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On the Cover

A modern ear-clip design in diamonds by Nat Koslow, New York, received an award in the Diamonds, U.S.A. Awards sponsored by N. W. Ayer & Son, Inc.

Photo courtesy Dorothy Dignam, N. W. Ayer & Son, Inc., New York.

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The Nature of Jade

Part II

by

DR. RAYMOND J. BARBER

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The oldest rocks related to the jadeite deposits of Upper Burma are Paleozoic limestones, now found in small isolated blocks associated with an extensive complex of ancient crystalline schists. These show local predominance of glaucophane (significant as containing the jadeite molecule), hornblende, chlorite, kyanite, vesuvianite, idocrase (especially near the limestones), graphite, and talc. Inclusions of iron oxides, zircon, augite, garnet, zoicite, and chromite are frequently found.

At about the close of the Cretaceous period, these basement rocks were invaded by a great mass of peridotite, which caused yet further changes in the invaded rocks along the contacts, and itself became gradually altered to serpentine. This serpentinized peridotite is now exposed as a roughly oval-shaped area, something over twelve miles long by four wide, northwest of the Uru River. In it are contained all of the outcrop mines of jadeite.

The next igneous event was the outpouring of a granitic magma, in successive phases, which ended during early Eocene time as pegmatite and aplite dykes. Then, perhaps as end-products of the aplite intrusions, came the jadeite-albite dykes, or sills, that were injected into the serpentinized peridotites. And, finally, there came eruptions of picrites and volcanic breccias in the early Tertiary, followed by gabbro, granodiorite, quartz-porphyry, and rhyolite in late Tertiary time, which closed the succession of added primary rocks.

During much of the long Tertiary period there was extensive surface erosion, and widespread deposition of the resulting shales; bluish, greenish, and yellowish sandstones; and coarse tight gravels. These formed the high-bench conglomerates, which have been so extensively mined for jadeite boulders. When the present drainage system gradually developed, the flood waters cut down through these high conglomerate beds, further sorting the jadeite boulders along the tributaries of the Uru River. Subjection to such stream erosion, and repeated scourings of sandy water, served to break off the jointed and fragile portions of the primary jadeite, leaving boulders of fine quality along the banks and in the river channels, to be won by the patient digging of the native miners.

Thus were completed the geologic processes whereby the world's finest jewel jadeite was deposited in that out-of-the-way and pestilent region in Upper Burma. This is yet another instance — not uncommon in the mining industry — of a highly valuable mineral deposit being tucked away in a most uncomfortable place.

Regardless of nationality or faith, the miners always propitiated the Jade-Nats, or mountain spirits, before starting to work. They believed that, if these Nats were pleased, the mines would yield up the jadeite more quickly to the lucky digger. During the rainy season mining is done along the high-bench conglomerates, when water that has been diverted from a stream is caused to spill over the top of the bank, and so helps to expose and loosen the boulders being picked down by the miners. Then, when the rains have ceased — ordinarily in November — they go to the bedrock outcrop mines where about three months must be spent in bailing or pumping out the pits and cleaning off the accumulated mud, after which they can dig from about March until May, when the rains begin again.

At the Tawmaw Dwingyi Mines the succession of rocks from the surface downward is:

(1) A very thick overburden of red earth,
(2) Serpentinized peridotite,
(3) Thin, earthy, very light-green chlorite schist,
(4) Siliceous, cherty, schistose serpentine,
(5) Amphibolite schist,
(6) Banded amphibole-albitite rock,
(7) Albitite } At some places jadeite occurs as lenses in the albitite,
(8) Jadeite }
(9) Amphibolite.

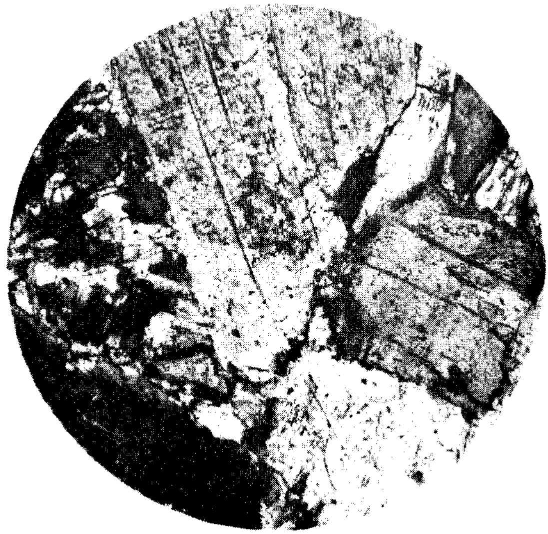
Nearly all the jadeite mined in Burma eventually reached China. Much was smuggled eastward over the mountains; some was sent legitimately by camels or mules along the overland trade routes; but mostly it was carried westward by porters the sixty miles or more by trail to Mogaung. There it was taxed and stamped, then loaded on Irawaddy River craft for transport down to Rangoon, and thence by ocean boats to the Chinese ports.

The dealers in Burma recognize eight commercial varieties of jadeite. The most highly prized, called *Mya Yay*, or *Yay Kyauk*, is translucent and of a uniform, grass-green color. Next in calue is the *Shwelu*, which is light-green with bright-green spots and streaks. *Lay Yay* is clouded and semi-opaque. *Hmaw Sit Sit* is dark-green, and rather soft and brittle. *Konpi*, the reddish-brown variety, is found only in boulders imbedded in red earth at the conglomerate mines. *Kyauk-atha* is a translucent white; and *Pan-tha*, a semi-opaque white. Finally, the *Kyauk Amè*, a slightly translucent greenish-black variety, is the commercial chloromelanite, in which the aluminum of normal jadeite has been replaced largely by iron.

Such are the jade resources of Asia, from which have been supplied nearly all the demands of both East and West. Recently a small body of jadeite, in association with albite and quartz, has been reported from near the village of Kotaki, in Nügata Prefecture, Japan. This is of scientific interest, but the jade is not satisfactory for cutting since it has soft streaks of included tremolite and albite, and the color is not suitable for jewelry.

Turning now to the southern hemisphere, among the islands of Oceania nephrite and

• **Imperial Green Jadeite from Tawmaw, Burma. 50x.**



other green stones have been used since ancient times by the aboriginal Maoris for tools, weapons, and personal adornment. Such archeological pieces have been collected on many of the islands of the South Pacific, and this has led to reports of jade being found in New Gûinea, Tasmania, New Caledonia, New Hebrides, Society Islands, and as far east as the Marquesas. Many of these worked pieces, however, were what is called "Oceanic Jade," which is lacking in lime, essential to nephrite, and so has more the character of the softer mineral serpentine. But the Maoris of New Zealand had only to go to their South Island for real nephrite jade. They could find it in several places along the western shore, particularly on the beaches, and in the glacial drift of the Teremakau and Arahura Rivers in north Westland.

These aborigines recognized six distinct varieties of their native jade. That most frequently found was called Kawakawa, with the familiar green shades of color, and partly translucent. Inanga, an opaque pearly white, varying to light gray and green, was uncommon and highly prized. Kahurangi, a highly translucent, pale green, was valued more than any other variety. Auhunga, of a rather dull appearance, had the green color of Kawakawa and the opacity of Inanga. Totoweka (Weka's blood) was a variety of Kawakawa with stains of red iron oxide. Finally, Raukaraka (Karaka, leaf) was of an olive-green color, often clouded with streaks of dull yellow.

After the discovery of gold among the river gravels in 1857, the miners found many very hard rocks in their drifting, which, when broken, proved to be nephrite jade. Because of the iron-stained and bleached outer crusts of these boulders, however, which quite hid the fine green stone underneath, they usually were cast aside as worthless. After the beauty of polished jade came to be appreciated, however, many were recovered and sold to the local jewelers.

