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The Mining of Gems and Ornamental Stones by American Indians*

Digest by RICHARD T. LIDDICOAT
of an article by SYDNEY H. BALL,

"Anthropological Papers," No. 13, Bulletin 128, pages 11 to 77, Bureau of American Ethnology, Smithsonian Institution.

When Europeans arrived in America, they found the American Indian largely in the stone age, although a number of tribes, particularly those of Mexico, Central America, Colombia, and Peru, used certain metals. Imbued with our conception of racial superiority, we rarely think of the Indian as a capable prospector and a patient, if primitive, miner, yet the rapid development of mining in Mexico and Peru after the conquests was mainly due to the large number of ore bodies and gem deposits opened up by the local aborigines.

This article treats of the gems and ornamental stones used by the Indian before he came in contact with the white man. His metal mining has been frequently described: the pits he dug on the Lake Superior copper range, his exploitation of the mercury mines of New Almaden and Peru for paint, his placer gem mining in Georgia, Mexico, Central America, the West Indies, Northwestern South America and Brazil and his gold and silver lode mining in Mexico and Peru. Within the United States, copper and gold were treated as pebbles and pounded into the shapes desired, but in Mexico, Central America, and western South America an elementary smelting technique had been evolved, and in certain localities the skill with which metals were forged, cast, alloyed, and plated astonished the Conquistadores. Platinum, it may be recalled, was used by the Indians long before it was known to the white man.

The Indian's knowledge of gems and ornamental stones was, however, much more comprehensive than that of metals, and his most extensive mines, or at least those known to us, were of ornamental stones. His acquaintance with minerals suitable for decorative purposes exceeded in number at least that of the peoples of Europe and Asia at the time of the discovery of America. The Indians made use of some eighty-four gems and ornamental stones known to the writer. It can be said with considerable assurance that at the beginning of our era, or roughly two thousand years ago, the American Indian used the following precious and decorative stones: agate, agatized wood, alabaster, azurite, bloodstone, calcite, hematite, chalcedony, jadeite, jasper, jet, lapis-lazuli, lignite, malachite, mica, moss agate, nephrite, obsidian, common opal, pyrite, rock crystal, satin spar, selenite, serpentine, soapstone, and tur-

* A.G.S. Research Service.

quoise. By 1000 A.D., and even earlier, the following, among others, had been added: amber, carnelian, catlinite, chloromelanite, emerald, fluorite, galena, garnet, magnesite, marcasite, moonstone, noble opal, sodalite, variscite. As sources of material to study the subject, we have: (1) Artifacts preserved in public and private collections; (2) mine workings, although many which once existed have become obliterated; (3) early and present-day literature; and (4) the traditions and myths of the Indians.

The gems, as we know them today, were used by the American Indians in various ways. The most important use the gem materials had was ornamental. They consisted mostly of pendants, beads, and carved figures. Gem mosaics were worn among the Pueblos, the semicivilized Mexicans, the Peruvian peoples, etc. The Indian adores vivid colors and he has a childlike love of beautiful pebbles, particularly if brightly colored. To the semicivilized peoples from Arizona to Chile, the blue and the bluish green of the turquoise and the green of jade and emerald had a peculiar fascination. Such stones were eagerly sought and highly valued. Turquoise gained its color from the cloudless sky, and jade symbolized the growth of crops; their value being increased by the supernatural power gained thereby. So highly regarded were these stones that jade could be worn only by nobles among the Aztecs, and among the Yavapai (central Arizona) only a chief was privileged to wear turquoise bracelets.

Other materials whose beauty attracted the aborigines were utilized for other purposes by them. Obsidian was in great demand for arrow and other weapon points. Soapstone, quartz, pyrite, and other materials were used in the home; the soapstone for utensils, the quartz for knife edges and for use with pyrite to obtain sparks for fire. In addition, gem materials were used for surgical instruments, graving tools, abrasives, mirrors, windows, embellishment of buildings, pigments, and currency.

Like most primitive peoples, the American Indian saw in gems and decorative stones not only beauty but the supernatural and the awe-inspiring. Precious stones, therefore, were important factors in their religious life, indeed, fine gems were often actually worshipped by aborigines. Almost all gems were used as fetishes and charms. Some were protection against ill health, others against injury, others were supposed to bring good luck on the hunt. A common use of gems was as a native offering to the gods. They were also widely used by medicine men of the various tribes.

