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TWO NEW EDITIONS

TWO outstanding personalities of British Gemmology have recently published new editions of their books.* In each case the book is enlarged and enriched and in each case there is the omission of a qualifying phrase from the former title.

There are two extremes in the writing of scientific books, with all degrees of combinations in between. One extreme is the compendium type of book, which at its best is a carefully prepared dossier composed of relevant information from all sorts of sources. When made by an expert with access to many sources and with the knowledge necessary to select, arrange and present the material gathered, the result can be a reference book of great value and a distinct contribution to the literature of its special subject.

Mr. Anderson's " Gem Testing," formerly " Gem Testing for Jewellers," belongs to the opposite extreme. In this class of book a man who has devoted a great part of his working life to the subject pours out all the knowledge and wisdom accumulated as the result of his personal study and experience. A man can write only one general book of this class in a normal lifetime, although, of course, more detailed treatises on specialized aspects may well appear from the same pen.

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* " Gem Testing," by B. W. Anderson, B.Sc., F.G.A., 4th Edition. Heywood & Co., Ltd., London. Price 17s. 6d.

" Gemmologist's Compendium," by Robert Webster, F.G.A., 2nd Edition. N.A.G. Press, Ltd., London. Price 15s.

Mr. Anderson is a scientist by education, a specialist in the study and identification of gemstones by profession and a lecturer and teacher of exceptional renown: and it is abundantly clear to the serious reader of this great book that here is the genuine article straight from the fountain head. In a work of this calibre, packed with the knowledge and understanding which could only be accumulated by a first-class mind with exceptional opportunities, faults of diction and arrangement could well be forgiven, but we have here a book brilliantly written and admirably planned, with an index which is a joy to use.

Perhaps the most striking feature is the way the author leads his readers to appreciate and employ scientific methods. The distaste and mental paralysis liable to seize the ordinary person plunged into a flood of scientific and sometimes pseudo-scientific jargon are absent, because the scientific principles and terms are presented in a way which is at once the admiration and despair of writers of popular science.

The numerous illustrations are an integral part of the book. The frontispiece is a colour plate of nine typical absorption spectra, and practically all the instruments mentioned or described throughout the text are illustrated. But the great majority of the illustrations are photographs of the author's own taking, showing just what to look for when examining a stone through the microscope. These effects are quite impossible to convey in words, and to have an expert select a specimen, adjust the instrument and invite the reader to study the image at leisure is tuition at its best. This is precisely what, in effect, these remarkable illustrations do.

Only the author could find ways of improving the earlier editions ; just what more can be done when a fifth edition becomes due for consideration is a mystery which we shall look forward to seeing solved.

Mr. Robert Webster's 1937 " Gemmologist's Pocket Compendium " has now reached its second edition, and is so much enlarged that the word " Pocket " is wisely dropped. My copy of the original little red book is soiled, frayed and worn: dumb testimony to the constant usage it has had.

This book is an example of the type first mentioned, inasmuch as it is compiled rather than written. It presents in tabloid form a most comprehensive survey of the whole field of Gemmology and its neighbouring districts. Essentially a reference book, it is so complete and all-embracing that there is scarcely a question can occur to the gem student but the answer will be found, not by patient searching, but at first sight. The amazing Mr. Webster has achieved an unassailable position in the gem world by immeasurable industry and an infinite capacity for taking pains, coupled with sheer native intellect of a high order. His Compendium is an indispensable book built on the same basis.

As before, the book is divided into an alphabetical Glossary of Definitions, and a Part Two comprising general data in tabular and other concise forms. Besides a number of line illustrations, the new edition contains fourteen half-tone blocks and ten beautiful colour plates, all on art paper. Special interest and value attaches to the twenty typical Absorption Spectra. Five-figure logarithmic tables are included for convenience in making any necessary calculations. One questions whether some of the chemical data dealing with valency, atomic weights and atomic numbers, and especially the periodic classification of the elements, will be very much used ; but they are there if needed.

One notices minor discrepancies between the Spectra for alexandrite and blue spinel as given in " Gem Testing " and the " Compendium," but in spectroscopic work so much depends upon the individual specimen, the illumination, the instruments used, and above all on the personal observation factor, that such slight differences will always occur. The one thing to be condemned in scientific books is the perpetuation of errors by successive authors who blindly copy earlier works, and one finds no trace of this mischievous and all too prevalent practice in the Compendium.

G. T. Clarkson, F.G.A., M.B.H.I.

NEW OFFICES OF THE ASSOCIATION

The Gemmological Association of Great Britain and the National Association of Goldsmiths of Great Britain and Ireland have now moved to

93-94, Hatton Garden, London, E.C.1.

The telephone number remains unaltered.

MICROCHEMICAL TESTS CAN BE USEFUL

by

Robert Webster, F.G.A.

THE employment of chemical tests usually infers the partial destruction of the specimen and is therefore considered to have little application in practical gemmology. A number of chemical tests can, however, be carried out on the micro-scale ; where only small scrapings from the specimen are required, small quantities of chemical reagents used, and the resulting reactions studied under the microscope. The value of these tests may perhaps best be illustrated by relating an actual case where their use afforded confirmatory evidence of the nature of a substance, and where the more usual optical methods could not be employed.

The article, a necklace of irregularly-shaped ivory-white beads, came into the hands of the writer, not necessarily for testing but as an item of interest, for they were described as being the milk teeth of a young animal. As a point of interest rather than for a more pertinent reason it was decided to carry out tests for calcium and for phosphate. It is well known that the teeth of all mammals consist mainly of calcium phosphate, and if both calcium and phosphate were found to be present, there could be little doubt that the material was as described. To unstring the beads was considered unnecessary so tests by the microchemical method were carried out.

The test for calcium was made by scraping a small quantity of the material from the edge of the string canal on to a 3 x 1 glass microscope slide, drawing the powder into a heap in the centre of the slide and adding a drop of dilute hydrochloric acid from the end of a glass rod. After allowing a minute for the acid to combine with the suspected calcium of the substance, a drop of dilute sulphuric acid was added, and the action studied under the microscope.

Fig. 1 — Calcium Sulphate Crystals resulting from microchemical test (approx. x 20).

With such a test, if calcium be present, a white precipitate of calcium sulphate is formed which, under the microscope, is seen as bunches of acicular crystals of gypsum (*selenite*) ; the singular beauty of these radiating crystal groups can be best appreciated by reference to the photomicrographs. This crystalline precipitate was clearly evident in the test carried out on the beads, hence, calcium was confirmed as being part of their composition.

