed through "crossed filters". The absorption spectrum showed woolly bands in the red part of the spectrum, which are reminiscent of those seen with some stained jadeites. The fluorescence shown by the stones under the medium-pressure long-wave ultra-violet lamp (Hanovia lamp) was a greenish glow,which may well be due to the cement used in joining the two pieces of stones. However, when examined on edge there was no bright green glow along the girdle as would be expected if it was the coloured layer producing the glow. There was no luminescence when the stones were irradiated with short-wave ultra-violet light.

Examined under the microscope the stones showed, in the true beryl parts, mossy and two-phase inclusions and long canals (rain) which are typical of aquamarine. The cement layer showed bubbles in all cases, many of which produced round clear cavities owing to their being "squashed out" by the pressure used in the process of joining. There were also thread-like structures, which it is difficult to account for (Fig. 1). Between crossed polars there was no clear-cut quarterly extinction, which indicates that the two pieces of beryl used were not aligned crystallographically.

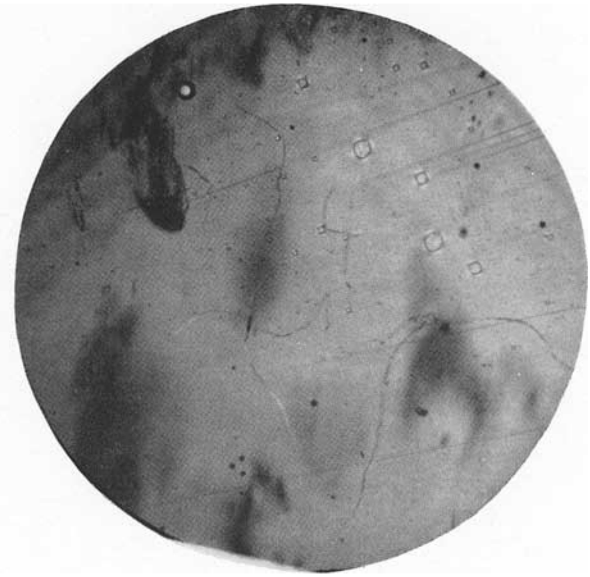


FIG. 1. *Photomicrograph of beryl soudé emerald showing the natural canals (rain); the bubbles and the peculiar thread-like marks.*

When the stones are immersed in water in a white porcelain cup and are viewed sideways, the colourless top and base with the dark line along the plane of the girdle are easily seen, as in the case of the normal quartz doublet. This, of course, is less easy to do when the stone is set in jewellery.

The stones make a good simulation of emerald but offer no problems to the gemmologist. There is the question whether the type of dye used to give the green colour is sufficiently stable to light so as not to fade, but time alone can tell this. The present price seems to be too high for the stone to be an effective competitor to the other emerald simulants.

REFERENCES

1. Webster, R. (1964). *Composite stones; a survey of their types and properties.* Journ. of Gemmology Vol. IX, pp. 167-169.
2. Kraus, E. H. and Holden, E. F. (1931). *Gems and gem materials,* p. 105.

BLACK TREATED OPAL: AN ANCIENT RECIPE

SOME four years ago a peculiar type of "black opal" made its appearance on the market. The appearance of these stones was very distinctive, the flashes of colour being seen as a small mosaic pattern, and the dark background having a speckled appearance. These were first recognized as treated stones by workers in the Gem Trade Laboratory in New York, but direct proof of treatment was difficult, since the material had the characters of pure opal, and the dark background colour which so enhanced its appearance was unaffected by acids or by other solvents.

Eventually, circumstantial stories as to the nature of the treatment were promulgated, and were without doubt true in substance. One such account stated that suitable Andamooka opal was first heated, then impregnated with sugar solution, and finally "carbonized" by warming with strong sulphuric acid—essentially the time-honoured process used for producing "black onyx". Other informants spoke of heaps of poor quality rough opal being covered with old sump oil, which was then ignited. Whatever method was used, there can be no doubt that the darkening of the originally pale background in these treated opals is due to finely disseminated particles of carbon, which accounts for their remaining unaffected by any of the usual solvents.

All this is recent history: but the gentle art of faking gemstones has its roots in the distant past, and I suppose I should not have been so surprised to find the following passage in the appendix to the 1823 edition of John Mawe's famous little book "A treatise on Diamonds and Precious Stones". Here is what he says, complete.

"*THE OPAL.* Many impositions have been practised in forming imitations, or enhancing the effect, of the opal. The first I shall describe (if indeed that can be called an imposition, which, like the shades of a picture, tends to display to greater advantage its rich and glowing colours) is effected by warming the stone, and immersing it in oil or grease, which is afterwards burnt off. The rents which had absorbed the grease, by this means become dark, and agreeably contrast with the beautiful iridescence of the stone, which now assumes the name of black or green opal".

Mawe's tolerant attitude towards this form of opal "improvement" may perhaps be better understood when one realises that the fine black opals from Lightning Ridge, or indeed any of the Australian opals, were quite unknown in his day, so that the treated stones probably did present a more beautiful appearance than any of the natural stones then available.

Incidentally, the treated Australian stones have often been referred to as "opal matrix", but the many specimens we have examined in the Laboratory have all been pure opal, as proved by their density range, radiography, and X-ray diffraction.

B.W.A.

STRANGE NOMENCLATURE

In the 1966 Vol. 3, No. 2 issue of the *Japan Watch & Jewellery Journal* (international edition) there is a report of a "new fascinating artificial stone Asia Green Sapphire". It is claimed that the firm making the stones is marketing them as "Asia green sapphire" without any qualification as to whether the stones are synthetic or imitation. As the firm making them is a large producer of jewels for the Japanese watch industry, presumably the "Asia green sapphire" is a synthetic sapphire. Possibly the correct description has suffered in translation, for in the same article there is a reference to an "Asia star ruby sapphire".

S.P.

COLOUR-COMPOSITION RELATIONSHIP IN SPESSARTINE FROM AMELIA, VIRGINIA

by JOHN SINKANKAS, B.Sc., C.G. and ARCH, M. RIED Ph.D

INTRODUCTION

THE characteristic colours of gemstones have been shown to be fairly reliable indicators of composition. Because of such colour-composition relationships, the gemmologist is often able correctly to assign to a cut stone an identity which needs only to be confirmed by one or two physical property tests. In the garnet group, in which miscibility among end-members is the rule rather than the exception, it is, however, far more difficult to draw conclusions as to composition even when property tests are applied in conjunction with assessment of colour. Difficulties arise because property values extend over fairly broad ranges due to the miscibility mentioned, while colours, particularly among the species in the pyralspite group, tend to grade imperceptibly into one another and become, seemingly, less reliable indicators of composition than one could wish for.

