Gems & Gemology

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Radium-Treated Diamonds

A certain quality of yellowish or brownish diamond when exposed to the radiations of radium alters to a decided green color. The diamonds are packed in direct contact with radium bromide or other radium salt and left for a period of several months. The result of this exposure to intense radio-activity is not only the change of color of the diamond, but also a definite alteration of the material in certain localized areas. In these areas either the carbon is altered so that it becomes radio-active or a small amount of the radium salt penetrates into the diamond. The green color in a radium-treated diamond is particularly strong in the vicinity of tiny pits in the surface which are apparently the result of this breaking down of the diamond.

Several methods of detection of radium-treated diamonds have been devised; all depend on the above effects. The pits with green color localized about them can easily be seen under the microscope and form quite definite proof of radium treatment. The radio-active nature of the transformed carbon or of the enclosed radium compound can also be detected by various means. The most common is, perhaps, the self-exposure of diamonds thus treated. Placed on a photographic plate in the dark room for a suitable period, some radium-treated diamonds will expose the plate, an effect which can be detected by developing the plate. Also the radio-activity may be detected by a delicate electroscope or by a spinthariscope. Still more delicate tests for radio-activity are also available.

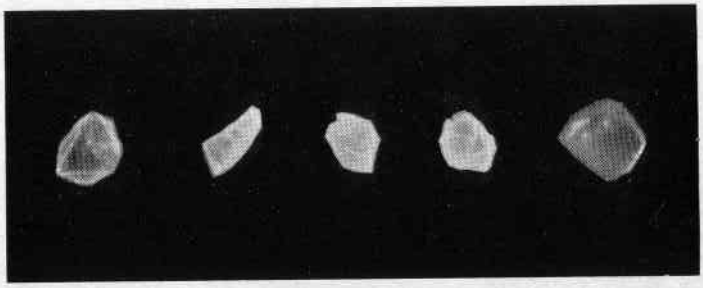
Radium, in breaking down, produces three forms of energy. These are (1) alpha particles, which are positively charged atomic nuclei; (2) beta particles, which are negatively charged electrons; and (3) gamma rays, which are light waves comparable to X-rays. Of these three forms of energy, the gamma rays are the most penetrating. A radium salt, as ordinarily used, is shielded by a thin metal container which absorbs the alpha and beta particles and allows only the gamma rays to pass. However, the only known method of altering the color of diamonds by radium involves packing the stone in direct contact with the radium salt. In this contact, of course, the stone is under the influence of the alpha and beta particles as well as the gamma rays, and furthermore, has opportunity to pick up by contact some of the radium salt itself. It is not known whether the gamma rays alone have produced the alteration of the color to green or whether alpha or beta rays are also necessary to produce the alteration.

If the alteration can be produced by the gamma rays alone, yellowish diamonds can be turned green by pure gamma rays or by intense X-rays (without the use of radium), and, therefore, can be altered without the resulting radio-activity in the diamond which now is used as a distinguishing test. Research is desirable on this point, but both the necessary diamonds and the radium or intense X-rays are very expensive.

Supposed Synthetic Diamonds Tested

The attempts of Dr. J. Willard Hershey, of McPherson College, Kansas, to synthesize diamond received considerable newspaper publicity in the Spring of 1938. The experiments which received this publicity were a continuation of work begun by Hershey and his assistants and students in 1929.

In a report to the Kansas Academy of Science,[1] Hershey described the method he used in attempting the synthesis of diamond. This is essentially the same as that used by Moissan in 1890-1900. In brief, molten iron is fused with carbon at an extremely high temperature by means of the electric furnace. The molten mass of iron, which dissolves some of the carbon, is then suddenly chilled. The pressure which results from the hardening and contraction of the exterior of the mass, while the interior is still expanding, theoretically should produce the pressure necessary to cause the carbon to crystallize as diamond. In the same paper, Hershey reports other methods attempted, using tungsten, copper, lead, silver and even blue ground from the South African mines. None of these solvents appeared to give as satisfactory results as did the iron. Also various methods were attempted in an effort to cool the molten mass of iron and carbon rapidly, brine with ice being found the most satisfactory. Dr. Hershey, in his report to the Kansas Academy of Science, and in his report to the American Chemical Association at Denver in 1937, stated that from the residues obtained by dissolving the iron, small diamonds were picked out. These stones were tested for "insolubility in hydrofluoric acid; hardness, density; and index of refraction; the burning of diamonds in an atmosphere of oxygen. The density is determined by methylene iodide, which has the same density of diamond, 3.51."[2]



MAGNIFIED 8 TIMES

Figure 1. Five specimens sent to the G.I.A. Laboratory by J. Willard Hershey of McPherson, Kansas. Magnified approximately 8 diameters. From left to right, natural diamond, natural diamond, quartz, quartz, stone possibly synthetic but more likely natural diamond.

