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BLACK CORAL

by ROBERT WEBSTER, F.G.A.

MANY text books refer to a true black coral which has been prized by the Chinese and Indian peoples but which does not appear as a medium for personal adornment in Western countries. There has recently come into the possession of the Gemmological Association a branch, some 10 inches long, of this black coral, and it has been the writer's privilege to be allowed to examine the specimen.

Black coral, the axial skeleton of the antipathes, is a coral of many genera, only one of which does not produce a black axial skeleton. Antipathes, one of the sub-class *Zoantharia* of the *Anthozoa*, are flower-like animals termed *polyps* belonging to the phylum *Coelenterata*. According to Sedgwick[1] the antipathidae are colonial zoantharia having six tentacles and six primary mesenteries and generally have a usually branched axial, hollow, horny skeletal rod containing an epithelial sheath ; this is the coenosarc which secretes the material which builds up the skeletal rod. Walton[2] has discussed the formation of coral most fully in his informative article on precious coral and repetition will not be necessary.

The antipathidae have a wide distribution and grow to a considerable height and thickness in tropic waters. The black coral fished for commerce is known as " Akabar " or " King's coral " and is taken from the waters of the Indian Ocean and the Persian Gulf. Halford Watkins[3] mentions a black coral akin to the Indian Ocean material which is found in the Mediterranean and is termed " Giogetto."

In outward appearance the branch examined is a slightly curved rod with a single side appendage due to the cutting off of a side branch. The surface was shiny black and the cut ends showed that the rod had a central cavity—indeed the " rod " is a tube. The solid part showed the structure to be spiral, just like a rolled up paper tube.

For the purposes of examination two sections were cut off from one end of the branch. The cut end showed the material to be brownish in colour—a similar effect is seen in the case of jet. The density was found to be 1.32 for one piece and 1.35 for the other. This implies that the material is not horn (keratin) but conchiolin ; for the densities found agree with the value for conchiolin found by the writer[4] some years ago. The density for horn is 1.29 and varies very little from that value. A polished flat was put on one piece of the black coral and this surface gave a clear shadow edge on the refractometer of 1.56. There was no effervescence, even with the dust from the sawing process, when treated with acid. This indicates that there was no carbonate in the composition.

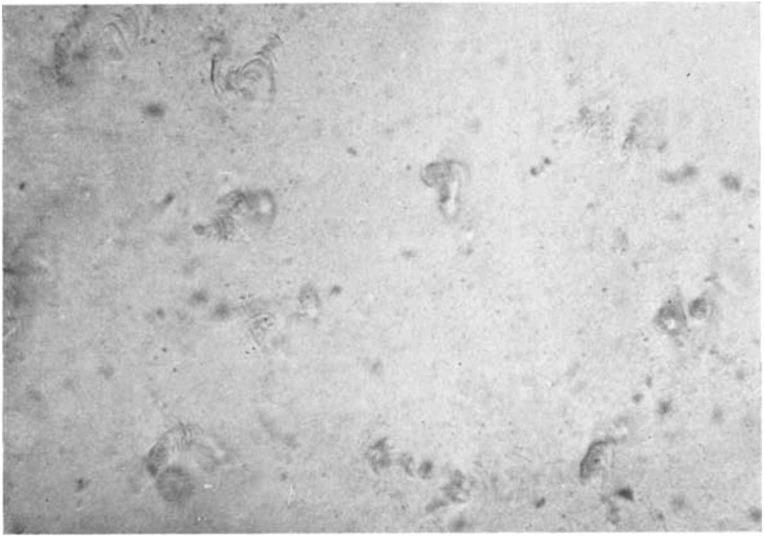


Fig. 1. *Longtitudinal section of black coral. Approx.* 80 × .

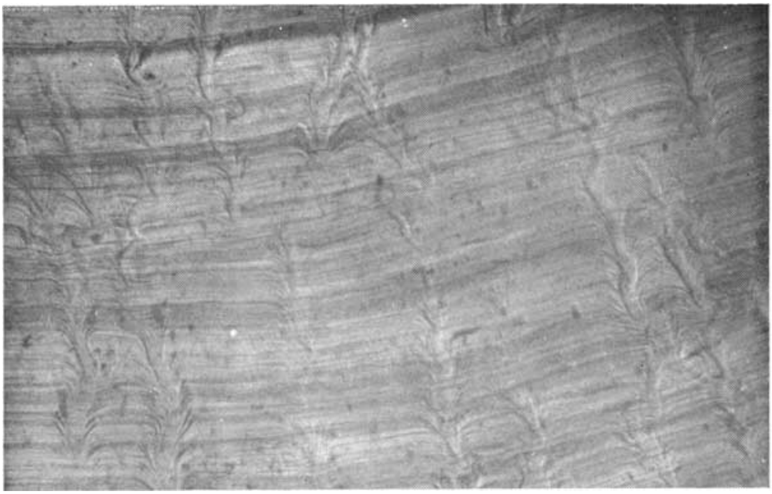


Fig. 2. Transverse section of black coral. Approx. 50 × .

In order to examine the structure two thin sections were made; one transverse to the axis and the other parallel to it. Microscopical examination of the longitudinal section showed a field interspersed with " knots " as in a piece of wood, and indeed was reminiscent of " bird's-eye maple " (Fig. 1). Between crossed nicols the field showed strong polarization colours indicating anomalous double refraction, the strain patches being most pronounced around the localities of the " knots." The transverse section showed, with very low power magnification, banding or striae conforming to the spiral arrangement noticed in the macro section, and under higher power a finer arrangement of the striae could be seen. Over the whole of this field were observed feathery radial channels (Fig. 2). This section again showed strong anomalous double refraction when observed between crossed nicols, the strain patches being related to the channels. It is presumed that these " knots " and " channels " are remains of points of attachment of the polyps to the coenosarc and represent differential deposition of the conchiolin-forming secretion.

1. Sedgwick, A. *A student's textbook of zoology.* London 1898.
2. Walton, J. *Coral.* Gemmologist, Vol. XVII, No. 202, pp. 107–118. May 1948.
3. Halford-Watkins, J. F. *Coral ; its occurrence and collection.* Gemmologist, Vol. XIII, No. 153, pp. 39–41 and No. 154, pp. 47–49 and 55. April and May 1944.
4. Webster, R. *Operculum.* Gemmologist, Vol. VIII, No. 88, pp. 49–51, November 1938.

The ORIGIN of the COLOUR in PRECIOUS OPAL

by G. F. LEECHMAN, F.G.A.

SUPERFICIAL examination of precious opal emphasizes the presence of structural peculiarities which emit bright colours. Formerly these were thought to be due to thin cracks which had been refilled, but recent research appears to indicate that they originate in incipient lattice structures which have developed in the natural silica gel.

It is frequently said that opal is amorphous but this very broad statement is clearly not strictly correct. Some common opal may be completely without regular internal structure, although it has been shown by X-ray analysis that it normally contains crystallites of cristobalite and silica threads are probably present also, according to Sosman. Precious opal obviously contains many areas with visible orderly arrangement in the form of parallel threads or fibres, sometimes almost acicular. Between these two extremes is a comparatively seldom seen but nevertheless very revealing series of intermediate stages which clearly shows the gradual development of regular structures in the mass.

Several months spent recently on the opal fields have enabled the writer to collect a wide variety of specimens in which support for this suggestion is definite while evidence to the contrary is not to be found. Pieces of common opal which have obviously been cracked and subsequently flooded with a siliceous sol have often been carefully examined, but here no trace of the colour-effect is discernible. Many other pieces which bear no sign of any break carry indications of colour in various degrees. Finally, examples of the colloidal nature of the mineral are of course plentiful.

In this short summary it will be advisable to touch only on the more important points, omitting much detail and elaboration of many statements, so as to offer simply a straightforward and logical exposition of the method of attack and the progress made.

In order to discuss the subject satisfactorily some initial points, namely, the nature of colloids, the hypothetical cracks and the importance of the quality of the colour must be dealt with after which we may consider the theoretical aspect from the chemical, mineralogical and physical point of view. Practical work consists in a study of relative reactions in the laboratory, investigation of the geological field and associated minerals and the examination of many specimens both in the hand and under the microscope.

