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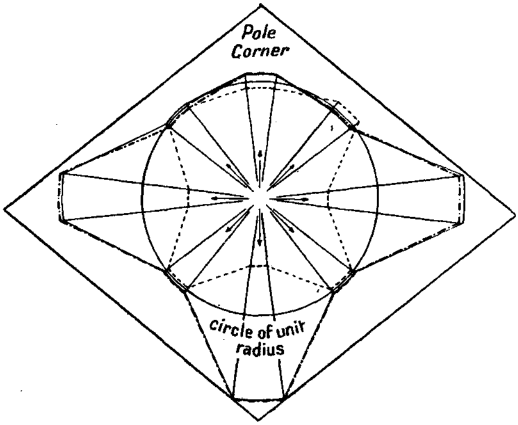
DETAILS OF HARDNESS

by W. F. EPPLER

GENERALLY speaking, the hardness of gem-stones is defined by Mohs's scale of hardness, which was established in 1822. Testing, according to this scale, is made by scratching one stone with another. By this means the resistance, which a stone in question shows against the penetration of a corner or a point of another stone is ascertained and this scratching procedure is, in practice, sufficiently exact to determine the hardness of stones. The resistance against scratching, i.e. the scratching-hardness, is similar to the grinding-hardness, for grinding can be regarded as a kind of repeated scratching. Therefore, it is easy to understand that testing by grinding gives similar results for hardness as when using Mohs's scale. This was known as long ago as 1896, when Rosiwal published his results on grinding-hardness. His method was afterwards improved by other workers, and particularly the work of Tertsch on calcite may be mentioned. An example of the usefulness of this method is seen in Fig. 1 (the values of the grinding-hardness on the cleavage plane of calcite). It exhibits the well known fact that along the shorter diagonal of this plane the hardness is greater from north to south than in the inverse direction from south to north. The most recent investigations on grinding-hardness are those of Grodzinski and collaborators, about two



Hardness differences in the cleavage plan of calcite.

------ 'reduced weight loss' for area of 1sq.cm.

——— 'relative hardness'

-·-·-·- 'relative hardness', ideal mean value based on symmetry.

Fig. 1

years ago. He used small rotating discs, charged with diamond, with which were produced grooves on the polished surface of the specimen. The length of the grooves gives the measure for the hardness. With this method the dependence of the grinding-hardness upon the crystallographic direction can be proved, particularly with diamond.

Now, if we look a little closer at the scratching method we find that by using a sclerometer (Fig. 2) this kind of hardness testing can be done accurately. This instrument was designed by Martens (1912). A diamond point with an angle of 90° is charged with a weight, so that the point rests with a certain pressure on the specimen. Then the stone is drawn beneath the point, and the resulting scratch or groove is measured with a microscope. The definition for the hardness is the weight which produces a groove with a width of 10 microns.

Later, this instrument was improved by Zeiss with an instrument called "Diritest." It is very useful, as it is practically a microscope, the objective of which can be exchanged for a diamond point.

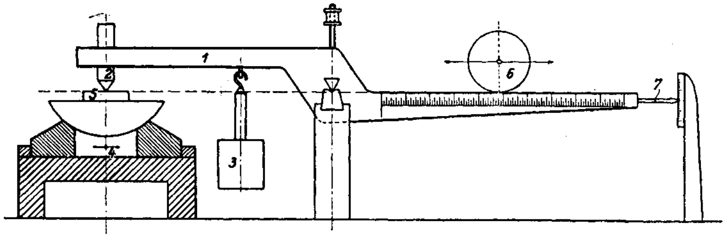


Fig. 2

If we examine a scratch, or a groove made by scratching, we learn that this groove is not only set in appearance by simply removing a certain part of the surface of the stone, but also by another phenomenon, plasticity. This is shown by Fig. 3, which

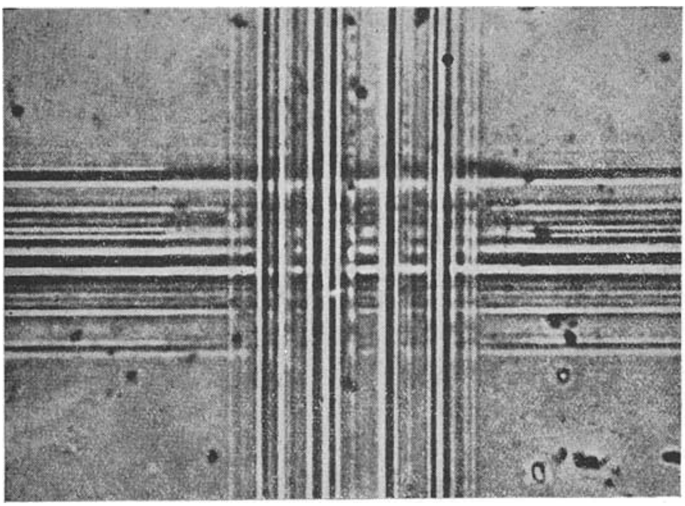


Fig. 3

depicts the surface of a piece of glass with intersecting scratches. This experiment was carried out by Smekal, some twenty-five years ago. He first scratched some parallel lines in the glass, which in the illustration are those running from west to east. Then he produced another series of scratches, running from north to south. It can be observed that the second series of scratches closes parts of the first series, where they intersect.

This seems only to be possible when the pressure, which is necessary to produce a scratch, causes parts of the surface-layers of the glass to be liquefied, or, as the *terminus technicus* says, to be plastified. As glass belongs, without any doubt, to the brittle bodies—just like the gemstones—we have to consider that gemstones also have this property.

These facts indicate that plasticity will influence that particular property of gemstones which we are accustomed to call hardness. The extent of this influence is not exactly known in every case. And as there are additional factors, which must be held in mind, the problem of hardness seems to be somewhat complicated—and it is very complicated indeed.

In Fig. 4 an attempt is shown to bring the basic factors of plasticity, elasticity, brittleness, and toughness in connection with the hardness, which, by the way, is sometimes also called strength. It is not possible fully to agree with such a simplifying construction. Softness can be stated as a very low hardness ; and plasticity only makes its appearance when the elasticity is exceeded by a mechanically produced stress or strain.

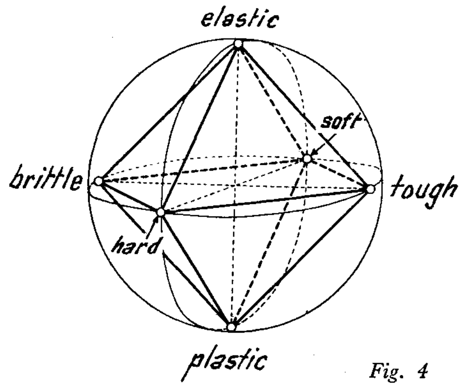


Fig. 4

To sum up : hardness is, in practice, a very useful property and the components which build up this property are related to each other and influence each other in a very complicated manner. A correct definition of hardness is, however, most difficult to devise.

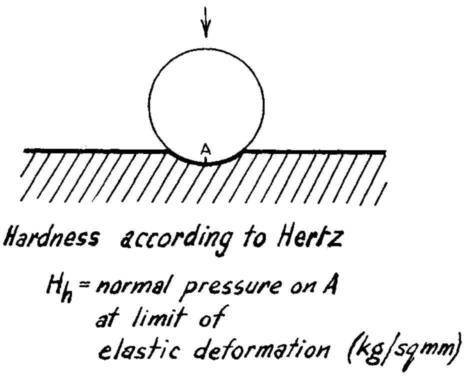


Fig. 5

Methods for testing hardness. Discussion here is confined to so-called brittle bodies, to which belong gemstones. The testing methods have to be divided into two categories—those which are called static, and those which are called dynamical methods.

Hertz (1882), an ingenious worker, proposed that if a ball be pressed on the flat surface of a brittle material, then a pressure will be reached under which the elasticity of the material is just exceeded and a first crack appears. This pressure in kg/sq.mm. shall be equal to the hardness of the material under test. To-day, we know that this definition describes the elasticity only.

Next must be mentioned indentation methods. The principle of these is that if a mechanically produced pressure forces an indenter to work on the flat surface of a specimen, then the surface receives at first an indentation, which corresponds with the elasticity of the specimen. By removing the indenter the surface recovers and the indentation disappears. But, if the pressure is increased to such an extent that the limit of elasticity is exceeded, then the plastic properties of the material will become apparent. This means that the material will flow and show a lasting deformation in the shape of the indenter. How great this plastic deformation or indentation will be depends on the form of the indenter, on the applied pressure, and on the material under test (Fig. 5). While the hardness, according to Hertz, gives an idea on the elastic property, all indentation methods give as a result figures for the resistance against the plastic deformation of a material in question.

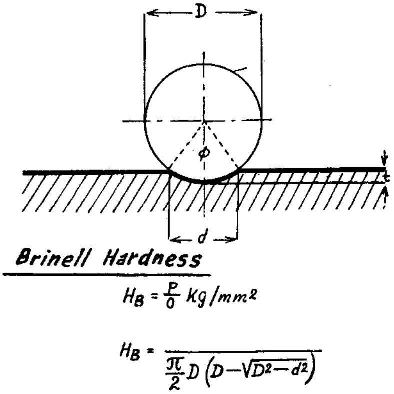


Fig. 6

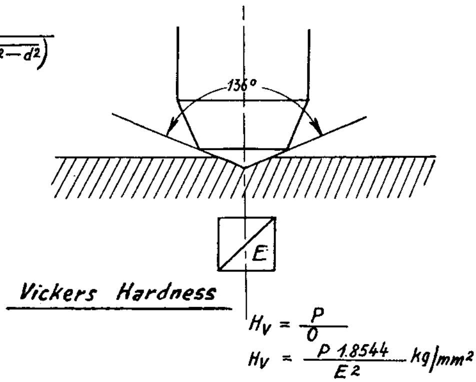


Fig. 7

Fig. 6 shows the principle of the well-known Brinell-hardness method, which was developed in 1900. This also uses a ball, but the pressure used is so great that a permanent indentation is produced. This pressure, measured in kg. over the surface of the spherical indentation, gives the Brinell-hardness in Kg/sq. mm. The values differ with the diameter of the ball. In spite of that, this method is widely used in testing the hardness of metals and alloys. For gem-stones it is not so useful, as their brittle material is so easily destroyed at its surface. The same applies to the cone-indenter of Ludwik. Here a cone is used with an opening angle of 90°. Better known is the so-called Rockwell-hardness, which also uses a cone, but with this method, the depth of indentation is measured, after a primary pressure is increased by a certain amount.

What is recognized as the best method for the hardness testing of gemstones by the indentation process is measurement by the Vickers-hardness (1922), Fig. 7. Here the indenter is a diamond pyramid, the opposite planes of which include an angle of 136°. The indentation has the form of a similar, but negative pyramid, which can easily be measured. The hardness is found by $\frac{P}{O}$, where " P " means the applied pressure in kilograms and " O " the surface of the indentation in sq. mm. As the surface can easily be calculated, when the diagonal " E " of the square base of the indentation is known, we find for Vickers-hardness $\frac{P \times 1{\cdot}8544}{E^2}$ with the dimensions of kg per sq. mm.

Many instruments are used for the measurement of Vickers-hardness. One type is very useful as it enables the Brinell, Rockwell, and Vickers-hardness as well to be ascertained. The specimen is placed on the table which then is screwed upwards, until it rests against the lower end of a holder, which looks like an inverted cap. Then the inner mechanism is set in action by one of the two handles at the right of the instrument. By this the diamond pyramid is lowered from above and produces an indentation with a previously chosen pressure. Then with the other handle, the diamond pyramid is withdrawn and exchanged for an objective of an opaque illuminator type. By this means an enlarged picture of the indentation is projected on the round screen, where it can be measured with a special rule.

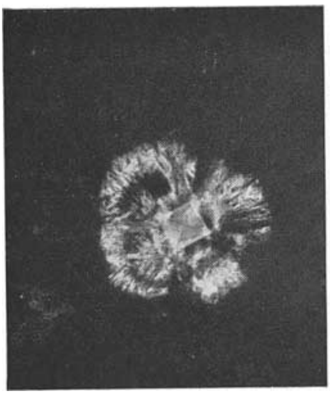


Fig. 8

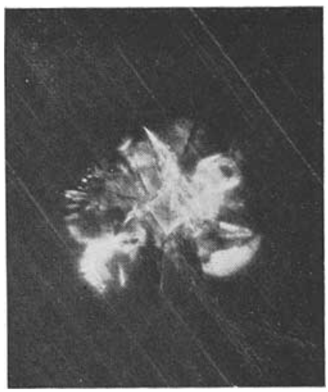


Fig. 9

Fig. 8 shows the indentation with a pressure of 2 kg. on synthetic-spinel, which was improved in hardness by heat-treatment. Besides the indentation itself there are cracks or fissures (which originated from the formation of the negative pyramid). Fig. 9 gives the indentation of a synthetic, colourless corundum, again with shear-cracks around the negative pyramid. In contra-distinction to this are the indentations which were produced on agate (Fig. 10). Here the edges of the base square are curved towards the centre. This fact indicates that the agate has not only a great toughness, but also a considerable elasticity. Incidentally, the reason for the toughness and great elasticity of agate is to be found in its structure. A thin section of this material (Fig. 11) exhibits the fibrous structure of its components. These fibres consist of elongated quartz crystals, similar to the form of a cigar. They are oriented perpendicularly to the layers of the agate. The spaces between the " cigars " are filled with opal, the non-crystallized form of silica. This arrangement produces the particular properties of agate.