The publicity resulting from Dr. Hershey's papers, and also from the

[1] *Synthetic Diamonds.* Trans. Kansas Acad. of Sci., 32:52-54, 1929.

[2] The specific gravity of methylene iodide is 3.32. In it diamond will sink.

paper read by his student-assistant, Lewellyn D. Lloyd, at the American Chemical Society, at Dallas, Texas, on April 20, 1938, was unfavorable to the jewelry trade. For this reason the Gemological Institute interested itself in the matter. After an exchange of communications, and through the valuable cooperation of William McNeil, then president of the American National Retail Jewelers Association, Dr. Hershey kindly consented to send several specimens of the material which he had synthesized to the Gemological Institute Laboratory for testing. These were received June 21, 1938, and from this date until January 10, 1939, a series of tests have been conducted by the Gemological Institute Laboratory and also by Dr. Thomas Clements of the University of Southern California, Dr. J. H. Sturdivant of California Institute of Technology and by David H. Howell, C.G., of Pomona College, California.

In his letter of June 19th, Dr. Hershey states: "On the request of Mr. William McNeil . . . we are sending you some gems, synthetic diamonds, to test." These were five stones (uncut, of course), the largest of which was less than 1/100th of a carat. They were enclosed in small numbered glass vials. These numbers will be used for reference in this article.

Stone No. 1 is a fairly well-formed octahedron which weighs something less than 1/100th of a carat. (1/500th gram). Upon observation under low power of the microscope, this stone has the appearance of the typical small South African crystal. However, tests were continued on it. By means of the Chaulnes method the refractive index was determined to be 2.4 (± .05). An electronic diffraction pattern was obtained on the stone by Dr. J. H. Sturdivant of the California Institute of Technology, who found the edge of the cubic unit cell to be 3.54 Angstrom units, which corresponds within the limits of error to the value (3.56 A) of diamond. This stone is a colorless octahedron with inclusions which resemble in all respects those characteristic of a South African diamond. In view of this extraordinary resemblance to genuine material, it was obvious the specimen could not have been produced synthetically. Dr. Hershey was contacted and asked specifically whether it be a natural diamond. In a letter of July 30th he revised the statement in his letter of June 18th, stating: "No. 1 that I sent is considered to be a genuine diamond. The remaining four are our synthetic gems made from carbon and melted iron as a solvent. We used chemical pure iron as a solvent for Nos. 2, 3 and 5 and commercial iron for No. 4."

Tests on the remaining four stones were then continued. Stone No. 2 is a fragment somewhat smaller than No. 1, apparently having been broken from a larger piece since it shows cleavage faces. This stone was tested for refractive index by the Chaulnes method, and it also gave a reading of 2.4 (± .05). In appearance, it is very similar to No. 1 except that it is more brownish in color and not as perfectly shaped externally. The inclusions are typical of a natural diamond, and this stone likewise is apparently a natural stone, not one which has been synthesized.

Stone No. 3 was found to float in methylene iodide of specific gravity 3.32, proving immediately that it

was not diamond. This stone was powdered and a small portion of the powder was used to determine the refractive index, which was found to be 1.55, and the optic character, which was found to be uniaxial positive. These properties indicated the material to be quartz. Inasmuch, however, as Dr. Hershey had stated in his papers that the tests for insolubility in hydrofluoric acid had been made (quartz, especially such a small fragment, would dissolve readily in hydrofluoric acid) it was believed desirable to make a confirming test. The remaining powder was burned in an arc by David H. Howell, C.G., and a spectrogram obtained by means of the Gaertner-Littrow spectrometer at Pomona College. Definite silicon lines were found in the resulting spectrogram, thus confirming the optical identification as quartz.