Colloidal solutions—or more properly " sols "—were formerly said to be those which on evaporation produce not a crystalline substance such as quartz or calcite but an amorphous jelly (or " gel "). A more modern and accurate definition is that the colloidal form is a state of sub-division of matter in which the particle size lies between that of the true solutions (less than 10^{-6} mm) and that of coarse suspensions (more than 10^{-4} mm). Many usually crystalline minerals may, under suitable conditions, be deposited in the colloidal state, i.e., having large non-crystallizing particles. Thus silica occurs both as quartz and as natural silica gel (as well as in many other forms) and calcium carbonate may be found as aragonite or as the sol from which the pearl oyster produces its nacre. The geologist and mineralogist frequently encounter colloidal forms but to some gemmologists they may be a new departure—amber, meerschaum and paste may be cited as familiar examples. In connection with the present subject ferric hydroxide and aluminium hydroxide are of importance as likely to influence the formation of sporadic structure in the colloid.

In 1801 l'Abbé Haüy, who has been termed the father of crystallography, suggested that opal colours appeared to be due to the presence of numbers of small cracks which had presumably developed in the mass when it was drying and shrinking. In spite of very strong evidence to the contrary this hypothesis has been repeated many times since. Only forty years later Sir David Brewster found it untenable and thirty years after that Behrens put forward the lamellar theory as preferable to that of Haüy. We are then in good company in doubting this suggestion and indeed superficial examination is sufficient to demonstrate its unlikely nature. If these areas were once cracks they do not resemble the conchoidal fracture of opal, concave with irregular borders and curved shell-like markings ; the cracks would presumably vary in size and direction, might be a potential source of weakness and perhaps entrap air bubbles. Instead we see nearly flat patches, with edges frequently straight for short distances ; frequently they have strong parallel equidistant striations. Their thickness is never great, they are usually similarly oriented ; they very seldom show on a cleft surface and fluid inclusions are not often found. According to the present suggestion it may be advanced that most of these attributes could reasonably be assigned to a lattice formation :—planar, with striations and rectilineal boundaries they are thin, parallel and regular in structure.

To the casual observer there is usually but little difference between the quality of the colour of thin plates and the quality of prismatic colours, but to the practised, interested eye, this difference in tone is obvious—as different as the rainbow is from oil on a rainy puddle. The colours of Newton's rings (which we see for example in iris quartz, cracked glass or dragon-flies' wings) are produced by the cancellation of certain wavelengths, leaving all the others in the spectrum operative ; thus if yellow were obliterated we should see a mixture of all those remaining—red, orange, green, blue and violet—a rather unpleasant tone, far from monochromatic and very deficient in brightness, since all the yellow is damped out. Such peculiar shades are typical of interference colours but are never seen in precious opal (or in the spectroscope, diffraction grating or blue butterflies' wings). Here the white light is analysed by differential refraction and dispersion and becomes monochromatic. Its prismatic nature may be demonstrated with the sodium light, but it is the quality of the colour which indicates to the student whether the hue is pure or not, composed of but one wavelength or of many, whether it is like a single clear piano note or a dissonance. It may be possible to obtain a piece of opal which is obviously cracked so that a comparison may be made between the appearance of the actual crack and those areas which emit the usual colour effect. The argument in favour of incipient lattices is very strong.

Chemically opal is hydrated silica SiO_2nH_2O. Commercially it is sold as silica gel and, being very porous, is valuable as an absorbent, hence the percentage of included water varies. It is manufactured by treating a soluble silicate with an acid,

$$Na_2SiO_3 + 2HCl = 2NaCl + H_2SiO_3 \text{ (silicic acid).}$$

The silicic acid is then heated sufficiently to drive off the combined water. Experimentally silica gel is prepared in the same way. A few drops of water-glass suitably diluted are treated with a dilute acid (or a saline solution) when a sol or a gel of greater or less mobility will be formed.

Sosman in his monumental work on " The Properties of Silica " points out that threads formed of SiO_4 tetrahedra may commence to form even in gaseous silica above 1800°C—this implies an orderly arrangement of molecules in a gas. Below 1700°C the silica, now a liquid, may be compared to a mass of moving wires or, as he puts it, wriggling worms ; at lower temperatures a pad of twisted wires, i.e., silica glass. If the decrease of temperature is slow enough however, the threads will tend to pack as closely as possible, that is, they will ultimately lie straight and parallel, side by side, ionic linkage giving first quartzine, then cristobalite, tridymite and finally quartz. It seems reasonable to assume that when silica is produced in an aqueous solution a similar series of events occurs, the SiO_4 tetrahedra linking up into chains (Si_2O_6 as in diopside) or silica rings as in beryl $Be_3Al_2(Si_6O_{18})$.

This is well set out in Rutley—49th edition, page 140, where further steps are described. The chains may be linked side by side as in the amphiboles and pyroxenes (nephrite and jadeite) and a sheet structure develops when the SiO_4 tetrahedra are joined by three of their corners, extending indefinitely in a two-dimensional network only the thickness of 1½ molecules. These sheets may be arranged in pairs, as in the micas. A three-dimensional framework is formed when each tetrahedron is connected up at all four corners producing a solid crystal as in quartz SiO_2 or felspar $KAlSi_3O_8$. Thus we see that before a three-dimensional crystal lattice is formed the sheet structure may be assumed and before that, the fibrous or chain formation. These appear to be connected with the striations and sheet structures we see in precious opal. It may be suggested that when a gel forms very slowly the chains of silica tetrahedra moving under the impact of other molecules are sometimes able to orient themselves into parallel positions and link up to form sheets, but that when solidification is rapid this is not possible and common opal almost devoid of structure is the result.

In the laboratory variations in the concentration of the reagents will be found of importance, as also will the resulting pH values. Here a universal liquid indicator is useful and it will be found that when a very light gel breaks down and accumulates at the bottom of the tube this precipitate is basic, the liquor above being acidic while higher it may again be basic. Thus we may have a test tube showing a clear transparent liquid between two less fluid areas, the amorphous gel lying below and more opaque silicic acid with sodium hydroxide encrustations above. In this clear acidic area after some 30 to 48 hours diaphanous films will develop as tenuous flexible sheets suspended at random in the liquor. These films appear to be related to those which under other conditions produce the opal effect. They are the result of polymerization, the linking together of molecules, a secondary continuation of the process which developed the gel, now disrupted and lying at the bottom of the test tube. Here it undergoes syneresis (or contraction and an increase of rigidity) and some of the dispersion medium (mono-silicic acid) is now gradually expressed, it having remained in the porous gel after it had set. It carries molecules which are still in a lesser degree subject to polymerization and this now slowly takes place so that layer lattices and lamellæ build up in the clear area. That a similar process takes place under natural conditions is clearly indicated by an examination of many opal specimens collected in the field.

There are three types of opal field in Australia, but probably more than 98 per cent of the supply comes from the sedimentary sandstones of Cretaceous age. The remainder, either volcanic or else boulder opal, is negligible yet any explanation of the cause of the colour effect must take these two varieties into consideration as being equally important with the sandstone opal. This is found in extremely flat country only very occasionally varied by small isolated flat-topped hills and ridges which sometimes carry deposits of opal in the clay beds between the strata. These elevations are generally ascribed to differential erosion, due to increased hardness which has been caused by a local increase in silicification. The cap rock of indurated sandstone protects the softer beds below, and it is said that capillarity has drawn the soluble silica to the surface where it has remained, the lower layers being thus depleted. However there are several difficulties to be surmounted before this can be completely accepted and an alternative suggestion is that deep-seated increases of temperature in Miocene times have resulted in hydro-thermal activity. Thus hot mineralized springs appear to have developed locally carrying silica which has seeped into the surrounding porous rocks both at the surface and lower in the workings.

.Rapidly sketching the geological history, we had a wide inland sea (usually shallow but once or twice it became fairly deep), dividing the continent almost completely from north to south. Clay was deposited and to-day we find in it cretaceous fossil shells, bones and so on, sometimes opalized. The sea dried out into lagoons and salt pans, traces of which still remain and a long quiet period ensued, the Eocene, lasting several millions of years. This was followed by the Oligocene and then the Miocene, during which there was some renewal of tectonic activity. It was during this period that the silica deposits are considered to have invaded the Cretaceous sandstone beds, filling the seams and crevices, the cavities where plant remains and even fish had once been, then through the centuries gradually drying and hardening into opal. An essential feature of this is the wide extension of thick horizontal beds of originally porous argillaceous sandstone which has been saturated with siliceous solutions and consequently hardened, rendering the strata quite impervious and thus preventing any but the minimum evaporation from below them. On account of this a sol which contained much water or silicic acid as the dispersion phase would be able to gel only extremely slowly, the large polymerized molecules would be free to move and would do so until each had settled into a secure position from which it could not readily be dislodged by the impact of other molecules.

The opal is usually found dispersed in clay between the thick sheets of sandstone, but it may also occur in the rock above or below the layer of " opal-dirt." This clay appears to be of an estuarine origin and it is here that most of the fossils are found, giving some picture of the conditions at the time it was deposited.