The difficulties will be appreciated by considering the data given below upon the ideal end-members of the pyralspite sub-group. These data are from determinations made upon synthetic end-members by Skinner (1956). It is to be noted that all gradations between properties may occur in natural specimens depending upon which end-members are present and in what amounts:

TABLE 1

Properties of Synthetic Pyralspite End-Members

End-Member	Formula	G.	*n*(Na)
Pyrope	$Mg_3Al_2Si_3O_{12}$	3·582	1·714
Almandite	$Fe_3Al_2Si_3O_{12}$	4·318	1·830
Spessartine	$Mn_3Al_2Si_3O_{12}$	4·190	1·800

As yet, no natural garnets of end-member composition have been reported. Analyses of natural specimens indicate combinations of three or more end-members (Ford, 1915; Heritsch, 1927; Fleischer, 1937; Tröger, 1959). This is reflected in the typical ranges of properties of gem-quality pyralspite garnets as accumulated from gem-testing experience (Anderson, 1964):

TABLE 2

Properties of Natural Gem-Quality Pyralspite Garnets

Principal End-Member	G	*n*(Na)
Pyrope	3·7-3·9	1·73-1·76
Almandite	3·9-4·2	1·76-1·81
Spessartine	4·16-4·19	1·80

Because of the wide range of substitutions possible in the pyralspite garnets, measurements of density and refractive index serve as guides but do not lead to unique determinations of composition. However, a third property, colour, may be useful in further narrowing the compositional possibilities if it can be shown that specific colours are consistently related to specific end-members While the perception of colour is a subjective response known to vary considerably among individuals, it is nevertheless of great diagnostic value and is commonly used by experienced gemmologists to guide their identification efforts. Gemmological experience indicates that the following hues are characteristic of pyralspite garnets in which the end-member named predominates:

TABLE 3

Hues of Natural Pyralspite Garnets

Principal End-Member	Colour	Characteristic Tinge
Pyrope	Dark red	Red
Almandite	Dark to pale purplish-red	Purple
Spessartine	Dark red-brown to pale orange	Brown to orange

The results of our investigation of fifty colour-graded spessartine samples from Amelia, Virginia, indicate that the colour range in Table 3 is characteristic of spessartine from this locality. When colour is used in conjunction with refractive index measurements it is possible to estimate the composition of the Amelia spessartine garnets.

Our specimens were deliberately colour-graded by visual inspection under conditions of lighting normally used by gemmologists. In order to obtain more precise data on colour, however, we plan at a later time to test each specimen for chromatic absorption over the visible spectrum.

OCCURRENCES OF GEM-QUALITY SPESSARTINES

Several parageneses of spessartine are discussed by Deer, Howie and Zussman (1962), but from the gemmologist's viewpoint, only spessartine from granitic pegmatites consistently provides gem material. Notable sources are pegmatites of the central highland region of the Malagasy Republic, the states of Ceará and Minas Gerais in Brazil, and the Ramona district of California and the Amelia district of Virginia, in the United States. In many granitic pegmatites spessartine occurs as fractured crystals in outer zones and as whole crystals or crystal fragments in cavities. Ordinarily only the spessartine from cavities provides clear areas sufficiently large for cutting into gems.

The spessartine used in this investigation came from the Rutherford No. 2 pegmatite near Amelia, Virginia. This pegmatite formed a dike-like body characterized by a large cleavelandite-lined central vug from which one of us (J.S.) collected a large number of spessartine crystals during mining operations in the period 1958-1959. The spessartine occurs as crude spherical masses up to about 23 cm in diameter consisting of numerous irregular, closely interlocked, etched fragments, all surfaces of which are covered by striations and steps similar to those shown upon the specimen depicted in Fig. 1. The fragments nearest the centre of the masses are darkest in colour (dark red-brown). Toward the

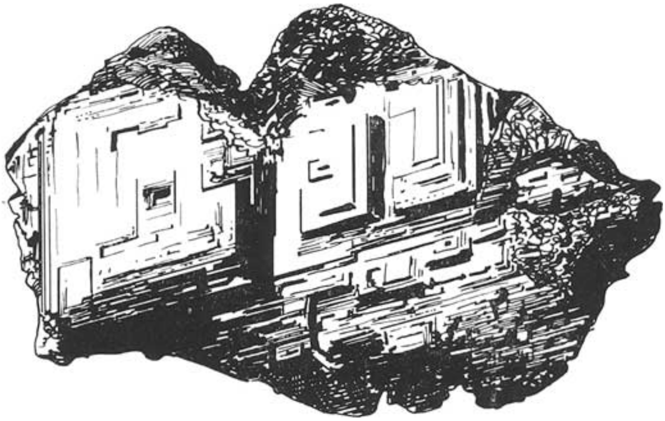


FIG. 1. *Typical etched mass of spessartine from a vug in the Rutherford No. 2 Pegmatite, Amelia, Virginia. Twice natural size.*

peripheries, the fragments gradually lighten in colour until the outermost fragments are red-orange in hue. It appears that each spheroidal mass originally consisted of a single crystal with the colour-change noted above reflecting the decreasing incorporation of iron as each crystal grew larger.

Preparation of Samples

The fifty samples were selected from about 10 kg of core spessartine. Care was taken to choose gem-quality crystals or fragments of about the same size to avoid misleading intensifications of colour due to varying thicknesses. These samples were colour-graded in ordinary transmitted light in the sequence: dark red-brown—red-orange—orange—pale orange. Fragments of 2-3 mm diameter, as flawless as possible, were detached from the master samples and mounted in two circular rows in a single epoxy resin disk of 24 mm diameter. The amount was ground and polished, surface-coated with a uniform conductive layer of carbon. This method assured easy handling in the electron microprobe, a uniformly absorptive carbon-coating, and minimal errors due to instrument drift between readings.

Compositional Results

The samples were analyzed with an Applied Research Laboratories electron probe microanalyzer. Examination of x-ray spectra in the region 1-10Å λ showed that the only major elements present are Si, Al, Mn, Fe and Ca. The detection limit was approximately 0·3 weight per cent under the chosen operating conditions. The major elements were analyzed by comparison with analyzed mineral standards (olivine, plagioclase, rhodonite). Data were corrected for dead-time, drift, background, absorption and fluorescence using the computer programs described by Frazer, *et al* (1966).

Only total iron was determined and the calculations for the end-member garnet molecules (see Table 4) were made on the assumption that all iron is present as FeO. The presence of OH or H_2O was not determined due to the limitations of the method.

Figure 2 is a plot of analyses against sample numbers. The samples are numbered according to colour gradation and are arranged in the colour order noted previously. The plot merely connects data points without attempting to establish smooth curves.

While there are several pronounced deviations in the colour-composition curve and numerous minor ones, the trend is unmistakable and shows that the colours reflect the ratio MnO: (FeO, CaO). It is to be noted that CaO follows FeO which indicates that Ca substitutes in the spessartine in proportion to Fe. The deviations of the MnO and FeO curves are probably due to inaccuracies in colour-grading because of the method used. This view is supported by the refractive index plot of Fig. 3 in which the index values closely follow the deviations of the FeO curve of Fig. 2.