The presence of phosphate in a material may be determined by the yellow precipitate which is formed when a solution of ammonium molybdate in water is added to a solution of the material in nitric acid. This test was therefore carried out on scrapings from the beads ; the scrapings placed on a glass slip, nitric acid added followed by the drop of aqueous solution of ammonium molybdate. NO REACTION WAS FOUND TO TAKE PLACE. To prove that neither the method nor the reagents were at fault a check test was carried out with scrapings from a known ivory. In the check test a canary-yellow precipitate formed, which under the higher powers of a microscope was seen to consist of small yellow octahedral crystals (*see photomicrograph*). This yellow precipitate, ammonium phospho-molybdate, forms much more quickly if the slide is warmed, but in practice the heat from the microscope lamp is sufficient to ensure copious precipitation.

Thus, the microchemical tests tended to disprove the contention that the beads were " the milk teeth of a young animal." The beads were then unstrung and a density taken to obtain further evidence as to the nature of the material. A bead weighing 7.72 carats gave a specific gravity for the material of 2·82, a value which agrees with that of the calcareous shells of certain mollusca. Final confirmation was carried out by X-rays, a lauegram giving a picture comparable to that shown by fibrous aragonite ; in fact, a typical cultured pearl picture. From the evidence obtained from these experiments the material was identified as marine shell, probably waterworn pieces of the thick central pillar of spiral shells.

It can be seen that microchemical tests (and there are many chemical reactions which can with advantage be studied under the microscope) can have a distinct value to gemmologists. This is particularly true in the case of certain opaque substances which do not easily lend themselves to optical methods. A word of caution must be given concerning the ammonium molybdate test for phosphate, for arsenates produce the yellow precipitate of ammonium arseno-molybdate indistinguishable from ammonium phospho-molybdate. However, in the very complete tables given by Dr. Herbert Smith in *Gemstones*, arsenic does not enter into the composition of any gem material so far encountered. That an arsenate mineral may turn up in the future cannot be overlooked ; the writer, during an investigation of turquoise, once came across a green mineral labelled *kalait*, which was identified by Dr. Bannister as *erinite*, a copper arsenate, and the sky-blue to verdi-

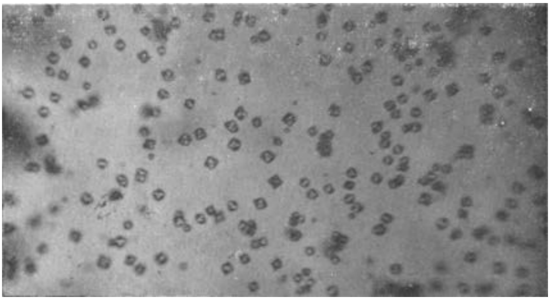

Fig. 2 — Ammonium Phospho-Molybdate Crystals resulting from microchemical test (approx. x 85).

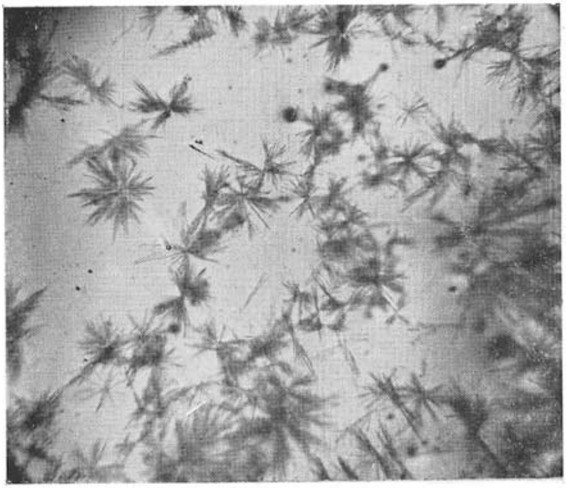

Fig. 3 — Calcium Sulphate Crystal resulting from microchemical test (approx. x 50).

gris-green mineral *liroconite,* a hydrated arsenate of aluminium and copper, is always a possible " turquoise."

To carry out known microchemical tests is a fascinating experience ; for those versed in chemistry to devise fresh reactions a perfect joy, and those with only an elementary knowledge of that science, whose only experiments must of necessity be on the " hit or miss " principle, can enjoy an intriguing hobby.

THE WORK OF THE GEMMOLOGICAL CENTRES

Enrolments at the various Gemmology Centres in Britain and in the Correspondence Courses continue to remain high. Over 55 have applied to attend at Chelsea Polytechnic for the Diploma (second year) Class, while 100 have entered for the Preliminary. Enrolments in the Correspondence Courses total 75 Preliminary and 51 Diploma. Figures for other centres are: Edinburgh, 30 Preliminary and Diploma ; Plymouth, 20 Preliminary ; Birmingham, 40 Preliminary and Diploma ; Glasgow, 64 Preliminary.

By D. S. M. FIELD

CANADIAN AMBER

IN the report of the Canadian Geological Survey for 1876-77, Dr. B. J. Harrington records that results of the examination of samples of fossil resin from the north Saskatchewan River, the Peace River, and from the Nechacco River south of Fort Fraser. The occurrence of amber at Cedar Lake, Saskatchewan, has also been known for many years. It is only comparatively recently, however, that fine quality " gem " amber has been noted in a quantity sufficient to warrant commercial recovery.

In December, 1921, a considerable amount of fossil resin was recognized in the waste dumps at the Coalmont Collieries, Coalmont, B.C., and a sample of lignite containing 10 cubic inches of opaque resin was submitted to the Department of Mines, Ottawa, for identification. It proved to be amber. This specimen fluoresced strongly in sunlight—reflecting a brilliant apple-green from the conchoidally fractured surfaces.

Most of the amber from Coalmont is transparent to translucent, varying in colour from pale yellow through brown to bottle-green and black. The darker specimens are almost invariably opaque. Some pieces are quite transparent and free from flaws, and are a bright, pleasing cherry-red colour. These resemble clear Mexican and Nevada opal of a similar tint..

Fragments of Coalmont amber submitted for test to Mr. R. T. Elsworthy, of the Mines Department, yielded only a small amount of succinic acid, and on this basis the resin was classified mineralogically as retinite.

It occurs close to the edge of seams of low-grade lignite, between the coal and slate contact, or as isolated, irregular fragments.

It is quite brittle and in common with all amorphous mineral substances or gem materials has a conchoidal fracture. There are, of course, no cleavage planes.

The hardness of Coalmont amber varies somewhat. Most pieces will readily scratch the better grades of Baltic amber (H. 2.0—2.5), but none will scratch calcite (H. 3). The hardness is therefore about 2.75 on the Mohs scale.

Owing to the presence of numerous gas bubbles, the specific gravity (hydrostatic and " heavy " liquids) varies within the limits 1.031—1.168. It softens at 180° C. (5 gm.)—200° C. (25 gm.), with melting point 250° C.—270° C. and 270° C.—297° C., respectively. The percentage by weight of oil distilled during the Government experiments ranged from 60 to 76.