Copi, or gypsum, is fairly common with ferric oxide and psilomelane but few other minerals are to be found although the former presence of saline solutions is strongly indicated when a sample of clay or of sandstone is washed. Small sheets of ferric oxide occur and red staining of the country rock by the hydroxide is quite common, being welcomed as indicative of precious opal. Aluminium silicate and hydroxide are of course present in the clay.

Except for the gypsum and salts all the minerals mentioned are in the colloidal form and were presumably originally present in the solutions which later formed the sol and finally the gel. This would give a silica gel with some impurities, which would have to be accommodated in the mass. As gelation proceeds some of the accessory minerals appear to segregate themselves and incipient crystal lattices form. How far this is successful would decide whether the result is to be merely common colourless opal, i.e., " potch," or gem quality material or else that intermediate product known to the miners as " potch and colour." Large quantities of unsaleable quality may be obtained, either discarded on the dumps or from the polishers and although of no value commercially, yet for the student here is obviously the key to the problem of the origin of colour. Whether examined as a hand specimen, with a small magnifying glass or under the microscope, a wealth of evidence is obtained which points conclusively to the colloidal origin of the mineral which yet occasionally undoubtedly shows obvious structure in the form of *small striated blocs* which actually flicker with colour on the surface of some specimens.

In order to appreciate the value of such evidence it is advantageous to look through great numbers of pieces, noting their implications carefully. In the larger lumps we see that the material is certainly solidified from a fairly mobile gel which has formed or been deposited in the seams and interstices of the beds of clay and sandstone. Various kinds of potch are noticeable, from the heavy almost opaque basic type to the clear water-white acidic hyalite. Sometimes cells or bands of the latter are included in the former, which normally lies in the lower part of the cavity. With a hand glass we may note the clear acidic areas where the colour occurs and examples may be found which show all five stages of colour formation. Specimens occasionally come to hand where small discrete sheets of colour, well isolated from their neighbours, may be observed without difficulty and their exact form and nature discussed. Rarely are to be seen pieces of opal which reveal on a fractured surface the striated bloc or film-pack structures previously referred to. Under the microscope these are quite obviously of a crystalline nature. Finally one may take a small fragment of colourful opal, crush it to the size of coarse sand grains and study these by transverse illumination—the typical shape of the particles approximates to a rectangular block in which packs of films may sometimes be seen while by polarized light areas will be found which are not amorphous but definitely regular in structure.

Assuming then that we have shown from direct evidence that such regularity exists, the question arises as to how such comparatively coarse formations can be connected with the colour-effect. The lengths of the waves of visible light lie between 3600 A.U. and 7600 A.U., the waves being far too long to be affected by the primary lattice spacing of crystalline silica which is about 8 A.U. We are, however, not working on crystalline silica but on the colloidal form which has had ample opportunity to polymerize and many years in which to bring the long chain molecules into ideal positions. When the primary silicic acid gel is first formed it has a molecular weight of 60 to 100, but this immediately begins to increase and the process continues until, under satisfactory conditions, the molecular weight may be more than 10,000 and the length of the giant molecules up to 30,000 A.U. or more. Here we have passed beyond the domain of visible light and we see that colloidal silica may normally reach this stage. We may well suggest that the coarse macro-structures of film-pack form which are clearly visible in occasional specimens imply without a doubt that finer micro-structures may be present which could monitor the light, provided the lines on their surfaces are regular, parallel and equally spaced, as they must be. (Spencer, *Key to Precious Stones*, 1936, p. 222).

Sheet structure is typical of the micas, feldspars and clays, which are, speaking generally, aluminium silicates, that is, silica with some silicon ions replaced by those of aluminium (and other metals, such as iron). These are not truly isomorphous since the aluminium ion is much larger than the silicon and so causes some interference with the regularity. The ambidextral rotation of the crystallization of quartz must be taken into account also, and the subsequent twinning (see Journ. Gemmology, Jan. '53, p. 23). All these factors must influence the lattice spacing, which appears to be of special importance in the highest quality gem material. In this we see the ultimate stage in the production of colour, the development of which must now be shortly considered.

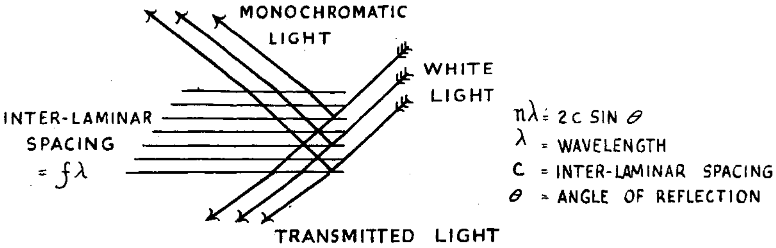
The first visible trace of colour is to be found in those specimens of hyalite which have faint *indefinite misty patches* of pale blue. These hazy parts have no obvious outlines ; the blue appears to be diffracted from minute silica particles sparingly dispersed through the gel. This material, while very common on the field is entirely valueless and is therefore seldom seen elsewhere.

With increased deposition of silica we get more plentiful and larger particles regularly spaced, thus we find *definite blue clouds* with obvious outlines and fixed positions. This second stage blue is rather darker and the specimens in general not so transparent. Further development in this direction may lead to opaque potch.

The third stage shows the silica particles building up coloured *diaphanous films.* Good specimens may be obtained occasionally in amber potch, which corresponds very closely to Mexican opal, but they are not common. Here we see suspended in the clear gel very obvious films, usually almost flat, with rectilinear outlines and smooth coloured surfaces, one colour all over. In different directions they are of different hues, and as the position alters the shade may change from one prismatic colour to the next. They are definitely monochromatic and mixed tones such as mauves, greys, browns or crimsons have not been seen. This type of stone also is seldom handled by lapidaries or jewellers as it is of no interest to the average customer, but Mexican opal sometimes shows the effect.

When these *films become more heavily developed* they are usually fibrous or striated and then constitute the fourth stage. Here they are frequently rather irregular at the edges and sometimes appear to be fractured through the surface, but they are more numerous and brilliant, the stones being quite saleable. The fibres are sometimes so definite as to resemble acicular crystals and under the microscope by reflected light they are completely opaque. A surprising change is revealed however on switching to substage illumination as they then disappear entirely, the area where they were being completely translucent ; however, in polarized light some indication of their presence is usually discernible.

Finally we come to the ultimate development, where the display of colour is at a maximum. Considering the brilliancy in particular we cannot deny that it surpasses that of any other coloured gem-stone and in fact approaches in strength total internal reflection or that of a backed paste. It seems incredible that such a thin translucent film could produce such a brilliant result, but let us consider the effect of one film forming behind another, with others similarly placed behind them, the spacing being such as not to interfere with the wavelength. Light entering laterally into a pack of parallel equidistant transparent films will be brighter, transmitted frontally, than light reflected under similar conditions from one plane only since the supporting films, being suitably spaced, will reflect a further proportion of light which would otherwise be lost.



It is concluded that this resonance effect, illustrated in the diagram, is the governing factor in the production of the unusually brilliant and highly monochromatic colours of precious opal.

Summarizing briefly we may say that previous explanations of the effect appear unsatisfactory in the light of modern knowledge. Opal was formerly considered to be typically amorphous until X-ray investigation proved the contrary. Chemically it is natural silica gel and it may be produced by simple reactions. Consideration of these and of the actual opal fields raises the suggestion that delayed polymerization and protracted evaporation favour the development of incipient crystal lattices in the gel and specimens showing well-developed film-packs on the surface have been obtained. Since these macro-formations can be verified the finer micro-structures may be accepted as proved. When the lattice spacing is of a suitable order a series of films, although translucent in one direction, can reflect in the other pure colours of great brilliancy.

In volcanic opal and in the boulder variety the mode of origin is different but the same requirements for the production of colour have been met. Where a hot solution of silica has been trapped in the cavities of igneous rocks or where it has penetrated the cracks of ironstone boulders embedded in clay, the solidification will still be extremely slow and undisturbed. There is still the freedom from crystalline salts which might interfere and provided the pH values and the temperature are satisfactory a suitable crystal lattice should form. Perhaps unfortunately it is but seldom that all the highly critical conditions are satisfied and it may be said that good quality gem material in large pieces does not normally occur.

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(*Continued from page 211*).

shame the few cabochon bronzites and mediocre faceted greenish-brown stones I have previously seen. A rich, reddish-brown in colour these gems can be regarded as something new for the collector. Although these reached me from Ceylon they came originally from India.