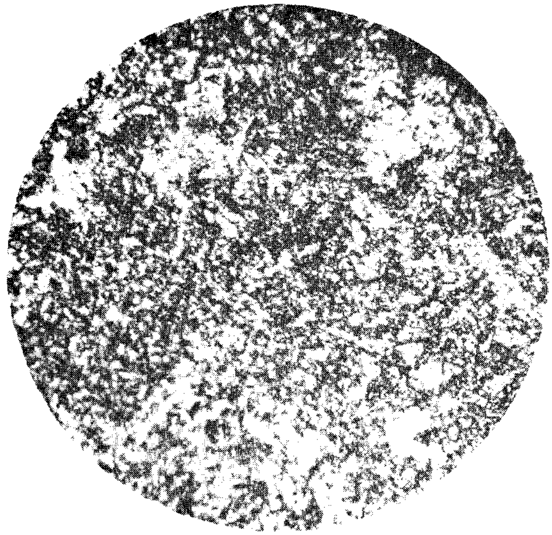
The richness of the gold "diggings" naturally attracted lode miners to the field, who found important copper and chrome deposits along a contact-zone between intrusive-olivine-garnet-pyroxene rocks and the limestone and slate sediments of Dun Mountain. Eventually these discoveries of economic minerals led to a geological survey of the whole Southern Alps, which disclosed an extensive zone of magnesian rocks along the westerly slope of the range, comprising serpentine, peridotite, gabbro, pyroxenite, and tremolite-talc schists. These ultra-basic rocks, which had been intruded into the sheared graywaches and phyllites, were found to constitute a belt parallel to the granitic axis of the Alps, and to the trend of the whole island.

During the progress of these detailed field studies, various deposits of nephrite were found at intervals throughout this zone of basic rocks in Nelson, Westland, and as far south as Lake Wakatipu in northwest Otago. The nephrite occurs as veins and nodules in dark-green and grayish-green serpentine, associated with talc-carbonate rocks. It has not been observed in extensive masses but as irregular bodies from a few inches thick up to as much as four feet through. Some of these mountain veins have been quarried for limited supplies of rough nephrite, but the New Zealand lapidaries still prefer stream-washed boulders from the rivers and beaches along the coast.

Until recently the only jade known to occur in the South Pacific was the nephrite on New Zealand, just described, but in 1947 W. P. de Roever reported a deposit of jadeite in place on the island of Celebes. It is said to have been found associated with acmite and albite in a quartz-lawsonite schist. So here again, as in Japan, patient searchers have been successful in uncovering another small deposit of this rare mineral; but since it has yielded no gem material, it is of interest only to scientists.

The Eskimos along the Pacific coast of North America were quite as well aware of the value of jade as were the Maoris of the tropical islands far to the south. All along the coast of northwestern Alaska, from the Aleutian Islands to the mouth of the Mackenzie River, wherever the early mariners went ashore for supplies, they noticed the natives using tools made of green stone. When some of these implements were taken back to New Bedford by Captain J. A. Jacobsen, master of a whaling vessel returned from the Arctic, they were recognized as nephrite jade. This report started some scientists to theorizing about migrations of jade traders from Siberia, because no occurrence of such mineral was known to exist

• **Contact of Brownish-red Jadeite, small grained, with main body of Gray Jadeite (large, striated xl). Ura River Conglomerate, Burma. 50x.**



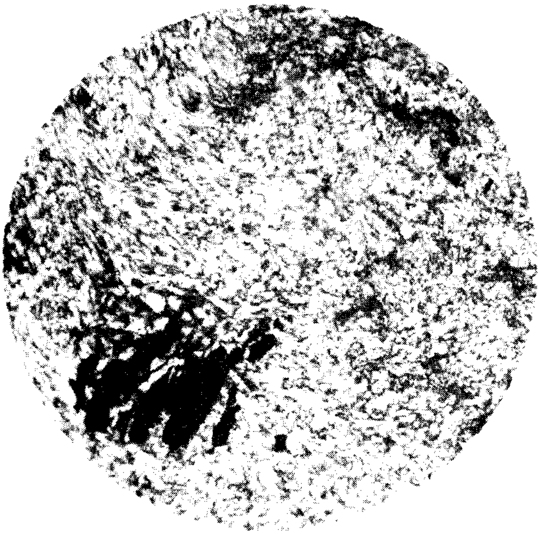
• "Mutton Fat" Nephrite from Khotan, Sinkiang Province, China. 50x.

anywhere in the western hemisphere.

Then, in 1883 Lieutenant George M. Stoney, of the United States Navy, went north to the Arctic coast of Alaska on a relief expedition. He saw the green-jade tools of the Eskmos, and by adroit questioning learned that the rough stones came from "*The Big River*" that emptied into Kotzebue Sound through Hotham Inlet. Since this river never had been visited by white men, and the ship was to cruise farther north for two weeks, Lieutenant Stoney decided to spend this time reconnoitering thereabouts. So he landed at the entrance of Hotham Inlet with a row-boat and two men. There he hired a native guide, and proceeded up one of the mouths of the Kobuk, 45 miles to the head of the delta, and then 40 miles above that on the main river. From there he had to turn back in order to meet the ship for the return voyage to San Francisco, but he determined to urge the advisability of continuing the exploration of "*the big river*". Accordingly, he requested assignment to that task, and the following summer was given command of a well-supplied expedition for the purpose.

The six months that he was allowed to be away from San Francisco gave only 42 days in the Arctic, but during that time he explored the Kobuk River for 200 miles from its mouth. At a point about 150 miles up, the native guides pointed out a mountain on the north side of the river, where they said the jade came from. It was only about eight miles away between two tributary streams, which he named Hunt River and Ambler River, but he could not persuade them to go with him because they believed they would be held there by the mountain-spirit. They said that none but the Shaman could go, and then only after long preparatory fasting. Nothing daunted, however, Lieutenant Stoney took one of his seamen and walked over the oozing tundra, fording several streams, until the mountain was reached. He found quantities of green stone, from which he chiselled off some samples and returned to the river boat. But when these samples were submitted to Dr. Baird, head of the Smithsonian Institution, he was disappointed to learn that they were not jade.

The following year, in the spring of 1885, Lieutenant Stoney was sent north again to



• **Green Nephrite with magnetite inclusions from Lake Baikal, Siberia, U.S.S.R. 50x.**

continue his explorations, and this time he was equipped to remain there for two seasons. His winter-quarters, called Fort Cosmos, he built of logs on high land about 175 miles up the Kobuk River, a little above a right-limit creek that the natives called *Shungnak*. Later he learned that this word meant "jade" in the native language.

Having now ample opportunity, and knowing better what to look for, he again visited what he had named Jade Mountain. Because of recent rains the journey was even more difficult than before, but once there he spent two days prospecting. In his own words: "The entire spur of mountains was of green stone and amongst it I found the jade. I also found asbestos in the strata of the rocks. I saw only a few marks that indicated visits of the natives." That his find on this third attempt was really nephrite jade was verified by Professor Baird of the Smithsonian, and by Drs. Clark and Merrill of the United States National Museum. This was the first discovery of a natural deposit of jade in the Western Hemisphere.

The surrounding schist and limestone rocks had been invaded by an extensive ultra-basic intrusion that formed a range now called the Jade Hills, of which the highest rises to about 3,100 feet above sea level. Originally this intrusion probably was a peridotite but the constituent olivine and pyroxenes had been almost completely replaced by serpentine.

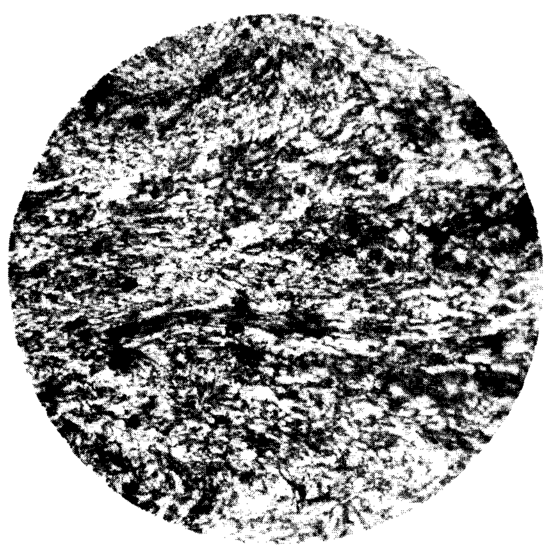
Jade Mountain is at the western end of this ultra-basic region, and although much lower than the wooded peaks in the background, it is conspicuous to travelers on the Kobuk River because of its bare, whitish-green rocks. Near the top of the mountain is a narrow zone where areas of schistose nephrite outcrop within the slickensided serpentine. On fresh exposures this nephrite is green, but weathered surfaces are distinctly brown, quite in contrast with the enclosing serpentine. Irregular narrow seams of asbestos — both chrysotile and tremolite — occur within the nephritic bedrock. Associated minerals, besides the serpentine, are magnesite, antigorite, and magnetite.