REFRACTIVE INDEX RESULTS

An additional 50 samples of spessartine were detached from the master samples for determinations of refractive index in sodium

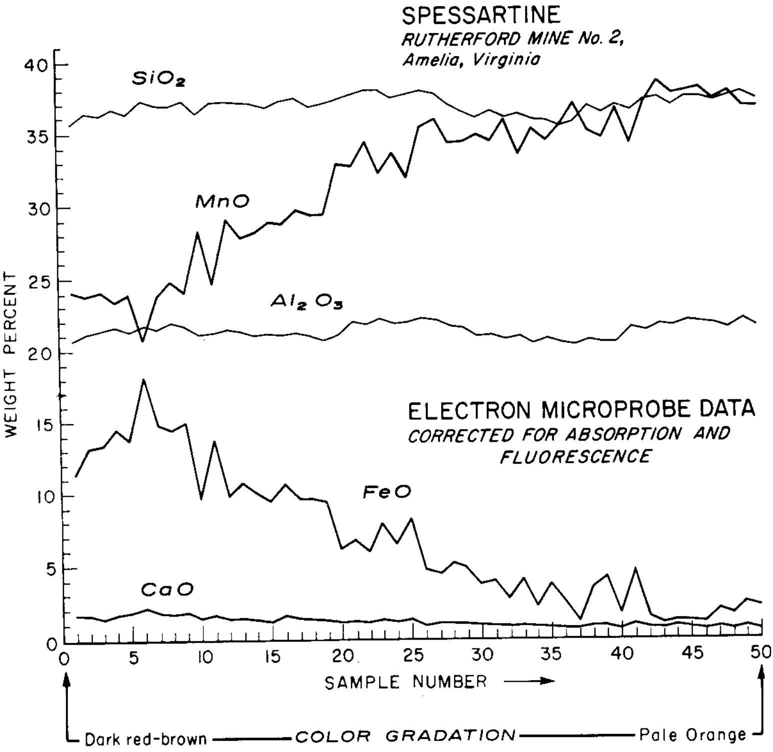


FIG. 2. *Chemical composition of Amelia spessartines plotted against sample numbers according to colour graduation.*

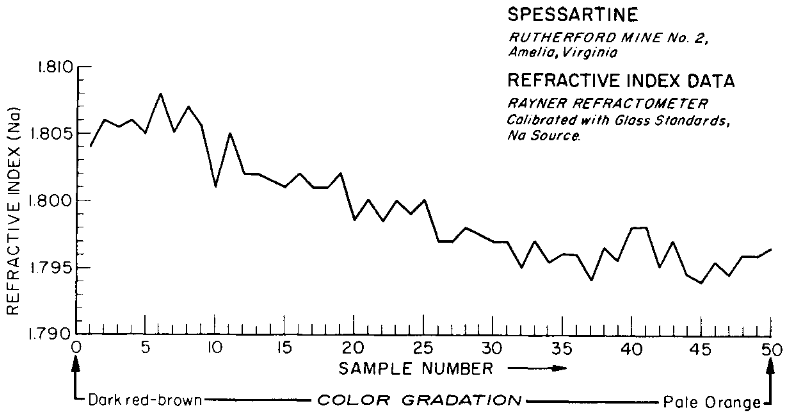


FIG. 3. *Refracted indexes of Amelia spe..sartines plotted against sample numbers according to colour graduation.*

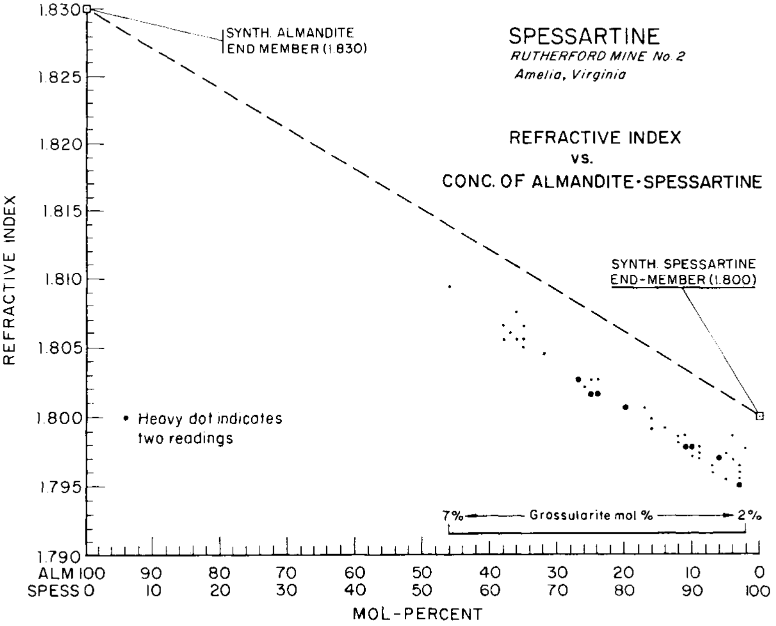


FIG. 4. *Refracted indexes of Amelia spessartines plotted against concentrarion of almandite and spessartine in nol-percents.*

light. Each was imbedded in epoxy resin and ground and polished to provide plane surfaces suitable for determinations upon a Rayner total reflectometer. A suite of polished glass standards, kindly provided by the makers of the instrument, were used to calibrate the instrument. Determinations to the second decimal place were read directly from the instrument but the third decimal place, for which no markings are provided on the instrument scale, are estimates. The results are plotted against sample numbers in Fig. 3 to show the consistent variation of refractive index with the change in the ratio Mn: (Fe, Ca).

To examine the trend of composition-refractive index in another manner, the microprobe analytical data were converted to concentrations (in mol per cent) of spessartine, almandite and grossularite. These data, and others, are presented in order of decreasing almandite in Table 4, while the refractive index data, with almandite-spessartine concentration data, are plotted in Fig. 4. The latter shows a dotted line connecting the ideal almandite and spessartine end-members on the assumption that refractive index is a linear function in the strictly two-component almandite-spessartine system. For purposes of this plot, grossularite in the Amelia spessartine could not be indicated except by a bar in the lower part of the figure showing the range of concentrations from the highest to lowest indexes recorded.

TABLE 4

Spessartine, Rutherford No. 2 Mine, Amelia, Va.
Composition—R.I. Correlations

Sample Nos. Arranged in Order of Decreasing FeO	Weight Per cent FeO	Weight Per cent MnO	CaO	Mol. Per cent Alm.	Mol. Per cent Spess.	Mol. Per cent Gross.	R.I.
6	18·1	20·7	2·2	43	50	7	1·809
9	14·9	24·1	1·9	36	59	6	1·806
7	14·8	23·8	1·8	36	59	5	1·806
4	14·5	23·5	1·7	36	59	5	1·807
8	14·4	34·9	1·7	34	61	5	1·808
5	13·7	24·0	1·8	34	60	6	1·806
11	13·7	24·1	1·6	34	61	5	1·806
3	13·4	24·0	1·5	34	62	4	1·806
2	13·1	24·0	1·6	33	62	5	1·807
1	11·3	24·2	1·6	30	64	6	1·805
13	10·7	27·7	1·5	26	69	5	1·803
16	10·6	28·3	1·5	26	70	5	1·803