Among stones for which there is no definite place of origin are several worthy of mention. One was a very fine rose pink scapolite cat's-eye. Another, a green tourmaline with a brilliant but unusually narrow chatoyant streak. A couple of cabochon cut dioptases and a bead of the rare Canadian mineral chlorastrolite complete my list.

SOME NOTES on UNUSUAL GEMS

by R. K. MITCHELL, F.G.A.

SEVERAL unusual stones have come my way in the past few months which have for the most part emanated from Ceylon —a seemingly never-ending source of the unexpected. I now list them briefly for the sake of placing them on record.

Firstly a large grey aventurine quartz, cut en cabochon, showed a faint but unmistakable six-rayed star. This is abnormal since it is usually considered that aventurine occurs only in massive quartz and not in the single crystals which would give the necessary orientation to the structure causing the star.

Another specimen was a small well-formed group of blue spinel crystals showing the very rare dodecahedral form dominating the more usual octahedron. The Natural History Museum had nothing like it so I parted with it to them.

A dark green glass with a four-rayed star and beautifully oriented inclusions is probably unique. Analysis shows that this contains lead and is therefore almost certainly artificial. I feel it may be a Ceylon " pit " glass of great antiquity which has reached an unusal state of devitrification. Work on this is still going on and further details may be published later.

A 60 carat water-worn sinhalite has also come to light. This definitely came from Ratnapura but more exact details are not available. It does serve, however, to give further proof of the origin of this newly recognized species.

Several iolites of good and medium quality have also reached me. Some years ago a 90 carat piece of rough passed through my hands. I have never seen another piece anything like it and still regret letting it go. This piece is now a prize exhibit in an American museum.

Perhaps the most interesting of all is a small parcel of *brown* gem-quality enstatite. The material is very strongly dichroic and has an extraordinarily rich absorption spectrum. It puts to

(Continued on page 210).

Gemmological Abstracts

POUGH (F. H.). *Gem collection of the American Museum of Natural History, New York City.* Gems and Gemology, Vol. VII, No. 11, pp. 323–334 and 351, Fall 1953.

A very full report on the gemstones in the New York Museum, of which the author was formerly curator. The collection owes much of its present magnificence to such well-known personalities as G. F. Kunz and J. Pierpont Morgan among others. The diamond display shows coloured diamonds and crystals which have been found in Wisconsin and Alabama. The corundum group includes among other large stones, a 100 carat orange Ceylon sapphire and the famed 100 carat De Long star ruby. The " Star of India," a blue star sapphire of 563 carats, is the world's largest star sapphire. The beryl collection includes the Schettler emerald, an 88 carat Indian engraved tablet, and a number of large size aquamarines reaching up to 400 carats in weight. These include some fine fancy coloured beryls, morganites and yellows. The notable topazes are the 144 facet egg-shaped blue Brazilian topaz weighing 1463 carats ; a 241 carat pale orange-brown Burma stone and a 70 carat spinel-red stone. Full description is given of the spinels, the garnets and the tourmalines, the latter having particular emphasis on those from Pala, California. The 208 carat cut blue zircon is said to be the largest stone of this type in the world. A clear green 6 carat zircon from Minas Gerais, Brazil, illustrates a new locality for zircon. The most notable peridot is an 82.5 carat Burma stone, and in chrysoberyls a 47.8 carat cat's-eye. The alexandrites are good but not large. The cases following, after a fine show of opals, consist of the rarer stones which include some exceptional kunzites and the largest known hiddenite. Unlike our National Museums the collection displays pearls. These are mainly freshwater, clam and conch pearls, but a selection of Japanese cultured pearls are also shown. Coral is also shown. The exhibit is finished with a case of the synthetic stones. 1 illus.

R.W.

FOSHAG (W. F.). *A visit to Idar-Oberstein.* Gems and Gemology, Vol. VII, No. 11, pp. 339–342, Fall 1953.

A historical survey of the gem cutting centre of the twin towns on the Nahe river. Comparison is made of the new and the old methods and the machinery used. Personalities are mentioned. 4 illus.

R.W.

Walsh (A.). *Electron micrograph of a diamond.* Gemmologist, Vol. XXII, No. 267, p. 180, October 1953.

Using negative formvar replica process followed by gold palladium shadowing, electron micrographs at 40,000x magnification have been produced of the surface of a polished diamond. Information on sub-microscopic pits and polishing marks have been obtained. 1 illus.

R.W.

Lewis (M. D. S.). *The History of Paste.* Gemmologist, Vol. XXII, No. 268, pp. 193–197, November 1953.

As its title suggests the article is a historical account of the use of paste (glass) as material for ornamentation. For perhaps 1,500 years glass was a material of great rarity and often worth more than precious metals. Glass was probably first produced in Egypt some thousands of years ago and for ornamental purposes. During the period up to the Middle Ages coloured glass was supreme (around the 14th century the re-discovery of the use of manganese for decolourizing glass allowed the production of colourless stones) and cabochon styles used. 1 illus.

R.W.

Webster (R.). *Inclusions in yellow chrysoberyl.* Gems and Gemology, Vol. VII, No. 11, pp. 343–346, Fall 1953.

Reference is made to a " bladed " or " stepped " series of planes seen in yellow chrysoberyl. These are suggested as being parallel to the brachydome faces of the crystal. Other inclusions seen in chrysoberyl are referred to. 8 illus.

P.B.

Webster (R.). *Gemstone luminescence.* Gemmologist, Vol. XXII, Nos. 265/6/7, pp. 139–143/161–164/188–191, August/September/October 1953.

(See Journ. Gemmology, Vol. IV, No. 4, p. 179). Continuation of the alphabetical series of the luminescence of gemstones, from Brazilianite to Paste.

P.B.

COGGIN BROWN (J.). *Emeralds in India.* Gemmologist, Vol. XXII, Nos. 265/6, pp. 133–136 and 165–168, August and September 1953.

A historical report on the occurrence of emerald in India. Udaipur emeralds found in 1943 when prospecting for mica and beryl for war purposes. Dr. Coggin Brown was formerly with the Indian Geological Survey and has full knowledge of Indian geology. 2 illus.

R.W.

MITCHELL (R. K.). *A new variety of gem enstatite.* Gemmologist, Vol. XXII, No. 265, p. 145, August 1953.

The report of a new variety of gem enstatite (or bronzite). Refractive indices given are 1.669 and 1.680 with a density of 3.33. Pleochroic colours are dark reddish-brown, pale reddish-brown and brownish-green. Spectrum shows the 5060 line very strongly with fainter supporting bands and others in the green and blue and violet. A micaceous cleavage is said to make cutting difficult.

R.W.

ANDERSON (B. W.). *The spectroscope and its applications to gemmology.* Gemmologist, Vol. XXII, Nos. 266/7/8, pp. 153–158/173–176/198–201, Sept./Oct./Nov. 1953. (To be continued).

The introduction to a comprehensive article on the absorption spectra of gemstones. These first three instalments give a historical account of the discovery of the solar spectrum by Newton in 1666, the work of Fraunhofer, Zantedeschi, who seems to be the first to use a collimating lens, Foucault, Fox Talbot, Swan and others. The important work of Bunsen and Kirchhoff is discussed and the discovery of the two new elements caesium and rubidium by these workers with the aid of the spectroscope is told. The employment of the diffraction grating by Ångström and his use of the ten millionth of a millimetre scale—known as the Ångström unit, and the diffraction gratings made by Rowlands and used by him to produce his *New Tables of Standard Wavelengths* are discussed. It is remarked that the absorption spectra may bear no apparent relationship to the emission lines of an element. Brewster and Stokes were the first to record absorption spectra of solids, and Church in the case of gemstones. The early work of Becquerel on the luminescence spectra is mentioned and also the work of

Herschel in discovering that the spectrum extends into the infra-red. In the ultra-violet similar discovery was the work of Ritter. This was further elaborated by later workers. 6 illus.

Rare gem found near Broken Hill. Commonwealth Jeweller and Watchmaker, Vol. XXXVIII, No. 4, pp. 145, Oct., 1953.

A report of the finding of small specimens of gem quality titanite near Broken Hill. Two gems are stated to have been cut. A.G.

SCHLOSSMACHER (K.). *Die Seltenheit des Saphirs.* The rarity of the sapphire. Zeitschr.d.Deutsch.Gesell.f.Edelsteinkunde, Autumn 1953, No. 5. pp. 8–11.

The colouring pigment in sapphire is iron and titanium, which two elements are found both in Sial and Sima rocks. Good quality stones are mostly found in pegmatites. E.S.

SCHMIDT (PH.). *Magie der Edelsteine.* Magic of the gems. Zeitschr.d.Deutsch.Gesell.f.Edelsteinkunde, Autumn 1953, No. 5, 13–16.