Stone No. 4 likewise floats in methylene iodide, has a refractive index of approximately 1.54 and is uniaxial positive in optic character. These properties identify specimen No. 4 also as quartz.

Specimens No. 3 and No. 4 are very deeply etched white semi-transparent fragments. From their appearance it may be inferred that they are the remainders of larger fragments of quartz which were attacked but not completely destroyed by the hydrofluoric acid used.

Specimen No. 5 is the most interesting of the specimens. It also weighs less than 1/100th of a carat, but it differs from numbers one and two in being of pronounced brown color. In external form it is a modification of an octahedron. Its highly rounded faces prevent an accurate designation of its crystal form, but it seems to approach the triangular trisoctahedron or the hexoctahedron. By means of embedding this specimen in a fused mixture of 159 parts selenium to 41 parts sulphur (74½% selenium, 25½% sulphur), which has a refractive index of 2.417 for sodium light, Dr. Thomas Clements found the refractive index of the stone to be approximately 2.42. Dr. Sturdivant determined the structure of this specimen also to correspond with that of diamond. The surface is not sufficiently clear to allow a detailed study of the inclusions to be made, but from its appearance this stone might possibly be diamond produced

ACTUAL SIZE

Figure 2. The same five specimens shown in Figure 1, here illustrated approximately actual size.

by Dr. Hershey's method. However, in view of the outcome of the tests on the other stones of this group, plus the appearance of this specimen, which likewise is quite similar to that of many South African stones, its synthetic origin may reasonably be doubted.

Because of the above facts, it is our opinion that the attempts of Dr. Hershey to synthesize diamond have not achieved much greater success than have those of any previous experimenter. Moissan, and others of his time, thought that synthetic diamonds could and had been produced by the general method of suddenly cooling molten iron in which carbon was dissolved. This general procedure was tried by Sir William Crookes, later by R. H. McKee of Columbia University and is now being attempted by Dr. Hershey. Both McKee and Hershey have received considerable publicity; and, just as

was the case as early as Moissan's experiments, completely acceptable proof of the actual production of even the most minute fragment of true synthetic diamond is lacking. As Dean Edward Kraus of the University of Michigan[3] has pointed out, "The method has been repeated many times and by experienced and skilled European investigators, and always with negative results. Indeed, one of the investigators was an assistant of Moissan at the time he carried on his experiments."

It is *possible* that Dr. Hershey has succeeded in producing tiny synthetic diamonds by this process. However, it is the contention of the Institute, and likewise of both Dr. Clements and David Howell that sufficient evidence has yet to be given to substantiate the synthetic origin of stone No. 5 or of stone No. 2.

It would seem that there may have been too much opportunity for confusion of specimens in the system followed by Hershey and his assistants in their attempts to synthesize diamond. In order that Hershey's synthesis of diamond may be accepted, more definite and convincing evidence will be required, in our opinions. As Sydney H. Ball has pointed out,[4] absolutely final proof will be lacking "until someone finances . . . observers who are to be present at a demonstration by Dr. Hershey. These men . . . should be permitted to mix the ingredients used in the experiments themselves and should be present throughout the experimentation period, and should actually dissolve the product out of the metal after the experiment is completed."

Furthermore, even though Hershey should ultimately prove, to the satisfaction of all concerned, that he has been able to synthesize diamond, the proof would be much more important from a theoretical than from a practical standpoint. The specimens which Dr. Hershey sent to the Gemological Institute Laboratory, even though all had been found to be truly synthetic diamonds, would have been of value only as abrasive material; and the tremendous cost of their production would prohibit their profitable production even though they had been many times larger and of quality suitable for gems. The largest of the specimens which Dr. Hershey sent is too small to be fashioned as the smallest grade of melee, and even the largest stone he claims to have produced (1/30 of a carat, according to his reports) would be worth only a few cents as contrasted with the many hundreds of dollars in time, equipment, and material required to produce it.

[3] In his letter of July 13, 1938.
[4] In a letter of October 11, 1938.

SELECTED BIBLIOGRAPHY
GEM DIAMOND

(Continued from last issue)

GENERAL

Chand, Gulal.
Essay on diamonds. Lucknow, 1881.