These relationships are not confined to Jade Mountain, but are found at various places from there easterly for a distance of forty miles or more, where the nephrite seems to represent one of the phases of alteration of the ultra-basic rocks of the region. Most of it is opaque and so scaly as to be unfit for cutting. Some, however, especially that found as wash-boulders in Jade Creek and the Shugnak River, is of gem quality from which deep-green, translucent jade stones have been cut into excellent jewelry.

Before proceeding farther southward to successive discoveries of jade minerals in the Americas, mention should be made of British Columbia. Along the lower reaches of the Fraser River, and of the Thompson River which flows into it from the east, the Selish Indians found quantities of nephrite jade boulders from which they made all manner of implements before the white explorers brought iron tools. These jades, too, were valuable articles of trade, which were bartered extensively from the Straits of Juan de Fuca to Yakutat Bay. From ancient villages and sand burial mounds many scraping and cutting tools have been unearthed; and fetishes or ornaments of jade are worn by the older people, to whom they have descended from the past. Going northward from Lytton for some 30 miles, water-worn and sand-polished jade boulders of moderate size still are found along the shores of the rivers and the smaller mountain streams, and among the placer mining debris of the gold-rush days.

The original source of this nephrite has not been discovered, but undoubtedly it will be found in the belt of igneous and metamorphic rocks that abound in the Cordillera mountains of British Columbia through which these streams flow.

About 1940 California came into the jade picture. Dark-green pebbles and sand-eroded boulders of nephrite were picked up along the shingle-beaches of the Pacific Ocean from Plaskett Point to Cape San Martin in southern Monterey County. Not long afterward, the bed-rock source of the boulders was discovered near the base of the wave-worn sea-cliffs. There, in twisted, gray to white schist of a scaly to dense texture, the nephrite occurs as small pods and occasional lenses up to a foot or more thick. Though it is enclosed in the schist, it is always near intrusive nodes of a great sill of green serpentine, which undoubtedly had much to do



• Green Nephrite from Monterey County, near Plaskett Cove, California. *50x.*

with its formation. Associated minerals are tremolite-actinolite, talc, albite, quartz, calcite, and grossularite garnet. Most of the nephrite in place is of a drab, grayish-green to black color; but some of the loose boulders and pebbles from the beaches are fairly translucent light-green, and have made attractive polished gems of fine quality.

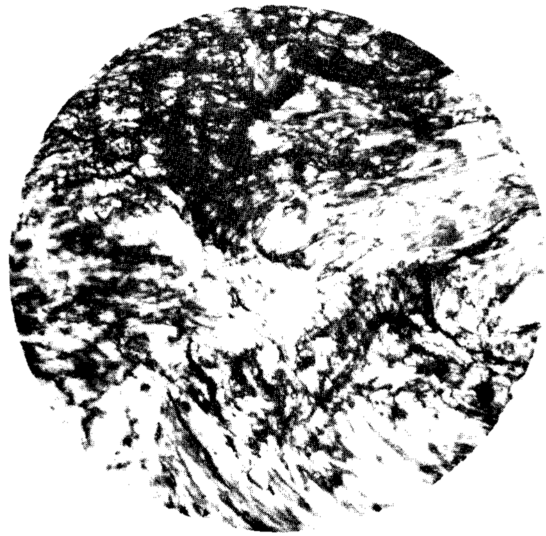
The next discovery of California nephrite was in 1949 near Porterville, Tulare County. There, also, as on the shore of Monterey County, a great sill of peridotite invaded the local sandstone and shale, altering these weak sediments to schists. Then, with the eventual change of the peridotite to serpentine, lenses of nephrite developed within it, by interchange of elements from both sides of the contact. In the several tons of nephritic material that have been blasted from this deposit, there has been some good translucent jade of fine green color suitable for cutting into jewelry.

In the following year, 1950, still another bedrock deposit of nephrite was found, this time in northern Marin County. It is on the easterly slope of Massa Hill, a part of the Vonsen ranch, near the Sonoma County line. Here again the jade occurs as small lenses and veinlets in sheared zones of surrounding serpentine, not far from the contact with schist containing albite, clinozoicite, and muscovite. Other associated minerals are: quartz, talc, glaucophane, epidote, chlorite, and chrysotile asbestos. The nephrite varies in color from pale olive-green to dark bluish-green, in places intergrown with white fibrous tremolite and green actinolite. For the most part it is not of fine quality, but some very good stones of unusual color have been cut and polished from the translucent center of one of the dark bluish-green lenses.

Near Lander, Wyoming, considerable interest was caused by the discovery, in the 1930's, of a loose piece of fine nephrite in the Warm Springs country, not far from Granite Mountain. In 1939 a good-sized boulder was found on the prairie at the foot of Crook's Mountain, and that caused nearly everyone in Lander to start jade hunting. Considerable quantities of "float" nephrite were picked up on the rocky slopes of the mountain, and occasionally there were pieces that weighed several hundred pounds. In 1940 the largest single boulder, weighing

• **Contact of a veinlet of white jadeite with green serpentine from Clear Creek, San Benito County, California.** ***50x.***

• Green Nephrite from near Lander, Fremont County, Wyoming. ***100x.***



1¼ tons was found, near Crook's Mountain. This was bought by a Chicago enthusiast, James L. Kraft, and given intact to the Natural History Museum of that city. By 1945 the published stories of "green-fortunes" had brought many prospectors to the town of Lander, which hummed with the excitement of a real "Jade rush". But the dreams of quick and easy wealth were not realized, and the boom soon subsided because fewer and fewer boulders were found; and no bedrock source of gem-quality mineral was discovered. Eventually, though, a vein of brownish colored jade was located in the Granite Mountains; and a ledge of black neph ite is claimed to have been found high up in the Wind River Range. Neither of these, however, has yielded any translucent green stone comparable to that of the erratic boulders from Crook's Mountain; and so the jade production of Wyoming is no longer active.

Artifacts of jadeite are continually being found in Mexico, Central America, and as far south as the Amazon River. The archeologists occasionally questioned natives as to where their ancestors obtained their supplies of *chalchihuitl* but without avail, and apparently no local source of the mineral was known to exist. Because of this, many people came to believe that all of the crude stone had been brought over from the Orient by sea-going traders. But when analyses of these American jades showed that they differed from the Burmese variety both physically and chemically, the belief in that foreign source gradually gave way to a growing conviction that the raw material came from local deposits, which eventually would be found. Among scientists who have interested themselves in this problem there have come to be recognized three rather distinct varieties of mineral among the archeological jades of Middle America: the Mexican, the Guatemalan, and the Costa Rican. Though all are jadeite — only a very few nephrite pieces having been found — each of the three varieties has features that serve to differentiate it from the other two.

In Guatemala, especially, there has been intensive search for jade sources by well-organized expeditions among which specialists in the different fields of science have collaborated. Encouragement came from the

• Green Jadeite from near Taxco, Guerrero, Mexico. *100x.*

discovery, by one of the expeditions sent out from the Carnegie Institution, of a 200-pound boulder of fine jadeite. It was found in a Mayan pyramid at Kaminal-juyu on the outskirts of Guatemala City, where no doubt it was kept for a supply of mineral from which to cut small pieces to be carved into ceremonial ornaments. A little of it had been so removed, but otherwise it was intact, and showed plainly that it came from a river-bed where it had been smoothed by the scouring action of sandy water.

The opinion that its source was not very far away is now justified by the report that Robert E. Leslie has discovered the outcropping of a lens of jadeite on the Motagua River near Guatemala City. Samples of the mineral, analyzed at the United States National Museum, were pronounced by Dr. William Foshag to be "diopside jadeite, admixed with albite". Thus, it corresponds with the many archeological jades from Middle America that have been similarly analyzed.

Mr. Leslie writes that the rock immediately surrounding the deposit is serpentine, but other details of the geological environment have not yet been fully studied. The outcrop shows no evidence of quarrying or mining, other than the presence of many broken pieces of impure jadeite strewn all about. Nevertheless, at a distance of only one kilometer, there is an archeological site where piles of chips and broken fragments of jade indicate an ancient cutting yard. Therefore, it may have been that here, as elsewhere, the vein material was too irregularly jointed and defective for good carving, so that preference was given to eroded boulders washed down from the outcrop into the streams, where the pounding of sandy water would have removed all but the hard core.