14	10·0	28·1	1·5	25	71	4	1·802
12	9·8	29·0	1·4	24	72	4	1·803
10	9·6	28·3	1·5	24	71	5	1·802
18	9·6	29·0	1·4	23	72	4	1·802
17	9·5	29·7	1·5	23	73	4	1·802
19	9·5	28·8	1·3	23	73	4	1·803
15	9·5	28·5	1·2	24	72	4	1·802
25	8·1	31·7	1·3	19	77	4	1·801
23	7·8	32·2	1·3	19	78	4	1·801
21	6·7	32·7	1·2	16	80	4	1·801
24	6·5	33·5	1·1	15	81	3	1·800
20	6·1	32·9	1·1	15	82	4	1·799
22	5·9	34.3	1·2	14	83	3	1·799
28	5·1	34.4	1·1	12	85	3	1·799
29	4·8	34·4	1·0	12	85	3	1·798
26	4·7	35·5	1·0	11	86	3	1·798
41	4·7	34·1	1·0	11	86	3	1·799
27	4·5	35·9	1·0	11	86	3	1·798
39	4·1	34·6	0·9	10	87	3	1·796
33	4·0	33·5	0·9	10	87	3	1·798
31	3·9	34·5	0·9	10	88	3	1·798
30	3·7	34·8	0·9	9	88	3	1·798
35	3·7	34·4	0·8	9	88	2	1·797
38	3·5	35·0	0·9	9	89	3	1·797
32	2·7	35·9	0·8	7	91	3	1·796
34	2·6	35·2	0·8	7	91	3	1·796
49	2·5	36·7	0·8	6	92	2	1·797
36	2·5	35·4	0·7	6	92	2	1·797
50	2·2	36·6	0·5	5	93	2	1·797
47	1·9	37·2	0·8	5	93	2	1·795
48	1·8	37·7	0·5	4	94	2	1·797
40	1·6	36·7	0·6	4	94	2	1·799
42	1·4	36·9	0·8	3	94	2	1·796
44	1·2	37·5	0·8	3	94	2	1·796
45	1·2	37·8	0·8	3	95	2	1·795
37	1·1	36·9	0·7	3	95	2	1·795
46	1·1	33·9	0·6	3	96	2	1·796
43	1·0	38·4	0·6	2	96	2	1·798

Figure 4 shows that the indexes are clustered about an approximately straight line which appears to be converging toward the synthetic almandite refractive index value. If indexes do vary linearly in the two-component almandite-spessartine system, then the general depression of the line may be due to the effect of the grossularite molecule whose ideal end-member refractive index is only 1·743 (Skinner, 1956). The projection of the index line away from the almandite end-member to intersect the vertical line beneath the spessartine end-member index results in a figure of about 1·795 as the refractive index of a garnet whose composition is approximately 98 mol per cent spessartine and 2 mol per cent grossularite.

CONCLUSIONS

The results of our investigation of the Amelia spessartine show that the colour and refractive index vary directly with the composition such that dark red-brown hues and higher refractive indexes are characteristic of higher almandite concentrations and pale orange hues and lower refractive indexes are characteristic of higher spessartine concentrations. The progression of colours established by this investigation suggests that a pure spessartine will be extremely pale orange in hue or possibly nearly colourless. While all of the samples investigated were spessartines by definition that is, molar concentrations of spessartine exceeded that of almandite and grossularite combined, the progression of colours toward almandite indicate that almandites rich in spessartine may retain a brownish-red tinge until the concentration of almandite exceeds considerably that of spessartine. None of the almandite-rich samples investigated by us showed any trace of the purplish tinge ordinarily associated with almandites.

Table 5 below summarizes the results of our investigation by providing suggested ranges of colour-refractive index according to composition:

TABLE 5

Ranges of Colour-Refractive Index in Amelia, Virginia, Spessartine

End-Member Mol Per cent				
Spess.	Alm.	Gross.	n(Na)	Colour
50	43	7	1·809	Dark red-brown
95	3	2	1·795	Pale orange

We gratefully acknowledge the helpful suggestions offered by Dr. G. O. Arrhenius, the text figures prepared by Bonnie Swope, and mathematical data prepared by Marjorie Sinkankas.

REFERENCES

Anderson, B. W. (1964). *Gem Testing*, 7th Edit., London, Temple Press Books Ltd., 271, 272, 358.
Deer, W. A., Howie, R. A. and Zussman, J. (1962). *Rock-Forming Minerals*, Vol. 1, pp. 76-112.
Fleischer, M. (1937). The relationship between chemical composition and physical properties in the garnet groups. Am. Min., 22, pp. 751-759.
Ford, W. E. (1915). A study of the relations existing between the chemical, optical, and other physical properties of the members of the garnet groups. Am. J. Sci., 40, pp. 33-49.
Frazer, J., Fitzgerald, R. and Reid, A. M. (1966). Computer programs EMX and EMX2 for electron microprobe data processing. Unpublished report. SIO Ref. No. 66-14.
Heritsch, F. (1927). Studien über den Chemismus der Granaten. Neues Jb. Min., Beil. Bd. 55-A, 60-91.
Skinner, B. J. (1956). Physical properties of end-members of the garnet group. Am. Min., 41 428-436.
Troger, E. (1959). Die Granatgruppe: Beziehungen zwischen Mineral chemismus und Gesteinsart. Neues Jb. Min., Abh.: 93, 1-44.

LINDE SYNTHETIC EMERALD

THE new Linde (U.S.A.) synthetic emeralds announced sometime ago, are still in the process of being prepared for commercial marketing. Data about them has recently become available.

The synthetic crystals are grown in an autoclave by suspending a seed crystal from thin wire. Although a slow process some very lovely emerald-green crystals result. The time taken for growth and need to replenish the solution from time to time, will keep the price high. In later batches the wire has not been used.

The refractive index range is between 1·566 and 1·571/1·572, with a bi-refringence of about ·005. These indices are somewhat higher than those of the synthetics produced by Gilson, Chatham or Zerfass.

In reporting upon the fluorescence and phosphoresence, Robert Webster states that for a crystal which he examined, there was a strong fluorescence and that phosphorescence (after-glow) was of over thirty seconds duration.

Phenacite is a characteristic inclusion, as well as the veil-like feathers which are often seen in various synthetic emeralds. Webster also reports nail-like inclusions, i.e., a rod-like crystal with a larger or group of crystals at one end, which are somewhat similar to those seen in crystals made by Nacken around 1925. (Some early Nacken crystals in the Association's library do not show such nail-like inclusions, but some crystals had veil-like wisps and rod-like inclusions with flat ends). The nature of the inclusions is likely to be the best basis for discriminating the new synthetic product, together with the strong luminescent characters.

Gemmological Abstracts

CROWNINGSHIELD (R.). *Developments and highlights at the Gem Trade Laboratory in New York.* Gems and Gemology, 1965/6, XI, pp. 20-23 and XII, pp. 359-367.

Notes are given on doctored and imitation turquoise and on odontolite, on a purple-black clam pearl and on solution-grown synthetic rubies. A number of naturally coloured diamonds are reported upon. A "piggy-back" diamond ring made up of three separate diamonds set one below the other is an unusual item discussed. Inclusions in a 6 carat diamond, some of which resembled a growing root and others icicles, and a diamond which had a yellowish coating due to a deposit of iron-rich hard water are mentioned. Some comments on laminated tortoiseshell and fluorescent idocrase (this may well be due to a mixture of idocrase and grossular garnet) are made. The spectrum shown by a synthetic yttrium-aluminium garnet is described and illustrated.