Coalmont amber is much less soluble in ether than is the Prussian variety. Experiments carried out by the Mines Branch, in which the resins were powdered and subjected to the boiling solvent (in special flasks) for several hours, gave the following figures:—

Solvent	Per cent. soluble Coalmont	Per cent. soluble Prussian
Ether	5.0	18.8
Absolute alcohol	8.7	14.3
Acetone	10.8	23.3
Chloroform	38.4	17.3

The finer grade selected pieces are quite suitable for beads, pipe stems, cigar and cigarette holders, small carved objects and the like. Smaller fragments, and inferior material, might be pressed into " block amber " or employed in the manufacture of lacquers and varnishes.

An increased number of synthetic stones have recently been submitted for testing, including the synthetic sapphire that simulates alexandrite.

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It was reported to the Association that an embryo gemmololist had, on looking at a natural amethyst through a colour filter, diagnosed the stone as a synthetic. Thus do the inexperienced falter.

SELECTIVE REFLECTION and its possible bearing on Gemmology

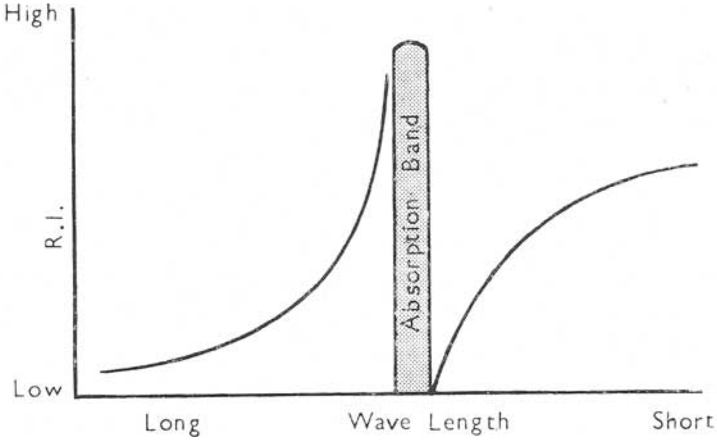
By M. D. S. LEWIS
A.R.C.S., B.Sc., F.G.A., C.G.

PALE emeralds or even colourless quartz when closed at the back are often foiled, a process which if skilfully performed can impart quite a good emerald colour to virtually colourless stones. When recently examining a piece of this green foil the writer was surprised to find that it showed slightly red through the Chelsea Filter. A white paste or quartz when placed on the foil and viewed from certain directions appeared definitely pink. This is probably an example of the phenomenon known as " Selective Reflection."

Most transparent coloured substances appear approximately the same whether viewed by transmitted or reflected light. If we hold an emerald between our eye and a source of light it appears green because the rays during their journey through the stone have suffered some preferential absorption. If we now move the emerald so that light is reflected from it to our eye it still appears green for the same reason. A small proportion of the white light falling on the stone is reflected at the surface still as white light, but the majority of the rays enter the stone. Some are there scattered by inhomogeneities and others are reflected at the back facets to reach our eye. In both cases the light has travelled an appreciable distance through the stone. This is an important condition, implying that substances of this type have small absorbing power, or as physicists say a low " coefficient of absorption." Red glass when finely ground yields a white powder, the particles of which, being small, cannot impose sufficient absorption on white light to produce colour. For the same reason the froth on beer appears white.

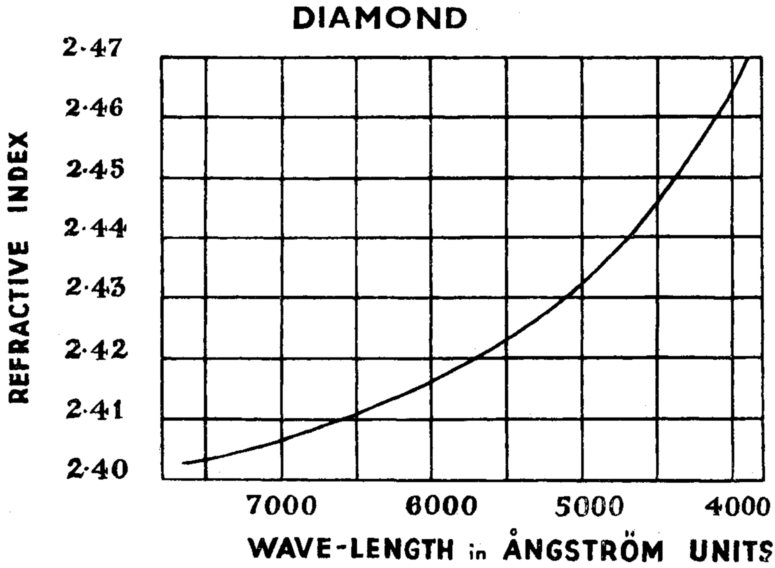
There exists, however, another class of substance, of which the organic dyestuffs are typical, characterized by intense colour, high coefficient of absorption, and bands in the visible spectrum of almost metallic intensity. In these, light cannot penetrate more than a wavelength or so and they possess the peculiar property of appearing differently coloured according to whether they are viewed by transmitted or reflected light. If the dyestuff methyl violet be dissolved in alcohol an intense violet coloured solution results. A drop placed on a glass slide soon evaporates, leaving a thin film of dye which is violet by transmitted light, but green by reflected light. This strange behaviour—known as selective reflection—is due to abnormal changes of refractive index occurring in the neighbourhood of an intense absorption band.

In idealized form a graph connecting the Refractive Index of such a substance and the wavelength of the different rays would probably take this form:—



It will be observed that on the long wave (red) side of the absorption band the R.I. becomes very large and on the short wave (blue) side very small. Now the reflective power of a substance depends on its R.I. For light incident perpendicularly, the proportion reflected is given by the expression $\left(\frac{n-1}{n+1}\right)^2$ where "n" is the R.I. (If we substitute the values 2.42 and 1.5 respectively, we find that diamond reflects about 17% and glass 4%—hence the far greater brilliance of diamond.) It follows, then, that those rays with high R.I. on the left hand side of the absorption band will be predominantly reflected whilst those with low R.I. on the right hand side will be mainly transmitted and almost entirely absent from those reflected at the surface. Suppose the absorption band is in the green, then the rays reflected at the surface will have a very strong yellow component but almost no blue. The transmitted light will be strong in blue and deficient in yellow. This is the cause of the difference between body colour (due to transmitted light) and surface colour (due to selective reflection) although a certain amount of the former is always present with the latter.