It has been mentioned that with the measurement of the Vickers-hardness shear-cracks could be observed. In Fig. 12 these particular cracks are seen as a drawing. If a square is drawn which includes the possible area of those cracks, by using the formula given in the illustration, an expression for the shear-strength can be found. This newly developed measurement of the shear-

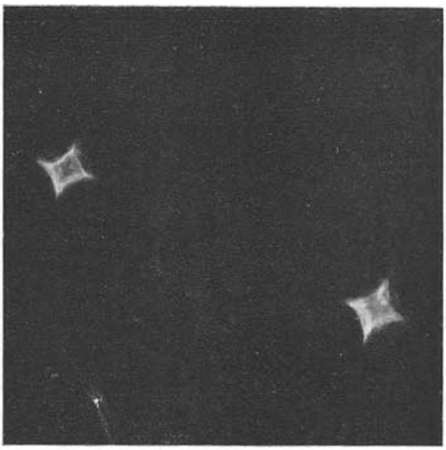


Fig. 10
Indentations produced on agate.

strength has been found to be very useful in finding, for example, the best colour for jewel bearings of synthetic corundum. A similar indentation method to the Vickers is that of Knoop (1939). Here, the indenter has the form of an elongated pyramid. Consequently, it produces an indentation of a lozenge- or rhomb- shape in which the length is seven times the width and thirty times the depth. The latest development is the so-called " double-cone-

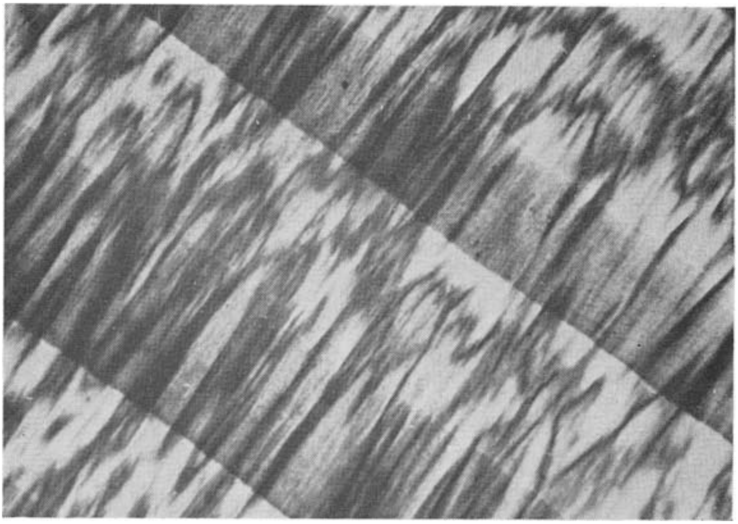
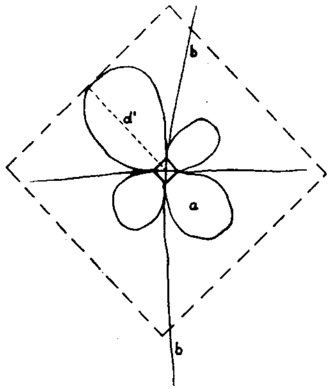


Fig. 11

indenter," which was introduced by Grodzinski. In 1941, the Zeiss-factory in Jena developed a new kind of Vickers-indenter, which allowed determination of the hardness of very small specimens. This instrument was called a " Micro-Hardness Tester." It consists of an objective, which bears in the middle of its front lens a small diamond pyramid or a small Vickers indenter. This instrument allows the application of loads up to 100 gram. which can easily be realized by using this objective in a special microscope. The loads or the applied pressure can be controlled and observed during the pressure by the means of a scale within the objective, and this scale is visible in the eye-piece of the microscope. This instrument is of great value in testing ores or alloys.

These indentation methods are statical. Of the dynamical methods we have already considered two—scratching and grinding. Besides these there exist numerous other dynamical methods, which are mostly and properly developed for the testing of metals. But, two of them are interesting enough to be mentioned—pendulum hardness and the impact abrasion hardness methods.



$$Hv = \frac{P}{l} = \frac{P \cdot 1{,}8544}{d^2} \quad kg/mm^2$$

$$Sv = \frac{P}{O'} = \frac{P}{4d'^2} \quad kg/mm^2$$

Fig. 12
Vickers-hardness shear-cracks, shown as on drawing

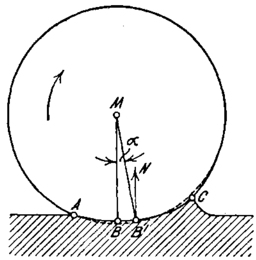


Fig. 13

The pendulum hardness method was first applied by Herbert in 1923. He used a pendulum which is so constructed that its centre of gravity lies just a little below the moving support, so that it can swing easily. The support itself consists of a steel ball of about one millimetre in diameter. This is placed on the specimen to be tested and the pendulum set in oscillation. The oscillations are reduced by the friction of the ball support, and this reduction gives a measurement for the hardness of the specimen. Fig. 13 demonstrates the indentation in the surface of a metal and indicates how the oscillations are reduced. At present this method is not used on brittle materials, such as gemstones. It might be worth while, as it seems that many interesting results could be obtained with this somewhat unusual method.

The second dynamical method is the impact abrasion hardness. It was first applied by Ridgway and collaborators in 1933. This is based on the technique of sand-blasting. Compressed air is forced into an injector, by which the sand is transported upwards in a combined nozzle under which rests the specimen under test. This is sand-blasted for a certain time and afterwards its loss of weight is determined. The surplus sand falls down in a funnel, from which it is used again. The whole is placed in a housing of sheet-iron which carries a window and an exhaust, to remove dust. This device is very simple indeed, if one knows all the tricks which make the difference between success and failure. This method was used to find out whether or not it was possible to harden agate, as this stone is widely used as bearings in instruments and particularly in balances. It was imagined that such a hardening could be done, if transformation of the component of the agate, which consists of opal, into crystallized quartz, could be achieved. This could be possible by a heat treatment within a reasonable range of temperature. It failed ; not because the method of sand-blasting was not good enough, but because the impact abrasion hardness of agate is more than three times higher than that of the crystallized quartz. This was not known in advance, but was ascertained later, as is shown in Fig. 14. At a little over 200°C the impact abrasion hardness drops until it reaches a constant low value, which is identical with the hardness of quartz. Here, for the first time the elastic properties of a material were found to have a considerable influence on the hardness and particularly on the values of the impact abrasion hardness.

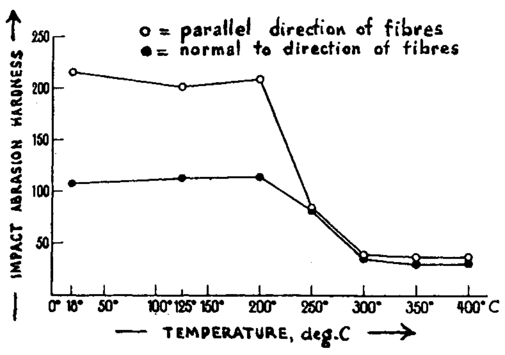


Fig. 14

Next this very sensitive method was used to test the hardness of synthetic corundum, that is in the directions parallel and perpendicular to the c-axis and after heat-treatment as well. Even a heat-treatment of 24 hours at 1,200°C has no measurable influence on the hardness of this material.

Hardness according to Mohs	Relative grinding hardness according to Rosiwal (Quartz=100)	Relative impact abrasion hardness (Quartz=100)
1	0·03	6·2
2	1·04	6·2
3	3·75	10·1
4	4·17	9·9
5	5·42	5·0
6	31	46
7	100	100
8	146	81
9	833	594
10	117,000	109,000

Fig. 15

It is very interesting to compare the impact abrasion hardness with other methods of hardness testing. Fig. 15 shows the relation with grinding-hardness, all numbers correlated on quartz equal to 100. Both kinds of hardness follow Mohs's scale, but with a much more increasing rate. Of particular interest is the fact that impact abrasion hardness number 8, measured on topaz, appears to be distinctly lower than number 7, measured on quartz. Here again the influence of elastic properties may be responsible for such extraordinary findings.

To emphasize that such seldom used practices as impact abrasion hardness can be very useful, Fig. 16 shows the result of an investigation on the hardening of synthetic spinel. Synthetic spinel can only be produced commercially if it contains an excess of alumina in the form of gamma-corundum. It was shown by Rinne, as early as 1928, that, by heat-treatment the additional alumina can be precipitated within the spinel. He also demonstrated that the precipitation of micro-crystalline alpha-corundum produces an asterism, which, by the way, is too poor to be of any value. It was considered that by such a precipitation the hardness of the synthetic spinel itself could be increased. During our investigations it was noted that the sand-blasting method, which provides the impact abrasion hardness, is able to disclose very small differences in hardness. There is a large increase in the impact abrasion hardness by heat-treatment, also for the normally produced synthetic spinel with a ratio of 1 magnesium oxide to 3·5 aluminum oxide. It was further ascertained that the addition of more alumina could not increase the hardness to an appreciable extent.

Fig. 17 exhibits the very fine differentiations in the effect of sand-blasting. It was wondered what would happen if blasting was extended over several hours instead of minutes. The picture shows the surface of a synthetic corundum which formerly was flat and even. After extremely long sand-blasting grooves were found which seemed to be the softer parts of the stone. But, besides this, harder parts which indicated a greater resistance against the sand-blasting and which formed ridges were noticed. These chains of ridges are nearly parallel to each other. And it is thought that they follow in orientation the edge of the trigonal rhombohedron, which is the ruling crystal-form of synthetic corundum. Before the ridges is a plane, geographically speaking, with some small elevations. The altitude of the elevations over this area was found to be 150 microns. The indentation hardness of the ridges and hollows was measured and the hardness of the plane area and the bottom

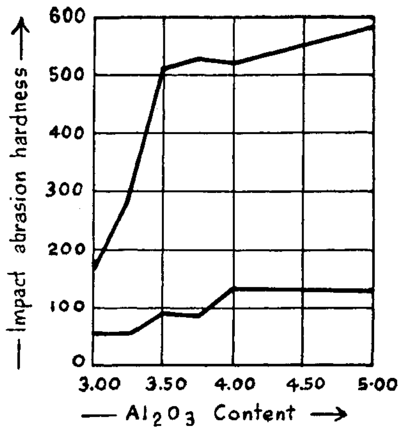


Fig. 16

Results of an investigation on the hardening of a synthetic spinel

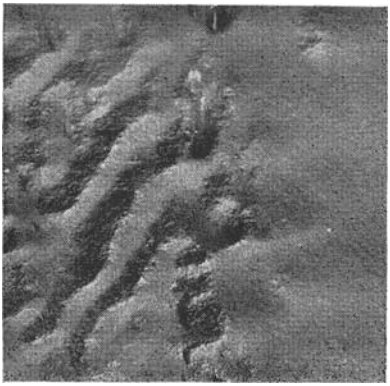


Fig. 17

Five differentiations in the effect of sand-blasting surface of a synthetic corundum.

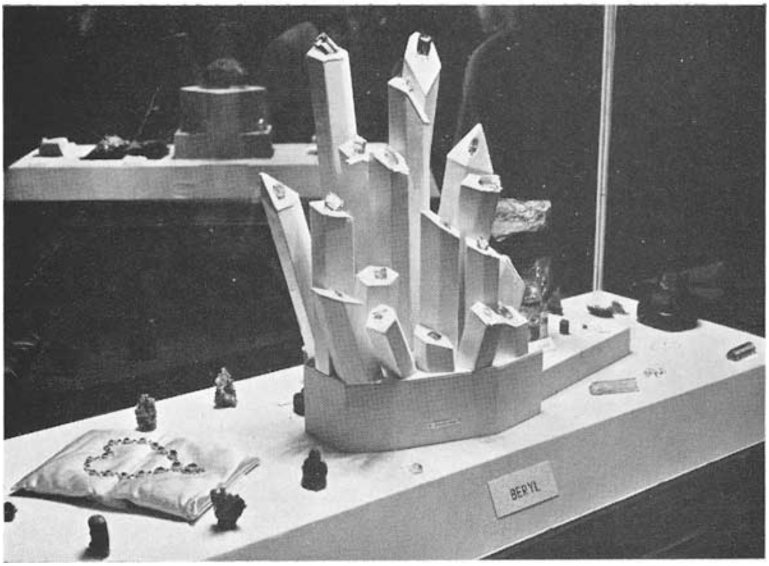
of the " valleys " were found to be identical. The top of the ridges, however, had a Vickers-hardness which was 220 kg/sq. mm. higher. This shows astonishingly great differences in the hardness of synthetic corundum in a single crystal.