American Indians mined gems and metals in a large number of localities. Many of the important mining centers of the present were worked originally by the Indian. As miners, the Pueblos, Aztecs, Peruvians, and the Indians of the southern Appalachians were outstanding, while the Mayas and Mound Builders depended largely on commerce for their supply of gems. The Indian, generally using tools of stone, by long experience became a fair geologist, knowing the rocks most suited to his needs and their characteristics — indeed, probably much better than we do. This required a knowledge of texture, hardness and mineralogical makeup, so that he could recognize the same mineral if found in two different places. Many minerals were known to him that were unknown at the time in Europe. The fact that arrowhead material was sought in stream gravel rather than from outcrops or detrital boulders shows that he realized that stream material was unaltered and would not shatter badly, in contrast to weathered outcrop material.

The Indian was also an excellent prospector. In some cases he realized that where some easily noticed minerals were found, certain gems were usually present. Proof of the Indian's ability is the fact that practically all of the known turquoise localities of our own Southwest and the emerald deposits of Colombia were worked in pre-white time. As to nephrite and jadeite, the aborigines had sources which are still unknown to their white successors. Although most gem mining was confined to placer deposits, some actual hard-rock mining was carried on. Both open-cut and shaft mining was undertaken in various places. Often the rock was broken by building a fire on the place to be broken and then quenching with water. In some mines there were several levels, and in some cases galleries extended for 300 feet. The laws that sometimes regulated mining are quite interesting. Most tribes usually at war were likely to meet on peaceful terms at a mining site, where they would work side by side, in peace. Levity was not tolerated at most mineral sources. Often tributes were offered to the spirit who guarded the mine.

GEMS MINED BY AMERICAN INDIANS

Diamond

There is some evidence that diamonds were known to the Indians of Brazil and British Guiana.

Emerald

To the South and Central American Indians, emerald was by far the most prized gem. Archeologists tell us they were used at least as early as 500 A.D. and probably much earlier. The Colombian emerald mines we know today were all worked by Indians. They prized the gems so highly that only chiefs were allowed to wear or own them.

Quartz

Quartz was one of the most important minerals the Indians had. It served countless purposes. Flint was extremely important because it tipped the arrows they needed to kill game. In addition, it was necessary to produce fire. Amethyst, agate, rock crystal, etc., served as gems and ornamental stones.

Turquoise

The most prized gem to the North American Indian was turquoise. It served as an ornament, as a native offering, as a fetish, and as a measure of wealth and a means of investment. They judged its value much the same as does the modern jeweler, on the depth and purity of the blue color. It was mined extensively, especially in our own Southwest. The largest early mining project was at Los Cerrillos, New Mexico. The size of one open-pit in that locality suggests that 100,000 tons of rock must have been removed. Colorado, Nevada, Arizona, and California had turquoise mines. The gem was also important in South America, especially among the West Coast tribes.

A small half-inch piece, of good color, was worth at least the price of a pony. The gem was also highly regarded by the South American Indians, but held second place to emerald in their esteem.

Jade

Both jadeite and nephrite were extensively used by American Indians. In contrast to most of the other gems used, the sources of jade are rather obscure. Nephrite is found in some quantity in Alaska and as boulders in British Columbia and Oregon. It also occurs in Bolivia, Brazil and British Guiana. No jadeite sources are known that are important, but the Aztecs doubtless obtained it from southern Mexico. In three southern states of Mexico jadeite pebbles have recently been found. The aborigines cut small figures and beads from pebbles. In a good green color the material was very highly regarded. To the Mayas it was the most precious of possessions; its ownership an insignia of wealth or power.

Pyrite

Pyrite was rather widely used in both North and South America. The Mayas polished large pieces of it to use as mirrors. Northern tribes used the mineral to strike fire, much in the same way flint and steel was later used.

Mica

Mica was mined extensively in the Southern Appalachians. Some ornaments were cut from mica and sheets of the material were wrapped around beads to produce imitation pearls.

Other Gems

Many other gem materials were of importance to the American Indian. Among the most important were: Obsidian, used for arrowheads and knife edges, catlinite for pipes, steatite or soapstone for cooking utensils, and amber used for beads and other ornaments.

DIAMOND GLOSSARY

(Continued from last issue)

Borneo (Malay Archipelago). Systematic diamond mining was conducted by the natives of Borneo when the Dutch first arrived there in the 17th century. The diamond deposits are notable because of the exceptional number of colored stones which have been found there. Borneo has been a minor diamond source since the 18th century.