Review of magical powers attributed to gems during the ages. Far East, Middle East and old Roman jewellery is discussed. E.S.

SCHÜTT (E.). *Die Bestimmung hochlichtbrechender Steine.* Determination of stones of high refractive index. Zeitschr.d.Deutsch. Gesell.f.Edelsteinkunde, Autumn, 1953, No. 5, 17–20.

Stones of higher R.I. than 1.81 and the use of Clerici solution undiscussed. E.S.

KRACEK (F. C.), NEUVONEN (K. J.), and BURLEY (G.). *A thermodynamic study of the stability of jadeite.* Journ. Washington Acad. Sci., 1951, Vol. XLI, pp. 373–383. 1 fig.

This paper is interesting to the gemmologist insofar as it again emphasizes that all attempts to produce jadeite have failed as yet. There is the suggestion that jadeite might be formed at an atmospheric pressure around 25°C. S.P.

ADAMS (L. H.). *A note on the stability of jadeite.* Amer. Journ. Sci., 1953, Vol. CCLI, pp. 299–308. 1 fig.

Thermodynamical equations are formulated to arrive at the pressure-temperature range for the formation of jadeite. There is a break-down to glass, nepheline and albite at temperatures above 800°C. There was no definite result to the experiments recorded.
S.P.

BOOK REVIEW

FISCHER (W.). *Praktische Edelsteinkunde.* Practical Gemmology. (Opuscula Mineralogica et Geologica, Vol. III). Published by Gustav Feller—Nottulnm Kettwig/Ruhr, Germany, 1953, 187 pp., 48 illus. Price £1 10s.

This publication is an important contribution to the much neglected branch of gemmology concerning itself with the fashioning of gems from the rough. In its special part the book deals with 68 gem species and in most cases valuable hints are given regarding grinding and polishing means and lap materials. To the amateur lapidary this section will be of the greatest value and the apprenticed lapidary too will make good use of this information which the author was in a particularly favourable position to compile, because he is the present director of the Trade School for Diamond Polishers, Lapidaries and Goldsmiths at Idar-Oberstein. In the preceding general part the author tries to satisfy the more scientific interest of a necessarily different group of readers, because it seems inconceivable for instance that his pupils will master the intricacies of crystal structure and crystallography. The more advanced student, on the other hand, will detect in this part several inaccuracies, simplifications, omissions and a general lack of references which may be due to the fact that the author seems to rely in the first instance on compiling material, but did not apparently refer to some of the most important contemporary works. His bibliography includes some English and American authors, but—B. W. Anderson, R. Webster, K. F. Chudoba and E. J. Gübelin are not mentioned. A modern book on practical gemmology omitting some of to-day's leading gemmologists is incomplete.

One particular item belonging to both the general and special parts is the interesting relationship between the crystal lattice of the diamond and its preferred grinding directions. Whilst the theoretical relationship is made perfectly clear (for instance in Table 1 and the appendix), the fact is not mentioned that of two, three, or four preferred directions in the three main crystal planes, there is frequently only one best grinding direction in a (main) plane, which is used in practice. This curious fact has already been described by Eppler and implicitly also by Holstein. In spite of this and similar flaws the book is a very valuable contribution to gemmology. W.S.

SIMPLE PHOTOMICROGRAPHY

by J. R. H. & P. M. H. Chisholm.

DR. GÜBELIN(1) has amply demonstrated what beautiful and informative results may be obtained by photomicrography of gemstone inclusions and Messrs. Vincent,(2) Day(3) and Trumper(4) have shown how satisfactory results may be obtained without either complicated or expensive apparatus. It is the purpose of this article to dispel any lingering doubts that may remain in the minds of some gemmologists that photomicrography is beyond them. In truth there is no cause for alarm either in the difficulty of the procedure or in the expense of the necessary apparatus, since photomicrographs may be taken easily with apparatus which can easily be improvised.

By Anderson's(5) fascinating " immersion contact " technique the " interior decoration " of gemstones may be recorded photographically without the use of either a camera or a microscope, but for photomicrography a microscope is essential. The only other essentials are a light-source, a photographic emulsion, whether on a plate or a film, and some means whereby the plate or film may be held above the microscope so that (1) it is exposed to no light except that passing through the optical system of the microscope and to that only for the time required and (2) it receives sharply focussed the image of the object projected by the microscope.

The requirement of a microscope should present no difficulty. A gemmologist without a microscope is inconceivable and any microscope suitable for examining gemstone inclusions is also suitable for putting them on permanent record by means of photomicrography. The light-source is satisfactorily provided by any ordinary electric microscope-lamp, although, particularly for large and dark-coloured stones or high magnifications, a more powerful bulb may be desirable to avoid unduly long exposures. The plate or film is easy to obtain and not expensive, so the only possible cause of difficulty or expense must lie in the provision of the required plate- (or film-) holder.

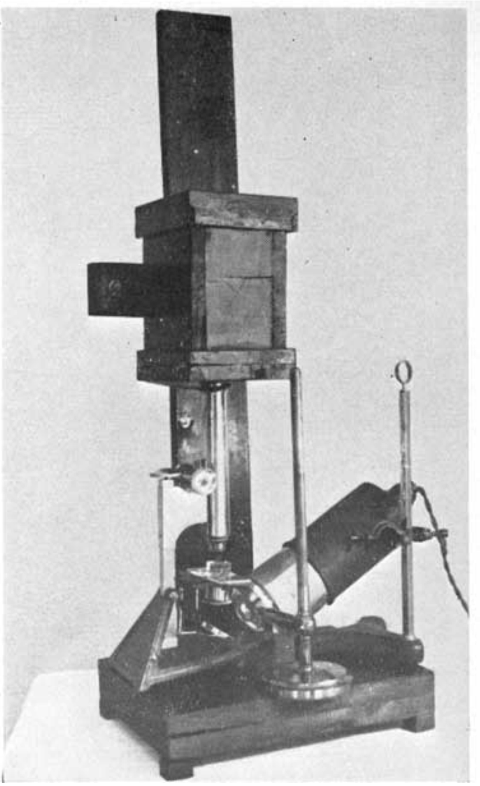
The requirements in respect or the plate- (or film-) holder are twofold. The plate or film must be (1) capable of being fixed rigidly in focus and (2) protected from all unwanted light. The first requirement may easily be met by using laboratory retort stands (Vincent), making a simple wooden or metal stand (Day, Trumper), or adapting a photographic vertical enlarger (Trumper). Our very simple and easily made wooden stand is described below. The second requirement can obviously be met by using a camera—" any camera," as Trumper is no doubt correct in saying, although some cameras are much better for the purpose than others.

Vincent obtained satisfactory results using a box camera and roll film, but found it necessary to add a tube containing a series of supplementary spectacle lenses ; and Trumper illustrated the use of a folding roll-film camera. It is generally, however, not so easy to obtain exact focus of the image on the emulsion in the ordinary roll-film camera, as it is with a plate camera having a ground glass focussing screen and it is not every gemmologist who owns a plate camera or wishes to buy one (although old ones, eminently suitable for this purpose, may be picked up quite cheaply).

For the gemmologist who has no easily adaptable camera, Day suggested a method, whereby, instead of the plate or film being housed in a camera to exclude unwanted light, all the light was shut in by a container allowing none to escape except through the optical system of the microscope. This involved a complete light-tight boxing-in of both the light-source and the microscope itself, causing some inconvenience in handling the object under examination and in adjusting the focus of the microscope. Moreover a light-tight box to include light-source and microscope, having cloth-covered openings to allow the hands access to manipulate the contents, is a more complicated piece of apparatus than the situation requires.

Since we had neither a camera specially constructed for photomicrography nor a plate camera with a focussing screen, we considered that rather than try to adapt a roll-film camera or follow Day's example it would be easier to make a plate camera for ourselves of the most elementary sort, and experience has convinced us that this is indeed the simplest and easiest solution of the problem.

Fig. 1.