This experiment was possible because the impact abrasion method is very sensitive, and a further contribution to the fact that the ideal crystal only exists in the imagination was gained and that the so-called " real " or " realistic " crystal with its deformed or disturbed lattice-structure, is that which is both offered by nature and likewise found in artificially-made crystals.

BIRMINGHAM GEMMOLOGICAL EXHIBITION

THE gemmological exhibition organized by the City of Birmingham Museum and Art Gallery and the Midlands Branch of the Association was opened by the Lord Mayor of Birmingham (Alderman A. Lummis Gibson) on Wednesday, 12th October. Mr. Trevor P. Solomon, Chairman of the Midlands Branch, who thanked the Lord Mayor, was supported by Sir Cyril Dyson, Chairman of the National Association of Goldsmiths. Great credit is due to the organizers, particularly Mr. Solomon, Mr. D. N. King, the Branch Secretary, and Mr. N. A. Harper, Vice-Chairman of the Association, for staging such a splendid exhibition. Attendance for the period 12th–30th October was 50,400. Those responsible for the exhibition produced a display gems, both unmounted and in jewellery, which was every bit as fine as the exhibitions staged previously in London and Glasgow.

Many of the exhibits were obtained from private collectors, museums and associations. Her Majesty the Queen lent an opal



and diamond suite which contained the Andamooka opal, a present to her from the people of South Australia, and the Duke of Devonshire loaned the famous Devonshire emerald, an uncut crystal of 1,383 carats. Many of the show-cases were devoted to single gem species and outstanding of these were those of diamond, beryl (this case contained a huge aquamarine crystal weighing 28,504 carats) and opal, and the case of lesser known gems, such as hiddenite, sphene, euclase, and a specimen of taaffeite.

Mounted specimens were displayed side by side with the cut and uncut gems and an extremely fine emerald necklace was outstanding. A few pieces of Carl Fabergé emphasized the genius of the jeweller, and many carved ornaments of jadeite, nephrite, coral, quartz and amber were a delight.

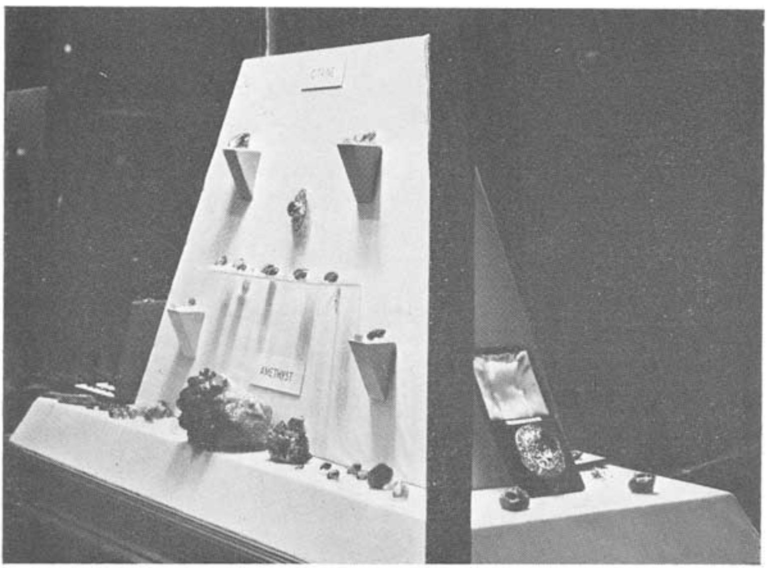
On the whole it was the unmounted stones, which were in a majority, that impressed most visitors and the way in which they were presented was most rewarding to those that had painstakingly gathered the many gems together during the past twelve months. The diamond exhibit alone was valued at more than £100,000, and there were some excellent stones, including one valued at £16,500.

The greater part of the exhibition was arranged in show-cases grouped round Sir Jacob Epstein's statue of Lucifer, while cases containing miniature models of diamond-cutting apparatus and gem-testing instruments were in an adjacent room. A special feature was periodic demonstrations of gem-cutting, given by Neville Deane, F.G.A.

The organizers had catered for every interest—lovely gems to delight and interest the non-technical to fluorescent gems and cyclotron-bombarded diamonds for the initiated.

To assist those who were interested and to form a permanent guide to gemmology a fifty page booklet—*An introduction to gemstones*—was issued with a front cover of gems in colour. (See p. 270.)

Once again members of the Association, by much hard work, had been able to demonstrate the loveliness of gemstones, and it will be a long time before another exhibition is staged that will be as successful as that arranged by the Midlands Branch.



Gemmological Abstracts

SWITZER (G.). *Diamond Industry 1954.* Jeweler's Circular—Keystone, 15 pp., 1 map.

Total diamond production in 1954, at 20,440,000 carats, was once again a world record. 16,840,000 carats were of industrial grade and 3,600,000 of gem quality. The U.S.A. consumes about three-fourths of world production. This annual report (the thirtieth) contains the usual information about cutting, mining, technology, and there is reference to synthetic diamond.

S.P.

BROSE (H. W.). *Civilizations and Gems of America* (Part One). Lapidary Journal, Vol. IX, No. 4, p. 354, October, 1955.

One can forgive the author if there is little information on gems. In the search for gems it is easy to get lost—among people. Perhaps it is that gem research provides a more human approach, compared with the strict historian or pre-historian.

That the question of " civilization . . . is open to argument " regarding the races of America before the white man appeared, is surely wrong. So much has been uncovered in recent years that it might be difficult for the white man, fully conversant with facts, to feel superior. While scientists are unrolling the carpet one way, archaeologists are unrolling it the other, with comparable speed.

The author writes of two schools of thought on the origin of early American peoples. He might have added a third, for it claims a substantial proportion. This is the theory of *two distinct migrations.* Of these invaders, one group came from Asia, via the Bering Strait, still obvious by the Mongolian features of the Eskimoes and northern Indians, and one from the north and east coasts of South and Central America respectively. This race is believed to have involved the Atlanteans, as the author suggests. According to Plato the final sinking of this continent took place between 9,000–10,000 B.C. But there were earlier catastrophies. It is suggested that parts were submerged long before, sending its colonizers all over the known world with tales of a terrible flood that lives on in the Bible story, and in many an unwritten literature of races unacquainted with the Old Testament.

Some experts attribute the Crô-Magnon or Aurignacian race of Europe—described by Sir Arthur Keith as one of the finest types, mentally and physically, the world has ever known—to this very race. They appeared in Europe at the end of the last Ice Age, about 25,000 years ago. Other off-shoots or developments of this sunken continent are supposed to have lived on in races that to-day we know quite a lot about. The outstanding civilization, in this respect, is Egypt. As the author says of the American races, they did not develop their culture *after* arrival. The Egyptologist, Walter Bryan Emery, gives an example of a ready-made civilization. Mesopotamia, he says, started from simple things, with its lowest levels of crude implements used by near-savages and its upper strata gradually improving. When the " Egyptians " took over the Nile, they found the established culture neolithic, of a fairly high grade, but not a civilized grade. They came with a written language and papyrus to write on.

The author gives the first cities of the Incas as 500 to 600 B.C. Obviously these were no early Americans. The Incas merely took over what was already there, mostly stone colossi.

Brose comments upon the poorly polished gems in this period, that is, around 500 B.C. and later, and suggests that polishing was a lost art. Among non-metal people the art of polishing was very high indeed. The beautiful jade cylinder from Guiana in the British Museum is an example of the lapidary's art in this part of the world. And fine jade polishing has lived on, not only among the cultured Chinese but in the neolithic Maori.

E.R.

HASTIE (R.). *My Trip to Jade Mountain in Alaska.* Lapidary Journal, Vol. IX, No. 4, p. 296, October, 1955.

Perhaps no one could have been more helpful to the author on this subject than the man he sought—James Kraft. Mr. Kraft, like many another anxious to locate the Jade Mountain of early maps, some years ago went to the length of backing an old native of those parts whose story he believed. Fortunately, Mr. Hastie was able to make the greater part of the journey by air. With a confederate and his two-seater plane, the rest was all but easy. Even before they arrived at the base of Jade Mountain the author discovered boulders of jade released from the earth in the process of gold-mining. Although some of this jade was of inferior quality, other boulders were good, ranging in colour from dark green, mottled with black spots, to a light grey. Further away they came upon an old prospector who had spent thirty years mining gold and had built himself a jade-cutting machine, using water power and a cutting wheel of 24 inches. Later, the explorer located Jade Mountain from the air, with its " large amount of green serpentine " covering it. Eskimoes had said that, on a sunny day, the reflection from this deposit made it easy to identify. Landing so as to minimize walking, the two men covered " approximately seven miles, across the tundra and up Jade Mountain." On the way, after crossing Jade Creek, they came upon the finest jade of their trip, some of it of gem quality, with variegated greens and free from the black spots of the earlier finds. Other explorers too had been impressed, for here were cabins and a diamond-cutting saw, with power provided by a gasoline engine. The equipment must have travelled by barge up the Kobuk river, " and then pulled on a drag across the tundra to its location."

The top of Jade Mountain reads a little like a fairy-tale. Tremendous boulders of jade were lying everywhere " as though a giant had dropped them indiscriminately." Some weighed approximately 20 tons, and more. Most fantastic perhaps was that a complete area had been staked out as a claim. To-day, with all the jade resources of Alaska to draw on, the author sought a boulder that might prove worthy of time, trouble and cost. The selected one, to quote again " had a smooth, rust-coloured rind with green showing at several spots." The problem to-day is not only one of cutting and polishing, with labour at a premium, but transportation.

E.R.

SWITZER (G.). *Star spinel showing four six-rayed stars.* Gems and Gemology. Vol. VIII, No. 6, pp. 163–164 and 190. Summer, 1955.

The description of an unusual phenomenal stone from the Ratnapura district of Ceylon. Identification of the stone was made by the X-ray powder diffraction method. The stone is black in colour and the specific gravity was found to be 3·550. No measurement of refractive index could be given as the stone is cut as a double cabochon ; measures 12 × 14 mm. and weighs 11·80 carats. When viewed from the top it shows a sharp well-centred six-ray star and when viewed from various directions nearly parallel to the girdle, three additional six-ray stars are distinctly visible, being placed around and slightly above the girdle at 120° to one another. Each of the three girdle stars has one ray in common with the main star. The stone is a single crystal and is not twinned. The crystallographic relations—the stars are said to be due to inclusions oriented to the edges of the octahedral faces—are fully discussed. The stone is said to be unique as all known star spinels have four-rayed stars due to inclusions parallel to the edges of the cube faces.

4 illus. R.W.

BENSON (L. B.). *Why make appraisals ?* Gems and Gemology. Vol. VIII, pp. 172–190. Summer, 1955.

A very full discussion on the carrying out of the work of jewellery appraisals and on appraisal policies as they relate to the retail trade in the United States of America. Five reasons are given showing why firms tend to refuse this type of work, and the writer suggests that these reasons need not be valid. The ambiguity of the term value ; the question of the competitor ; misrepresentation, and the attitude of the customer is discussed. The necessary requirements of an appraisal service are given and the basis for the fee to be charged is discussed. It is brought to notice that insurance coverage includes payment for damage as well as for loss, and most appraisal forms do not give enough information for the insurance company to determine the extent of damage. The types of forms used for reporting the appraisal as used by many firms are considered in detail and suggestions for improvement made. An article of use to jewellers and gemmologists.

6 illus. R.W.

WALTON (J.). *The formation of quartz and chalcedony.* Gemmologist. Vol. XXIV, Nos. 288/289/290/291, pp. 119–123; 139–142 ; 164–169 ; 191–194. July/Aug./Sept./Oct., 1955.

Silicon, while not occurring in the free state, forms 28% of the earth's lithosphere. Combined with oxygen the silicon may then occur as free quartz, which, while containing no hydrogen, acts like an acid. Rocks are classified according to the amount of free silica present in them. The outer layers of the lithosphere—Sial and Sima—are referred to, and the rocks and their classification discussed. A large proportion of the free quartz occurs massive and in veins, crystals not occurring until there is space for their free growth. The formation of pegmatites is discussed and the order in which minerals crystallize out in them and in veins is given. Weathering may expose the crystal containing cavities and the crystals subsequently breaking down and finally becoming water-worn pebbles forming the alluvial gravels. A general discussion on the formation of geodes is made. Rose quartz is usually found massive and localities for this material are given. Aventurine quartz is mentioned as a quartzite containing inclusions of fuchsite or hematite. Quartz cat's-eyes and tiger's eyes are mentioned in the closing remarks on crystal quartz. Crypto-crystalline quartz is made up of multiple sub-microscopic crystals. Prase may be rock crystal coloured green by many actinolite fibres. The term chalcedony is used for the whole crypto-crystalline quartz group, and for the uniformly greyish-green translucent variety ; it is suggested that the name chalcedony be reserved for the variety and the group designated as crypto-crystalline quartz. The group is said to be concretionary in origin, to contain small amounts of hydrated silica in the amorphous form opal, and to have been deposited from concentrated hydro-thermal solutions. The formations produced and the varieties are mentioned, the latter being due to impurities and colouring material from the mother rock. Most, including jasper, show in varying degree a banded structure, but the author puts forward a theory that chalcedony and cornelian be not so and deduces this from the effect seen when a polished slice is rotated in transmitted light. It is inferred that these roughly hexagonal areas seen under such conditions are due to growth in concentric layers from widely separated nuclei which eventually meet one another and produce this pseudo-hexagonal mosaic effect. This effect is not seen in chrysoprase or chalcedony which has been stained. The colour of cornelian is ascribed to dark brown grains of hematite surrounded by red circles which are aurioles of greater iron pigmentation to the diffused iron which has coloured the main mass. The banded formation of agate is made up of layers of varying porosity. An elaborate survey is made of the theories of the formation of agate geodes, and included in this are the so-called " Thunder eggs." Green moss-agate may be derived from included twisted fibres of green asbestos, and prase is suggested as a closely packed form of this type of green moss-agate. Many moss-agates owe their " moss " to granular inclusions, and bloodstones may be a similar closely packed effect with the addition of flakes of, possibly, the mineral chlorite. The series closes with a short note on jasper.