As the first discovery of a natural deposit of jadeite in Middle America, this occurence in Guatemala is of great scientific importance, and it should stimulate the search for other sources of this valuable gem-stone, especially in Costa Rica and Mexico.

To those who have been studying the jade problem, it appears that this particular mineral was venerated in Mexico from very early times. Some of the oldest pieces of carved jadeite have been found there in the excavations of ancient temples, and particularly in burials of high-priests and nobles. Some of these jades were inscribed with historical records. Of actually dated pieces, the earliest yet found has Mayan numeration corresponding to the year 96 B.C., but from correlative evidences there were others much older, going back more than a thousand years before the time of Christ.

It is interesting to note that there appear to have been definite styles in the chosen color of jade stones. From researches of the distinguished historian, Miguel Covarrubias, it seems that during the earliest "Olmec" period (from about 1400 B.C.) blue-gray jadeite was predominant. In late Olmec, down to the beginning of Mayan domination, the tendency seems to have been toward blue-green. Then, during the Classic Mayan period, which extended over most of the first millenium of the Christian Era, there commenced the preference for bright-green stone. This latter is further evidenced by the Mayan jades found in that royal tomb uncovered at Palenque, in the State of Chiapas, by the eminent archeologist Alberto Ruz. Among the fabulous ornaments buried there, in the Temple of Inscriptions, were many pieces of highly polished jadeite equal in color and transparency to the best "imperial-green" from Burma.

Probably the ancients obtained their crude *chalchihuitl* as pebbles and washed-boulders from the channels and playas of mountain streams. The sizes and shapes of the original stones unquestionably influenced the form and design of the carving that was done so artistically, especially on the older archeological jades. Also this opinion is supported by the writings of the early Spaniards who recorded in various Codices their observations of Indian culture.

As to the places where the rough stones might have originated, something may be guessed from the concentrations of jade objects that have been picked up after rainstorms, or dug from the ground by farmer's plows. But, since these might have been brought from a distance, more dependable guidance probably can be had from the Tribute Roll of Montezuma, which recorded the names of several towns that regularly supplied articles of carved jade for the overlords of the Mexican court. It seems reasonable to suppose that the allocation of such tributary requirements most likely would have been guided by knowledge of the possibility of fulfillment. Then, as a further guide, there is the geological limitation that jadeite would occur only where there are metamorphic rocks favorable to its formation. And so, after having plotted the location of all the ancient towns that paid tribute of jade, as has been described elsewhere, and then delimiting those areas by study of the country rocks, there appears a definite likelihood that jadeite most probably will be found by exploration in the mountainous parts of the States of Guerrero, Oaxaca, Chiapas, or Vera Cruz, in Mexico.

Farther to the south there are the peculiar deep blue-green jades of Costa Rica not yet traced to their source. Then, too, the mystery of the jade ornaments found in Venezuela and along the Amazon River still remains unsolved. But the several discoveries of local sources in other American regions where artifacts of jade abound, give encouragement to the belief that these, also, will yield up their secrets eventually to methodical exploration.

Here, then, may well be concluded this paper, which gathers into one place the bits of information gleaned from many sources as to the nature of jade. Development of the names of the two varieties has been traced. Differences in mineral composition were then discussed. Various means of identification have been outlined. And, finally, there were described the manners of occurrence of all known deposits of jade, ending with a recital of those that beckon yet to be revealed.

Notes on the Fracturing Around Zircon and Other Gemstone Inclusions

by

B. M. SHAUB, Ph.D.

The study of inclusions in minerals has yielded much data that is invaluable in identifying some gemstones, but it is of much greater value in distinguishing natural stones from the synthetic or artificial materials. The natural inclusions in minerals have been studied by mineralogists and petrographers from the invention of the petrographic or polarizing microscope to the present, a span of about one hundred years. The inclusions studied by the mineralogist or petrographer are, of course, in practically all cases, the same as those that occur in gems, for gem quality minerals are only the more perfect examples of certain mineral species.

Probably the least understood of the inclusions in gems are those referred to as zircon with its "halo," "radio-halo" or "pleochroic halo." The crystal forms of some of the so-called zircon crystal inclusions do not appear to be tetragonal but more closely resemble the orthorhombic forms. It is often difficult to determine accurately the crystal form of inclusions as the face edges are usually rounded and often the entire inclusion is decidedly rounded or it may consist of a rounded or irregular grain of the material rather than a crystal.

A true pleochroic halo consists of a spherical zone or shell of the inclosing mineral, about the included one. Such zones show definite pleochroic properties when rotated in polarized light. When observed in thin section on the stage of the polarizing microscope they show up clearly about the inclusion as a dark circle at every 90° of rotation. Most of the included minerals also show a high birefringence and relief.

One cannot always make a positive identification of the minerals causing a particular pleochroic halo although at times one can obtain the optical interference figure having the character of that of zircon, consequently pleochroic halos are most frequently said to be due to radioactive zircon. Not all minerals which contain zircon grains and/or crystals are pleochroic. Minerals which are normally pleochroic show the halos best, as those in the mineral biotite, while the colorless minerals do not develop the pleochroic halos, but acquire in many instances an irregular persistant halo of a brownish-yellow color which is often arranged in a stellate fashion about the inclusion. Such halos are sometimes referred to as being a "radio-halo" and the fracturing about the inclusion as being due to the forces of radioactivity. This, apparently, is not the case for the radioactivity of zircon is probably never very strong. The mineral deposit at the Ruggles Mine near Grafton Center, New Hampshire, contains masses of zircon several inches across and these masses contain considerable amounts of uraninite as a three dimensional dendritic intergrowth. Although it is associated with uraninite the zircon is so weakly radioactive that a photographic film exposed six weeks in contact with a section of the zircon yields no visual darkening upon being developed, while the associated uraninite produces a very strong exposure in 24 hours. The writer has studied the billion year old uraninite crystals inclosed in a clear glassy quartz from the McLear Pegmatite near Gouverneur, New York, and has found a complete ab-

FIGURE 2
• Similar "halo" surrounded zircon inclusion
Photo courtesy E. Gubelin.

FIGURE 1
• Enclosed zircon surrounded by a typical "halo"
Photo courtesy E. Gubelin.

sence of halos or fracturing due to radioactivity. Neither were there any other effects produced by the radioactivity of this strongly radioactive mineral. In this instance the contraction of the uraninite during cooling was somewhat greater than that of the quartz which allows the crystals of uraninite to be sufficiently free within the quartz so that many crystals drop out completely upon breaking the quartz.

Certain groups of minerals as the euxenite-polycrase group, also allanite and cyrtolite as well as others have a variable composition and contain varying amounts of the rare earth elements as well as elements of the radioactive series. These minerals are usually unstable and invert to an isotropic and amorphous structure although the crystal forms of the original mineral are well preserved. During the transformation of these minerals there is a decided increase in volume and a decrease in specific gravity as well as the index or refraction which, however, usually remains well above 2. While these minerals are often slightly radioactive this property has practically no effect whatsoever upon the inclosing mineral except in a few specific cases where the inclosing mineral is normally quite pleochroic. The prominent and conspicuous effect is the radial shattering of the inclosing mineral due to the greatly increased volume of the inclosed mineral during its structural change. This alteration is accompanied by the penetration of a minute quantity of the alteration products into the fractures about the inclusion. Most of the mineral inclusions which revert to an amorphous state usually carry some iron; consequently the alteration products will stain the inclosing mineral brown or yellowish-brown *along the fractures*. Such colorations are very irregular instead of being spherical and they sometimes clearly delineate the fractures developed by the inclosed mineral.

The alteration of high zircon to the low form, with its accompanying increase in volume, is accountable for the fracturing shown in Fig. 1, and the coloring along the fractures is undoubtedly due to the minute amount of colored alteration products which entered the fractures.

One may inquire as to the effect of such inclusions in a gem. The answer is a simple one from a qualitative point of view. In each case of radial fracturing about an inclusion within a gem there is a set of fractures which has developed about a center of internal expansive pressure. There may or may not be stresses still existing along the fractures which may cause them to increase in size if the gem is given a severe shock. As an example one may note that the fracturing about large crystals of allanite:—(1) is often so severe that the surrounding minerals as well as the allanite are so thoroughly fractured that they will separate into many small pieces when the rock containing the allanite is broken across the included crystal. In gems, however, the inclusions are minutely small in comparison, and also small in comparison to the size of the gem, nevertheless the fracturing about certain inclusions is a sign of possible weakness although it may be very infrequent that a gem or gem quality mineral specimen has split apart from this cause.