29 illus. R.W.

GÜBELIN (E.). *A visit to the ancient turquoise mines of Iran.* Gems and Gemology, 1966, XII, pp. 3-13.

The history of Egyptian turquoise and the various names applied to the gem preceeds very full notes on the composition and properties of turquoise, and on the nature of its formation. The article then tells of a visit to the mines of Iran (Persia). The writer gives a fine geological survey of the area from his own personal observations. A description of a turquoise mine is given. The methods used by the native cutters in fashioning turquoise are given and the names given to the various qualities of the gem are mentioned. The turquoise mines are owned by the Iran Government. An important and informative article.

11 illus. R.W.

LIDDICOAT (R. T.). *Developments and highlights at the Gem Trade Laboratory in Los Angeles.* Gems and Gemology, 1965/6, XI pp. 24-29 and XII, pp. 368-376.

The usual quarterly reports mention a number of interesting stones examined in the Los Angeles laboratory. These include an unusually coloured emerald and intense colour banding in a flat hexagonal crystal of emerald mounted as a brooch. Although not yet on the market, several Linde synthetic emeralds were examined and were found to have a very strong red fluorescence under short-wave ultra-violet light. A new colour—chrysocolla blue—has been noted in stained chalcedony. Some cameos made of two-coloured plastic are mentioned. Pink dyed quartzite has been sold as "pink jade". Some star diopsides, a deep red topaz and pressed amber are mentioned. Photomicrographs, some at 200x, help to show the effect of the coating on a diamond. The results of the examination of a number of flux-fusion rubies are given. The effect of a strong alkaline cleaning fluid on the surface of opals is remarked upon.

29 illus. R.W.

PARSONS (C. J.). *The terminology of gem colours.* Australian Gemmologist, 1966, 58, pp. 7-8.

A good simple survey of the names applied to gem colours. The meaning of the terms hue, tone and intensity are explained. Other terms sometimes used are described. A colour circle illustrates the various hues.

1 illus. R.W.

HAMILTON (J.). *The Black opals of Lightning Ridge.* Gems and Gemology, 1965/66, XI, pp. 355-358, and XII, pp. 14-19 and 31.

An account of the Lightning Ridge black opal fields. The history of the finding of opal in the area to the present day is given. The story is told of the endeavours made by T. C. Wollaston to popularize the gem. It was not until 1910 that black opal became really saleable. The methods of mining are described.

6 illus. R.W.

CRAM (L. G.). *Boulders of opal.* Australian Gemmologist, 1966, 57, pp. 12-13.

The story of the finding of the Hayricks opal mine on Mount Canaway in Queensland, Australia. Boulder opal is the type of opal found in the mine.

R.W.

POLUTOFF (N.). *The Siberian diamond deposits.* Gems and Gemology, 1965/6, XI, pp. 342-349, 351, 377-379.

An important article detailing much of the history of the finding of diamonds in Yakutia. The geology of the locality is given. The story of the finding of the first "pipe" by a young lady mineralogist named Z. Popugaewa is fascinatingly told. The shapes and the colours of the diamonds found in the various "pipes" are given and something is told of the inclusions present in the stones. A few crystals of over 40 carats have been found. The economics of the Russian diamond fields is discussed.

1 map. R.W.

BOOK REVIEW

COPELAND (L.L.). *Diamonds . . . famous, notable and unique.* Gemological Inst. America, 1966. 188pp., 8 colour plates and many black and white illustrations. $7·50.

A comprehensive survey of the great and near-great diamonds of history, with useful references to some lesser-known stones. It is the best compiled work of its kind yet published and will be a useful reference source to many gem enthusiasts. Considerable trouble has been taken to verify information and some interesting and hitherto unknown facts have been brought to light.

S.P.

ASSOCIATION NOTICES

OBITUARY

Caudell, Peter, 4th July, 1966. (Diploma 1952).

WEST OF SCOTLAND BRANCH

The summer meeting of the West of Scotland Branch was held on 25th June, 1966, and took the form of a day's hunting for garnets in the Pass of Killicrankie. Some rocks were found completely covered with garnets but only on the surface. Many well formed garnets were also found weathered out of the parent rock but only one was recovered which was a gem quality. Members considered that the 1966 outing was the most successful and interesting so far.

GIFTS TO THE ASSOCIATION

The Council of the Association is indebted to Viktor Kämmerling of Idar-Oberstein, who has presented three specimens of beryl doublets simulating emerald (see article on page 120).

Mr. Thor Johne of Oslo, has kindly presented the Association with a ruby crystal mined at Froland, S. Norway.

GEM DIAMOND EXAMINATIONS

In the 1966 Gem Diamond Examinations held by the Association, there were fifteen entries and the following, arranged alphabetically, is a list of successful candidates:—

Passes

Brian Oswald Bailey, Handsworth Wood, Birmingham
Ronald Bailey, Dudley
John Evans, South Yardley, Birmingham
Alfred Jones, Coventry
Eljas-Jussi Kiuas, Helsinki, Finland
Mrs. Evelyn Krzempek, Mapperley, Nottingham
Donald Ashton Light, Four Oaks, Sutton, Coldfield
Rodney Charles Randle, Bournville, Birmingham
Frank Riding, Ribbleton, Preston
Anthony Reginald Thorne, Halesowen
Francis Sidney Hope Tisdall, Sutton Coldfield
Roy Nevil Wetton, Alrewas, Nr. Burton-on-Trent

TALKS BY MEMBERS

Coop, N. "Gemstones", Women's Institute, Cholesbury-cum-St. Leonards, 1st March, 1966; Townswomens Guild, Norbury (A) Croydon, 3rd May, 1966; Townswomens Guild, Portsmouth Waterlooville, 16th May, 1966; Soroptimists, Barnes & Sheen, 1st June, 1966; Senior Wives' Fellowship, Rochester, 7th June, 1966.

GEMMOLOGICAL EXAMINATIONS 1966

Centres for the 1966 Examinations of the Gemmological Association of Great Britain were established in twenty-six overseas countries, apart from the United Kingdom. Three hundred and eight candidates sat for the Preliminary and 195 for the Diploma Examinations. These figures represent the highest in the Association's history.

Upon the recommendation of the Examiners the Tully Memorial Medal has been awarded to Bernard Frank Martin of Sheffield, the Rayner Diploma Prize of gem testing instruments to Peter Otto Reiter of Lucerne and a similar prize in the Preliminary Examination to Miss Elizabeth Strack, Idar-Oberstein.