21 illus. R.W.

SHERMAN (E. G.). *Gem of all gems—the opal.* Gemmologist. Vol. XXIV, Nos. 290/291/292, pp. 159–163 ; 183–186 ; 208–211. Sept./Oct./Nov., 1955.

An outline of the opal and its mining in Australia written by a miner and dealer in this gem. The opening paragraph deals with the romanticism of opal. The Hungarian occurrences are mentioned as being found as deposits of little veins in a hard white rock. Australian opal is found in flat desert country with scant vegetation. There is little in the way of geological structure to guide the prospector ; and occasional " floater "—a piece of surface opal—may give an indication, but this may have been washed down for miles away and the indication be therefore spurious. Claims, 150 by 150 feet, are staked and miners need a licence, commonly called a " Miner's right " in order to work the claim. The opal is usually found some 15 to 85 feet below the surface and mining is by shaft, dug until the opal stratum "band" is reached. The sandstone of the district overlies a floor of clay, but between this lies a highly ferruginous and siliceous stratum varying from a film to two inches thick which is known as the " casing." The base of the sandstone for a thickness of two to eighteen inches is somewhat ferruginous and hardened and this is generally called the " band." Opal is found in the clay, the " casing," the " band " and in the main mass of the sandstone. Horizontal tunnels are driven along the " band " from the bottom of the shaft and the earth so removed is brought up in cowhide buckets and spread along the top of the shaft. Illumination is provided by candles or by carbide lamps. There are four types of opal—*boulder* opal, *sandstone* opal, *seam* opal and *black* opal. Boulder opal was first discovered in Central Queensland in 1875. This variety occurs in thin veins ramifying through hard jaspideous greasy and brown boulders varying in size from a man's fist to a man's body and occurs at varying depth. The cost of carting big boulders is heavy and they are usually broken up by the use of a tomahawk. The seams are thin but the colour brilliant and this opal is said to be harder than some other varieties. *Sandstone boulder* and *Vowah nuts* are sub-varieties of boulder opal, the vowah nuts occurring in a unique formation not far from Vowah Homestead ; they are the size of walnuts or large almonds and are found in a regular band about one foot thick around the floor of the mine. These contain opal either as a central kernel or as a thin jacket running between the outer coating and a deep chocolate-brown ironstone centre. Occasionally little veins of opal traverse the centre but never run to the outer edge. Sandstone opal was found in 1889 in Central Queensland. It is a variety forming " pipes " with a thickness varying from that of a needle to an inch or more running through the free sandstone. Seam opal was discovered in 1890 at White Cliffs in New South Wales. It is found in flat cakes with a thickness from that of a wafer to that of a dog biscuit and comes clean out of the ground without any adhering matrix. In vertical seams it is thicker and extends below the " band " but often the major portion is common opal, called " potch," with noble opal as thin bands in it. Black opal was found in 1903 at Lightning Ridge in New South Wales and is mined to a depth of 120 feet in places. This opal is found in the grey clay below a steel-like band, commonly called " shincracker," owing to the way the pick flys off it, and which lies below the sandstone. The opal is located in small pockets of small " nobbies " as they are called locally, and are said to be pseudomorphs of corals and sponges. The important cut and named opals are discussed and the story told of the unscrupulous people known as " night-ratters " who work another's shaft during the night. The seam opal at Coober Pedy in South Australia was discovered in 1915 in a part still rather inaccessible. The opal is found in slides and verticals and is a rich but small field although two years ago only seven old men were working there. In 1930 opal was found at Andamooka, also in South Australia. The opal here, which is harder than most other types, is found in shallow workings in a small area. This opal does not tend to crack like much which comes from the damp clay. Some black opal is found at Andamooka. An article with much information and illustrative of mining conditions. R.W.

Kennedy (N.). *The classification and storage of gemstone specimens*. Gemmologist. Vol. XXIV, No. 291, pp. 186/7. October, 1955.

Describes the use of stone papers of different colours as an aid to storing a gem collection ; with particular reference to the control of stones for teaching purposes, different colours of paper being used for stones classified as having particular properties, e.g., dichroism, fluorescence, etc.

R.W.

Anderson (B. W.) ; Payne (C. J.). *The spectroscope and its applications to gemmology*. Vol. XXIV, Nos. 290/291/292, pp. 171–174 ; 195–197 ; 204–206. Sept./Oct./Nov., 1955.

This series continues with the consideration of the absorption spectra of idocrase, actinolite and serpentine, minerals in which the spectra are due to ferrous iron, and are three materials which simulate the jades. Nephrite is a convenient term for the massive amphibole of the tremolite-actinolite series, " Mutton fat " nephrite being nearly iron free tremolite while the commoner green nephrite is nearer to actinolite in composition. The strongest and most constant band in the absorption spectrum of idocrase is centred in the blue at 4620A and was first noted by Henry Becquerel in 1889. The band is characteristic of the extraordinary ray only. In brown idocrase this band may be masked by the strong general absorption in the blue-violet. In the green types it is broad and clearly seen and, although narrower, is seen in the massive green variety called *californite*. Other bands are seen in idocrase at 5280A (narrow) and a broad band at 4870A, but these are relatively weak. In some Laurentian (Canada) brown idocrase the rare-earth spectrum of didymium consisting of fine lines in the yellow and green may be seen. In actinolite the bands are weak. There is a vague band in the yellow and two faint and narrow bands at 5100A and 4950A, the latter sometimes being seen in " mutton fat " nephrite which also shows another band near 4600A. Most of the serpentines show a typically ferrous iron band at the junction of the green and blue at about 4920 to 4980A and another at 4650A. The bowenite variety has vague bands at 4970A and at 4640A which have little diagnostic value. The williamsite variety has a vague band near

5400A and a narrow band at 4500A. The serpentinous calcite known as Connemara marble shows the 4650A strongly but is usually masked by the general absorption at this region. There is a weak band at 4950A. Pseudophite, the so-called " Styrian jade," is mentioned as having a line at 4980A. A specimen of antigorite, another variety of serpentine, showed lines near 5400A and others in the blue. It is noted that the region near 5000A is a key position for spectra due to ferrous iron. The absorption spectra of gemstones which owe their colour to ferric iron have their maximum at a shorter wavelength, at about 4500A. Sapphire is the most important, and in the green sapphire there are three evenly-spaced absorption bands centred at 4710A, 4600A and 4500A, the last being the strongest and almost merges into the next strongest at 4600A. Australian blue sapphires have a similar spectrum. Burma, Kashmir, Siam and Montana blue sapphires show the 4500 line clearly while in Ceylon sapphires it is extremely weak. The use of a copper sulphate filter allows the line to be more clearly seen. In deep coloured blue sapphires a vague absorption may be seen centred at 5850A. Yellow sapphires show a similar spectrum ; in the case of Australian, Siam and Montana stones the lines are distinct but in Ceylon stones very weak. There are diagnostic bands in the ultra-violet in natural blue, green and yellow sapphires. The synthetic blue, green and yellow sapphires show no bands and this aids distinction. In yellow chrysoberyl there is a strong band centred at 4440A which may be distinguished from the sapphire bands by its single composition. In some deep yellow chrysoberyls there are faint narrow bands at 5050 and 4850A. In brown chrysoberyls the 4440A band is masked by the general absorption of the blue-violet, but in the honey-yellow and greenish-brown catseyes it may be seen and aids distinction from quartz catseyes. The absorption spectrum of aquamarine cannot usually be seen unless the stone is fairly large when a moderately strong line at 4270A and a feeble line at 4560A may be seen, with a line at 5370 which is narrow and clear. This line, and the others, are seen most clearly in the extraordinary ray and a polaroid employed to separate this ray will assist observation of the 5370A line, which can also be observed in colourless and yellow beryls. The beryl from the Maxixe mine in Minas Gerais, Brazil, shows an unusual spectrum consisting of a strong narrow band at 6950A and another at 6940A with weaker bands in the orange and yellow and a weak vague band in the green at 5500A. Maxixe beryl has a high density (2·80) and refractive indices of 1·584–1·592, but the material is not used for jewellery to any extent for the colour is said to fade. Yellow orthoclase feldspar from Madagascar shows a weak diffuse band at 4480A and a stronger diffuse band at 4200A and in the ultra-violet there is a strong band at 3750A. The pyroxene minerals yellow spodumene and jadeite have precisely similar spectra to each other as far as the lines in blue due to ferric iron are concerned (as mentioned earlier in the series the green jadeite shows lines in the red due to chromium). These ferric iron lines consist of a strong band at 4370A and a weaker " echo " at 4330A, these being the same for yellow spodumene and for jadeite. Kunzite does not show these lines. The 4370A line in jadeite is diagnostic, but may need a fairly open slit to the spectroscope for it to be seen, and the use of a copper sulphate filter to cut out the red, yellow and bright green part of the spectrum will facilitate the observation of this line.

6 illus. R.W.

BOOK REVIEWS

MONNICKENDAM (A.). *The magic of diamonds.* Hammond, Hammond & Co., London, 1955. 192 pp., 28 plates, 16 line drawings. 18s.

Although at first sight this book seems expensive it is a well-written account of personal experiences in many years of diamond trading and cutting. There is comment about famous stones and old aspects of diamond history are embellished by the author's own experiences or observations. Mr. Monnickendam suggests that a stone once shown to him by an Indian Prince was most likely the Orloff, re-cut. Portraits of Boer farmers winning diamonds in the early days and the rivalry between Rhodes and Barnato are vividly depicted. As is to be expected from a master diamond cutter the technical section of this book is excellent and as good as anything that has yet appeared for the general reader. The control of diamond mining and distribution are re-stated and the book ends with a brief reference to the production of synthetic diamond and the prospect that such production is likely to be restricted to industrial needs.

S.P.

TOLANSKY (S.). *Microstructures of diamond surfaces.* N.A.G. Press, London, 1955. 67 pp., 143 plates. 40s.

The author has specialized on the microphotographical structure of the surfaces of diamonds for many years and this book is, to a large extent, an up-to-date record of his work. The text has been restricted to emphasize the numerous pictures. The optical techniques used in the study of diamond surfaces, the nature of trigons and etched surfaces are chapters of considerable interest. Discussing diamond polishing Professor Tolansky suggests that a Beilby layer does not form when diamonds are polished and interferometric observations support this view. Although it is claimed that the book is written for the general reader, the specialist is most likely to read and understand its valuable technical contents.

A.G.

HARPER (NORMAN). *An introduction to gemstones.* City of Birmingham Museum and Art Gallery, 1955. 50 pp. 2s. 6d.

Written with the intention of supplying the need for an inexpensive book suitable for the lay person visiting the gem exhibition held under the auspices of the Midlands branch of the Gemmological Association and the authorities of the City of Birmingham Art Gallery and Museum, " An introduction to gemstones " is a short but surprisingly complete " text-book."

The fifty-page paper-covered book has the cover showing eleven gemstones in full colour printed on a grey background.

The frontispiece is that familiar illustration of the " big hole " of the Kimberley diamond mine. The caption says 3,601 feet deep. This is the depth of the shaft mine and not that of the open working which is illustrated and which is only somewhat over one thousand feet in depth.

The preface tells the reasons for the publication of this book and mentions some of the important exhibits shown in the exhibition, and also something of the valuable collection of gemstones in the Natural History Department of the Museum itself which includes the Ansell collection of sapphires and spinels.

The general survey given at the commencement of the text is a masterpiece of lucid coverage leading up to sections dealing with the physical and optical properties, preceded with a section on elementary crystallography, the crystal systems being well described with the aid of line drawings. There is a short section on the chemistry of gemstones and a very full one on specific gravity where the direct weighing method of density determination is described with examples, heavy liquid methods also being told. The factors depending upon cohesion are mentioned followed by the section on optical properties, in which the behaviour of light rays in different media is told and this leads up to considerations of the refractometer and its use. Colour phenomena are covered by references to dispersion, pleochroism and absorption spectra. At first sight a section on electrical and luminescent phenomena appeared to be superfluous in such a book until it was recalled that a fluorescence exhibit was incorporated in the gem exhibition.