By this stage many readers may have become distinctly uneasy, because when the absorption band occupies a central position in the visible spectrum the rays of long wavelength, say orange, have a greater refraction than those of short wavelength, say blue, all of which is quite contrary to gemmological teaching. This apparently peculiar behaviour is known as " anomalous dispersion," but actually there is nothing very strange about it. If now we turn to " Herbert Smith "—always a wise procedure in gemmological discussions—we find on page 23 a quite impeccable, well behaved dispersion curve for diamond (reproduced below).



Diamond: refractive index-wave length diagram

It will be noted, however, that on the right the curve is beginning to rise very steeply and the R.I. has already reached a high value. It is probable that an absorption band is being approached, to the left of which the R.I. will be very high and if the graph is sufficiently extended the curve will reappear somewhere low down to the right of the band. We may, therefore, here only be looking at a part of the picture. In fact, the suggestion has been made that most substances show anomalous dispersion if considered over a wide enough range of wavelengths, the so-called " normal " dispersion being merely a special case of the anomalous, over a comparatively small range of wavelengths. Unless the absorption band is really intense and in the visible spectrum, we do not notice any abnormal effects.

Returning to our green foil, which will probably be found to consist of a thin sheet of bright copper covered on one side with a film of green dye. Most of the rays pass through the latter and are reflected at the metal, emerging as transmitted light of a predominantly green colour. At certain angles, however, we catch the selectively reflected rays—in this case red. Although it is just possible that colourless stones thus foiled might show red through the Chelsea Filter, a spectroscopic test (by reflected light) at once shows that the green colour is not due to chromium and that the stone is therefore not an emerald.

There remains one further aspect of " selective reflection " with a possible bearing on gemmology. We have seen how the whole phenomenon turns on R.I., but this is always dependent on *two* substances in contact. Thus, when we speak of the R.I. of a gemstone we really refer to the gemstone-air boundary. If the stone is immersed in a liquid the R.I. is different, because here we are dealing with the gemstone-liquid interface. The colour then selectively reflected from a dye may vary according to the substance on which it is deposited. If we look at our spot of methyl violet (deposited on a glass slide) by reflected light it appears green at the dyestuff-air interface. If now we reverse the slide so that the spot is underneath and again view it by reflected light it appears quite another shade of green because here we are dealing with the dyestuff-glass interface. The difference of R.I. between glass (1.5 approx.) and air (1.0) produces this change of tint. The writer had hopes that white stones of varying R.I. (diamond, zircon, corundum, quartz, etc.) might show different colours when a selectively reflecting dye was deposited on them. Although numerous dyes were experimented with, no tangible results were obtained with the unaided eye, but there remain perhaps theoretical possibilities. One difficulty is due to the appearance of interference colours of typical " thin film " type which tend to mask slight changes of tint. It is of interest to note that the normally reflected rays are almost completely plane polarized at Brewster's angle and can therefore be extinguished by a Nicol prism, but the selectively reflected rays cannot thus be removed as they are elliptically polarized. Readers interested in this subject should consult the articles on " Selective Reflection " and " Anomalous Dispersion " in Wood's " Physical Optics," Preston's " Theory of Light " or Bowen's " Chemical Aspects of Light " (2nd edition).

THE TERM " SEMI-PRECIOUS "

In connection with the Gemological Institute of America's recommendation that the term " semi-precious " should no longer be used, it is interesting to quote from the Retail Jewellers' Course of the National Association of Great Britain: " The term ' semi-precious ' is often used in the jewellery trade to describe those gemstones that remain after diamond, ruby, sapphire and emerald have been grouped as ' precious.' It is not a fair division and not even logical. It is true that in many cases there is a drop in prices per carat after the ' precious ' varieties named due mainly to the fact that other gemstones are often found in great quantity, but this fact should not allow the jeweller to prejudice public interest (or even his own) in lesser known gemstones, some of which are very beautiful.

The term ' semi-precious,' being open to misunderstanding, should be discontinued, and all real stones referred to as ' gems ' or ' gemstones.' "

Some Vagaries of BIREFRINGENCE

by R. KEITH MITCHELL F.G.A.

IT is a simple matter to consider refraction in gems from an elementary viewpoint ; to use white light for refractometer work and to be content with readings from diffracted shadow edges, hazily accurate to two places of decimals at most. But the deeper one goes into gemmology the more necessary it becomes to work accurately ; to use monochromatic light to estimate that third decimal place which is important for the determination of many of the lesser-known gem minerals. The advanced worker soon realizes that the so-called " constants " of a gem are in fact averages around which there can be quite considerable variation ; a fact exemplified more in the refractive indices than in most other physical characteristics. It is evident that in many cases the behaviour of the readings as the stone is turned on the refractometer is of great importance as a diagnostic feature.

In order fully to understand the fluctuations which may be observed in the indices of doubly-refractive stones it is necessary to remember one or two facts about the instrument. Although the shadow-edge is ingeniously projected on to a scale giving a direct reading of the R.I., it is in actuality a projection of the shadow occasioned by the critical angle for the two media (the optically dense glass and the stone under test). That is to say, the angle of incidence within the glass which produces an angle of refraction in the stone of 90° to the normal. It therefore follows that the instrument cannot give the R.I. for any direction other than those in the plane of the facet under test. And since the light is

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FOOTNOTE.—It should be emphasized that the word " direction " is used expressly in its strict meaning, and although a direction may be represented in a figure by a single line, the optical properties described will apply equally to light passing through any part of the stone or crystal in a path parallel to that line.

travelling in a parallel path through the instrument, any given reading will be for a direction parallel to the optical axis of the instrument and to the facet under test. The principle of the refractometer (Fig. 1) will illustrate these points.

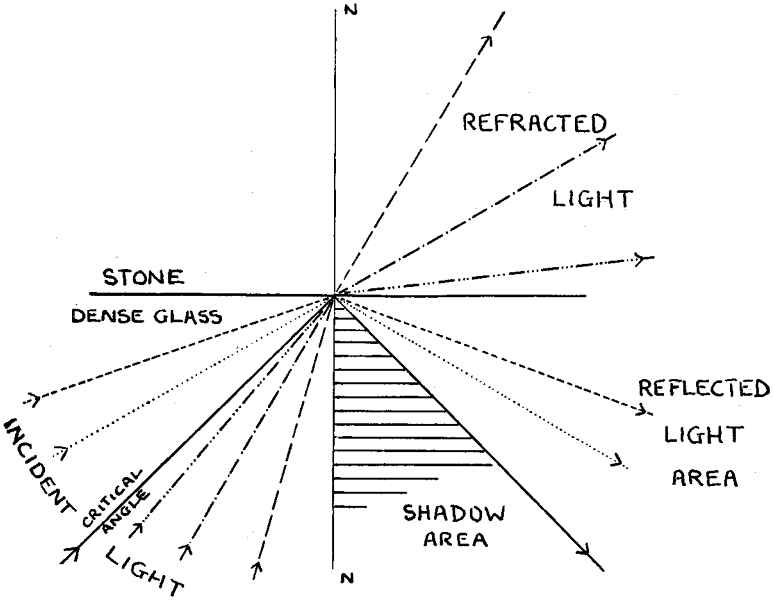


Fig. 1 — Principle of the Refractometer. Incident light entering at the critical angle will graze the surface dividing the glass from the stone. Light entering at a greater incident angle will be totally reflected within the dense glass.