Bortz (borts). Same as Bort.

Bort (boart, boort, bortz, bowr). Round form of a poorly crystallized diamond, dark in color and translucent or opaque. Cleavage is difficult. Used for industrial purposes. "In the trade the definition of 'bort' is extended to all impure diamonds, provided, on account of their small size or because of impurities, they are valueless as gem stones." (Ball.) But mineralogically and industrially, bort is a distinct variety of the gem species. Bort occurs in Brazil (in all deposits), in South Africa and in British Guiana.

Bowr. Same as Bort.

Braganza Diamond. Found in the 18th century in Brazil, and was said to be a diamond. It has been reported by various travelers as in the possession of Portugal, and to have weighed 1,680 carats, but it is generally thought to be a topaz and not a diamond.

Brazil. Important diamond source. Diamonds discovered in 1725. Exported to Lisbon in 1728. Most of the deposits lie in the present river beds and in the terraces above the rivers. Diamonds are also found in deposits which lie high on the hills and plateaus above the present water courses. See, also, Itacolumite. See, also, name of diamond. See, also, Occurrence.

Brazilian Cut. A term used by Herbert P. Whitlock to describe a cushion-shaped stone, with eight additional facets around the culet, making 66 facets.

Break Facets. The 32 small facets along the girdle of a brilliant stone; 16 of these are above the girdle and 16 below.

Breccia. When a rock is similar to conglomerate, except that it contains coarse angular fragments, rather than rounded pebbles, it is known as breccia.

Brewster, Sir David (1781-1868). Leader in the study of optics. He made his name by a series of investigations on the diffraction of light. Made all important discoveries regarding the laws of polarization. Discovered crystals with two optic axes and many of the laws of their phenomena, including the connection of optical structure and crystalline forms. Sir David Brewster was one of the founders of the British Association for the Advancement of Science.

Briggs' Scale. A scale to determine the comparative toughness of the so-called brittle minerals by pressing the fragment of one mineral against another until one broke, the first to break being classed as the lower in toughness. Carbonado occupies the highest position in the scale.

Briljandeerer. See Brillianteerer.

Brilliancy. The comparative "brightness" which reaches the eye as a result of (1) reflections from the internal surface of facets (called total internal reflection) and (2) reflections from the external surfaces of the table and other facets of a gem (luster). See Total Internal Reflection. See Luster.

Brilliant. Word sometimes used to mean a diamond cut in the brilliant style, but more generally to mean that style of cutting itself when applied to any stone.

Brilliant Cut. A style of cutting usually used for diamond which is designed to give maximum brilliancy and fire. It has 33 facets above and 25 below a round girdle.

Brilliant Cut (variations). The brilliant style is applied in cutting the marquise or navette, the brilliant pendelogue, the oblong brilliant, the triangular brilliant, the half-moon, etc. All of these forms are fancy shapes of the brilliant.

Brillianteerer (Dutch, briljandeerer). The workman who polishes the facets of a brilliant other than the bezel and pavilion facets. The remaining facets are polished by a "lapper." See "Lapper."

Brillianteering. The placing and polishing of facets other than the bezel and pavilion facets.

Briolette. Pear-shaped or oval stones faceted all over with triangular facets.

"Bristol Diamond." Rock crystal.

British Guiana (South America). Diamonds were first discovered on the north coast of South America in the early gold days. In 1890 diamonds were discovered in the gravel of the river bed of the Mazaruni River. Between 1890 and 1902 less than 9,000 carats came from this deposit. But in 1927, more than 170,000 carats, valued at 724,152 pounds sterling (about $3,750,000) were exported.

Brittle. Crumbles under knife or hammer, cannot be cut in slices. Means that a gem is not flexible, ductile, etc., but not necessarily fragile.

Brown (very light). Diamond with a very light brownish tint, placed between crystal and top cape in the more usual trade classification.

Brown (Fancy). Stones are not uncommon: reddish brown, clove brown and coffee brown diamonds not infrequently reach the trade. These are particularly desirable in jewels, especially the "coffees."

Brown (Slightly). Color grade of diamond used by some dealers.

"Brownies." Term loosely used to describe any diamond with light brownish tinge. Not applied to more desirable brown diamonds of pronounced color.