To make a folding roll-film camera would no doubt be a job to daunt even a more than competent handyman. But the camera required for our purpose is merely a light-proof box with (1) a lid under which the plate can rest horizontally and (2) a small hole (about $\frac{1}{2}''$ diameter) in the bottom : no lens is required and no shutter either. Our apparatus, which was made entirely from pieces of $\frac{5}{8}''$ and $\frac{7}{8}''$ floor-boarding (because we happened to have some), is described below, not as an example to be copied, but merely to show how simply apparatus which will work can be made. Actually, although the stand needs to be made of something substantial to ensure rigidity, a neater job might have been made of the " camera " if we had had some 3-ply : alternatively anyone

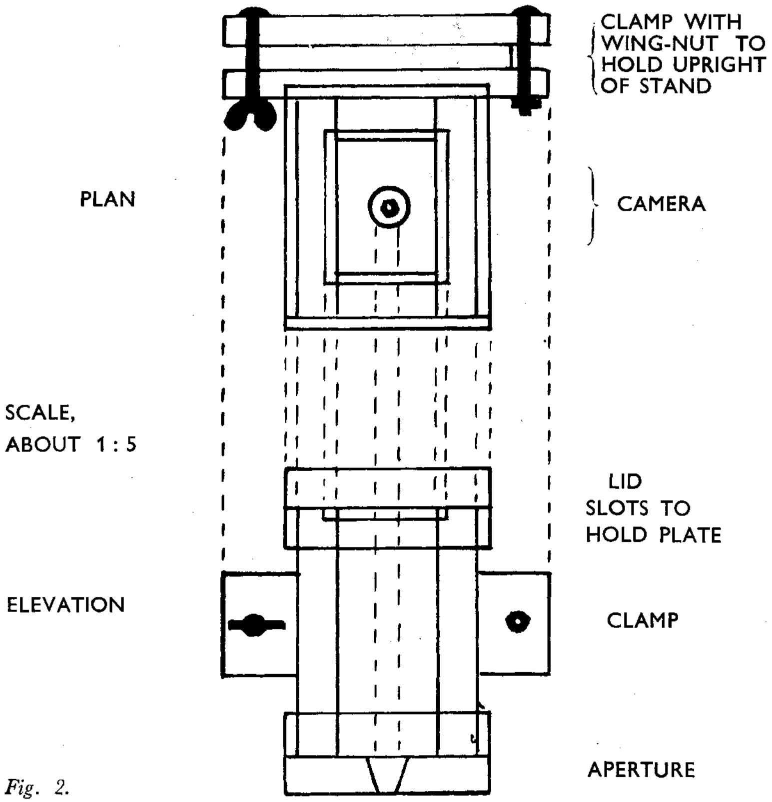


Fig. 2.

at all handy with a soldering iron could make an excellent camera for this purpose out of an old biscuit tin : or even more simply a stout cardboard box could be used.

Our apparatus complete with lamp and old Beck microscope is illustrated in Figure 1. The stand is made of a ″ × 3¾″ × 30″ upright screwed firmly to a base of two pieces of plank of ⅞″ × 9″ × 12″ also firmly screwed together. The construction of the camera and the clamp holding it on the upright is shown in Figure 2. The clamp may be loosened by the wing nut to allow movement of the camera to any desired position on the upright. The camera is simply nailed together. No dove-tailing is needed and if necessary adhesive tape or paint run into the joints ensures light-tightness.

The first photomicrographs taken with this apparatus were of a hair, a drop of blood and a biological slide. They were successful but are not shown here. The first photograph of a gemstone was of an amethyst and the result is shown in Figure 3, which for a first attempt we considered encouraging. Incidentally, it shows that we had not yet learnt to arrange the stone to the best advantage so as to keep the maximum amount of its contents within the limits of the objective's depth of focus ; the inclusions observed were mostly in one plane, but, since that plane was not quite normal to the optical axis of the microscope, the two sides were respectively too close to and too distant from the objective and only a band across the middle of the picture is properly in focus. In our next photograph (Figure 4) this fault was eliminated.

Not all our photographs were taken using the same microscope. We also brought into service an old Wenham binocular, using of course the straight up ocular only, with the prism withdrawn from the optical system. This also proved satisfactory (see Figure 5), but having a 10″ tube increased the size of the image on the plate and therefore required rather longer exposures. Kodak 0250 orthochromatic quarter-plates were used.

The procedure with our apparatus differed little from that described by Day. The stone is placed on the microscope stage—either immersed in liquid in a cell or supported by plasticene on a slide—and the particular phenomenon to be recorded is brought into focus in the usual way. The " camera," with the back off and the ground glass plate in position (ground side down), is lowered until it is almost touching the eyepiece of the microscope and is then fixed, taking care that the image on the ground glass plate is properly centred and focussed : this may involve some slight adjustment of focus of the microscope. The light is then switched off—apart from a safelight, the actual " photography " must take place in the dark, as with Day's method, since the "camera" has no shutter—the sensitive plate unwrapped and substituted (emulsion side down) for the ground glass plate, the back replaced on the " camera " and the microscope lamp switched on for the desired exposure time. The plate is then removed—still in the dark—and either developed straight away or rewrapped for development subsequently.

Fig. 3.

Amethyst (cut stone).

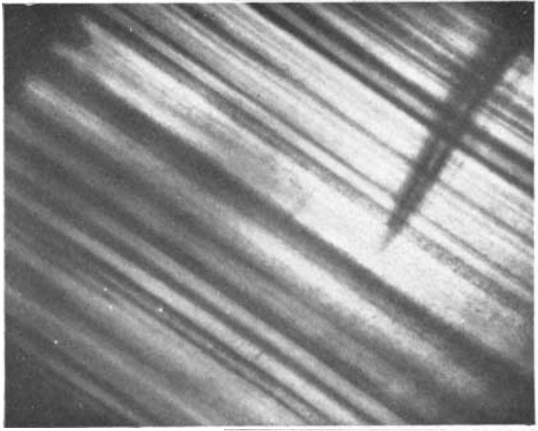


Fig. 4.

Blue-green Sapphire crystal.

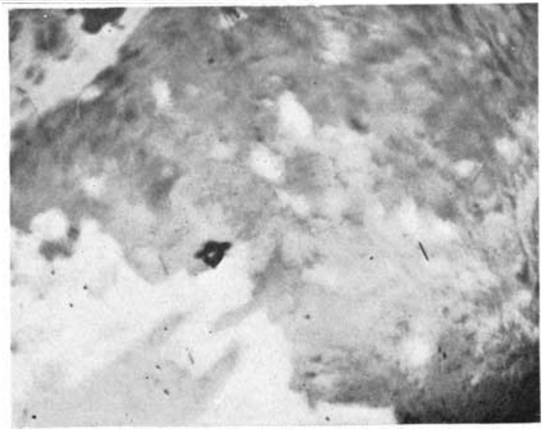


Fig. 5.

Alamandine cabochon.

Day has described the method for ascertaining the correct exposure time by a test plate and has also described the developing, but suggests it may be desirable to hand over the printing to a professional photographer. This, however, appears to be a needless confession of weakness, as the printing processes present no more difficulty than the developing and can best be carried out by the man who knows the particular results he wishes to obtain. It is surprising what different details can be brought out from the same negative by the use of different grades of printing paper (Kodak supply four contrast grades—soft, normal, hard and extra hard—and Ilford five—ultra hard in addition to the other four). For instance, Figure 4 lacked sufficient definition until printed upon Ilford ultra hard paper; in another case (not shown) the stone-edgd, visible when printed on Kodak normal, vanished on ultra hard.

In our work of collaboration P.M.H.R. made the apparatus and was responsible for the photography, while J.R.H. was principally concerned with manipulating the stones and the microscope and writing this article. As a child has been defined by Parliament(6) as " a person under the age of 14 years " and P.M.H.R. made the apparatus and took the first photographs within two months of his 14th birthday, we have grounds for asserting that it is so easy a child could do it.

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1. E. Gübelin. " Gemstone Inclusions," Journ. Gemmology, Vol. I, No. 7, pp. 7 *et seq.* (July 1948) ; " Diagnostic Importance of Inclusions in Gemstones," *ibid.*, Vol. II, pp. 281 *et seq.* (July 1950) ; " Inclusions in Diamonds," *ibid.*, Vol. III, pp. 175 *et seq.* (Jan. 1952) ; " Inclusions as a Means of Gemstone Identification," Gem. Inst. Amer. (Los Angeles, 1953).
2. John Vincent. " Experimental Photomicrography," Journ. Gemmology, Vol. I, No. 3, pp. 13 *et seq.* (July 1947).
3. Norman H. Day. " Simple Photomicrography as applied to Gemstone Inclusions," Journ. Gemmology, Vol. III, pp. 87 *et seq.* (July 1951).
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5. B. W. Anderson. " Immersion Contact Photography," Journ. Gemmology, Vol. III, pp. 219 *et seq.* (April 1952) ; " Immersion Contrast Simplified," *ibid.*, Vol. IV, pp. 107 *et seq.* (July 1953).
6. Children and Young Persons Act, 1933 (23 & 24 Geo. 5, c. 12), s. 107 (1).