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

Tully Memorial Medal

Martin, Bernard Frank, Sheffield

Rayner Diploma Prize

Reiter, Peter Otto, Lucerne, Switzerland

Qualified with Distinction

Azzopardi, Joseph, Floriana, Malta
Cremer, Viktor, Munchen, Germany
Douglas, David Norman, Manchester
Gatward, Anna Bradly, Hitchin
Korber, Dietlinde, Munchen, Germany
Ponahlo, Johannes, Vienna, Austria
Salt, Ilse Emilie, Fort Nelson, Canada
Sanford, Sheila, Enfield
Theisen, Verena, Lucerne, Switzerland
Wilkins, Robert Festus, California, U.S.A.
Woodall, Christopher, Streetly

Qualified

Ash, Grahame David, London
Bastos, Francisco Muller, Minas Gerais, Brasil
Boruszak, John Kasmick, Blackpool
Bruford, Leslie Gordon Nicolas, Hailsham
Buckingham, Lionel James, East Croydon
Butland, William Martin, Natal, S. Africa
Butler, June Iris, Waltham Abbey
Byworth, David Roy, Brookmans Park
Cameron, Donald Aldert, Ottawa, Canada
Chikayama, Akira, Kofu, Japan
Clarke, John Egbert, London
Collier, Rowley Walter, Hornchurch
Connolly, John Patrick, Wilmslow
Cook, John William, Chelmsford

Crombie, Michael Seymour Ivor, London
Doherty-Bullock, Gabrielle June. Lower Wick
Downes, Bryan, Silkstone
Dunne, Michael Bernard. Southport
Edleston. Carolyn Isabel, Liverpool
Engelsman. Albert, Rotterdam. Holland
Ewart, Myra, Bailliestow
Falcon, Lionel James, Nottingham
Fillan, Ian, Huddersfield
Fournet, Bertrand Pierre, Hong Kong
Frizzell, Alan Stewart, Motherwell
Fuller, Donald George, St. Helens
Geddes, Margaret Hutchinson, London
Gregory, Hugh Milne, Beckenham
Guthu, Steinar, Sandefjord, Norway
Helmen, Karin, Oslo, Norway
Hilton, John David, Macclesfield
Huish, Diana, London
Hunt, Anthony Gerrard, Hucknall
Ingram, Roger, Sheffield
Jones, David Martin, Birmingham
Kilcoyne, Anthony John, Wolverhampton
Kirchner, Brit, Erlangen, W. Germany
Klimek, Karol Stefan, Burham
Laycock, Keith, Sheffield
Leech, Alan Gerrard, Heywood
Lenan, Cornelius, Heath
Levy, Warren Irving Jack, Boreham Wood
Lowe, Peter James, Green Lane
McCorquodale, Samuel, Selangor, Malaysia
McLean, Eldred Mervyn, Transvaal, S. Africa
Menton, Joel, Edgware
Miller, Elizabeth Anne, Wolverhampton
Miller, Jeanne Stratton, Arlington, U.S.A.
Moore, Martin Cale, Birmingham
O'Connell, Sean, Harrow
Pamphilon, Christopher Guy, Birmingham
Perren, Richard B., Toronto, Canada
Popper, Madeleine Charlotte, London
Pryke, Christine May, Colchester
Ranasinghe, Vernon Victor Clement, Colombo, Celon,
Rayner, Denise Ann, Cuffley
Rae, Alexander, Ontario, Canada
Stoddart, Harry, Sheffield
Sutherland, Michael Bruce, Basildon
Sutton, Andrew Leece, London
Sweet, Ronald David, Sidcup
Thompson, Peter Lindsay, Nottingham
Verney, David Laurence, London
Widnall, Harry, Sheffield
Wijkström, Gunnar, Stockholm, Sweden
Wild, Walter Frederick, Liverpool
Winkler, Gunter, Augsburg, Germany
Woods, Norman Ronald, Sheffield
Zwollo, Paul, Oosterbeek, Holland

Preliminary Examination

Rayner Prize

Strack, Elisabeth, Idar-Oberstein, Germany

Qualified

Aase, Nina, Bergen, Norway
Ahrens, David, Ilford
Amedeo, James, New York City, U.S.A.
Andresen, Ragnar, Sandefjord, Norway
Anthony, Ann Catherine, Selston
Arbeid, Martin Joils, London

Arends, Henri, Amsterdam, Holland
Bamford, Roderick, Nottingham
Barlow, Brenda Mary, Totnes
Barlow, Seaton, Totnes
Baxter, James Edinburgh
Beck, Cyril Anthony, Manchester
Becker, Jeffrey, Prestwich
Beevor, Christopher, Pinner
Bergmans, Paul, Schoonhoven, Holland
Berwick, Keith James, Portsmouth
Besant, Bruce, Bristol
Bloom, Victoria Catherine, Sutton Coldfield
Boers, Leone, Naarden, Holland
Bonner, Anthony, Liverpool
Bosworth, John Charles, Salisbury, Rhodesia
Brandreth, Raymond Stanley, Knutsford
Broughton, Timothy John, Knutsford
Brown, Judith Audrey, Altrincham
Brown, Janet Irene, Congleton
Bruford, Leslie Gordon Nicolas, Hailsham
Buchanan, Kenneth Ray, Oklahoma, U.S.A.
Bull, Rudolph, Lugano, Switzerland
Burnstein, Burton Alvin, Los Angeles, U.S.A.
Burr, Rosamund, London
Bytheway, Keith Leonard, Walsall
Carmichael, John Michael, Kirkella
Catley, Reginald Arthur John, Salisbury, Rhodesia
Chan, George Kivok-Leung, Kowloon, Hong Kong
Chartier, Henri Paul, Esher
Cherns, Jack Jacob, London
Collier, James Edward, Chislehurst
Cowbourne, Elizabeth Mary, Bingley
Cox, Edward Michael, Gt. Yarmouth
Craft, Herscu Rozen, Venezuela, S. America
Croydon, Robert William, Norwich
Cumming, Phyllis Eleanor, Kuala Lumpur, Malaysia
Cuss, Christopher Jude, Ipswich
Cutts, Michael James, Surbiton
Daker, Roy Victor, Walsall
Dale, Robert, Carshalton
Dalewski, Orest, London
Dean, David, London
Denley, Peter Gordon, Bristol
Dennis, Jean Elizabeth, Dagenham
Doughty, Mary Forbes, Birkenhead
Duckitt, Catherine Patricia, Rickmansworth
Dudek, Clelan Francis, Oregon, U.S.A.
Edwards, Stephanie Looan, Birmingham
Evans, Royston Thomas, Coventry
Eveleigh, Michael Leonard, London
Everitt, Alan, Liverpool
Fardon, Pamela, Wembley
Farringer, Dale Eldwin, Virginia, U.S.A.
Fjogstad, Kaare, Oslo, Norway
Folkes, Trevor Robin, Cheam
Forman, Evelyn May, Buckingham
Forman, Stephen Michael, Manchester
Gardiner, John Clive, Prestwich
Gavin, Donald Fleming Sinclair, Edinburgh
Gay, Phillip G., Florida, U.S.A.
Giertta, Claes Erik, Stockholm, Sweden
Goldsby, Reginald Henry, Bradford
Goodman, Brian John, Walsall
Glen, Susan Elizabeth, Coventry
Greenhalgh, John Clive, Radford Semele
Gregory, David George, Liverpool
Gregory, Hugh Milne, Beckenham
Gregory, Jack, Barnsley
Halls, Norman Edward, London
Hamilton, Allan Bruce, Formby
Hamnett, Norman, Radcliffe
Harding, James Norman, Northwood Hills
Haunss, Owe Karl Bertel, Farsta, Sweden
Hawdon, Elsie, Hyde