Chester, Chandler, B.
The science of diamonds; a self-educated book on diamonds, the only one of its kind in the world. Chicago, Chester & Bergman, 1910.

Cohen, M.
Beschreibendes verzeichniss einer sammlung von diamanten. Wien (Vienna), 1822.

Crookes, Sir William.
Diamonds. [In Proc. Roy. Inst., 1897, p. 477].
Diamonds. London, Clowes & Sons, 1897. Published in Smithsonian Institution annual report, 1897, pp. 219-235 and in Nature, vol. 56, Aug. 5, 1897.
Diamonds. London and N.Y., Harper and brothers, 1909.
Diamonds; a lecture delivered before the British Association, at Kimberley, Sept. 5, 1905. London, [Chemical news office] 1905.
Romance of the diamond. No. Am. 187:371-8 Mr '08.

d'Houville, G.
Diamants. Revue des deux mondes, ser. 8 41:203-4 S'37.
Diamonds, description of [In Phil. Trans. Abr., II., 1708, p. 405].
Diamond, The, or the pest of a day. London, 1797.
Diamonds. Connoisseur 4:248-52 D'02.
Diamonds. In Min. Ind. Brit. Empire & foreign countries, 1919-21: 15 pages.
Diamonds. A fresco of the mines from Golconda to the Congo. Fortune 11:67-My-Je '35.

Dieulafait, Louis.
Diamants et pierres precieuses. Paris. Hachette et cie, 1871 (2d éd, 1874).
Diamonds and precious stones; a popular account of gems. Tr. from the French of Louis Dieulafait. N.Y., Scribner, Armstrong and company, 1874.

Emanuel, H.
Diamonds and precious stones, their history, value and distinguishing characteristics with simple tests for their identification. 2 ed, with a new table of the present value of diamonds. N.Y., Putnam, 1873. [1st ed London, J. C. Hatton, 1865; 2d ed, 1867.]

Fergusson, John Clyde.
Diamonds and other gems. Los Angeles, n.d.c., 1927.

Fersman, Aleksandr Evgen'evich, supervisor.
Russia's treasure of diamonds and precious stones. Moscow, Peoples Commissariat of finances, 1925-26. [Published in Russian, English and French.]

Fersmann, A. von and Victor Goldschmidt.
Der diamant, eine studie. Heidelberg, C. Winters universitätsbuchhandlung, 1911.

Fornano, Carlo de.
Krichna's gift—the legend of the diamond. N.Y., Marcus & co., 1901.

Forster, J. A.
Diamonds and their history. J. Microscopy Nat. Sci. III, 1884:15.