Glass imitation gemstones are well explained, some notes on their distinctive characters being given and the metallic oxides used to give the various colours to glass are tabled. The artificial formation (synthesis) of gemstones is entertainingly told, and includes notes on the synthesis of diamond which has so recently broken on the world of gemmology. Verneuil's process for the production of synthetic corundum and spinel is clearly explained, synthetic (alexandrite colour) corundum and synthetic star stones being mentioned and also the uses that are now made of such synthetically produced material in industry. The synthetic emerald, and synthetic quartz, are dismissed in just over four lines. Artificial coloration by heating, by staining and by bombardment with particles of atomic size are discussed. A general survey of precious stone cutting is given, the styles of cutting being well illustrated by line drawings. A note is given on the units of weight employed for gemstones and some of the factors in gemstone valuation.

Thumbnail sketches are given of the more prominent gemstones ; these being diamond, corundum, beryl, topaz, spinel and garnet, tourmaline, olivine, chrysoberyl, zircon, opal and quartz, and finally " Chinese jade." The text for each stone adopts the usual style—the composition and constants, a general note, varieties, if any, the style of cutting used and the localities where found. A number of the rarer stones are dealt with in tabular form at the end of the book, which closes with a short bibliography.

There are few errors in this work, and none serious. The gemmologist might disagree with the values of density and refractive index given for topaz, 3·53 and 1·62–1·63, which are values very rarely found in actual practice, there being two distinct divisions of the topaz family with slightly different values. The term " blue white " for perfection diamond might have been omitted in view of the proposed discontinuation of this term. For a similar reason the term chrysolite might have been with advantage left out. Are quartz cat's-eyes wrongly described as cat's-eyes ? Surely cat's-eye is the term for an optical effect and not the name for a gemstone, whether it be the prized chrysoberyl or the more lowly quartz—or tourmaline for that matter. It would have taken only a few more words to give the colours of aventurine quartz, the "aventurescence" of which is not always due to mica. That the nephrite jade mineral is " Chinese jade " would not be acceptable in trade circles, which term only the material from Burma " Chinese jade," i.e., jadeite. Sphene, despite mention in the text, is omitted from the table of rarer stones. The absence of a full point after *alum* in the chemical composition of oligoclase and labradorite feldspar tends to infer that the mineral contains a double sulphate (alum). There is no sulphur in feldspar.

The book is printed on good quality paper, and a very clear type is used which makes for easy reading. The text is considerably enhanced by the line drawings so very well done by Jean Rice. At two shillings and sixpence " An introduction to gemstones " makes a really cheap authoritative book.

R.W.

SINKANKAS (J.). *Gem cutting.* D. van Norstrand Co., N.J., U.S.A. 397 pp., profusely illustrated. $8.95.

A comprehensive book dealing with all aspects of gem cutting and written primarily for the amateur who wishes to become a proficient worker. The author has been at pains to study the literature on the subject and has added to the knowledge gained therefrom his practical experience. The book is divided into three sections, the first dealing with equipment, its uses and limitations ; the second part of the book discusses faceting, bead making, drilling and sphere cutting, and cabochon work ; and the final section tells how to collect gem materials and gives other information of use to the enthusiastic gem cutter in North America. The title is the same as that used by J. D. Willems in 1948.

S.P.

MIDDERIGH-BOKHORST (B.). *Glans en Gloed uit donkere diepten.* (Lustre and fire out of dark depths.) Levensverzekeringmaatschappijen, Nillijm/Arnhem. 88 pp., numerous illus., colour, and line drawings.

This book, the production of which was financed by a Netherlands Life Assurance Company, is outstanding in its presentation—and inexpensive, for it sells at about five shillings. It has been written to interest young and old alike in the world of gems, and it succeeds admirably, for history, romance and scientific data have been carefully written. There are numerous illustrations, in colour, of gems and gem minerals, which are extremely well done and which contribute greatly to the book's value. Proceeds from sales are being given to institutes which aid crippled children.

S.P.

PERIÓDICO DA ASSOCIAÇÃO BRASILEIRA DE GEMOLOGIA. Ano. 1, No. 1, 1955.

The first number of the official journal of newly formed *Associação Brasileira de Gemologia.* Illustrations in line are good but some photographs of mineral crystals suffer in the quality or the age of the blocks and details are sometimes lost in an inky blurr. Papers are in Portugese and of an introductory nature. They include : Gemmology—Science and Art ; The Large Brazilian Diamonds: Structural Imperfections and irregularities in Gems: Ideal dimensions and angles for stone cutting ; Colour of precious stones. Official notices give particulars of the Brazilian Association formed under the auspices of the Department of Mineralogy and Petrology at the University of São Paulo in July, 1955, Pro. R. Saldanha as President. Courses of instruction are planned.

At the present official rate of exchange the annual subscription for associates is in the region of £20, but it is noteworthy that this fee exchanged at the free market rate would be no more than £5. A further example of the peculiar exchange conditions is in the price of an ordinary dichroscope, advertised as a " Magic eye," and costing at the official rate roughly £35, and at the free rate about £9.

JADE STORY—EUROPEAN

(*The fourth part of the Story of Jade in Europe*)

by ELSIE RUFF, F.G.A.

IN leaving behind the 18th century, we by no means divorce ourselves from *The Jade Question*, though at that period the question had not been isolated. Travelling back in time, we find the first contributor of note to be Robert Boyle, a natural philosopher. In 1672 he published an essay entitled *Origine and Virtues of Gems*. Robert Boyle was a Fellow of the Royal Society, a linguist, and one of the leading scientists of the day. On p. 115 of this essay, we read :

" And from the greater or less plenty, and natural activity of the impregnating particles in this or that gem, may possibly be deduced the difference in colour of some, and in virtue of other stones of the same denomination, of which we have in a learned writer or two, eminent examples gives us of the great virtue of some, and the inefficiency of other, that experience has discovered among those stones that go under the title of *Lapis Nephriticus*."

And on p. 132 : " As I remember, that an ingenious Physician told me of a Spleene Stone, as they call them, in the hands of an acquaintance of his (where I might have seen it if my occasions had permitted) amounting to about four score pounds weight."

Further, p. 175 : " That sometimes stones that are thought without scruple to be of the same kind as hath been particularly observed by Learned men of the *Lapis Nephriticus*, are of such different qualifications, that some of them have very considerable Remedies in cases where others prove almost utterly ineffectual. And I have observed also, though very rarely, that a Medical Stone may have virtues that are taught to be the properties of stones of another kind."

Here we have an Englishman (an Irishman to be exact) using two well-known terms for the same material. His words suggest that Spleene Stone was rather the prerogative of the medical man, since to him it was mainly a medical stone, and that *Lapis Nephriticus* was the correct or scientific term. Only 77 years separated

Raleigh's publication, in 1595, from this work of Robert Boyle, and Raleigh himself was recognizing the jade of South America as the Spleene Stone of England. (See *Journ. Gemmology*, Vol. V., No. 1, 1955, p. 7.)

Lapis Nephriticus (as well as Achate[1]) is mentioned in 1632 and in 1661, both works by Joannes Jonstonus, and here referred to as a product of New Spain. The author writes of the tremendous healing powers of this material which, he says, are both natural (physical) and psychological. It has been proved, he affirms, by many effective cures.

More than 200 years earlier than Monsieur Blondell, who pointed to the separation of jade and jasper as " somewhat modern " (see *Journ. Gemmology*, Vol. V. No. 3, 1955, p. 148), Ulissi Aldrovandi in a posthumous publication of 1642, was writing of this very difference. Nevertheless his rendering of the term *Lapis Nephriticus* is not clear, though undoubtedly he uses it in part to cover both nephrite and jadeite. As Aldrovandi died in 1605, the year he founded the University library of Bologna (the beginning of the museum of Bologna is also attributed to Aldrovandi's collection) this must have been written about fifty years earlier, viz., towards the end of the 16th century. In a still later publication, we find : " . . . As *Heliotropius*[2] is counted a jasper, so is *Lapis Nephriticus*, but it differs in being very much harder, the surface is greasy and cannot be highly polished. It is used for health reasons as it is not elegant." This author quotes Boetius, who was looked upon as an authority in this century. Aldrovandi calls for respect, not only because he states that *Heliotropius* is a jasper but because, knowing that *Lapis Nephriticus* was also considered a jasper, he nevertheless sees differences between the two. While we know that there is little between the hardness of nephrite and that of jasper, the toughness of nephrite must have led, often, to Aldrovandi's conclusion.

In 1636 R. P. Bernhardus Caesius was writing of *Lapis Nephriticus*, of its recent arrival from New Spain, and of its value in

1. Agate. According to *Gemstones* (G. F. Herbert Smith) this name is derived from the river Achates, in Sicily, where it was found at the time of Theophrastus. (See *Journ. of Gemmology*, Vol. IV, No. 8. p. 347.)

2. Bloodstone.

expelling calculi. Here, too, was another writer to refer to the difference between jade and jasper and also the fact that jade was recognized by various names such as *lapis nephriticus*, *pierre néphrétique*, and *piedra de ijada*. Furthermore, he identifies the various occurrences which, in the light of present day knowledge, were not incorrect. The only doubtful one he lists is India. For the remainder he gives China, Burma, Mexico, and Central America.

An important contributor in the 17th century was Joannes de Laet. There are three editions of this author's work. The first, in Latin, was published in Antwerp in 1633. It was called *Novae Hispaniae* (New Spain). On p. 324 is the following :

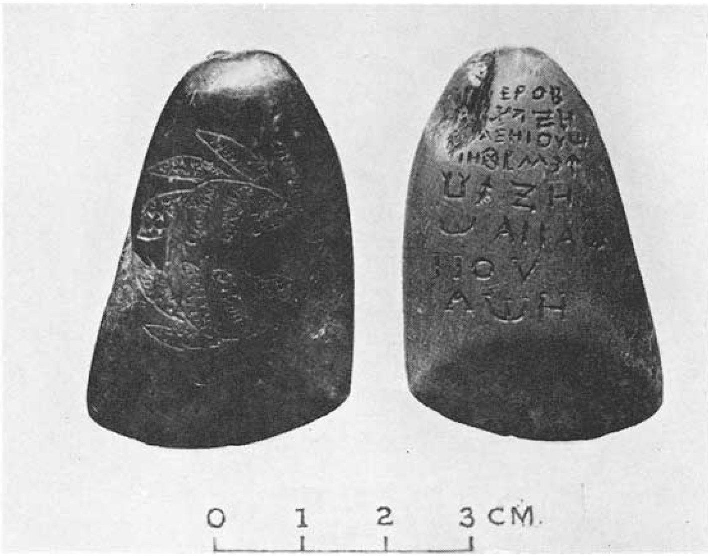
" Let us speak a little on gems . . . a species of Jaspis with points (punctulis) white, variegated, which are called IZTLIA YOTLI QUETZALIZTLI, or not transparent *Smaragdus*,[1] and which attached to the arm or the region of the reins[2] scatter the nephritic pains, break and expel the calculi and various things that pass from the body which obstruct the passage."

The next edition was in French and published in Leyden during 1640. In Volume V, Chapter IV, entitled : *De Quelques fleurs et herbes, animaux, et pierres précieuses de la Nouvelle Espagne* we read, p. 144 : " The Mexicans call EZTETL a stone which seems to be a kind of green *Iaspis* with certain spots of colour of blood ; they affirm that attached to the arm and neck it stops all flux of the blood by reason of that they have the habit of putting this, powdered, in the holes of the nose when they are bleeding too heavily. There is found another species of *Iaspis* spotted with small points (poincts) of white which they call IZTLIA YOTLI QUETZALIZLI or dark emerald, which attached to the arm or the right of the reins mitigate the pain nephritic (as they say) break down the stones and expel the matters altogether that block the passage. Compare what Monardes says on this point.

"There is still a third category, darker colour with no points and more uniform, which they call TLILAYOTIC, which they believe cures colic if applied to the navel. Finally, to mention all, there is another stone black, uniform and not polishable, which they say is very good for the ills of the matrix . . . see Monardes."

1. Emerald. 2. Kidneys.

This, as we see, is a development of the first edition, the opening sentence of which refers to the bloodstone ; information, apparently, which Laet collected from Monardes. The third edition, written in Latin, was printed in 1647. This was called *De Gemmis et Lapidibus*. Here Laet writes : " The stone which to-day is called *Nephriticus* for his most eminent virtue of being potent in the ejection of sandy grains from the reins, is called by the original inhabitants of New Spain IZTLIAYOTLI QUETZATLI because they considered it a species of darker Smaragdus, thus wrote Fr. Ximenes.



Small jadeite axe. Engraved on both sides with Gnostic inscription

Spaniards call it *Piedra de los Riñones*,[1] Italians *Osiada* from Sciatica, as its carriage is said to cure this, the French call it *Siadre*, a corruption of the Italian word according to Boetius. To which, we add, in the same New Spain is found another stone which the Spaniards call *Piedra de Hyada* ; which the Italians call *Osiada* and the French *Siadre*. It seems that Boetius deals with two stones which are different. Thus Fr. Ximenes describes this *nephriticus* in the other chapter, where he comes to it.