One may, however, be reluctant to place as high a valuation upon an otherwise fine stone containing pronounced radial cracks about inclusions as he would if the inclusions were minerals which do not invert to another structure having an increased volume at a lower temperature.

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The Origin of GEMSTONES

by

PROFESSOR DR. K. SCHLOSSMACHER

Translated from the German by

MARTIN L. EHRMANN

Gemology, as an independent science, has been in existence for the past half-century. Much has been written about the mineralogical properties of gemstones and the development of identification methods. Occurrence and localities are often mentioned, but with very little reference to origin. A complete summary on the subject of origin is conspicuously absent. Therefore, a short but general review seems very important, and shall be given. Writing on this subject is especially interesting as it brings us close to the border fields of mineralogy, geology and the history of the origin of the earth.

Direct observation can be based on our access to only a few thousand meters in the upper layers of the earth's crust. This is called the silicate layer or lithosphere, which reaches to about twelve hundred kilometers deep. Then follows the sulfide-oxide layer (twelve hundred to twenty nine hundred kilometers), which consists of metals in combination of sulphur and oxygen. Below that (twenty nine hundred to sixty three hundred and seventy kilometers) lies a core of iron nickel. We find from our observations that the locating and obtaining of useful minerals and gemstones are almost at the surface of the lithosphere.

The silicate layer received its name from the fact that the greater part of its content consists of the element silicon, a metal. With oxygen, it builds the silicic acid which, purely crystallized in large quantities as quartz, appears in still larger quantities in combination with other elements in which silicate is present. Most of the rock-building minerals such as feldspar, mica, augite, hornblende, and olivine are that type of combination. Also, in the gemstones we have many silicates.

When we locate a single place in which minerals are found thru the process of origination, we call it a locality or deposit. We differentiate four large genetic cycles or groups of deposits: igneous rocks, sedimentary rocks, metamorphic rocks, and disintegration or weathering development.

For the study of gem localities, the disintegration group and the igneous rocks are the most important, (on the earth's surface). The name volcanic rocks indicates that an eruption of a volcano has taken place, but it actually embraces a much larger area. In an eruption of a volcano, large masses of tuff are spewed forth. From the crater flow the lava streams. The latter show us that somewhere in the depths of the earth, volcanic molten masses must have existed in a flowing state at high temperatures. When deep-seated, these are called magma. We have further proof of this magma's existence in the fact that when these masses cooled, they solidified in the form of rocks. Each granite has thus gone thru the magmatic process of development.

The name igneous rock has been given to the solidified molten masses which occur in the depths, even if they were not caused by volcanic eruption. We differentiate those rocks that have solidified in the depths of the earth from those discharged by the lava streams. If parts of molten masses are caught in crevices of the earth and are thus solidified, then you sometimes find a mineral deposit that the miners commonly call a vein or lode. That is how the name "lodestone" originated. Gemstones occur in all three types of rocks, (under discussion here).

The solidification of a magma in the depths of the earth is no simple process, but takes place in three phases. The first phase is the intramagmatic phase in which the molten masses, through a succession of crystallization of various mineral types, slowly turns to stone. That is how plutonic rocks originate. Known examples are the granites, diorites and gabbros. Gemstones of this phase are the diamonds, some garnets, the peridots and the labradorites, etc.

By such crystallization processes the molten mass is reduced. In the remaining residual solution, there are present temporarily all those elements which have not amalgamated into the stone-forming minerals up to this point. The further the crystallization process progresses, the more the solution residue is enriched. Mainly, they are the readily volatile ingredients of the magma, such as water, fluorine, chlorine, boron, sulphur, carbonic acid, etc., as well as heavy and precious metals and a string of rare elements. With the concentration of the readily volatile ingredients, the gas pressure rises in the residual liquid mass. Often, when the great pressure and/or heat develops, the magma surrounding the rock layers and parts of the residual magma, turn into metamorphic rocks.

Therewith begins the second phase of the magma solidification— the pegmatitic—pneumatolytic phase. Lodestones, or veins, are formed, of which the pegmatites are of the greatest importance as gem-bearing rocks. The pegmatite minerals are: tourmaline, topaz, most of the beryls including aquamarine, chrysoberyl, euclase, phenakite, etc. Tourmaline contains boron from the readily volatile ingredients of the magma. Topaz, fluorite, and the three last-mentioned gem minerals contain for this phase the characteristic element, beryllium. Besides the pegmatites, there are many other types of veins. None, however, is as important as the pegmatites in the formation of gem deposits, and also of ore deposits. From the crevices in which the residual solutions penetrated, the second phase effect shows in the neighboring rocks of the earth's crust. This happens in metamorphic rocks in which extensive decomposition processes and new crystallization takes place; in which contact rocks and contact minerals form. This whole process is called contact metamorphosis. Deposits of rubies and a large part of the sapphires, emeralds, nephrite, etc., are of this type. In the contact process, the readily volatile gas-forming ingredients play a very important part. They are called pneumatolytics. Pegmatite-forming and pneumatolytic formations often parallel each other, or mix with each other, in the same formation. It is self-evident that such contact zones also form in the solidifying of the magma substance of the depth rocks.

After the expiration of the second phase, there still remain hot, watery solutions in the hot magma which in the third or hydrothermal phase in the surrounding rock layers, penetrate and travel great distances. Hydrothermal vein fillings such as (barite), fluorite, quartz lodes and hydrothermal contact manifestations develop in this hydrothermal phase. The thermal flow can easily force such solutions to the earth's surface. Man gemstones in the quartz group belong in this development phase.

These three phases take place from within the earth's crust and are therefore called intrusive. However, if the molten mass is forced all the way to the surface of the earth, there is volcanic action which produces extrusive processes. Only the development of the opal and the agates belong here, so these processes are less important to gemology than the intrusive. The origin of both opals and agates is due to hot watery silicic acid solutions which rose with the volcano action and in which the silicic acid in solution prevented crystallization.

The sedimentary group of rocks is of no importance in the development of gemstone dposits. In it, develop, through sediments assembled by water and air, unstable deposits such as gravel, sand and clay. To this group also belong aggregations of lime and gravel shales, skeletons of animals, plant substance. In the course of geologic time, deposits solidify through outward crystallization of agglutiments and rearrangement of the substance to solid rocks. Thus form conglomerates, sandstone, shale, clay clay schist, limestones, dolomite and the varius coal types. Gemstones do not develop by this process. At best, we could include amber and jet in this group. However, it is among the gravel mounds and rocks where most of the gemstones are found. They did not originate in them, but they entered together with the sand and the gravel which was transported and deposited by water. They are, therefore, not a first, but a secondary deposit.

There are two reasons why most gemstones are not found in their original but in such secondary deposits, especially in loose mounds or gravel beds in small creeks and rivers. In order to obtain minerals from their original souice, it is only possible by mining the surrounding area, and using explosives. By this method, the costs are high, and most of the gem minerals are shattered by the explosives. When they are situated in loose gravel mounds, they can easily be removed without damage to the gems. Of course, they are water-worn. The second reason lies in the concentration of gemstones nature bestowed upon us as a gift. The original rock disintegrates on the earth's surface. Loose disintegrated soil is formed in which minerals that are not harmed by water and other atmospheric conditions (gemstones belong to this group) are imbedded and remain in excellent condition. This integration is washed away by the waters and the gemstones are washed along as well. When the rivers stop running, and the water-falls stop falling, and the amount of water is reduced so that there isn't enough power to wash this material any further, they sink and conglomerate together in an alluvial placer. Such placers are found in the now-present rivers, as well as in the old, higher located stream beds. The gem-carrying gravel lies mostly under one or more sandlayers which were formed after the original deposit.

If, in the course of the earth's history, such gravels solidify, then sedimentary rocks, containing gemstones, originate. Later it is possible that they might go into

(continued on page 92)

The Gem and Ornamental Stone Market of Hong Kong Today

by

COMMANDER JOHN SINKANKAS, U.S.N.