Framinet, Claude.
Le diamant et ses imitations . . . préface par Alexandre Dumas. Paris, M. J. Madre [1868].
Gibbins, H. J.
Curiosities of diamonds. Gent. M. N.S. 52:243-250, Mr'94.
Groth, P.
Grundriss der edelsteinkunde. Leipzig, W. Engelmann, 1887.
Jacobs, Henri et Nicolas Chatrian.
Monographie du diamant. Anvers, Librairie universelle de L. Legros, 1880. New and enlarged work based on their "Monographie du diamont," Paris, G. Masson, 1884.
Jannettax, Edouard. (N. and E. Fontenay, Em. Vanderhegen and A. Coutance).
Diamant et pierres precieuses; cristallographie, descriptions, emplois, é valuation, commerce. Bijoux, joyaux, orfévreries au point de vue de leur historie et de leur travail. Paris, Rothschild, 1880.
Jeffries, David.
A treatise on diamonds and pearls in which their importance is considered and plain rules are exhibited for ascertaining the value of both; and the True method of manufacturing diamonds. Lond. C. and J. Ackers, 1750. The 2d ed, with large improvements, Lond. 1751. The 3d ed, with large improvements, Lond. R. Lea [etc.], 1800. The 4th ed, corrected to present time. Lond. W. L. Molyneux, 1871.
Traite des diamants et des perles, oú l' on considère leur importance, on établit des régles, certaines pour en connôitre la juste valeur; et l' on donne la vraie methode de les tailler. On y trouve aussi des observations curieuses, égalemente utiles aux négociants, and aux voyageurs, and qui intéressent même la politique. Paris Debure l'âine [etc.], 1753.
Abhandlung von der demanten und perle worrinen ihr vorzug nebst regeln ihren wahren zu bestimmen, untersuchet, die rechte methode sie zu schneiden gezeiget, und zugleich viele seltene und sowohl für kaufleute als reisende nüssliche anmerkungen mitgetheilet. Werden. Danzig, G. M. Knoch, 1756.
An abstract of the treatise on diamonds and pearls by which the usefulness to all who are in any way interested in these jewels will sufficiently appear, and therefore addressed to the nobility and gentry of this kingdom, and to the traders in jewels. London, 1754.
Joyaux, diamenta, perles et pierres précieuses provenant de la collection du prince. Dont la vent aura lieie hotel Drovot. Paris. [A. Maulde et cie] 1888.
Juweilier, Der Aufrichtige, oder anweisung aller Arten edelsteine, diamenten, und perlen zu erkennen, nebst liner aus dem Englischen ubersetzten en abhandlung von der diamanten und perlen. Frankfurt, 1772.
Kunz, G. F.
The new international metric diamond carat of 200 milligrams (adopted July 1, 1913, in the United States). N.Y., Amer. Inst. of Min. Eng., 1913. Reprinted fr. Trans. Amer. Inst. of Ming. Eng. v. 47, pp. 748-769, 1913.
Laufer, Berthold.
The diamond: a study in Chinese and Hellenistic folklore. Chicago, 1915. (Field Mus. of natural history, Pub. 184, Anthropological series, Vol. XV, no. 1.)
Launay, Louis de.
La crise du diamant. Revue des deux mondes, 13:370-390 '23.
Leviticus, Felix and Polak, Henri.
Geillustreerde encyclopaedie der diamantnijverheid, door, dr. Haarlem, DeErven F. Bohn, 1908.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

TOPAZ (Continued)

Topaz is found in the Ural mountains in Russia, in the Mourne mountains in Ireland, in Brazil, Africa, Japan, Mexico, Ceylon, Cornwall, Saxony, Tasmania; and in the United States in Utah, Maine, California, Idaho, Montana and New Hampshire.

OPAL

Opal is perhaps one of the most simple of gems, and yet in some respects one of the most complex. Indeed it is one of the most beautiful. Chemically, the opal is merely hydrous silica. But optically the opal is more or less complex. It is amorphous and, therefore, is isotropic. The index of refraction varies from 1.44 to 1.45, depending on the water content of the gem. The water content will vary from 1 to 21 per cent. However, in precious opal the content is usually about 5 to 10 per cent. The chemical formula is usually written SiO_2xH_2O. The cause of the color play in opal has been a matter of question for many years, but it is now an accepted fact that the color is caused by differing indices of refraction in the different portions of the gem. This may be due to small cracks or fissures in the gem, but it is much more likely that it is due to the various layers of silica having different indices due to mere physical density. It is well known that opals are formed by deposition of silica from superheated waters which carry a large amount of silica. As these waters are forced up from the inner earth they each time give the passage way a coat of new silica, until a wall is eventually built up. Thus this wall is built of very thin layers or laminae. It is believed that the difference in the indices of refraction of these different layers or laminae produces the color play which we see in opal. It is true also that opals often contain clouds of some mineral substance which is foreign, such as a metallic oxide, usually iron. These may cause some of the color play, for such clouds would tend to increase the index of the strata or plane in which they lay. Other impurities are not uncommon in opals.

Opal is light in weight, the specific gravity being only 2.1 to 2.3. It is soft, only 5½ to 6½ in hardness. Due to its structure and water content, it is more or less brittle, and breaks with a conchoidal fracture. The luster of opal is vitreous to dull, and shining to splendent in intensity.