Brunswick. Blue diamond. Weight 44¼ carats. Probably a portion of the Tavernier Blue ("French Blue"). The Hope diamond is believed by many authorities to have formed the larger part of the Tavernier Blue. See Hope Diamond.

Bruting. Rubbing or bruting two diamonds together until desired shape was secured. Now the process of cutting replaces the awkward method of bruting.

"Bubbles." A globule of air or a globular vacuum in a transparent solid, as bubbles in window glass or a lens. Spots in diamonds which are usually air bubbles, but may contain gas.

(To be continued)

Natural and Cultured Pearl Differentiation*

by

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(Continued from last issue)

Radiography of Natural and Cultured Pearls

That radiography or the shadowgraphic technique might be used as a means of distinguishing pearls seemed worthy of investigation, in spite of the fact that an opinion has been expressed to the effect that insufficient difference in density existed between the nacre and the core of a cultured pearl and that consequently no useful shadowgraph could be obtained.[7] Within the past two years, however, a usable, and wholly accurate, technique has been evolved and perfected. The method has been described in detail elsewhere.[8]

The success or failure of this method was found to revolve around three conditions: Correct exposure, use of a suitable masking agent, and the employment of a very fine-grained x-ray film.

Heretofore, too high a kilovoltage and milliamperage had been used, as well as the wrong kind of x-ray film. Continued experimentation showed that a lower kilovoltage was essential. Now the penetration of the rays is governed by the voltage applied to the x-ray tungsten target equipped tube. For satisfactory radiographs it was found that a kv of 55 and an ma of 5, with an exposure of about 45-60 seconds was most effective for distances of 10 inches from target to film plate holder. Of course, size and weight of the pearl to be tested are factors that must be taken into consideration, and which will determine the amount of kv and ma to be used.

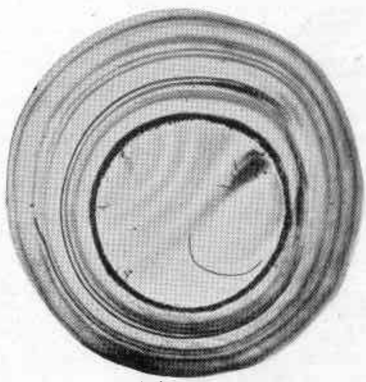

Figure 6

Cultured fresh-water pearl, showing glass core. A thin section. 3-grain pearl.

Relative to the use of a suitable masking agent, a consideration of the pearl shape had to be taken into account. A spherical shape is a difficult subject to radiograph because of its great variations in thickness. Furthermore, the area of the film

7 Anderson, B. W.: The Gemmologist, 8, no. 88, 52-4, 1938.

8 Alexander, A. E.: Photo Technique., 50-52, March, 1941.

* G.I.A. Research Service.

outside the shadow of the pearl receives the full x-ray exposure and a portion of these rays is scattered within the shadow itself, with the result that the image is blurred and detail is impaired. To avoid this undesirable effect, the pearl should be surrounded with a suitable substance to absorb the scattered x-rays. The most satisfactory masking liquid found for this purpose is carbon tetrachloride. This fluid will not injure either the organic or inorganic

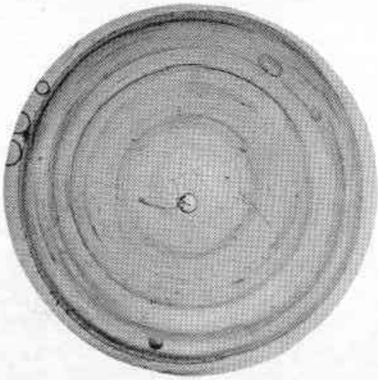

Figure 7
A typical Persian Gulf natural salt-water pearl. 19.6 grains. A thin section.

matter of which natural pearls are composed.

Finally, it was found that a very fine-grained x-ray film was absolutely essential in order to bring out the delicate differences that are inherent in each and every pearl.

Before presenting the results of the radiographic study of pearls, a few words describing the distinguishing characteristics of a natural pearl are in order. The natural gem, either of salt- or fresh-water origin, is usually composed of exceedingly thin layers of aragonite, the orthorhombic variety of calcium carbonate, deposited concentrically throughout the jewel. A small amount of organic matter, termed conchiolin, forms a tenuous network throughout the mass of calcium carbonate. In rare cases, calcite may be associated with the mineral aragonite.