1. See *Journ. Gemmology* Vol. V., No. 1, 1955, p. 10.

"There is another species, green *Iaspis,* much different from the proceeding called TLILAYOTIC by the natives and different in weight, colour, form and qualities from the previous. The Germans call it *Nephriticum, Kallesznin*n (Pliny calls it *Callais*[1] *Callaias*) Belgians one *Kalzbee,* bad form of the name *Callais* as one would say ; as they have nothing in common. Some classify the green *Iaspis* . . . some older experts judge it to be still another kind of green *Iaspis ;* this, however, is not likely so, because it is harder. Still further from the truth are those who compare it with *Prasius.* I classify it as a species in its own right, contrary to the old experts, potent in virtue as I know, also very hard, more like the darker species of *Smaragdus* which has been described as pure green. Neither is this gem very dark nor transparent, but only half way in both considerations and it has this special property that it never can be properly polished and that the surface is always somewhat oily and fatty. . . . The one Monardes exalts is even more green. A third which is mentioned by Fr. Ximenes, *smaragdus* green of the darker kind has, however, points either of white or of ash-grey. The fourth is of a yellow green like honey with a fatty surface. The fifth is a mixture of divers colours, green, yellow, white, and black. . . . Sixth, mentioned by Boetius, dark green, opaque as somewhat with black intermingled ; this like *Ophite*[2] has also some black spots. Very hard, distinguished by some lines and placed by Pliny in Cyprus, as reported by Augerius Clutius who had some amongst his Nephrites, some of which he has shown me, but of whose genuineness I have some doubt. It is admitted that Boetius classifies it amongst the Crystals, but I observed the white cloud independent of the green.

"Besides these there is also found the honey-coloured variety mostly found in America on the brinks of the Amazon river and other rivers, which in this part flow into the ocean, many and most in New Spain from where many stones came to Spain and the rest of Europe. They are partly in massive blocks, thus Boetius writes that he has seen in the gem collection of the Emperor Rudolph II (1552–1612) a piece of the value of 1600 thalers of which was cut a cup of large size. I remember having seen in *Anglia* a block the

1. Here it is thought that Pliny refers to our turquoise.

2. Serpentine.

size of a man's head which had originated from America, i.e. the Amazon river, it was a milky green. He who had brought it valued it at £50 (quinquaginta libris sterlingensibus) . . . . Original inhabitants of Guiana work large pieces and use some of pyramid form for ornaments of the lower lip. These Gesner calls *Oripendula*. Monardes writes of the virtues of this stone saying that the Indians have a habit of wearing them attached against the kidney and stomach pains thus to expel calculi and renal impediments. They praise them as cures for Nephritic diseases. I know a nobleman owning one beyond compare, this attached to the arm expelled so many stones that he feared it to be too excessive, he took it off from time to time. . . . Dulcissa Bejar suffered three times from nephritis in a short interval, she made herself an armlet of this stone which she wore perpetually, her pain ceased and has not returned for ten years, many others felt the same effect, therefore these stones have a high value, not only as they are difficult to get but also on account of their miraculous quality. . . . Ximenes, who wrote in his commentary in New Spain itself and edited in a Mexican town, presents and recognizes one green like *Iasper* but variegated with white spots. Boetius lauds the stone, Nobleman Nicolai Dammani possesses one dark green with small black spots. Others speak highly about others. I can in consequence of certain experiments which were made on my wife, affirm that an oblong stone I have in my possession, at the same time a flat and separately thick stone of faint honey colour with an oily surface, I can attest that worn in the hollow of her arm my wife experienced the same effects which Monardes attributes to the stone of his noble friend. I have also another stone armlet of a dark green stone with nearly black points which also my wife has worn often. I know of many which underwent great dangers in this Amazon river, but there these stones did not always show such results. Therefore it should be investigated on what part of the body it should be attached to obtain the best results. Shall it be in the arm-hole or on the part where the doctors measure the pulse, it seemed to me the most useful. But others favour the place of the reins or where the pain is felt. I believe it is best to experiment and act accordingly."

In this third edition we see the author's indebtedness, which he acknowledges, to Gesner and to Monardes. Indeed, it is questionable whether he knew the nobleman of whom he writes, or whether he is not here quoting Monardes. Since there are nearly eighty years between the two publications, it could hardly be that this gentleman was known to both. Dulcissa Bejar was, it seems, Monardes' *Ladie, the Duchesse,* though Bejar appears to have been of American-Indian birth.

Although it is obvious that Laet has tried to classify the various stones, his efforts afford little help to the 20th century investigator, particularly as there is much confusion of terms. Between the second and third editions Laet must have given this subject a good deal of thought, to say nothing of experiments. In the third edition he writes (in Latin) of *Nephriticus.* Earlier, this same stone was, to him (and to many another), a jasper. Material of the necessary green and transparency was classified as an emerald, that is, *smaragdus*—an error that may still occur, so like an emerald are fine pieces of jadeite. Quite clearly Laet separates bloodstone and jasper. And he is also definite that *Nephriticus* is not prase.

Perhaps the outstanding contribution of Laet is that he appears to be separating two species. The jade coming from the New World, or New Spain as it was then called, was, it is thought, jadeite. Was he separating this from the jade of Europe, with which he was familiar, a jade that was likely nephrite ? Or was it the jade of Turkestan, also nephrite ? Lange (see *Journ. Gemmology,* Vol. V, No. 2, July, 1955, p. 152), in 1704, clarifies this for us with the statement that " Laet is right. *Nephriticus* is a species of its own, neither Prase nor Jasper." To add to our confusion of this New World jade, turquoise seems to have come under the same heading as jade, that is, *chalchihuitl,* and was regarded as a close second in preciousness. It is likely too that, used ornamentally, when the softer substance would not be so easily distinguished, turquoise often passed for jade. Frequently the turquoise is more truly green than blue, particularly after it has been worn or used for some time.

We come now to another publication of some importance, its date 1628. Here is Bartholinus of Malmoe, or Caspar Berthelsen, who was born in Malmoe, Sweden, in 1585, and died a year after *A Small Essay in four parts* was published. One of his sons, Erasmus (1625–1698), is of interest to gemmologists as the discoverer of double refraction in Iceland Spar. It seems that Bartholinus was a physician (as most of the scientists of that day were), a linguist and a traveller. From the section of his work called *De Lapide Nephritico* we learn that in Spain it was called *Jgiada* (still another spelling), and in Belgium *Calsvee* which is probably the *Kalzbee* of Laet. In Chapter III we are told that *Lapis Nephriticus* is often found in conjunction with *Jaspis* and *Prassius,* though more frequently alone. Cups, he says, are made of it and sometimes thought to be green *smaragdus* or *callais* " on account of the soft green tint." In quoting Pliny, via Caesalpinus,[1] and one Encellius, it is most difficult to determine whether the author and Pliny mean exactly the same thing. Nevertheless, he does say that the hardness of *Lapis Nephriticus* exceeds that of jasper. (His description of the way in which this material is found is a direct copy of Pliny's *Callaina,* which we believe is our turquoise. This is corroborated in a later chapter of Pliny where the reference is to *Callais* or *Callaina.*) A statement of interest to us is that Bartholinus quotes the authority of Boetius for the occurrence of *nephriticus* in Spain and Bohemia, but adds : " This is little believed by mineralogists, they attribute it to the finding of *smaragdus, prassius,* or *Jaspis.*" Since no source of nephrite has been found, up to this date, in Spain, we must laud the author for disagreeing with a much-quoted contemporary.

Throughout these times there would seem to be an enormous number of people not above counterfeiting *Lapis Nephriticus* or passing other substances off as such. The curative properties would, of course, make this well worth while. So here, in Chapter 5, we read : " Notwithstanding what has already been stated, it will not be difficult to differentiate between *Nephriticus* and other stones. The diagnosis is so much easier when the similar close species are present. Let us not be imposed on by fakers of Gemstones. There are indeed some or other dealers who sell adulterated stones as *Nephriticus.* Take for instance the merchants of Frankfurt who sold false stones to the Magnates in the form of bracelets and girdles, as stated by Clutius, substituting similar (looking) stones for *nephriticus.* Such are : 1. *Jaspis* ; 2. *Callaitidus* ; 3. *Smaragdus* ;

1. Andreas Caesalpinus (1519–1603) was a distinguished Italian botanist and physician to Pope Clement VIII.

4. *Prassius* ; 5. *Smaragdus-Prassius* (most likely prase, which was sometimes called Mother-of-Emerald)[2] ; 6. *Heliotropius* ; 7. *Malachitus* ; 8. *Ophitus* ; 9. A very low-grade *Nephriticus* as they call it from the West Indies, nearly black,[3] and opaque, less hard than the oriental *nephriticus*. The power of this *nephriticus* is not established. The inhabitants of those parts use it for wedges in their wood-work, and as hammer-heads, weapons in battle, and for the execution of offenders. This is a list of real Gemstones and near species, with the exception of No. 9."

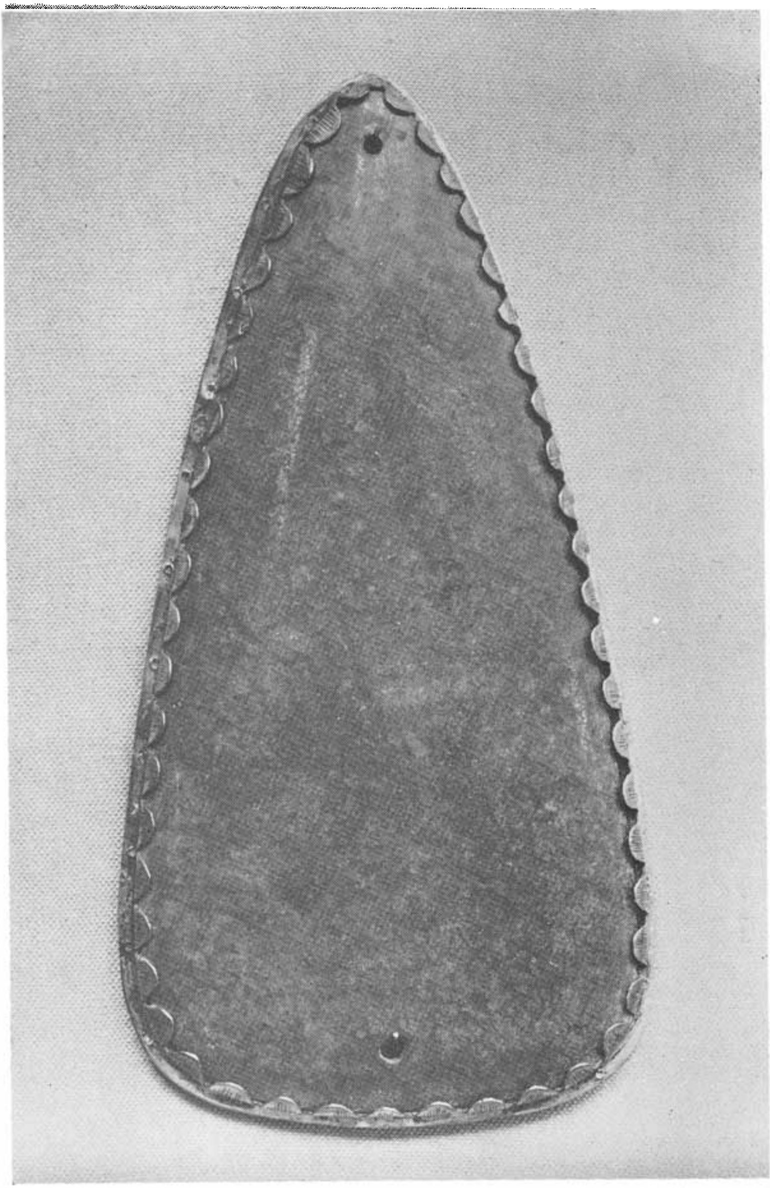
A study of this list leaves one full of admiration. Not only did it state the case for that period, that is in 1628, but the list could take its place in a modern text-book. There was no doubt, it would seem, in the mind of Bartholinus about *lapis nephriticus*. Nor did he ignore the curative side. In Chapter XI of this work, the author writes of " the derision of Erastus, Gesner, and others who condemn and deride the use of amulets completely. Trallianus perhaps upholds them when he says Galenus teaches such use notwithstanding that he has started by mistrusting them." " Not only," he continues, " does he (Galenus) speak of what he heard, but he speaks of his own experiments. Erastus attacks him on the score of amulets. . . . Whatever is pointed out we know that there cannot be any effect. If applied for as long a time as you like, the illness is not affected. . . . It is sensible to help the evacuation, which is stated before to be done by the application of *lapis nephriticus*."

This statement is not the contradiction it first appears to be. The following paragraph explains the author's meaning, in which he is differentiating between a remedial stone and those believed to promote virtue and so forth :

" I well know what by some is attributed to the stone, things which are unobtainable by the simple means of nature can be obtained by invisible influences in affections of the eyes, provoking adultery, which is attributed to the *smaragdus*, to bestow eloquence, make poor, render beloved of all, make rich, fortunate, victorious,

2. G. F. Herbert Smith gives " Prase, or mother-of-emerald, which at one time was supposed to be the mother-rock of emerald, is a quartz, coloured leek-green by actinolite fibres in the interior."