Many opals are very fragile due to loss of the water content of the stone after its removal from the earth. This will be noticed in uncured Nevada opal. The opal coming from the Nevada mines is of a high water content. Upon evaporation of this water the opal will shrink to some extent and this will cause a stress that, if it is not great enough to cause the opal to crack up of itself, will cause it to burst upon receiving a slight jar. Such

a stress will also cause anomalous double refraction to appear, which sometimes will puzzle the amateur. It is possible, however, to cure these opals by replacing or displacing the water content or part of it with silica. The process used is a trade secret and is known to comparatively few. Most of the miners try to cure these gems by slowly desicating them in earth taken from the mines. While a slow drying process is to be preferred to a sudden evaporation, yet the loss of water will, nevertheless, cause a shrinkage. This is clearly manifested by the peeling of the opal when so cured. The opal, when mined, is covered with a "peel" or coating of siliceous earth, which, when the opal has dryed out enough so as to contract a little, will peel off, leaving behind the gemmy opal. Other miners try to replace the water in the gem with some fluid which will not evaporate, such as glycerine. This, however, is not effective and would, of course, be objectionable in a gem. The fact that Nevada opals are so fragile and the fact that so few lapidaries are able to properly cure these gems, have, together, made the gems more or less unsatisfactory on the market. In beauty, however, they are unsurpassed.

Precious opal includes those varieties which have a good play of color and are used for gem purposes. The varieties are:

White Opal—including varieties of precious opal of light color.

Black Opal—including varieties with black to grayish-black and deep blue color.

Fire Opal—includes the yellow to reddish semi-transparent opals with a fiery play of color.

Lechosos Opal—includes those varieties showing a deep green color play.

Harlequin Opal—are those which exhibit patches of color of a rather uniform size, the name being suggested by the likeness to the harleqin's motley dress.

Girasol Opal—is a variety of opal which is bluish-white and translucent, with a reddish chatoyancy.

Opal Matrix—is a term applied to opal cut with the matrix.

Common opal includes those varieties which have little or no color play. Most of these are not suitable for gem purposes, but a few are used to some extent in cheap jewelry. The greater part of this material is used for making ornamental goods such as fountain pen bases, ash trays, clock cases, etc. Common opal includes the following varieties:

Milk Opal—milk white, yellowish, reddish, greenish, or bluish in color.

Agate Opal—a variety which is banded similar to agate.

Jasper Opal—reddish to brownish opal, marked like jasper.

Prase Opal—a green opal with an appearance similar to prase.

Resin Opal—a variety of opal with a resinous luster and of a yellow color.

Rose Opal—a variety with a pink to rose tint.

Wood Opal—pseudomorphous, after wood, and retaining the structure of the wood. Also called opalized wood, etc. Pseudomorphs, after shells, etc., are also known.

Hyalite—a variety which is colorless and very transparent, having the appearance of glass.

Menilite—a brown to grey concretionary variety, sometimes called liver opal.

(To be continued)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Pegmatite (peg'ma-tite). Coarsely grained igneous rock composed chiefly of quartz and feldspar.

Pendeloque (pan"d'loke'). A style of cutting, a pear-shaped modification of the round brilliant, often used for a pendant. Formerly applied also to the briolette style when fashioned in a pearl shape.

Penetration Twin. A pair of crystals developed in reverse position with reference to one another and each penetrating through the other.

"Pennsylvania Diamond." Iron pyrite.

Pentagon (pen'ta-gon). Any of several variations of the step cut, having five straight sides.

Peredell Topaz. Light green to yellowish-green topaz.

Perfect. Without internal defects or inclusions of any kind. May also include correct cutting and fine polish.

"Perfect Cut." A term sometimes used by unscrupulous dealers to convey to a customer the impression that a diamond has no imperfections. In its literal sense, *Perfect Cut* is seldom used, as few or no gem stones are ever absolutely correctly fashioned.

Perfection Color. Finest color of that particular variety.

Perforated beads. Beads carved through to an irregular design.

Peridot. A gem species known also as *olivine* and as *chrysolite*. Orthorhombic system, R.I. 1.66-1.70, S.G. 3.3, Hardness 6½-7. Transparent, yellow to fine green and dark green to brown.

"Peridot of Ceylon." Same as Ceylon Peridot.

Peridotite (per'i-doe-tite). A very basic igneous rock, consisting chiefly of olivine and pyroxene.

Perigem (per'i-jem). Trade name for light yellow green synthetic spinel.

Periostracum (per"i-os'tra-kum). The outermost horny layer of the shell of the mollusc.

Perlite (pur'lite). Volcanic glass with a concentric shelly structure due to curved cracks produced by contraction in cooling. See also spherulite.

Persian Lapis (pur'shan or zhan). Fine lapis lazuli.