ASSOCIATION NOTICES

COUNCIL MEETING

A meeting of the Council was held at the Medical Society of London on Wednesday, 2nd December. Mr. F. H. Knowles-Brown presided. The following were elected to membership :

Fellows

Hermann Bank, Jun., Idar-Oberstein
Walter W. Bowen, Birmingham
Anthony W. Davis, Potters Bar.
John F. Hodges, Chester.
Roger W. Jones, Cirencester.
Vincent G. Jones, Sutton.
John B. Kemp, Bristol.
Norman A. Lambert, London.
Brenda E. Lewis (Miss), Bristol.
Jeanne G. M. Martin (Mrs.), San Diego
Leonard G. Noye, Ipswich.
Richard J. N. Oliver, Eastleigh.
Geoffrey H. Parsons, Bristol.
Anthony I. Stanton, London.
Roger I. Thomson, London.
Derek Walden, Enfield.
Leslie N. Wells, Oldham.
Helge R. Westgaard, Oslo.

Transfer from Probationary to Fellowship

Trevor M. Brook, Lincoln.
Robert C. Fox, Ilford.
Ronald A. Hall, Lingfield.
Anthony L. Kemp, Bristol.
Raphael I. Roth, London.
Colin S. Wickens, London.
Samuel Bache, Old Hill.
Alfred J. Brack, London.
Rodney F. Collyer, Birmingham.
John N. Forsey, Sutton Coldfield.
John Galloway, Edinburgh.
Graham E. Keay, London.
Michael J. Kutner, Wembley.
Peter F. Leese, Northwood.
David G. Lennie, West Kilbride.
Eric Lewis, Woking.
Dermot S. Rogers, Belmont.
William Sena, Singapore.
Gunnar B. Sunde, Oslo.
Ronald F. Tugwell, Thornton Heath.
Leslie P. Waites, Birmingham.
Peter J. Watson, London.
Harold J. Wheelock, Birmingham.
Beatrice M. Wood (Miss), London.

Probationary

Iris Chadwick (Miss), London.

Ordinary

David Cameron, Edinburgh.
Vincent A. Davidson, Walsall.
Nellie E. Deane (Mrs.), Wednesbury.
Frank E. Goldie, Birmingham.
Bjarne A. Jensen, Bergen.
Patrick J. Laird, Omagh, N.I.
Atluri R. Sastry, Vijayawada, India.
Gordon M. Shaw, Edinburgh.

The Council amended By-law ten so as to prohibit the reproduction of the Seal of the Association in any form without consent of the Council.

BRANCH MEETINGS

Midland Branch

A meeting of the Branch was held on 13th November, when a gemmological competition was arranged. Meetings arranged for 1954 include : 22nd January (Imperial Hotel) ; 12th March and 14th May.

At the annual meeting held on 24th September Mr. Trevor Solomon was re-elected as Chairman, and Miss P. Cutts and Messrs. Harper, Perry, Conway and Leng elected to serve as the Committee. Mr. D. King was elected Honorary Secretary.

West of Scotland

At the extra-ordinary general meeting held on 23rd September, Mr. S. D. Wood was re-elected as Secretary of the Branch and Mrs. J. McKay and Messrs. J. Gillougley, I. McKenzie, E. McDonald and G. S. Wade, were elected Committee members. Mr. F. Bryan was re-elected as Chairman for a second year at the annual meeting held earlier in the month.

East of Scotland

Mr. G. Winnert has been elected Honorary Secretary of the East of Scotland Branch of the Association in place of Mr. D. J. Ewing. Mr. Ewing, who serves on the Council, has handed over in order to avoid filling two offices.

A competition between the East and West of Scotland Branches was held in Edinburgh on 26th November, and it proved highly successful. The specimens for the competition were provided by Head Office.

TALKS BY MEMBERS

Blythe, G. A. : " Gemstones," Young Wives' Association, Southend, 8th October ; North Country Club, Southend, 15th October, 1953.

Solomon, S. T. : " Gemstones," Townswomen's Guild, Plymouth, 12th January, 1954.

Webster, R. : " Gemmology," De la Beche Club, Royal School of Mines, Imperial College, South Kensington, 12th October, 1953 ; " The story of the synthetic gemstone," Chelsea Polytechnic Geological Society, Chelsea Polytechnic, 2nd December, 1953.

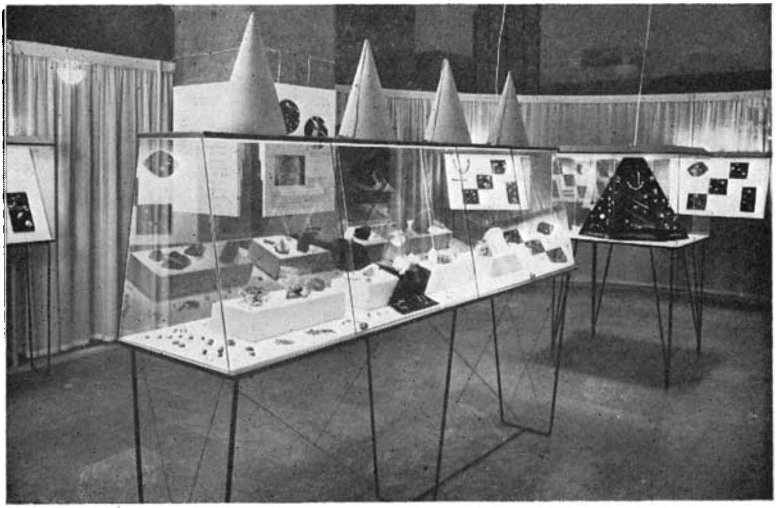
Melrose, R. A.: "Gems," Newcastle-upon-Tyne Branch of the British Horological Institute, November, 1953.

Leak, F. E.: "The Science of Jewellery" to the inmates of H.M. Prison, Falfied (the famous "Prison without Bars") November, 1953; "The Science of Jewellery" St. Dunstan's Church Fellowship, Bedminster Down, Bristol, November, 1953 ; "Diamonds," Victoria Park Methodist Church, Contact Club, Bristol, 3, January, 1954.

NATURAL HISTORY MUSEUM APPOINTMENT

The principal trustees of the British Museum have appointed Dr. G. F. Claringbull to the Keepership of the Department of Mineralogy in the British Museum (Natural History) in succession to Dr. F. A. Bannister, who has retired.

Dr. Claringbull, who joined the department of Mineralogy in 1935, has been an examiner in gemmology for the Association since 1938, succeeding Mr. A. H. Ward, and has also served on the Council since that time. He became General Secretary of the Mineralogical Society of Great Britain also in 1938. Dr. Claringbull has the best wishes of members on his new appointment.



Sveriges Forening Exhibition 1953

SWEDISH GEM EXHIBITION

The Sveriges Forening Gemmologiska recently held a jewellery and gemstone Exhibition in Stockholm. For a first venture it was a great success and it is reported that nearly 50,000 visitors attended during the week that it was open.

Emphasis was placed on fine quality jewellery and, apart from outstanding pieces set with diamonds, rubies, sapphires and emeralds, there were many examples of the use of aquamarine, topaz and lesser known stones of equal beauty.

The Association reports that they have gained much goodwill for their organization, both in the trade and with the public.

The Exhibition was held in the Showrooms of Aktiebolaget Nordiska Kompaniet.

MEMBERS' MEETING

A meeting of members was held in the hall of the Medical Society of London on 2nd December. The Chairman, Mr. F. H. Knowles-Brown, presided over an " Any Questions " programme, which, for the Association, was in the nature of an experiment.

Mr. B. W. Anderson, Mr. R. K. Mitchell and Mr. A. Ross Popley comprised the Panel.

Question : What is the cause of some cultured pearls turning black after being in use for some time ?

Mr. Anderson replied that this question had often cropped up in the laboratory. There was a large number of such queries in 1947, and in the past year. It seemed that such queries occurred at times when there was a great deal of sunshine. It was wondered whether it was due to light on shop windows where the pearls were displayed, or on the necklaces while they were worn, causing some photo-chemical action. Unfortunately, research was limited because they had not been allowed to cut the pearls. But during the past year a Fellow of the Association had made available some pearls on which experiments were conducted. X-rays showed nothing. It was found that the colouring was not, as was suspected, in the layer between the nucleus and the outside of the pearl ; it was in the outer nacre. Mr. Webster had been able to effect a partial remedy by treatment of the pearls with hydrogen peroxide, but whether this was a permanent improvement or not was not known. The full scientific answer to the problem was not yet known. This explanation brought some questions from a member of the panel, Mr. Mitchell, who was told that the blackening was, in fact, an ugly grey colour ; there was no evidence of shrinkage ; some had, and some had not, been in wear. It was suggested during the discussion that due to the porous nature of the pearls something might have been picked up from a wearer's perspiration. The hydrogen peroxide treatment was certainly rather drastic. It was better to scrape the pearls.