(continued from Summer 1954)

NEPHRITE

Being the jade used from the earliest days of Chinese jade carving, nephrite pieces predominate not only in number but in variety and in artistic achievement. Whitish shades are most frequently noted along with admixtures of other shades. Solid color carvings from this material depend upon excellence of form and deeply incised patterns to make them stand out. Carving in this extremely tough material is often very delicate as attested by one covered jar about 7 inches tall which was as light as a feather because its interior had been skillfully hollowed out to leave a wall thickness of somewhat less than 1/8 inch. No *tricky* color effects are possible with this type of nephrite and the carver is severely tested to turn out striking pieces of good design. Pale greenish-yellow nephrite in fairly large carvings is also seen but is far less common. None of these nephrites are startling in color, subdued tones being much the rule, and the remarkably uniform coloration interrupted only by the bright areas of the skin of certain pebbles which have suffered some alteration or impregnation by earthy salts. The cores are mostly of the same whitish hues already referred to but the outsides may be black, brown, brownish red, orangy brown, and, depending on how thinly cut the outside layer, may show even more varieties of coloration. Suitably bi-colored specimens are cleverly used by the carvers to achieve effects impossible with uniformly colored material, for example, a carving of a boy holding aloft a bird in hand may have the lad himself white, a bundle on his back reddish brown, and the bird a dark brown — all possible by utilizing the different skin colors properly.

An intensely colored yellowish-green nephrite strongly resembling the finest New Zealand nephrites is also seen and very much treasured. It is bright and conspicuous and of remarkably uniform coloration and texture. One piece, a flat tray of a leaf pattern with a carved frog perched on the leaf was much more expensive than a comparable piece of any other nephrite.

Dark green nephrite of a blackish cast and with an easily apparent fibrous structure provides the largest carvings. This mineral is called "Jasper Jade" by most shopkeepers and is less highly prized than the fine-grained nephrite of lighter tones. At times it is of very compact quality and capable of a superb finish. Suitable pieces are cut into remarkably thin dishes and bowls, some being barely a sixteenth of an inch at the edges. A magnificent pair of deep bowls of this material was seen in one shop which were not only thin but perfectly fluted on the sides, the dimensions being roughly 8 inches in diameter and about 3 inches deep. Such carvings are truly the work of a virtuoso in stone! All such delicate works are called "egg-shell" jade by the Chinese. The dark green jade referred to here is also used for bases on very important pieces of different color.

Before leaving nephrite it is interesting to remark upon the views held by the Chinese on the origin and growth of jade which generally assume that inferior jade-like minerals are continually *growing* and will some day be true nephrite of pure white color and invisible grain. Thus under this theory, serpentine and similar minerals which bear a superficial resemblance to jade, although sadly lacking in other points of resemblance, are considered to be *new* jades, or jades in their infant stages. "Soochow Jade" is called "New Jade" as are other finely granular materials which are softer than nephrite but look like it. "Jasper Jade" is the name assigned to the dark green varieties which are as hard as nephrite but are still considered mere adolescents compared to the final product — *old* jade, the finely-grained, lighter-hued nephrite.

No doubt readers will find this growth theory amusing since the vastness of geologic ages precludes pretty much the possibility of the human race ever seeing the metamorphosis of something like "Soochow Jade" into pure white compact nephrite of carving quality. Nevertheless the theory is basically sound in the light of present day concepts on the genesis of nephrite and jadeite, and it is an interesting speculation to think of some ancient Chinese petrographer who confronted with jade in situ, came to the conclusion that the enclosing matrix was actively engaged in *growing* the nodules of nephrite locked within.

JADEITE

In contrast to the nephrites, jadeite carvings are often lacking in artistic merit, however several uses for this material are unique and worthy of discussion. White jadeite was seen for example, in very thin and delicate "egg-shell" carvings as in bowls and dishes, its extreme translucency being brought out well by this treatment. Also its color variations either within the heart of the raw pebble or as a result of alteration and weathering on the outside were more often used than was nephrite, possibly because such colors seemed richer and afforded more striking contrasts. It appeared that jadeite is not held in the same reverence as nephrite and therefore its prime use is for decorative pieces more or less devoid of the wealth of symbolism normally incorporated in so many nephrite carvings. Jadeite also receives a very high polish, much higher ordinarily than nephrite and for this reason its distractive effect is taken into consideration on carvings which cannot incorporate too much fine detail lest such detail be lost in the strong light reflections from the surface. Vases and jars are popular subjects for jadeite as well as screens, plaques, snuff bottles, belt buckles and so on. Since the rich emerald green shades are so highly prized for jewelry, the tendency has been for carvings to be rather pallid in color except for those in which exterior skin colors afford a pleasing contrast.

One carving of jade treated as a subject an old man, bent with age, whose whole body was a lovely uniform mauve jadeite, his back figured with patterns of reddish material from the skin of the boulder. Standing about 4 inches high it was unfortunate that the artistic treatment fell far short of the superb raw material from which it was carved. As a sculpture it was awkward and lacking in the fine firm strokes used to express musculature and garment folds which the Chinese expert does so well and the addition of the red color on the back had so governed the actions of the carver that he created a figure which could not stand on its own legs without toppling over. The finish and the stand as well as the lack of skill in design indicated that this was a modern piece.

The best carvings in jadeite or in any other material for that matter are firstly, executed by an artist and secondly, cut by a skilled lapidary — without this combination, no piece is top notch. The highly skilled craftsman will devote attention to a piece from all aspects, the detail and finish of the bottom is just as important as the sides. The use of contrasting colored areas must be governed by great restraint lest the design be unduly influenced by this consideration alone. Pierced work as shown by branches and floral sprays, must be natural and finished off wherever access can be had to the hidden portions. Branches and twigs should taper outward and be reasonably like natural growths. Fine lines used to represent lion's manes and similar surface treatment must be uniform in depth and parallel to each other and to the sweep and swing of the area so engraved. These are just a few of the finer details which distinguish the work of a master in the object itself but there is yet another criteria which is surprisingly useful but seldom considered important enough to be worth mentioning, — the matter of stands or rests for the carvings.

It is axiomatic in the jewelry trade that fine gems deserve fine mounts and needless to say the Chinese craftsmen were aware of this and provided stands of great elegance and harmony with a fine piece of carving. Conversely, if a poor opinion of a finished piece was held, the base reflected this opinion by being made of inferior wood with inferior design and finish. It would be desecration in the eyes of the Chinese to mount a splendid jade upon a poor base and therefore, if by no other means, this is one way to get an indication of the value of the carving itself.

Many bases are works of art in themselves, capable of being detached from the carving and admired for the soft smooth finish of the wood and the sweeping curves of the design. Always the base is harmonious in design and feeling with the piece it supports, harmonious in the sense that it detracts nothing from the stone but indeed adds to it by giving the impression of height and grace and importance. From the design standpoint it need not be *en suite* or matching, indeed it may be entirely different but as stated before, never in disharmony. An elaborately carved piece to illustrate the point, may be either fitted with a complicated stand or one of extreme simplicity. If the former, then the stand is likely to be in the same spirit as the carving; a formal, geometric carving perhaps having a formal base with a fairly complicated pattern or else utterly plain. A very simple piece on the other hand, — such as a dish, may have an extremely complicated wooden base to provide contrast in texture to the piece it supports. In any case, the best test is to assemble all of the components, the base, the carving, and if provided, the cover, and view the whole from near eye level. Everything about the piece should be completely pleasing.

PACKAGING

Another phase of Oriental carvings in stone is the great care taken to preserve the pieces whenever they are not in use. The attention to this aspect stems directly from the fact that Oriental culture, particularly the Japanese, considers a relatively simple interior in dwelling places to be the most tasteful. The cluttered, over-crowded rooms of Western style homes are abhorred and any ornamentation is restrained to provide one focal point of interest in any given room. Since only one or two objects of art can be displayed under this code of interior decoration, any others accumulated by the owner must be stowed away until their exhibition is deemed appropriate. Almost all pieces of value are provided with a compartmented case of silk-covered wood in which the various components of the object are placed upon recessed cushions. Closing the cover which is also padded, presses the objects into place and keeps them quite secure. Such boxes are seen everywhere in the antique and curio shops and by virtue of their construction provide great security against accidental breakage. A well-made box filled with its precious contents can indeed be thrown violently to the floor without damaging the object it protects.