Cubic or isotropic gems tested in monochromatic light and rotated on the instrument will show no variation in their single refractive index, since light is refracted equally in all directions within the stone and no plane polarization takes place. Singly refractive gems are not numerous and are widely distributed on the scale of refraction. When once the slight possibility of confusion with paste is eliminated, there is no further difficulty unless an abnormally high spinel reading be mistaken for an equally abnormal low reading for garnet.

In gems belonging to the other systems of crystal symmetry the case is different. The incident light is split under the influence of the atomic structure of the crystal into two rays plane-polarized at right angles to each other, and having different velocities and hence different refractive indices. In tetragonal and hexagonal crystals there is one direction or axis of single refraction which is parallel to the long or *c* axis of the crystal, and they are known as " uniaxial." Orthorhombic, monoclinic and triclinic crystals are optically biaxial, having two directions of single refraction.

When tested, gems of these five systems give two readings which in most cases show a fluctuating amount of birefringence as the stone is rotated. The manner and degree of movement of the shadow edges depends in part upon the orientation of the testing facet to the optic axis or axes.

In the uniaxial gems of the tetragonal and hexagonal systems one of the two readings, that for the ordinary ray, will not move, while that for the extraordinary ray will generally move as the stone is turned. The birefringence being greatest when the direction of test is at right angles to the optic axis. If the movable shadow-edge gives the higher reading, the stone is optically positive and vice-versa.

Figure 2 shows a stone cut from a hexagonal crystal with its table facet parallel to the optic axis. In tests on this facet the extraordinary reading will fluctuate between the position of greatest birefringence and the position of the reading for the ordinary ray as the stone is rotated. So that in two positions the stone will appear to be singly refractive.

In Figure 3 the stone is cut with the table at right angles to the optic axis of the crystal. All tests on this facet will therefore be in directions at 90° to that axis ; the extraordinary reading will remain at the position of greatest birefringence and neither shadow edge will move as the stone is rotated. A test on another facet would be necessary before the optic sign could be determined.

Figure 4 gives us a case between these two extremes. The table is inclined to the optic axis and therefore in no position of this facet can a test be made parallel to that axis. In two positions of the stone, however, the readings will register the full birefringence of the stone. The readings for the extraordinary ray will therefore fluctuate from the optimum position to one approaching that of the ordinary ray, but will not coincide with it. The degree of movement will vary with the angle made by the table facet with the direction of single refraction.

In the biaxial gems of the remaining three systems the effects seen are more complicated.

There are two directions of single refraction and three principal optical directions generally indicated by the signs α, β and γ. α and γ are the two bisectrices of the optic axes and β the direction perpendicular to the plane in which they lie. α and γ correspond to the least and greatest refractive indices while β corresponds to their optical (not mathematical) mean. If the index for β is nearer that for α than that for γ the optic sign is positive, and vice-versa. In a negative crystal α, and not γ, will be the acute bisectrix. These optical directions are indicated in Figure 5 in their relation to the directions of single refraction. The behaviour of the refractive indices can be more directly referred to them than to the optic axes.

If a gem be tested in any one of these principal optical directions the readings will correspond to those for the remaining two directions. Thus light passing through the stone parallel to β will be plane-polarized at right angles, the wave motions being in the directions α and γ respectively, and the readings obtained will be for the least and greatest indices. It will be obvious, then, that complicated results may be expected as the orientation of the testing facet changes with regard to the principal optical directions.

In Figure 6 we have the case of a stone with its table facet parallel to the plane of the optic axes (and incidentally to α and γ) and perpendicular to β. It should be a simple matter to see that as the stone is rotated through 360° there will be four positions in which it will be apparently singly refractive, with a reading corresponding to the mean R.I. (β); two readings for the least (α) and mean (β) R.I.'s; and at right angles to these two more giving the mean (β) and greatest (γ) R.I.'s. In effect, then, one shadow edge will remain steady and give the mean index, while the other will cross the first as it fluctuates between the least and greatest readings.

The stone depicted in Figure 7 has its table facet parallel with the plane of β and γ and perpendicular to α. If this facet is

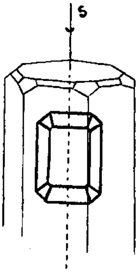


Fig.2.

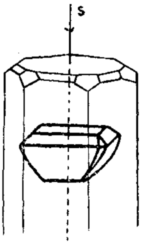


Fig.3.

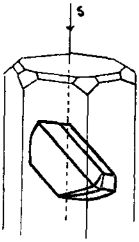


Fig.4.

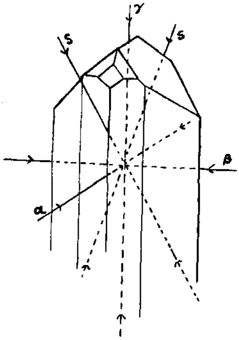


Fig. 5.

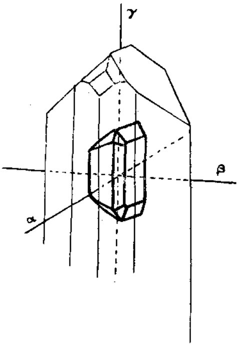


Fig.6.

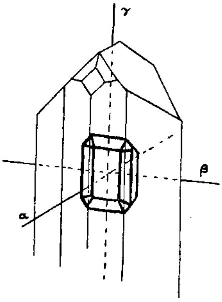


Fig.7.

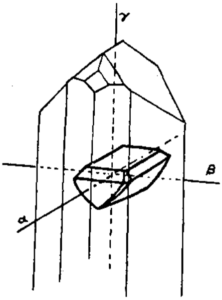


Fig.8.

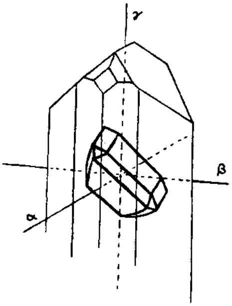


Fig.9.

In Biaxial Negative Crystals positions of α and γ are reversed.

tested and the stone rotated, two positions will give readings for the least and greatest refractive indices ; and at right angles to these two more giving the least and mean indices. That is to say, one shadow edge will remain steady at the lowest reading while the other will fluctuate between the greatest and mean positions, giving the effect of a uniaxial positive stone! A test on another facet will reveal the biaxial nature of the gem.