Mr. Kaye then asked : On heating, certain minerals have changed colour due to atomic structure of the gemstones ; what happened if gemstones were brought down to a very low temperature—would the slowing of atomic movement cause changes ?

The experts agreed that there was no reliable information on this, but it was interesting to cogitate on the matter. There was no facility, so far, for subjecting the gems to extremely low temperatures, though it was known that this would have to be done extremely carefully. One speaker said he had had a large emerald with him in the East for some time, during which it was subjected to about 50 degrees of frost without colour change. Mr. Ross Popley advanced the view that probably any colour change brought about by artificially low temperature would not be permanent.

Heat Treatment of Stones

Question: Is it possible to restore the colour to zircons which have faded in sunlight ? Mr. Ross Popley : It is possible to restore blue stones to their colour, and even to improve the colour, with stones which have faded, either in the window, or in wear. He added that the heating had to be most carefully controlled, and had to take place in a non-oxidising flame, followed by very slow cooling. Subject to these conditions they had obtained about 90 per cent success ; but experience was necessary.

Mr. Mitchell, in a supplementary, wondered how many times this restorative could be applied to one stone. The stone reaching this country was a product of heat. He was of the opinion that there would come a time when that could no longer be done in the laboratory.

Mr. Anderson replied that in some cases the first treatment was permanent, but in some cases, such as zircon, it was " re-altered " ad infinitum. Usually, a proper treatment was permanent, however.

Mr. Ross Popley, during discussion, said that stones would fade with the heat of rhodium plating (only about 180 deg. F.), and it was much more difficult to restore such a stone than one that had been subjected to sunlight. Mr. Anderson did not think, in answer to further questioning, that it was possible to improve opals ; he had not tried to, but the cause of colour in opals was such that it was highly unlikely that colour could be improved by heating.

During exchanges concerning cracks in stones which had been repaired with oil, Mr. Ross-Popley said it had happened that some stones treated in white oil had lost a great deal of colour.

Mr. Anderson said he had normally considered loss of colour in zircon to be due to ultra-violet light, but it might possibly be due to heating to comparatively low temperatures. Mr. Ross Popley said that sometimes stones had lost colour while in the safe.

Synthetics

Mr. Ullman asked why, since synthetic and natural sapphires came from the same chemical elements, the synthetics rarely showed a line at 4,500 under the spectroscope ? Mr. Anderson said this had always worried them because they used that waveband considerably in testing sapphires. They knew iron was used in the making of synthetic sapphires, but it apparently evaporates during manufacture, having contributed to the colour formation, since it melts at a temperature lower than the titanium oxide.

Mr. Kent asked : If droplets of alumina crystallize immediately, why could long bubbles form which seemed to be at right angles to the formation of the boule ? Mr. Mitchell questioned whether the droplets did crystallize immediately (" how does it keep its shape ? " was interjected from the back of the hall). The surface of the boule was kept at a high temperature and he rather doubted whether droplets did crystallize at once. Mr. Anderson supplemented by saying the surface layers of the boule were in a fluid condition and it was a very gradual business, getting the right temperature on the surface to give a single crystal instead of the poly-crystalline mass. He thought the bubble was gas (hydrogen), rising to the surface and as more layers were applied the hydrogen was still trying to force its way to the surface, like a death watch beetle coming to the surface of a wooden beam.

The panel did not accept the accounts published from time to time of Indian lapidaries making stones, from a formula handed down from generation to generation, from powder remaining after the cutting of other stones. Mr. Anderson said that none such had reached the laboratory. Another speaker aid from what he knew of Indian lapidaries he marvelled that there should be any powder available. Re-heating would only produce a sort of glass—it might be quite hard. Dr. Gübelin had recently received samples of rubies with instructions on how to make them. Beryl glass had been seen but it was quite unlike crystalline beryl.

The indiscriminate use of the word " rhinestone " was deplored and the panel were amused by a reference in a national newspaper to " rhinestone pearls." There was general agreement to the suggestion that the word " rhinestone " had been taken up by the dressmakers and exploited. The omnibus use of the term was deprecated.

The meeting was also informed that the name was given years ago to attractive quartz pebbles won from the bed of the river Rhine (Rheinkieser).

Inclusions

Miss E. Ruff said the gemmologist waxed ecstatic about inclusions while the public was reared on the desirability of clear stones. Had anyone bridged the gap ? Mr. Anderson said that Dr. Gübelin showed the public, if they were interested, how one stone cost £50 and another £200 and attempted to explain how one has a number of inclusions which were very beautiful—though they do cause a " spotty " appearance. It would be a good thing if the public were to appreciate that inclusions could be signs of genuineness of the stone. There should be no objection to blemishes as long as they did not disfigure the stone. Mr. Mitchell stressed the importance of this when there was, in fact, a great shortage of clear stones. He thought it was mainly in diamonds and limpid stones that people desired a clear stone.

Another question asked whether the public was really interested in the lesser known stones. The theory was advanced that one of the troubles was lack of knowledge and interest by the jeweller. Some years ago one man in London had tried to popularize these other stones—but he had not made a great fortune out of it. Unfortunately the public were inclined to buy stones, not for their beauty so much as for investment purposes. Given more trade education the public could be sold these stones, one speaker considered. The colours, of course, were not so sharply perfect in these lesser-known stones.

Discussion then turned to the unfortunate aspects of referring to stones by their districts of origin—some districts were literally " damned " in the public eye, while others had a name which was absolute magic—like Kashmir. This was quite indefensible.

Can poor quality stones be improved by skinning ? another questioner wanted to know. Mr. Ross Popley answered that if the colour went through the stone it could be, but if the stone was stained one might be much worse off after skinning it.

In a discussion on detecting real stones and those which had been stained it was suggested that the answer lay mainly in experience, and comparison with as many other stones of known quality as possible. Sometimes it was a useful hint to beware of the stone which appeared to be " too good." Natural colouring was by no means always so equally distributed.

Coloured stones also showed the colour running into cracks and so on. But the most important point was a comparison which was as thorough as possible.

Cyclotron treated stones

Further questions on colouring showed that bombardment of a stone other than by radium gave no radio-activity a few hours after it had been carried out, although the radio-activity was considerable at the time of the work. One should, therefore, examine the fluorescence and colour distribution. Sometimes the bombarded stone showed a little " umbrella " at the base, or a girdle having a run of dark colour.

Laboratory proof of this treatment, it was again stressed, was not easy to produce. In the diamond it was very difficult to find out the colour distribution because of the extremely high refractive index, even in highly refractive oil. A speaker from the body of the hall answered another question by saying he had often seen parti-coloured diamonds ; points often appeared darker. The parti-colouring was usually patchy, and most often seen by the observer in industrial diamonds. One often had layers which could be seen after cleaning. The thickness of a " skin " on a diamond varied widely from the thinnest film to one or two millimetres.

Reverting to bombardment of stones it was stated that cyclotron-treated diamonds could usually be polished back to their original state, but the effect of neutron bombardment was carried right through the stone.

Asked whether the lapidary could tell the difference, on the wheel, between real and synthetic stones (sapphires), Mr. Ross Popley said in about nine cases out of ten the answer was affirmative, because of the different " feel " of the stones on the wheel. He and other speakers, however, went on to reveal that there were startling (and often worrying), exceptions. A ruby mistaken for a garnet was one case instanced. It was dangerous to rely entirely upon the touch, however skilled that touch might be.

Mr. Anderson dealt at length with a questioner who asked why various text-books gave different figures (e.g. specific gravities), for the same stones. He said that there had been an unfortunate tendency for many authors to accept without study the figures of others, but that—often in earlier books—one found variations which were more acceptable than agreed figures because they were based upon actual tests made with gems from a given district. He did not think any examiner would penalise a student for giving a figure which lay within the acknowledged range, provided this figure was arrived at by reliable means. Quartz, of course, was very constant—fortunately—but this did not apply to other gemstones.

The Chairman then called the meeting to a close with some reluctance as it was evident that all had enjoyed the very interesting evening at which much useful information had been imparted.

It was agreed by the general wish of those present that a further session of this kind should be included in the Association's 1954 programme.

Change of Address

The Laboratory of the Diamond, Pearl and Precious Stone Section of the London Chamber of Commerce is moving to 15 Hatton Garden, London, E.C.1. on 1st February, 1954. Articles or stones for testing through the Association should continue to be sent to 19/25 Gutter Lane, London, E.C.2.

Telephone Number

The Gemmological Association's telephone number is MONarch 5025/6. The number MONarch 0871 should only be used in case of difficulty.