In Japan, boxes are also provided for treasured art objects but these are simply wood without linings and depend on the wrapping of the object to provide the necessary cushioning effect. Chinese boxes are fastened on the outside by two straps of cloth similar to that used in the covering and terminated with tapered ivory pegs which fit in loops on the front side. Japanese boxes on the other hand are usually secured with a doubled length of stout cloth tape which passes around the bottom, up the sides, and is then knotted at the top to hold the loose lid in place.

CONCLUSION

As a result of the Communist domination of the Chinese mainland, much wealth has filtered into Hong Kong in the form of all kinds of Chinese works of art including carved ornamental stones. In addition there appears to be an abundance of modern material which is probably being made in good part by carvers still working in Communist China under their auspices. Stone carvers as such appear to be totally absent in either Victoria or Kowloon and it must be assumed that contractual work going on at the present time, finds its way into the mainland and finds its way out again in the form of finished pieces.

There are no import or export taxes laid upon gemstones and carvings by the government of the Crown Colony, yet prices are high and wages are rising steadily. Quoted costs of producing carvings compare very closely to current Japanese charges (at Kofu) and German charges (at Idar-Oberstein). Raw material is critically lacking and the Hong Kong market appears to be a fruitful field for exploitation in this respect. Gem jades are high in price and only one shop is said to be actively engaged in cutting jade cabochon stones and small carvings for setting in jewelry. There is one shop in Kowloon which does facet work on all materials except diamond.

Carvings both antique and modern are moving very slowly because of United States Customs bans on their import which effectively prevents the most lucrative buyers from access to the market. Most merchants frankly condemn this policy but are holding their stocks at high prices in the expectation that the ban will be lifted soon.

A thriving jewelry trade specializing in mountings has sprung up under the impetus of eager buying of mounted jade in rings, bracelets, pins, necklaces, and earrings. This buying is stimulated by the fact that such items are not banned by the U.S. Customs and may be brought into the country without question. Jewelry work is generally quite substandard in comparison to contemporary American and European craftsmanship. Small, poorly equipped shops are the rule with workmen familiar only with sheet metal fabrication and scarcely familiar if at all, with casting techniques. Designs are Western copies and suffer from being executed by persons who have no background in Western design ideals. Finishes on metal parts of jewelry are substandard also. Workmanship

(continued on page 92)

Gemological Digests

A NEW SUBSTITUTE FOR LAPIS-LAZULI

by

B. W. ANDERSON

A peculiarity of the synthetic spinels manufactured by the Verneuil flame-fusion method has been that they have never been used to represent natural spinels but have been made to imitate more popular gemstones, such as aquamarine, with which they have nothing in common save a superficial resemblance.

Another type of synthetic spinel, made by a different process, has recently appeared in Idar-Oberstein, Germany, and this time the stone represented is none other than lapis-lazuli. The producers, I understand, resent the label "imitation" being applied to their material under the mistaken idea that this word must always imply a glass or other non-crystalline material, of inferior hardness. At the present time their product is being advertised, rather cleverly, as "LAPIS lazulifarbige synthetische SPINELL," which, apart from the tendentious use of capitals, is undeniably correct enough. Probably the trade will in due course adopt some convenient pet name for the substance, just as "Swiss lapis" is almost universally understood and accepted as a name for the well-known stained jasper imitation of lapis-lazuli, though from the purist's point of view its use is highly misleading and improper.

Now for a few words about the appearance and properties of this new material. It must be admitted that it is very handsome stuff, rivalling in colour the ultramarine blue of the finest Afghanistan lapis, though of a slightly redder cast. Being essentially spinel, it has a hardness of 8 on Mohs's scale and this enables it to take a high polish. Those pieces so far seen have been fashioned in cut-corner rectangular or oval shapes, up to some two centimetres in length and a few millimetres deep. In this form they are suitable for use as seal-stones, for which the genuine lapis has a certain popularity.

It is nearly but not quite opaque: "sub-translucent" could best describe it. Light from a 500-watt lamp was transmitted as dull purplish glow through a piece some 3 mm. thick. Under a Chelsea colour filter the material assumes a brillant red appearance, and this simple test alone would distinguish it quickly from both the genuine material and from "Swiss lapis" imitations. By reflected light the expected cobalt absorption bands can be seen through a pocket spectroscope. To the naked eye, but more clearly under magnification, the texture is noticeably granular. That the substance is not a single homogeneous crystal is also shown by passing a beam of X-rays through it on to a photographic plate, when a mass of spots in random orientation is seen on the developed plate.

X-ray powder photographs kindly taken for me by Dr. Claringbull, Keeper of Minerals in the British Museum (Natural History) gave him measurements of $8.065 \pm .005$ for the substitute lapis, which is not far from the accepted figure for a natural magnesium spinel, though greater than that given for the Verneuil synthetics with their 1:3.5 Mgo : Al_2O_3 ratio. Refractometer readings are not at all sharp, partly because of the opacity of the material, but more especially because of its lack of homogeneity. A vague shadow near 1.725 can, however, be seen. The density of several specimens has been measured hydrostatically, and 3.52 seems to be the most usual value, though one specimen gave a figure as low as 3.495. Single crystals of natural spinel have 3.57 as their lower limit, but one would expect a sintered mass to have the lower densities recorded.

One of the simplest and most practical tests for genuine lapis has been provided by the little brassy specks of iron pyrites which can almost always be detected at one point of the surface or another. The makers of the lapis-coloured spinel have remembered this little point, and can provide their stones with little specks of gold on them, if so desired, to add to their verisimilitude. It is rather amusing to realise that in this case "fool's gold" (pyrites) is the sign of a genuine stone, while real gold is a sign of an imitation material!

It can be said that, save to the unwary, the new substitute for lapis should have no terrors for the gemmologist nor even for the jeweller. The very perfection of the material should give rise to suspicion, and a scrutiny of the texture under a lens, or a glance under the Chelsea filter should confirm this. Behind such simple tests, of course, lie a whole barrage of more scientific, though hardly more effective, methods for discriminating the true from the false.

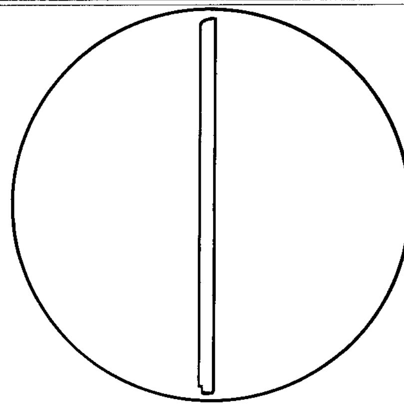


FIGURE 1

• Disc in set position showing blue line

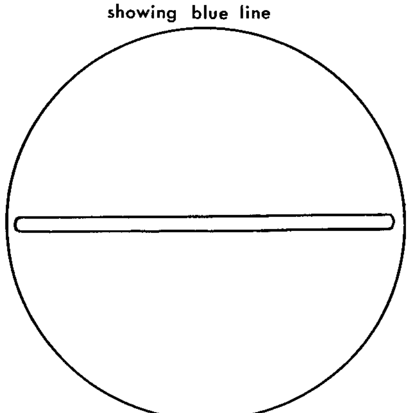


FIGURE 2

• Disc in set position showing green line

DICHROSCOPE EXHIBITED AT HASLEMERE EDUCATIONAL MUSEUM IN ENGLAND

by E. J. BURBAGE, F. G. A.

During recent months the writer has had the interesting task of helping to arrange a special exhibition on the theme of Gem Study and Gem Testing at the Haslemere Educational Museum in Surrey (England). Our planning was conditioned by the fact that most visitors would be non-specialists, who would need simple explanations of the various instruments displayed, and where practicable, to see them in operation. Our solution of the latter requirement with respect to the dichroscope meant the construction of an instrument varying sufficiently from the conventional form to be worth recording.