Figure 8 illustrates the opposite case to Figure 7. The testing facet is perpendicular to γ and parallel to the plane of α and β Here the upper shadow edge will remain stationary while the lower will fluctuate between the lowest and the mean positions, giving the effect of a uniaxial negative stone.

A table facet inclined haphazardly to the main optical directions, as in Figure 9, will give readings rather more difficult to interpret. As the stone is rotated on the table of the instrument the direction of test will be vertical to each of the main optical directions in turn but never to two at the same time. Thus each of the principal refractive indices will be reached by one or other of the shadow edges at different positions of the stone. In practice it is difficult to determine the exact reading for β, but α and γ are simple enough. Both shadow edges move and it is a matter of taking the lowest reading reached by the lower and the highest reached by the higher edge to determine the full birefringence of the stone. Generally the optic sign may be obtained by noting which of the two shadow edges passes the half-way mark between the highest and lowest readings. If it is the upper one the stone is positive, and if the lower it is negative.

In practice the majority of cut biaxial stones seem to have their table facets cut in accordance with this last example. Perhaps because lapidaries tend to take a large natural facet as a convenient starting point in shaping their stone. Thanks to the peculiarities of the crystal symmetry of the three biaxial systems, such facets are not often found parallel to two of the main optical directions.

RESULTS of the 1947 Examinations

IN the 1947 Examinations in Gemmology 28 candidates entered for the Diploma Examination, in Great Britain and Overseas. A record number of entries was received for the Preliminary Examination, 21 from overseas and 119 in Great Britain, making a total of 140.

On the recommendation of the Council two Tully Memorial Medals have been awarded. One of the medallists, Lt.-Col. G. M. Sprague, has also been awarded the " Anderson " Prize for the best work in the practical examination.

The names of the successful candidates are:—

DIPLOMA

Tully Medal	Rutland, Dr. Ernest Hugo (London).
	Sprague, Lieut.-Col. George Martin (Edinburgh).
Distinction	Farn, Mr. Alexander Edward (London).
	Levinson, Mr. Leslie Harold (Bournemouth).
	Meisl, Mrs. Rose Rachel (London).
	O'Callaghan, Mr. Harold (London).
	Redknap, Mr. Samuel Frederick (Twickenham).
	Stern, Dr. Werner (Wembley).
	Wheeler, Mr. Henry James Blackburn (Hornchurch).
Qualified	Ash, Mrs. Gladys Violet (Wembley).
	Clark, Mr. Herbert Austin (London).
	Diggan, Mr. Gerald (London).
	Hancock, Mr. Gerald Arnold (Cheshire).
	Livsey, Mr. Geoffrey (Blackpool).

PRELIMINARY CERTIFICATE

Rayner Prize	Bowen-Evans, Mr. H. P. (London).
Qualified	Ackerhalt, Mr. Robert (London).
	Alderson, Mr. John Aubrey (Huddersfield).
	Allan, Mr. Wallace Stewart (Ayr).
	Bailey, Mr. Brian Oswald (Birmingham).
	Bailey, Mr. Joseph Arthur (Southall).
	Baker, Mr. Leonard Alfred (Seven Kings).
	Barrie, Mr. Andrew (Edinburgh).
	Baxter, Mr. Douglas (Blackpool).
	Bennett, Mr. Ronald Leslie.

Benson-Cooper, Mr. Peter (London).
Bolton, Mr. Leslie (Leeds).
Buckingham, Mr. William Charles (Ilford).
Buckle, Mr. Robert (Edinburgh).
Cairncross, Mr. Alastair Duff (Perth).
Cameron, Mr. David (Edinburgh).
Carmichael, Mr. George Latus (Hull).
Christie, Mr. Edwin (Dundee).
Clarke, Mr. Raphael Victor (London).
Conway, Mr. Arthur Douglas (Birmingham).
Cooper, Mr. Edward George (Ilfracombe).
Cooper, Mr. Walter Thomas (London).
Corbin, Mr. Anthony Bazille (Wickford).
Crombie, Mr. Walter (London).
Cumming, Mr. George Richardson (Edinburgh).
Davenport, Mr. Charles Edward (Sutton).
Davidge, Mr. Kenneth Charles (Sevenoaks).
Dawkins, Mr. Charles Edwin Thomas (London).
Day, Mr. Norman Harry (Salisbury).
Dean, Mr. Alan Arthur (Cheltenham).
Eames, Mr. Richard Harry Bateman (Stourbridge).
Ewen, Mr. James Spence (Castle Douglas).
Forsyth, Mr. Adam (Edinburgh).
Gaggs, Mr. John Christopher (Blackpool).
Gilmer. Mr. Denis Arthur Gordon (Bath).
Godfrey, Mr. Kenneth Ernest (Winchester).,
Hale, Mr. Sidney John Warwick (Maidstone).
Hall, Mr. Ronald Albert (E. Grinstead).
Hedges, Mr. Frederick Charles (London).
Hession, Mr. Cyril William (Rugby).
Higgins, Mr. Thomas Francis (Birmingham).
Higgs, Mr. Paul Henry (Stourbridge).
Hodge, Mr. John (Campbelltown).
Inches, Mr. Ian Hamilton (Edinburgh).
Jenkinson, Mr. Herbert Arnold (Birmingham).
Jones, Mr. Ellis (Leicester).
Jutson, Mr. Allan Harry (Sandwich).
Kent, Mr. David George (London).
Kino, Mr. Richard Charles (London).
Kirtley, Mr. Dennis Campbell (Sunderland).
Knowles, Mr. Walter Herbert (Woking).
Laidlaw, Mr. Francis John (Edinburgh).
Law, Mr. Thomas Cunningham (Edinburgh).
Levett, Mr. Leonard (London).
Levy, Mr. Harry J. (London).
Llewellyn, Mr. Graham David (Ilford).
Lines, Mr. Harold Thomas (London).
Martin, Mr. Roy (Southall).
May, Mr. Claude William (Ilford).
Meade, Mr. John Arthur Morby (London).
Meek, Mr. David L. (Edinburgh).
Mortimer, Mr. Richard Thomas (London).
Murray, Mr. Arthur Stuart (Edinburgh).
Nicholson, Mr. John William (Edinburgh).
Page, Mr. John Albert Robert (Orpington).
Pastor, Mr. Hynek (London).
Plas, Mr. Joseph (London).
Pyman, Miss Joan Mary (Letchworth).
Ricketts, Mr. Leslie (London).