Cultured pearls, on the other hand, are composed essentially of two distinct parts: first, a large internal mass manufactured from mother-of-pearl shell, and second, the concentric layers of pearl aragonite which have been deposited around the core by the pearl-oyster.

In radiographing a cultured pearl, the mother-of-pearl core shows a greater absorption of the x-rays than the nacre or natural pearl aragonite which covers the core. As a result, the radiograph reveals a lower photographic density for the mother-of-pearl than for the nacre. The boundary between these two structures is generally fairly sharp. The higher absorption of the mother-of-pearl core is believed to be attributable to its greater density. For example, the mother-of-pearl nuclei of cultured pearls have an average density of 2.835, while natural pearls have an average density of 2.685. In ascertaining the effect of light on mother-of-pearl, it was found that the greatest degree of absorption occurs where the (001) crystal planes are set perpendicular to the beam of light. If these planes are oriented parallel with the light beam, the least absorption takes place. But this phenomenon does not apply to x-ray absorption which is independent of the orientation of the crystal planes. It is only the higher density of the mother-of-pearl substance which distinguishes it from the natural pearl material in the radiograph.

The line of demarcation, where the nacre or natural pearl aragonite is initially deposited on the mother-of-pearl, is easily seen in the x-ray pictures of all cultured pearls. The presence of this line is a distinguishing factor which at once permits cultured pearls to be differentiated from natural pearls.

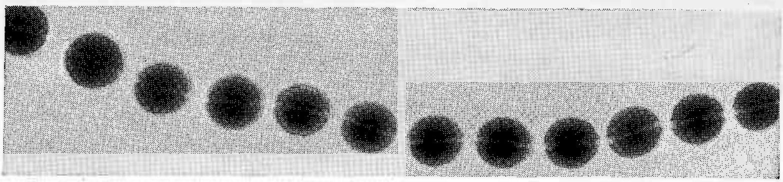

Figure 8
Radiograph of a Japanese cultured-pearl necklace, showing large mother-of-pearl cores, and lines of demarcation—where nacre joins the MOP nucleus.

Natural pearls, either of salt- or fresh-water origin, do not show a definite line of demarcation. Such lines as do occur are more or less irregular in outline and are apt to extend only part way around the pearl. If the specimen is turned 90 degrees; the line or lines may be longer or shorter, or may be absent entirely. A cultured pearl, of course, will not yield an anomalous shadowgraph of this kind. Some natural pearls, especially those of salt-water origin, may be so uniform in structure, with the laminae closely packed together, that difficulty is experienced in bringing out detail in the radiograph, regardless of how the gem is oriented with respect to the x-ray beam.[9, 10, 11]

Binocular Observations

The writer is very partial to this method. If a pearl is drilled, it is possible to easily and quickly determine it by means of binocular observation. Essential, first, is the need of good optical equipment. The Bausch & Lomb microscope, of the type incorporated in the "Diamondscope" is an example of what should be had. An adequate light source, with filament band, or 100-watt projection type bulb, is a necessary accessory.

In the case of cultured pearls, the line of demarcation is usually readily discernible. If the pearl has been dyed, as many pink specimens are, the dye can be seen concentrated at the line of demarcation. The core of a cultured pearl is usually the same color throughout: white, gray, yellow-white, etc., if undyed; or pink, or some variation thereof, if dyed, and, therefore, in turn can be distinguished from the nacre which is often of slightly different hue.

Many natural pearls are found to become progressively darker yellow in color as the interior of the gem is approached. This condition can be easily detected under the microscope. Cracks, flaws, concentration of impure, dark-brown, or black aragonite (the so-called "mud" center or "blue" pearl) located in one or more parts of the gem, are also distinguishable. Some natural pearls are encountered that have been artificially dyed black, blue-black, bronze, "gun metal," etc., and it is often possible

9 Pfund, A. H.: J. Franklin Inst., 183, 453-64, 1917.
10 Friza, F.: Biochem. Z., 246, 29-37, 1932.
11 Haas, F.: "Bau und Bildung der Perlen." Akademische Verlagsgesellschaft M.b.H., Leipzig (frankfort a/m) 1931.

to detect this condition by means of binocular observation—especially if a poor dyeing job has been done. Mother-of-pearl slugs (used to reduce enlarged drill holes), metal fillings, cement of all kinds, etc., can also be detected with good optical equipment.

The use of the binocular microscope becomes more effective as experience is gained in using the instrument, and as hundreds of pearls are carefully examined. Only by studying a large number of pearls is it possible to become proficient in analytical work of this kind. The instrument has, of course, the added advantage of being useful for examining cut stones of every type and description.