3. Probably chloromelanite.



Jadeite axe, mounted in silver, and perforated for attachment to a belt. Believed to have been worn in Scotland as late as early 19th cent. as a protection against kidney diseases and all kinds of things. *Adamentis* is described as giving faithfulness, victory, courage, the smoothing of wrath, conjugal affection, reconciliation. Thus far goes human madness, that we read that some precious stone confers the favours of the Deity, or drives out demons. It is enough in mending bodily ailments to follow the natural processes. We do not put our faith in the superstitious use of Gems."

It is not always easy to remember the limits of 17th century literature, living as we do in an age of ever-increasing printed matter. Since too most of the available literature was in Latin, reading was necessarily restricted to classical scholars. Nevertheless it did mean that these scholars were acquainted with, perhaps, *all* the available literature. And this state of affairs had further merit in that a variety of interpretations and points of view have come down to us. Furthermore it preserved the authorities of antiquity, providing us with opportunities for checking the accuracy of the older manuscripts. Thus we see how Pliny was quoted, how Monardes and Gesner were quoted—to name only three.

All this is particularly noticeable in one Cluyt (Outiger) who wrote under the Latin name of Augerus Clutius. His first work, which included an *Essay on Calsue or Nephritic Stone* was published in Rostock, Germany, during 1627. He writes : " The stone *Nephriticus*, by some called Calsue, comes to us from New Spain, a province of America. It is not dissimilar to *Prasius*, always green with a shade of yellow, *prasius*-like or leek-green wax : various shadings appear at times but it remains steady regarding the basic colour and hardness. Besides this the stone is bright and of high clarity . . . Dr. Bernard Paludanus, a famous and excellent expert, Curator of all natural and medical matters, kept with him a piece of *Nephriticus* the size of a Reichs thaler which he employed together with some of his friends making use of it as an example. It was handed to Mrs. Elisabeth Parvia and Mr. Egberris Enchusiensis, in which cases it worked happily, which benevolent action Monardes attributes to Calsue."[1] Here again we read of the Dulcissa Bejar quoted by Laet, in this case called Princess Bejarise, of the West Indies. " Thus also several others in West India found the same help with the greatest improvement in their health, which is a proof of the potential value of the stone. Therefore, the Indians

1. The word *Calsue* does not appear in the English translation of Monardes' work.

hold the stone in high esteem, which results in the fact that the stone is only rarely obtainable ; as the kings, princes, and inhabitants conceal the provenance of the *Calsue*, they hold it for their ornaments and not only conserve them as treasure but also on account of the magnificent and incredible effect. Thus Monardes even secured it very rarely." Speaking of the Emperor Rudolph, he writes : " He made an ample collection of gems to a great extent from the cold German and Bohemian mountains, mainly *jaspis*, both transparent and dark of similar value to the oriental prase and heliotrope from India, going for the most beautiful specimens and craftsmanship. There are also in *Gallia* persons of high standing who prefer the green *Calsue* to all other stones especially the one similar to the transparent prase. . . . Many places have had the advantage of being indicated as the home of this stone and have been recognized by the experts as true *Nephriticus*. . . . Mons. S. Annae collected a species of serpentine stone similar to our ORIENTAL species, however less hard and easily breakable, which is helpful in colic complaint and cures stomach colds, if heated, applied to the body : thus he applies it and sells it for this purpose. This species has not been found in the river Amazon." Helpful here is a statement about the word *Calsue*, which we now meet for the first time, and which, according to this writer, is interchangeable with the Nephritic Stone. " *Calsue* is a species of dark dross-like colour and much darker is not highly estimated. However, it is frequently used by the people of the isthmus (presumably the isthmus of N. and S. America) because it can be easily divided into small entities. Hendius, in Theatre Orbis, mentions this stone for its elegance, and it is in artistic ways incrusted in wood on the weapons of these people with which they execute men condemned to death, and which they use in battle. This gem, as I remember when I was young, had some spots, but it cannot be compared with the ORIENTAL kind. In some parts of the river a superior species is found and highly valued by the local inhabitants, it is of a feeble white colour with minute spots or lines, it is used for handles of knives or daggers. It is perforated and often round as if made to be slung to the body. This stone is not unreasonably compared to the so-called stone of the Nile which is found in the bottom of the river Nile notwithstanding that it is also found in India and Attica,[1] so

1. A district of ancient Greece.

says Andrea Caesalpinus, Book 2, cap. 26, and if I remember right this is the stone CALLAIS which name has been changed into *Calsue*. It is affirmed that this stone in the past has been found in nests of birds[2] and is known in ancient times as Melancoryphos." Cluyt wrote further of "*lapides Nephritici* of all sizes and forms worked into shapes and fashioned, imported from BOTH INDIES. Also brought from Germany, made into figurations with or without acknowledged designs, prepared for special applications in a variety of forms. . . . Some are shaped in the form of a heart beautifully chiselled of the size of a thaler, with name inscribed with inscriptions in Arabic[3] characters telling of the power and strength of the *Calsue*. However, they are not seldom without such inscription, pieces of idols, if larger, in the form of a barefoot boy or the form of an arm. Not less frequent are those in the form of a belly, or the reins, they have a certain use. . . . We do not speak of the heliotrope as it is a species of stone dissimilar to ours . . . so many authors have written about it, as well in general of medical plants, stones, and the varieties of such materials and effects." "As I have some vacant space," the author sums up, "here is a note on Anselmus Boetius de Boodt. As heliotrope is cited amongst *jaspis* so also *Nephriticus*. As *jaspis* appears in various colours, so *Lapides nephritici*. The difference between *jaspis* and *nephriticus* can be stated. *Nephriticus* is harder, never red in itself. Then it cannot be quite polished. The surface feels fatty as if of oil. It seldom has two colours, whatever the shade, the ground colour is always milky-green, of equal import. If not thinner than a little finger it is darkly translucent. It is called by the Italians *Osiada* from sciatica, which it is considered to heal if carried. Belgians call it *Kalsuee*, Germans *Kalsbee*, Gauls say *Siada* from the Italians."

One's first impulse is to disqualify Cluyt, but as we begin to study him we find him interesting and often correct. The biggest hurdle to surmount would appear to be the word *Calsue*, adding still another spoke to the umbrella of jade. This word, he tells us, comes from *Callais*, a word we have met earlier. The *Callais* of

2. This information is to be found in Pliny.

3. It will be recalled (*Journ. Gemmology, Vol. V, No.* 1) that Sir Hans Sloane mentions the same thing in 1725 of material he saw in Jamaica.

Pliny would appear to refer to our turquoise or turquoise matrix. Yet, as mentioned earlier, in South America the turquoise was known by the same word that was used for jade—Chalchihuitl. Certainly the turquoise is not hard enough to be used as a weapon, the weapons of South America cited by Cluyt. Weapons of the New World, as elsewhere, were frequently of jade. And the colour of this *Calsue* suggests that chloromelanite, the dark variety of jadeite, is being described. It is easy to see where the Belgian *Kalsuze* and the German *Kalsbee* are developments of *Calsue.* Yet the Italian *Osiada* is closer to *iada*, the jade of Italy. (See *Journ. Gemmology* Vol.V, No.1, 1955, p.15.) In the list of Bartholinus, quoted above, number 9 refers to " very low-grade *nephriticus* . . . nearly black, and opaque, less hard " and this was the weapon and the implement of the inhabitants of the Indies. There would seem to be hardly a doubt that this was also Cluyt's *Calsue.*

A few years earlier, in 1623, was Laurembergius (Guilielmus, the Elder). Here is another medical man and his work takes the form of what might be a modern journal. He writes of his " deplorable state of health " in 1609, when he was at the beginning of his 63rd year (rather an old man in those days). And he describes his " nephritic pains " which, he says, he had " never sensed before." Over a period of thirty-six weeks the author is naturally concerned with a cure, giving a list of herbal medicines. He adds, p. 11 : " Let me in the same respect mention the gem called in Spain *Igiada* . . . Somebody treated this way for calculi was cured, but as at the same time other medicaments were given it is doubtful if the healing can be attributed to the gem. . . ."

Around the turn of the 17th century, there were two authors of the same name. One was Christophile de la Costa, writing of the medicines of the American Indians. This work, published in French during the year 1619, was called *Histoire des Drogues, Espiceries.* Here again we find a repetition of Monardes, including La Duchesse de Bejar (a compromise in titles, it seems). The second author, a Spaniard, José de Acosta (*c.*1539-1600) was more original. As a Jesuit he was sent to Peru in 1571. It is claimed that his was the first book to be published in Peru, and that as early as 1590. It is interesting also that an English translation was evidently so desirable that one appeared in 1604, fourteen years later. In

Chapter XIV, headed *Of Emeralds*, it is almost certain that, in part at least, the reference is to jade :

" The Kings of Mexico did much esteem them, some did use to pierce their nostrils, and hang therein an excellent emerald, and they hung them on the visages of their idolls. . . . The emeralds grow in stones like unto cristall. I have seen them on the same stone, fashioned like a vein, and they seem by little and little to thicken and refine. I have seen some that were halfe white and halfe greene ; others all white, and some greene and very perfite. I have seen some of the bignesse of a nut and there have been some greater found."

This excerpt is particularly valuable, not only because it brings us closer to Monardes (separated by no more than 21 years) but because it was written and published on the spot.

Between the last two authors was another writer whom Laet frequently quotes and moreover informs us that he wrote in New Spain and edited in Mexico. His name was Francisco Hernandez or Ximenes, and his work, in four books, was published in 1615. This author refers to *Piedra de los Rinones* and also *Piedra de Hijada*, treating them as different stones. Of *Piedra de Hijada* he says : " It is a kind of green *Jaspis*, although much rarer. . . . For use it is made into several shapes and cut according to the affected parts into flat pieces like plates, or round pieces like a ball, and attached to the hands or as often as not to the part of the body where there is pain. It cures the ills of colic, and the reins, ejecting the troublesome bodies from the affected place ; it is very often attached to the wrist." Nevertheless, this author is far from clear. Later he writes, presumably of the same stone : " It is often taken for another stone of the same species on account of its very clear green similar to *jaspis* or the inferior emeralds. . . ." And, just as we distrust Ximinez' differentiation, so he distrusts the Indians " because they are always on the war-path and have no time to distinguish much between one stone and another." The important point for us here is that the same stone was used for the same cures and this was written and published, seemingly, in Mexico. Even so, at this date, the *cure* could have been introduced or created by the Spaniards.

When we come to de Boodt—Anselmus Boetius—in 1609, we are studying a much quoted writer. Boetius was a physician to the Emperor Rudolph, as we have read, and he classifies *Lapis Nephriticus* as a jasper, and describes the stone as not very beautiful but useful in kidney disorders. Once more Monardes is quoted and occurrences given as Spain, Bohemia, and New Spain. We have seen how Bartholinus disagreed with this statement as far as it concerned Spain and Bohemia. A much later author, Charles William King, M.A.[1] in 1867, said : " . . . even the practical de Boot was evidently a firm believer in *Lapis Nephriticus* and the prices quoted by him testify to the general faith in its medicinal virtue, a piece no larger than a half thaler selling at one hundred crowns. . . . De Boot again mentions (under *Smaragdo-prasius*) that the West Indians, the Caribs, wrought this particular stone, which some held to be the only genuine Nephrite, into a cylinder. . . . He also asserts a very singular thing, that the true nephrite was then found in Spain and also in Bohemia, a fact that he adds was but little known, because the ignorant lapidaries mistook it for smaragdoprase, or the green jasper." In King's earlier book[2] published in 1865, he writes : " Supported by the authority of Galen its (achates) efficacy was undisputed even in 1609. De Boot testifies that in his own practice he had observed effects scarcely credible from the application of the Red Jasper in cases of haemorrhage, and mentions the prevailing belief that a Green Jasper engraved with the figure of a scorpion, when the sun was entering the sign, was a sure preservative against the formation of the stone in the bladder." Here De Boodt was obviously referring to the bloodstone, in the first example, about which there seems to be no problem, and his green jasper was almost certainly his *Lapis Nephriticus*.

According to Thomas Wilson, in his comprehensive paper *Jade in America*, 1900, Boetius followed the opinions of his predecessors in the first two editions, but in the third, published in 1647 (nearly 40 years later than the first edition), he recognizes and reports the different minerals, describing jade under the heading *Lapis Nephriticus* " a greenish stone mixed with milky veins or splotches brought a few years ago from New Spain."

1. King (C. W.) : *The Natural History of Gems and Decorative Stones.*
2. *The Natural History of Precious Stones, Gems, and Precious Metals—Ancient and Modern.*

There was, as we have seen, a great interest in jade during this century, not least the urgency to separate Jade from Jasper, suggesting it had long been confused. (And was to continue so, for something like 200 years.) Nevertheless, our search has taken us no further back than the beginning of the 17th century. Yet it is apparent that the writers of this era do not appear to be coining a new term for a new stone (or perhaps one should say, identifying a new stone), or translating the Spanish of Monardes into Latin. All authorities go back to Monardes as the final and perhaps the first word, so that any literature of the 16th century or earlier that may come to light, using the term *lapis nephriticus*, will add much to this research.