Persian Turquoise. Fine turquoise.

Peruvian Emerald (pe-roo'vi-an). Emerald from Colombia, South America.

"Pesas Diamond." Quartz.

Petal Pearls (pet'al). Flattened, leaf-like pearls.

Petrifaction (pet"ri-fak'shun). Process of changing organic material into stone by replacement. The original structure is sometimes retained.

Petrified Wood (pet'ri-fide). Wood which has been entirely replaced by silica, and hence converted to quartz. See *Petrifaction.*

Phenacite or Phenakite (fen'a-site or kite). A mineral species sometimes used as gems. Transparent, colorless to light red, light yellow, or light brown, R.I. 1.67-1.70, S.G.

2.95, Hardness 7½-8, Hexagonal crystal system.

Phenomena (fee-nom'ee-na). Plural of *Phenomenon.*

Phenomenal Gem (fee-nom'ee-nal). A gem-stone exhibiting an optical phenomenon. See phenomenon.

Phenomenon (fee-nom'ee-non). In gem-stones, an optical effect in visible light occurring in certain, but not in all, specimens of that species. See also: Adularescence, Asterism, Chatoyancy, Girasol, Labradorescence, Orient, Play of Color, Schiller, etc.

Phosphorescence (fos"fore-es'ens). The property by some substances of emitting visible light *after* exposure to ultra-violet light, cathode rays, X-rays, etc. See also Fluorescence.

Pierre Precieuse (Fr. pyar"prae"-syuz'). Precious stone.

Pigeon Blood. Color of the finest quality of ruby.

Pinacoidal or pinakoidal (pin"a-koi'-dal). Crystal form of two parallel planes which are also parallel to two or more crystallographic axes, or developed (as cleavage or parting) parallel to such a form.

Pinchbeck. Substitute for gold, so-called after inventor Christopher Pinchbeck (Pinsebeck).

Pin Fire Opal. Opal in which the area of the individual colors is very small.

"Pink Jade." A combination of jade and quartz.

"Pink Moonstone." Scapolite.

Pink Topaz. Topaz either naturally pink or artificially colored pink by heating yellow or brown varieties.

Pinking. Heating topaz to change its color to pink.

Pin-Point Opal. Opal with play of color in very small patches. See also Pin-Fire Opal.

Pipe Opal. Term applied in Australia to any long, narrow cavity filled by opal. Also opalized belemnites, long, narrow, cigar-shaped fossils.

Pipes. Volcanic chimneys or fissure widenings.

Piqué (pee-kae'). Touched with tiny imperfections.

Pisolitic (pie"soe-lit'ik or piz"oe-lit'-ik). Composed of or containing rounded masses about the size of peas.

Pistacite (pis'ta-site). Epidote.

Pit. A small fracture in the flat surface of a facet of a gem, or along the junction of two facets.

Pitch Opal. A brown variety of common opal with a pitchy luster.

Pitchstone. Obsidian with a pitchy luster.

Pitchy. Resembling pitch.

Pitchy Luster. Resembling the luster of a fresh surface of pitch.

P.'K. An abbreviation for *piqué.*

Placer (plas'er or pla-ser'). Alluvial or glacial deposit in which minerals are found. Are usually accumulations of sand and gravel containing gold, gem material, or other minerals of value.

Plagioclase (plae'ji-oe-klase"). A subdivision of the feldspar group. Includes the species albite, oligoclase, labradorite, and others.

Plasma (plaz'ma). A brownish-green variety of chalcedony quartz.

Plastic. Capable of being molded or pressed into shape.

Plates. Laminated layers. Broad, relatively thin masses.

Platinum (plat'i-num). A rare mineral. A very heavy steel-gray precious metal of great usefulness in the jewelry art.

Platy (plat'i). Consisting of, or readily splitting into, plates.

(To be continued)

Photography in Gemology

(Continued from last issue)

A method developed in the G.I.A. laboratory and tried out subsequently by several students, has been found to be very satisfactory. It is described in detail below:

A single photoflood lamp* in a small reflector is used. For instance, a No. 1 photoflood lamp in an ordinary gooseneck desk lamp with reflector gives very satisfactory results. This is moved from point to point about the stone during exposure.