Examination of Undrilled Pearls by Optical Means

Where no x-ray equipment is available, or an endoscope for that matter, it sometimes becomes possible to differentiate natural pearls from cultured types through use of light transmission. A very strong light is directed on the pearl, all light being masked except that which comes through the gem. Pearls so examined should be viewed in a dark room. Mention has already been made of the parallel layers of the mother-of-pearl core that can be seen—if the nacre is relatively thin. The same effect, of course, can be seen if the light transmission method is used. Dr. Paul Kerr has described a device that can be used for this work, and the reader is referred to his original article.[12] Furthermore, if a cultured pearl is rotated, it will be found that the pearl becomes alternately light and dark every 90 degrees. This is due to the fact that strong incident light directed on the (001) layers (the iridescent surface of shell substance) is absorbed to a marked degree, whereas light directed on the (010) and (100) layers is more readily transmitted. Natural pearls, if they are concentrically perfect throughout and if they contain no impure mineral matter, will transmit substantially the same amount of light regardless of amount or degree of rotation. Of course, cultured pearls having relatively thick nacreous coatings will not react to differential absorption of light. Natural pearls usually reveal deep yellow shades in transmitted light, while cultured pearls invariably appear lighter to the eye—unless the latter type have been dyed. Cultured pearls have certain telltale blemishes, usu-

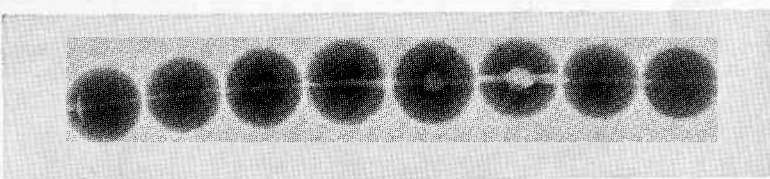

Figure 9

Radiograph of eight Persian Gulf natural pearls. First pearl from the left simulates a cultured pearl. Fourth pearl from the left shows a desiccation crack. Fifth and sixth pearls from the left show impure aragonite centers. Sixth pearl from the left shows an oversized drill hole.

12 Kerr, P. F.: The Jeweler's Circular, Oct. 14, 1925.

ally organic in character, which may be found just under the nacre—between nacre and mother-of-pearl nucleus. These blemishes may not be

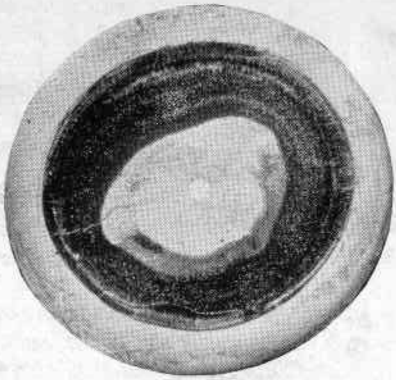

Figure 10
Natural salt-water pearl, showing clear, calcite center surrounded by red-brown crystals of aragonite, in turn surrounded by concentrically deposited aragonite. Such a pearl is the "blue" pearl or "mud" pearl of the pearl trade.

readily apparent in daylight, but may be brought out in strong transmitted light. Distinct air spaces, just under the nacre of a cultured pearl, and sometimes between the individual laminae of the nacreous coating itself, may be noted.

If a natural black pearl is tested by the above means it will be found, in most cases, that a certain amount of light is transmitted, usually unevenly. A black cultured pearl, on the other hand, which is invariably artificially colored, is apt to be wholly opaque or nearly so when subjected to the same test.

Lastly, it should be pointed out that the use of transmitted light and the effects that can be obtained are wholly contingent on the observer's experience in handling pearls. The more pearls, of all kinds, that can be examined and tested by this and other means, the more apt one becomes in "spotting" the cultured and imitated species from the genuine oriental gem.

For the beginning student in gemology, the short article on pearls, appearing in the December, 1940, issue of *The Gemmologist*[13] is worthy of consideration. For the advanced student or individual specializing in pearls, the work of Dr. Haas is noteworthy.[14]

13 The Gemmologist, 10, no. 113, 48-52, 1940.

14 Haas, F.: "Bau und Bildung der Perlen." Akademische Verlagsgesellschaft M.b.H., Leipzig (frankfort a/m) 1931.