A very early source quoted for the establishment of the term *lapis nephriticus* is that of a poem attributed to Orpheus. Orpheus, a Greek poet, is believed to have lived around the period of Homer. Poems attributed to him were much quoted and in circulation during the early part of the Christian era. One, entitled *Lithika*, or *Lithica*, was published in the 4th or 5th century. Yet evidence for the word nephrite is slim. The following extract, from two verses of this poem, is given by Charles William King[1] :

" Take in thy pious hand the Crystal bright,
Transparent image of the Eternal Light,
Yet though of fire the source, strange be it told,
Snatch from the flame the stone—'tis icy cold !
Girt round his loins with this, the sufferer gains
A sure-relief from all nephritic pains.

Hence to me the *Nebrite*, a gem divine,
A gift to mortals from the god of wine.
The potent *Nebrite* heals the venomed smart,
To wives it also binds their spouses' heart.
Hence were thy priceless virtues to me shown
Against the deadly asp, life-saving stone ! "

The first verse of this quotation refers to crystal, which was not, necessarily, the rock-crystal of to-day. Yet the evidence is not negligible, mainly because nephritic pains (a common ailment in early times, it seems) were treated in the same manner as in later

1. King (C. W.), *The Natural History of Precious Stones, Gems, and Precious Metals, etc.*

times. In the second part of the quotation we come across a word very like nephrite and later perhaps mistaken for it. According to Pliny, *Nebritis* was a stone sacred to Bacchus, commonly identified as the God of Wine. He tells us too that the stone receives its name from *nebris*, a Greek word referring to the skin of a fawn or deer as worn by the Bacchanals during their celebrations. A glance at the second verse of the above poem confirms this. In John Florio's Italian/English Dictionary " A Worlde of Wordes," which was printed in London during 1598, is *Nebrite*, " a kinde of precious stone." He also gives us *Nephrite*, an ache in the raines of the bache. Also the stone or grauell in the raines." It is well, however, to remember that not only were words frequently mis-spelt in early times but the same substance might be known under a variety of spellings. This applied even to proper names. Sir Walter Raleigh, a person famous enough to have an established spelling, is found to have had no fewer than five ways of spelling his surname. Although the second verse does not connect *nebrite* with nephritic symptoms, the species of this gemstone is not established. Pliny's translators believe it to be either agate or jasper, particularly the mottled variety similar to an animal's skin. But Pliny further states, after *nebris*, " There is also another stone of this kind that is black." Was he too referring to chloromelanite ? And was the mottled stone nephrite or jadeite ?

The oldest existing treatise on stones was written by Theophrastus, a native of Eresus in Lesbos, around 315 B.C. (*Journ. Gemmology*, Vol. IV, No. 8, 1954, p. 347). Unfortunately only a fragment of this remains. It was translated by John Hill and two editions published, one in 1746 and the other in 1774. It seems fitting, therefore, in our search for *Lapis Nephriticus*, to hesitate here. Dealing with the word *Prasius* the translator writes that it " more properly belongs to *Lapis Nephriticus*." Theophrastus was writing of *Prasius*, Root-of-the-Emerald. It has also been termed mother-of-emerald, as mentioned earlier in this article. The basis of both these terms is thought to be the mother rock of the true emerald. On the other hand Prase is leek-green in hue, and its Greek name *πράόμον* means a leek. So it is just possible that Theophrastus was not writing of the leek-green prase, but of an *emerald*-green stone.

TORONTO'S PUBLIC SERVICE GEMMOLOGICAL LABORATORY

by DEAN S. M. FIELD, F.G.A.

ESTABLISHED several years ago for the purpose of furnishing accurate scientific gemstone identifications and appraisals for insurance companies, trust companies and the jewellery trade, Toronto's Gem Lab has lately revised its policy and now functions as a public service institution staffed by three gemmologists representing both the British and American schools.

From a simple oak-topped desk with three or four basic testing instruments, the Gem Lab has grown, in the space of a very few years, to a modern, scientifically lighted laboratory equipped with more than twenty instruments—several of which are of unique design and usage.

Being the only public service laboratory of its kind in Canada unconnected with the retail jewellery trade or with a pawnbroking establishment, the Canadian public is showing great confidence in the work being carried out within its walls, and the number of persons visiting the premises continues to grow. Indeed, a second laboratory to accommodate the public is now in the blue-print stage; and this will house not only duplicates of many of the essential instruments now in daily use, but also X-ray equipment for gemstones and pearls, a full range of chemicals, and equipment for the restoration of the beauty of stained and soiled porous gems, such as turquoise and pearls. To date, only the excellent modern laboratory of Mappin's Limited, in Montreal, has X-ray equipment for the examination of pearls and crystals.

At first viewed with suspicion by jewellers of the "old school," more and more reputable tradesmen are availing themselves of the services the Gem Lab offers; realizing—what every gemmologist knows—that unscientific gem testing methods are no longer proof against the new synthetics and clever counterfeits now in the market, nor general appearance always a reliable guide.

Too, where proof of value for money received is urgently needed, the Canadian jeweller needs no longer to depend upon the ethics of a competitor or the honesty of a pawnbroker to effect a sale to a Doubting Thomas. If a jeweller is giving honest value, the Gem Lab will support his claim, and even issue a certificate to that effect ; for in this laboratory jewellery is not bought or sold, and opinions are wholly objective.

Since a great number of jewellery estates of Central and Western Canada now pass through the Toronto Laboratory for checking, it is not surprising that some interesting and unusual specimens have come to light ; and these, like all other items examined, are microfilmed and the details recorded on a special certificate for future reference in case of loss or theft. Among the loose gems that fall into this category, perhaps the most exceptional specimen, in recent months, was a large deep green peridot measuring $30{\cdot}1 \times 30{\cdot}6 \times 16{\cdot}5$ mm. This stone is, without doubt, one of the largest and finest gems of its kind in the world. Flawless to the unaided eye, and of very fine colour, a myriad of tiny included crystals were noted under the dark-field binocular microscope, giving the appearance of rounded particles in colloidal suspension. The peridot is emerald-cut, almost square in outline, and weighs 108·2 metric carats. Research has shown that only two peridots surpass it in weight, one being the huge gem in the Smithsonian Institution in Washington, D.C., and the other the 192·75 carat flawed stone said to be in the Diamond Treasury in Moscow.

Another but lesser gem—a 1·97 carat diamond—provided a pleasant surprise when placed under long wave ultra-violet light. It was a modern-cut brilliant of good white colour that fluoresced bright apple-green. Closer examination revealed that that portion near the culet fluoresced bright yellow while the remainder fluoresced light blue. This resulted in the strong apple-green blend mentioned above, when the stone was viewed from the front, in its setting.

Yet a third stone proved to be of more than usual interest. This was a fairly large antique brilliant-cut gem of lively appearance and resembling pink tourmaline or rubellite. A check on the refractometer gave a reading of 1·62 – 1·64 uniaxial negative. This seemed to be conclusive proof that the stone was indeed tourmaline. Subsequent checking with the microscope (a fast rule in the Gem Lab) revealed it to be a composite stone : lead glass at the back and with a pink tourmaline crown. This is the only example of its kind to come to the writer's notice, and points to the need for several tests before making a positive decision.

ASSOCIATION NOTICES

COUNCIL MEETING

A meeting of the Council of the Association was held at Saint Dunstan's House, Carey Lane, London, E.C.2, on Wednesday, 16th November, 1955. Dr. G. F. Claringbull presided.

The Council elected Mr. F. H. Knowles-Brown to act as Chairman of the Association until the next annual general meeting.

The following elections to membership took place :—

FELLOWSHIP

Anfield, John, Edinburgh
Bennett, Alan J., Cheltenham
Bialek, Walter, Birmingham
Bonanno, Antonio C., Washington, U.S.A.
Brinks, Feye, Leiden, Holland
Cameron, James S., Auckland, N.Z.
Chalmers, June R., London
Clark, Alastair R., Glasgow
Collier, Philip, Liverpool
Colman, Eric, Leamington Spa
Cooper, Paul O., London
Cross, Grace, Birmingham
Davies, Brian P., Gerrards Cross
Dungate, Peter J., Loughton
Havenhill, Asher D., Fresno, U.S.A.
Janes, Doris M., Margate
MacDonald, Ian C., Glasgow
Middlemiss, Albert E., London
Morrison, Neil C., Jnr., Inglewood, U.S.A.
O'Hara, Malcolm J., Sydney, Australia
Paterson, Douglas G., Edinburgh
Pyke, William, Wolverhampton
Schilling, Achim T., Stuttgart, Germany
Stern, Evelyn, Wembley Park
Summers, William H., Burnham
Todd, Evelyn, London
Williams, Donald K., Holland, U.S.A.
Wright, David, Weston-super-Mare
Wells, Robert A., New York, U.S.A.

FELLOWSHIP, TRANSFERRED FROM ORDINARY AND PROBATIONARY MEMBERSHIP

Clark, John A., Forfar
Dubois, Jean W., Hong Kong
Greenhill, Ann H., Belerno, Scotland
Hart, John, Glasgow
Henderson, Scott C., Dundee
Hessling, Frederick, Birmingham
Klippel, Robert, Sherman Oaks, U.S.A.
Lipman, Maurice, Johannesburg, S.A.
Muir, Ronald E., Wilmslow
Parkes, Frederick H. R., Lowestoft
Pyne, Eileen B., South Woodford
Rankine, Winifred M., Farnham
Sibley, Anthony J., West Wickham
Soukup, Edward J., San Diego, U.S.A.
Van Ameringen, Louis J., London
Vaughan, Howard M., Ross-on-Wye
Wells, Robert A., New York, U.S.A.
Worth, Bernard, Leicester

TRANSFERRED FROM ASSOCIATESHIP TO FELLOWSHIP

Field, Dean S. M., Toronto, Canada

Ordinary

Chittock, Arthur, Blackpool
Clifford, Edwin W., Cassington
Diss, Geoffrey D., Barrow-in-Furness
Fox, Hobart D., Austin, U.S.A.
Grimsdell, John L., London
Humphreys, George F., London
Janison, Murray E., Brooklyn, U.S.A.
Leiper, Hugh, Austin, U.S.A.
Longbottom, William, Hull
Mendis, Clement S., Colombo, Ceylon
Metherell, Anthony W., London
Muir, William A., Wilmslow
Parker, Norman H., London
Rossiter, Bernard M., East Barnet
Schoo, Johan J., Arnhem, Holland
Sibley, Leslie P., West Wickham
Smith, Lawson B., Birmingham
Vainer, Milos, London
Weller, George T., Tunbridge Wells

Probationary

Banks, Kenneth A., Manchester
Clarke, David R., Sutton Coldfield
Craven, Barrie R., Leeds
Hodgson, Edwin S., Darlington
Peters, Brian L., Camberley
Pringle, David A., London
Smith, Cora A., Grays
Street, Graham C. W., Sutton
Cassarino, Joseph A., New York, U.S.A.

A sub-committee was appointed to consider services available to members and to make recommendations.

MIDLANDS BRANCH

At the annual meeting of the Midlands Branch of the Association, held at the Auctioneers' Institute, Birmingham, on 4th November, 1955, Mr. T. Solomon was re-elected to act as Chairman of the Branch for a fourth term. Mr. A. E. Shipton was elected Secretary of the Branch in the place of Mr. D. King, who had resigned for personal reasons. The following were elected to serve on the Committee :—Miss J. Rice and Messrs. A. Conway, G. Davis, B. Leng and D. King.

The meeting discussed the results of the recent exhibition (reported on p. 257) and approved votes of thanks to all who had contributed to its success. The official attendance figure, for the three weeks that the exhibition was open, was 50,400, by far the largest number that have visited a gemmological exhibition held in the United Kingdom.

MEMBERS' MEETINGS

14th October : E. Gubelin, Ph.D., F.G.A., C.G.—" Some notes on gemstone inclusions," given at the Medical Society of London Hall, W.1.

9th November : Reunion and presentation of awards, Goldsmiths' Hall, London, E.C.2.

16th November : Film evening, British Council Cinema, London, W.1. Films shown : Mi Vida and Diamond Coast.

The lectures given in connection with the Birmingham gemmological exhibition were recorded on p. 164 of Vol. V, No. 3, of the Journal.

TALKS BY MEMBERS

Leak, F. E. : " The Science of jewellery," Redland (Bristol) Townswomen's Guild, 6th September, 1955 ; " Pearls," H.M. Prison, Falfield, Glos., 12th October, 1955 ; " The Science of jewellery," Toc H, Durdham Down Branch, Bristol, 28th October, 1955.

Parry, Mrs. G. : " Gemstones," Inner Wheel of Caerphilly, 7th November, 1955.

Melrose, R. A. : " Gemmology," Rotary Club, Newcastle-on-Tyne West, 14th November, 1955.

Stollery, E. : " Gemstones," Inverness Technical Society, 19th October, 1955.

GIFT TO THE ASSOCIATION

The Council of the Association has received the gift of a monochromatic light unit from Mr. K. Decker of Sweden. The lamp, which gives monochromatic light at 5893A is housed in a solid metal casing, chromium plated inside to give good light reflection.