Roberts, Mr. Ian Phillip (London).
Rossiter, Mr. Donald Frank (Clevedon).
Rostron, Mr. Norman James (Chiswick).
Ruddock, Mr. John Wharton (St. Albans).
Salisbury, Mr. Frederick Charles (Hanwell).
Sanitt, Mr. Leonardo (London).
Scanlon, Mr. Frank (Manchester).
Scarles, Mr. Basil Percival (London).
Spero, Mr. Douglas Marcel (London).
Stein, Mr. Nathan (London).
Stern, Dr. Werner (Wembley).
Stewart, Mr. Aulton (Bournemouth).
Stollery, Mr. Ernest William Renton (Glasgow).
Stone, Mr. Ernest George (Hove).
Stonley, Mr. Henry Gerald (Wembley).
Tugwood, Mr. Ralph H. (London).
Ungerson, Mr. Daniel (London).
Vanstone, Mr. Michael John (Plymouth).
Wade, Mr. Michael Balfour (London).
Walker, Mr. James (Edinburgh).
Weeks, Mr. Herbert William (Woking).
West, Mr. Laurence (Leicester).
Wheeler, Mr. Douglas (London).
Wigdorczyk, Mr. Hirsz (London).
Winnert, Mr. George Muir (Edinburgh).
Woolrych, Mr. Peter (Burton-on-Trent).
Worthington, Mr. Eric (Blackpool).
Young, Mr. Robert (Edinburgh).

OVERSEAS CANDIDATES

DIPLOMA

Distinction
Benson, Mr. Lester B., Jnr. (Los Angeles, U.S.A.).
Collison, Mr. William Tilghman (Los Angeles, U.S.A.).

Qualified
Bonebakker, Mr. Adrianus (Holland).
Mackenzie, Mr. Kenneth Fraser (Canada).
Porter, Mr. Maurice John (India).

PRELIMINARY CERTIFICATE

Bawden, Mr. Frederick Charles Michell (S. Africa).
Benson, Mr. Lester B., Jnr. (U.S.A.).
Bodes, Mr. P. N. J. (Holland).
Bond, Mr. Clyde Herbert (U.S.A.).
Bonebakker, Mr. Adrianus (Holland).
Collison, Mr. William Tilghman (U.S.A.).
Dave, Mr. Jatashanker Naranji (Pakistan).
Dragsted, Mr. Ove (Denmark).
Field, Mr. Dean Sterling Mark (Canada).
Hemachandra, Piyasiri (Ceylon).
Hutchings, Miss Mabel (Australia).
Mackenzie, Mr. Kenneth Fraser (Canada).
Mayers, Mr. Daniel Eric (U.S.A.).
Peresypkin, Mr. Oleg Paul (Hong Kong).
Porter, Mr. Maurice John (India).
Short, Lieut.-Col. George Valentine (India).
Wood, Mr. Mervyn John (India).

WORLD GEMMOLOGICAL NEWS IN BRIEF

■ ■ ■

AMERICA

Two members of the staff of the Gemological Institute of America, Mr. Lester B. Benson, Jnr., and Mr. William T. Collinson, qualified with distinction in the 1947 Diploma Examinations of the British Gemmological Association.

The G.I.A. has recently produced a miniature news-sheet for students called " The Loupe." It provides a popular digest of gemmological news items of interest to American readers and is more personal than the G.I.A.'s excellent quarterly " Gems and Gemology."

The appointment of an Editorial Board for " Gems and Gemology," the quarterly journal of the Gemological Institute of America, has been announced. The Board includes B. W. Anderson, London ; Dr. S. H. Ball, New York ; Dr. W. F. Foshag, Washington ; Dr. G. Switzer ; and Dr. E. Gubelin, Switzerland.

We are awaiting receipt of a new publication, " Handbook of Gem Identification," written by Richard T. Liddicoat, Jnr., of the G.I.A. We understand that the book, which contains a foreword by Dr. Edward H. Kraus, Dean Emeritus of the College of Literature, Science and Arts, University of Michigan, outlines simply and concisely methods for identification of all coloured stones and pearls. Thus it seems to run parallel with B. W. Anderson's " Gem Testing." A review of this new book will be given as soon as possible.

SYNTHETIC STAR STONES

The first man-made star sapphires and star rubies, to the layman undistinguishable from expensive naturally occurring gems, were recently put on display by Dr. F. H. Pough, curator of geology and mineralogy, at the Museum of Natural History.

The synthetic gems were made by the Linde Air Products Company in an oxy-hydrogen flame. They are the result of extensive war-time efforts to replace natural stones with synthetic substitutes for use as bearings in clocks and sensitive electronic and optical instruments.

A synthetic star ruby shown at the museum weighed about ten carats. It was shown in comparison with a natural star ruby of the same size. The natural ruby was estimated to be worth from $50,000 to $100,000 and the value of the synthetic ruby, similar in all physical and chemical properties but with some unapparent differences in internal structure, was estimated in the hundreds of dollars.

Linde Air Products Company representatives said that the production of the synthetic stones was a laboratory process which could not be adopted to large-scale production.

(Extracted from New York Times).

It is understood that the synthetic star stones show gas bubbles and striæ under microscope. The star is believed to be produced by crystallographically oriented needles of Rutile, which have been caused to grow in the boule. The perfection and brilliance of the star is reported to be good.

Rutile has recently been synthesized in the U.S.A. and is available in transparent, colourless boules.

DENMARK

The President of the Danish Goldsmiths' Association (Faellesrepraesentationen for Danske Guldsmede), Mr. Ove Dragsted, was a successful candidate in the 1947 Preliminary Examinations of the Gemmological Association of Great Britain.

OFFICIAL NOTICES

CHANGE OF ADDRESS

Members are requested to note that the Association's registered office is now at 93-94, Hatton Garden, London, E.C.1. Telephone: Holborn 1839.

GIFTS TO ASSOCIATION

The Council of the Association acknowledges the gift of a copy of " A Lapidary of the History of Pretious Stones," by Thomas Nicols, Cambridge, 1652, from Mr. John Vincent, F.G.A., of Weymouth. This book was the subject of an article in Vol. 1, No. 3, of the Journal.

A further gift has been made by Mr. R. Webster, who has presented the Association's Library with a copy of Mohs' " Treatise on Mineralogy." The work, in three volumes, was translated from the German by William Haidinger, F.R.S.E., and published in 1825.

Mr. Dan E. Mayers, of New York, has kindly given the Association an Andalusite from Brazil, and specimens of Mexican white opal and black opal, made by treating identical white opal mentioned in his article in Vol. 1, No. 3.

The Council records with appreciation the gift of instruments (including a Herbert Smith Refractometer, Spectroscope and Dichroscope) and books by Mr. Henry R. Gooch, F.G.A., of Worthing.