Hartmann, Carolus Johannes, Eindhoven, Holland
Hartley, Donald Wilson, Michigan, U.S.A.
Hayes, Lillian Eveline, London
Heald, Ronald, Manchester
Henriksen, Anne-Marie, Trondheim, Norway
Hill, Samuel, Liverpool
Hilliard, Christopher Paul, Portslade by Sea
Hogwall, Anna Stina, Stockholm, Sweden
Holcombe, John Westray, Queenstown, S. Africa
Holgate, David Edmund, Wirral
Huddlestone, Roy Victor, Baildon
Hughes, Anthony, Bradford
Humphreys, Maurice Norman, Wirral
Hundy, Christopher Leslie, Sutton Coldfield
Hunt, Ian Rodney, Rainford
Jackson, Della Ann, Prestbury
Jacobsson, Rolf, Jakobsberg, Sweden
Jamieson, Sara Blackburne, Co. Londonderry
Jaye, Alan Ross, Canvey Island
Johansson, Bengt Olov, Danderyd, Sweden
Johnson, Cyril Alan, Rugby
Johnston, Christina Ann, Perth
Johnstone, Robert Anderson, Giffnock
Jones, David Albert, Birmingham
Jones, Sylvia Margaret, London
Josephson, Karin, Danderyd, Sweden
Karlberg, Willy, Oslo, Norway
Kaye, David, Cardiff
Kean, John Snowden, Ayr
Knight, Malcolm Harold, Birmingham
Kusmirek, Jan, Crawley
Langfield, David Ronald, Farnham
Langley, Terence, Birmingham
Lau, Vibeke, Rdufoss, Norway
Lecolle-Brown, Ian Hugh, Johannesberg, S. Africa
Levene, Bernard, London
Levin, Jehuda, Tel-Aviv, Israel
Levitt, Andrew Steven, Ilford
Levy, Benzion, London
Levy, Marion David, Georgia, U.S.A.
Lewis, Elliott Anthony, Swinton
Lewis, Philip Adrian, Westcliff-on-Sea
Lieberman, Gerald, Ilford
Linares, Robert C., Connecticut, U.S.A.
Lindh, Ulla Helena, Stockholm, Sweden
Lorimer, Barry Anthony, Keighley
Luder, Johan Gerard, The Hague, Holland
McDonald, Ronald Lachlan, Toronto, Canada
McMullen, David Douglas, Edinburgh
Major, Peter William Ernest, Horsted Keynes
Marsden, Francis Roy, Harrogate
Marsh, Guy Anthony, London
Mechlin, Wilmer, Maryland, U.S.A.
Mendis, Cynthia Marguerite, Colombo, Ceylon
Metcalf, Clive, Richmond
Mitchell, Roger, London
Mobbs, Anthony, London
Moran, Vincent Paul, Salisbury, Rhodesia
Morken, Fridtiot, Trondheim, Norway
Muir, Kenneth Alfred, Liverpool
Mumford, Ronald Broughton, Kuala Lumpur, Malaysia
Muscroft, John, Mexborough
Nash, Geoffrey Edwin, Walsall
Neary, Geoffrey, Huddersfield
Neerbye, Lise, Vestre Boerum, Norway
Nessi, Annamaria, Lucerne, Switzerland
Newham, Frank Edward, London

Newman, Brian Anthony, Cape Town, S. Africa
Nixon, Rolf Thorp, Washington, U.S.A.
Parker, Arden William, Birmingham
Parkes, Frederick, Stanmore
Parsons, Anthony Laurie, Chalfont St. Giles
Patton, David, Wirral
Paulsen, Astri, Oslo, Norway
Patterson, C. Richard, Kansas, U.S.A.
Pearce, David Maresco, Colchester
Pearson, Marrianne, Darlington
Pearsons, Martin Howard, Romford
Pereira, Barbara, Colombo, Ceylon
Perera, Dixon Chandrasiri, Kingston-upon-Thames
Pinner, Benjamin Robert, Maryland, U.S.A.
Poole, Roger James, Yate
Porter, Graham Stanley Credland, Birmingham
Preedy, Jonathan Neville, London
Reece, Gail Ursula, Salisbury, Rhodesia
Rees, Dietlinde, London
Renfrey, Eric, Ormskirk
Richardson, Sydney Herbert,
Richardson, Sydney Herbert, Auckland, New Zealand
Rickenberg, Robert, Los Angeles, U.S.A.
Riddell, John, Armagh
Robinson, John Stuart, Huddersfield
Roff, Jeffrey, Newport
Rufli, Lisbet, Sollentuna, Sweden
Russell, Madeleine, Ilford
Sanderson, Clare, Romford
Sansford, Paul Victor, Weymouth
Satterthwaite, Frank Clement, Wraysbury, Bucks.
Schippers, Gustaaf, Rijswijk, Holland
Schnieden, Harold, Bramhall
Shillito, Ann Marie, Brixham
Slyper, Maria Anna, Amsterdam, Holland
Smith, Anthony Vincent, Bradford
Smith, Roger, Keynsham
Smith, Shirley, London
Smith, Wilbur Edward, Washington, U.S.A.
Solecki, M. A. N., Blackpool
Solomon, Marjorie Zena, Birmingham
Solomon, Samuel, Birmingham
Soni, Jaichand Lal, Phndm Penh, Cambodia
Spink, Stanley Francis Brian, Birmingham
Spohn, Winfried, Akazienallee, West Germany
Stephansen, Irja, Oslo, Norway
Stuckey, Howard, Sale
Subhan, Mohd., Kowloon, Hong Kong
Summerhayes, Edward, Gravesend
Suraweera, Don Nagaratna Opawansa, London
Sutton, Robert Michael, Bramley

Swain, Marilyn Janice, London
Talbot, Peter Ernest, Crayford
Tester, Robert Edward, Gibralter
Tilling, Malcolm Hewitt, Birmingham
Tribbeck, Roland Ralph, Salisbury
Urban, Rey, Stockholm, Sweden
Vad, Meena Suresh, Andhra Pradesh, India
Voyse, Terence, Rotherham
Wallace, Lindsay James, Gainsborough
Webb, Eric William, London
Weerakoon, Ranjith Laksham, Poruwedanda, Ceylon
Weller, Brian John, Birmingham
West, Lionel Waygood, Hatfield
Westall, Erica, Cape, S. Africa
Wilson, Geoffrey Alexander, Urmston
Wight, Willow, Marville, France
Windsor, Westly, Hoddesdon
Wong, Stephen, Liverpool
Yiu, Nellie, Kowloon, Hong Kong

PRESENTATION OF AWARDS

The presentation of the awards gained in the 1966 examinations of the Association took place on 24th October, and the proceedings will be reported in the next issue of the Journal.

HERBERT SMITH MEMORIAL LECTURE

The 1966 Herbert Smith Memorial Lecture will be given by Mr. R. C. Chirnside, of the General Electric Company, at Goldsmiths' Hall, Foster Lane London, E.C.2, on Tuesday 8th November.

1967 MEETINGS

25th January—Film Show, Hanover Street, London W.1.
6th March—Conversazionne, Goldsmiths' Hall, London.
23rd May—Annual General Meeting, London.