Highly concentrated spotlights or flashlamps can be used when a dramatic effect is desired, but these are not satisfactory when detailed photographs are desired. Often, however, it is more important to give a feeling of intense brilliancy and sparkle to a stone rather than getting an accurate reproduction, and the spotlights or flashlamps, especially if used in conjunction with the photofloods, will often achieve this effect. A single photoflood in a stationary position is satisfactory also.

The illuminator base of the Diamondscope has been found to be very satisfactory as a source of illumination for photography of gems. The microscope or loupe holder ordinarily used on the base may be removed and photographs, actual size or slightly enlarged, may easily be made of gems held in the specially designed tweezers of the Diamondscope.

When higher magnification is desired than is obtained with the camera and its focusing attachment, a microscopic system of some sort must be resorted to. The simplest method of achieving this is photographing through the eyepiece of the microscope. One of the eyepieces of the binocular microscope used with the Diamondscope can be used in this way with excellent results. Most photomicrography employs the microscope system as the camera lens; that is, the lens of the camera is removed and the camera, less lens, is mounted above the eyepiece of the microscope. A light-proof connection from the microscope to the camera is essential. If the lens cannot be removed from the camera, it is sometimes possible to remove the eyepiece of the microscope and focus the camera for the image formed by the objective alone. The latter method will place the camera at a considerable distance from the microscope, necessitating a long connection from camera to microscope.

The best position for the camera is found by trying it at several distances from the microscope, using the ground glass (or tissue paper) for focusing. A simple object—a feather is satisfactory—should be used on the microscope stage to arrange the set-up and locate the camera. The connection from the microscope to the camera may be made with any light-proof material—a very heavy black felt is easily worked.

Whatever microscope is used for photography, it is essential that the microscope and camera be so set up that they cannot vibrate with respect to one another. Perhaps the simplest means of achieving this result is to attach the camera directly

*Be sure the lamp is a photoflood, with a life of about two hours, rather than the photoflash, which gives an intense light of about 1/100 second duration.

to the microscope so that the microscope and camera vibrate as a unit. However, if it is not possible to attach the two together firmly, it often is satisfactory to screw both the microscope and the camera support firmly to a thick board.

If the camera used is capable of a very long bellows extension, it is often possible to mount a regular microscope objective in place of the photographic objective of the camera and thus to obtain high magnification without resorting to a complete microscope set-up. In this case, however, it is often difficult to secure the necessary illumination which is simply obtained from the sub-stage apparatus of a good microscope.

The flatness of the focus of the microscope lenses is not nearly so important in photographing cut gem stones as it is with thin sections, since even though the field of focus may be strongly curved, it will usually cover material inside the gem, whereas if a thin section were used, only a part of the field could be focused.

In experimental work done in the G.I.A. laboratory, almost every standard type of film was used. It was found that any panchromatic film, which is sensitive to all colors of light, was preferable to orthochromatic or regular emulsions. The hues of gems in completed photographs vary widely according to the color of the stone and satisfactory results were often impossible to obtain when other than panchromatic material was used. With panchromatic film, which is sensitive to all colors in more nearly the same ratio as the human eye, the values in the resulting print are much more satisfactory on the whole.

The photographing of gems can be divided into two general classes: (1) photomacrography (from macroscopic—visible to the unaided eye), the photography of small objects at magnifications from 1x to perhaps 10x or more and (2) photomicrography (from microscopic—not visible except with the microscope), the photography of objects too small to be seen by the unaided eye at from approximately 20x to several thousand magnifications. Of these two classes the average jeweler-gemologist will have much more practical use for photomacrography, i.e., those photographs which can be taken without the aid of a microscope. or with only the lower magnification of the microscope.

Of these two types of photography, the first — photomacrography — is probably the most difficult when working with gems. Arranging the stone and focusing the camera are not difficult, but illumination and correct exposure are subjects which require careful consideration. Illumination is important since, if it is incorrect, many reflections from top facets will be obtained with no penetration into the stone and the resulting photograph will be very uninteresting, unrepresentative of a fine gem. A method used to advantage in the G.I.A. laboratory is the following: The camera is focused on the gem and the stone brought up to the correct magnification by varying the distance between the lens and the stone and consequently the distance between the camera lens and the film or plate, until a sharp focus is secured.

(To be continued)

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