NOVEMBER MEETING

A meeting of members will be held at 6.45 p.m. on Thursday, 13th November, 1947, at the British Council Cinema, 3, Hanover Street, London, W.1. The meeting will include the showing of two films and a demonstration talk on diamonds. Accommodation is limited and members should notify the Association if they intend being present.

TALKS BY MEMBERS

S. T. Solomon (Hon. Regional Secretary, Devon and Cornwall). Subject: " Gemmology." September 1st, Whitchurch Women's Institute ; September 29th, Rotary Club of Honiton.

EXTRACT FROM MINUTES OF COUNCIL MEETING

A meeting of the Council was held on Thursday, 14th August, 1947, at 93-94, Hatton Garden, London, E.C.1, under the Chairmanship of Mr. F. H. Knowles-Brown.

The report of the 1947 Examinations in Gemmology was submitted by the Senior Examiner. The Council accepted the report and agreed to award the Tully Medal and Rayner Prize as recommended by the Examiners.

It was decided that in future, in the event of two candidates submitting papers that made award of Tully Medal or Rayner Prize difficult, a further test should be arranged. Further agreed that a candidate who sat for the Preliminary and Diploma Examinations in the same year should not be eligible for Rayner Prize.

The Council appointed Messrs. B. W. Anderson, R. Webster, T. G. Jones and G. F. Andrews to submit recommendations on gemstone nomenclature to next meeting of Council.

Sir James Walton, K.C.V.O., was appointed Curator of the Association's gemstone and gem mineral collection, and Mr. H. Wheeler was appointed Librarian.

Arrangements for the November meeting of members were approved.

The following Fellows were re-elected:—

Thomas A. Hahn, London.
Albert Shackman, London.
Mrs. G. Lindley, London.

The following Ordinary and Probationary Members were elected:—

ORDINARY:

Zoltan White, London.
J. Lovell Baker, Montreal.
Jack Batty, Keighley.
John A. Hardy, New York.
H. Paul Juergens, Chicago.
Veronica Mileson, London.
Stanley C. Sears, London.

PROBATIONARY:

Leon Shapshak, Johannesburg.
Richard C. Kino, London.

The next meeting of the Council will be held on 27th November, 1947.

LETTERS

to the Editor

Dear Mr. Editor,

I have been puzzled for some time at the apparent dual mentality of some gemmologists. On one hand everyone tries to assert his or her intense desire for labour-saving gadgets, whilst on the other there is an undoubted inherent love of complications.

The latest example of this is shown in the report (July Journal) of the use of a wetting liquid whilst ascertaining specific gravity by the hydrostatic method. This implies that the air is conveyed into the water by the stone and wire cage. My observations suggest that the stone and cage attract the air that has been entrapped in ordinary tap water during filtration and pumping. The formation of such bubbles can be prevented by using water that has been boiled.

I use distilled water. After all, the standard definition of specific gravity does mention " pure water." And perhaps I, too, have a dual mentality.

Yours faithfully,
F. E. LEAK.

Dear Mr. Editor,

I feel that Mr. Leak's letter is a tribute to his careful and cleanly methods rather than to a great advantage gained by the use of distilled water.

Surely, in this " latest example " the complication is of Mr. Leak's own making, in that he infers that by some mysterious process the air which is present in finely distributed form in a glass of tap water will concentrate of itself to form bubbles as soon as an object is immersed in the water.

Is not the usual explanation the simpler one, namely, that air in small pockets is entrapped in corners, and on uneven or dirty surfaces, as the stone and cage are immersed? Hence the recommended use of a liquid of low surface tension, such as toluol, which will penetrate into these places and drive out the air.

Yours sincerely,

G. M. SPRAGUE.

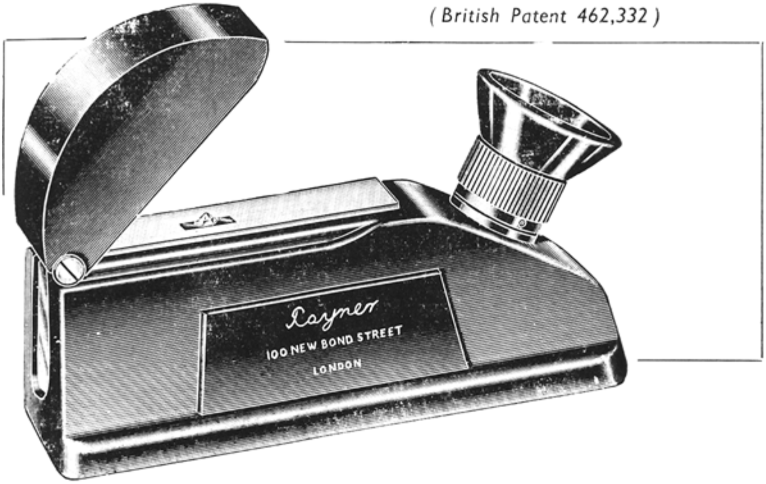
Dear Sir,

Where did the term semi-precious originate? It is not, apparently, aged. Perhaps even as young as the early part of this century. Was it used as a selling-aid by some jeweller who could not honestly dispose of a particular stone as *precious*—by the then precious standard—and so raised the status of what otherwise would have been just a gemstone? And was this repeated by his assistants till its continuity was assured? One guess is as good as another, but it does not make the term any less naïve or meaningless. It is therefore interesting to learn that the American Gem Society has recommended its discontinuance. Any enthusiastic gemmologist finds all gemstones precious. If the public could see him pass up a diamond, because it happens to be fairly easily identified on sight, they might wonder which was precious.

From the commercial point of view—assuming it began that way—the prefix *semi* has not really helped. It has merely extolled a handful of stones—by emphasizing the preciousness of a few—at the expense of many. It is a division between gemstones that is arbitrary. Not even on grounds of hardness may we divide. I recall a beautiful topaz once shown to a gemstone admirer. He studied it for a while, grew quite enthusiastic, and then said: " But it's only semi-precious, isn't it? " The implication was that he had said something knowledgeable. One searches in vain for an analogy. It is rather like saying of an *objet d'art*, " It's only half-precious." And you say " Why? " And the answer is: " Because it comes within the half-precious group."

Yours sincerely,

ELSIE RUFF.


Rayner
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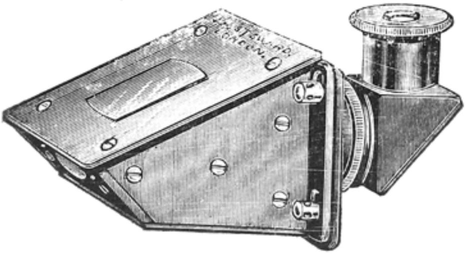
LONDON


J. H. STEWARD
LONDON