WEST OF SCOTLAND BRANCH

"Gems, real or fake". A lecture by Mr. Robert Webster, to be held at the North British Hotel, Glasgow, at 8 p.m. on 10th November, 1966.

COURSE INSTRUCTOR

Applications are invited from Fellows of the Association willing to undertake a limited amount of correspondence course instruction in preliminary and diploma grade gemmology. A good understanding of gemmological crystallography is essential. Applications to Secretary of the Association.

Actinolite ....
Alexandrite ....
Amblygonite ....
Analcite ....
Andalusite ....
Anglesite ....
Anhydrite ....
Apatite ....
Aragonite ....
Augelite ....
Axinite ....
Azurite ....
Barite ....
Benitoite ....
Beryls ....
Beryllonite ....
Boracite ....
Brazilianite ....
Calcite ....
Cancrinite ....
Cassiterite ....
Cerussite ....
Chondrodite ....
Chrysoberyl ....
Cinnabar ....
Clinozoisite ....
Corundums ....
Crocoite ....
Cuprite ....
Danburite ....
Datolite ....
Demantoid ....
Diamond ....
Diaspore ....
Diopside ....
Dioptase ....
Enstatite ....
Epidote ....
Euclase ....
Feldspars ....
Fibrolite ....
Fluorite ....
Garnets ....
Hambergite ....
Hiddenite ....
Hodgkinsonite ....
Hypersthene ....
Idocrase ....
Iolite ....
Jade ....

Jasper ....
Kornerupine ....
Kunzite ....
Kyanite ....
Lapis Lazuli ....
Lazulite ....
Leucite ....
Magnesite ....
Microlite ....
Natrolite ....
Opals ....
Orthoclase ....
Peridot ....
Petalite ....
Phenacite ....
Pollucite ....
Proustite ....
Prehnite ....
Rhodizite ....
Rhodochrosite ....
Rhodonite ....
Ruby ....
Sapphire ....
Scapolite ....
Scheelite ....
Siderite ....
Simpsonite ....
Sinhalite ....
Smithsonite ....
Sphene ....
Spinel ....
Sodalite ....
Sphalerite ....
Spodumenes ....
Stichtite ....
Tantalites ....
Tektites ....
Thomsonite ....
Topaz ....
Topazolite ....
Tourmaline ....
Tremolite ....
Turquoise ....
Uvarovite ....
Willemite ....
Witherite ....
Wulfenite ....
Zinc Blende ....
Zincite ....
Zircons ....

THIRD FOLD

POSTAGE
WILL BE
PAID BY
LICENSEE

NO POSTAGE
STAMP
NECESSARY IF
POSTED IN
GREAT BRITAIN
OR NORTHERN
IRELAND

FIRST FOLD

Business Reply Service
Licence No. WD 715

MAX DAVIS
38 OXFORD STREET
LONDON, W.1

SECOND FOLD

Please print your name and address (in ball point)

CUT STONES [A] ....

CRYSTALS [B] ....

CUT STONES & CRYSTAL [C] ....

ROUGH FOR CUTTING [D] ....

← **PLEASE CUT HERE,**
FOLD AND TUCK-IN THIS FLAP

A NEW ★★★★★ SERVICE

We will acquire any special STONE or STONES for your collection

Exchange any stone, and allow a good price on a better specimen of the same species

In addition we will CUT RARE STONES from your rough, e.g. Apatite, Fluorite, Euclase, Proustite

We can offer a large range of NATURAL CRYSTALS

Please complete the list, showing the stones you want to purchase or exchange. State ct., wt., and colour

WE INVITE YOU TO VISIT OUR SHOWROOMS AND EXAMINE OUR STONES

Are you interested in any of the following cut stone and natural crystals?

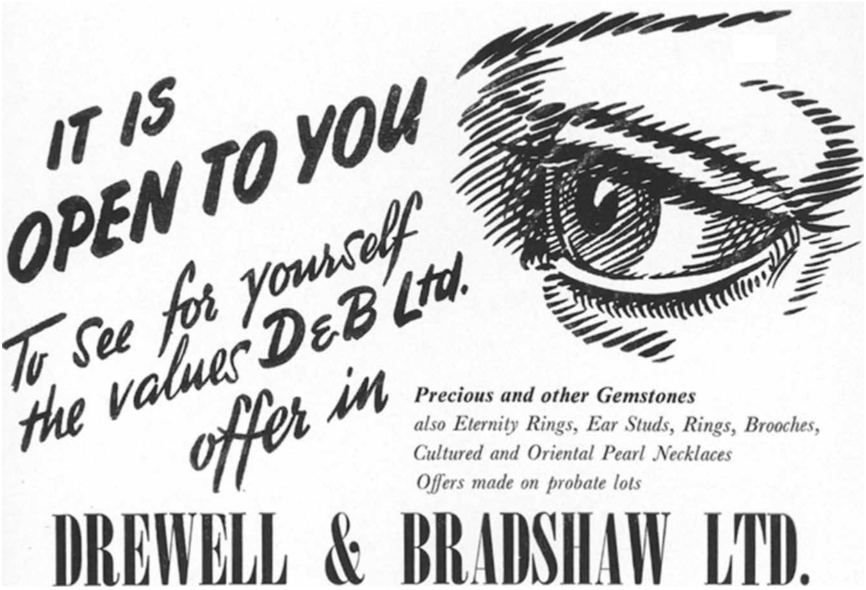
Actinolite
Alexandrite
Amblygonite
Analcite
Andalusite
Anglesite
Anhydrite
Apatite
Aragonite
Augelite
Axinite
Azurite
Barite
Benitoite
Beryls
Beryllonite
Boracite
Brazilianite
Calcite
Cancrinite
Cassiterite
Cerussite
Chondrodite
Chrysoberyl
Cinnabar
Clinozoisite
Corundums
Crocoite
Cuprite
Danburite
Datolite
Demantoid
Diamond
Diaspore
Diopside
Dioptase
Enstatite
Epidote
Euclase
Feldspars
Fibrolite
Fluorite
Garnets
Hambergite
Hiddenite
Hodgkinsonite
Hypersthene
Idocrase
Iolite
Jade
Jasper
Kornerupine
Kunzite
Kyanite
Lapis Lazuli
Lazulite
Leucite
Magnesite
Microlite
Natrolite
Opals
Orthoclase
Peridot
Petalite
Phenacite
Pollucite
Proustite
Prehnite
Rhodizite
Rhodochrosite
Rhodonite
Ruby
Sapphire
Scapolite
Scheelite
Siderite
Simpsonite
Sinhalite
Smithsonite
Sphene
Spinel
Sodalite
Sphalerite
Spodumenes
Stichtite
Tantalites
Tektites
Thomsonite
Topaz
Topazolite
Tourmaline
Tremolite
Turquoise
Uvarovite
Willemite
Witherite
Wulfenite
Zinc Blende
Zincite
Zircons

WE HAVE THESE IN STOCK

MAX DAVIS

38 Oxford Street, London W.I.

LAN. 7571


IT IS
OPEN TO YOU
To See for yourself
the values D&B Ltd.
offer in

Vol. 10
No. 4
October 1966

CONTENTS

Printed by F. J. Milner & Sons Ltd., Brentford & London. 66/20·00