For our purpose, there was no occasion for economy in size, but a paramount need to show as generous a dichroic display as

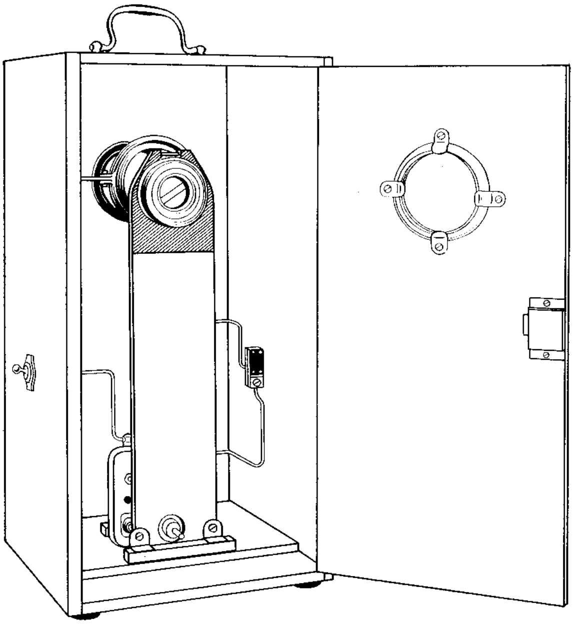


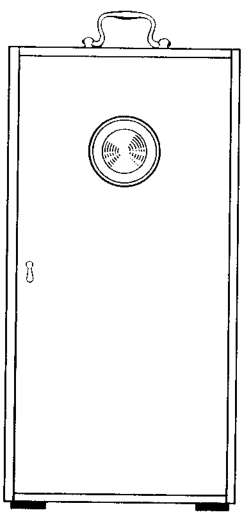
FIGURE 3

• Large display dichroscope in carrying case showing various electrical connections and switches needed.

FIGURE 4

(See below)

Closed case shows ease of transporting display dichroscope.



possible. In addition, consideration was given to the psychological fact that more interest is aroused by a moving exhibit than by a static one. To meet these requirements, it was decided to employ a principle which does not seem to have been previously used in dichroscopes. Briefly, the underlying theory is as follows: — consider a circular opaque disc having a thin radial or diametral slit containing a strip of Polaroid. If (say) a sapphire orientated to give maximum pleochroism is placed centrally behind the disc, the polarised transmitted light for two positions at right-angles will be blue and green, as in diagrams (1) and (2). On rotating the disc still further, the sequence will be repeated at 180° intervals. For slow rotation, these will be disparate phenomena, but if one rotates the disc with sufficient

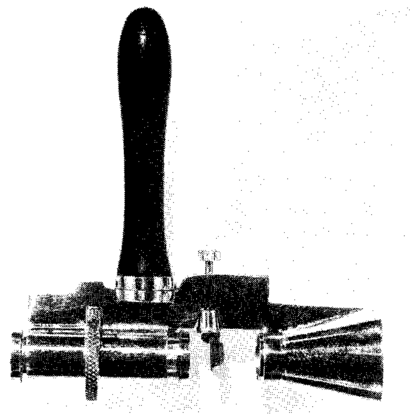


FIGURE 5

• A hand dichroscope, somewhat more convenient for the individual than the display type (see Figure 3).

speed, persistence of vision will ensure that a coloured figure will be produced in the form of a Greek cross arrangement of the principal dichroic colours, with intermediate colours between the axes.

As the writer has little constructional skill, and no facilities, the co-operation of a skilled engineer was necessary for the translation of the idea into actuality, and this was readily provided by Mr. Meakin of H. S. B. Meakin (Polarising Instruments) Ltd., of Victoria Street, London, who was good enough to construct the efficient unit shown in diagram (3). It consists of a circumferentially-driven disc spun by a small electric motor powered by A.C. mains. It was initially proposed to employ as the display a plate of blue synthetic sapphire, but the sectioning of several boules failed to provide a piece of a sufficiently homogeneous colour. Our final solution was to employ a synthetic red dichroic filter generously provided by the Poloroid Corporation of Cambridge, Massachusetts. This material is strikingly dichroic in red and colourless, and to complete the "Greek cross" dichroic figure an Ilford medium green filter was bound up with it.

Finally, my colleague Mr. G. H. Charlton was good enough to complete the instrument by the assemblage of a lamp, a ground-glass diffusion screen, a lens system to give a degree of magnification, and a carrying case of wood embodying the necessary electrical connections and switches.

Although an instrument of this sort could not profitably supplant the conventional types of pocket and table dichroscopes, it adequately performs its intended function of the public display of dichroism. An additional field of use in lectures and demonstrations is suggested by the ease with which the dichroic image can be projected onto a screen.

THE ORIGIN OF GEMSTONES

(continued from page 83)

another decomposition and begin the process all over again, so that tertiary deposits originate. The rubies of Burma, for instance, have their primary contact (pneumatolitic) deposit in marble-like limestone. From there, the secondary deposits branch out to the neighboring river deposits. The diamonds in the geologically very old conglomerates of India lay on secondary deposits. The primary deposits are not known. Through the weathering processes and water transport of the materials of this conglomerate, they were brought to the present-day stream deposits and are now tertiary deposits.

The crystalline schists and slates form an abundant rockworld in themselves. They originate from already present rocks, also from volcanic and sedimentary rocks, which were formed in either the depths or the shallow parts of the earth's crust and through pressure, temperature and circulating solutions were transformed into new rocks. These are powerful factors which, working together, makes it possible to build completely new minerals and rocks. Such rocks easily betray their development to the naked eye, through sporadic layer structures. This explains the names, schists and slates. Mineral content depends on the original rock, and from the share of the above-named factors in the transformation. That is the reason that the rock world is so extraordinarily varied. In these latter groups better-known rock species are: gneiss, mica schist, serpentine, marble, clay schist. Well-known gem species, as a few of the garnets and nephrites belong here. They, of course, at the same time, went through a contact metamorphosis. The group formed by this disintegration process does not lead to new mineral formations which would excite the heart of the mineral collector. Among the gemstones are only four which originate through the dissolution or oxidization process: turquoise, chrysoprase, malachite and azurite. Turquoise originated by the disintegration of certain volcanic rocks in combination with the disintegration of neighboring copper ores. Chrysoprase is an end product of disintegration of a once nickel-bearing gabbro. Malachite is a superficial oxidization product of copper ores, as is azurite. Even though disintegration processes produce few gemstones for us, they are nevertheless important in the formation of gem deposits. In the shaping of loose disintegration refuse, lie those gemstones which were not affected by the disintegration process itself. They are contained therein, and well-preserved, and can easily be removed by light washing. These types of deposits are called alluvial placers. A good example is the South African yellow ground of the diamonds, which is a weathered clay of the blue ground— the hard rock in which the diamonds are found.

THE GEM AND ORNAMENTAL STONE MARKET OF HONGKONG TODAY

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is improving however and proprietors are aware of deficiencies. Poor working conditions can be attributed directly to the tremendous growth in population in Hong Kong resulting from the last few years' troubled events in the Orient and the influx of population. All housing is held at very high rentals which are scarcely short of exorbitant. Labor and living costs are extremely high and food is almost all totally imported.

Although Hong Kong is still a *buyer's market* for many items, it is rapidly reaching a point where its products will no longer be competitive if the present trend continues. Regardless of this, it is still an extremely interesting place to visit.

Book Reviews

EDELSTEINE UND PERLEN by K. Schlossmacher. VIII + 280 pp., 103 illustrations in the text, 3 tables, and 3 plates (2 colored). 16 x 24.5 cm. E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nagele) Stuttgart, Germany, 1954. Price, bound, 25 DM. Reviewed by Dr. Edward H. Kraus.

This text is designed for lovers of gemstones and pearls, and also for jewelers, goldsmiths, diamond cutters, lapidaries and dealers. The book is considered an abridged replacement of Dr. Schlossmacher's revision of Max Bauer's classical EDELSTEINKUNDE, which was published in 1928-32 and is now out of print, and because of its size and the present unfavorable economic conditions cannot be revised.

The book is divided into three parts, designated as *general, special,* and *practical.* In the *general* part, which includes the foreword and introduction, the author gives rather comprehensive descriptions of the important properties of gemstones and of the methods and instruments which are used in determining them.

The *special* section makes up the bulk of the book and contains detailed discussions of the properties, occurrences, production, and limitations of the important inorganic gemstones. In addition, fourteen stones infrequently encountered in the trade, such as fluorite, obsidian, euclase, etc., are described briefly. The organic gems—pearl, amber, coral, and jet are adequately treated, as are cultured pearls. The syntheses of the diamond, corundum, spinel, emerald, rutile, and quartz, and reconstructed stones are amply described. It should be emphasized that Dr. Schlossmacher states definitely that the diamond has not yet been produced in the laboratory.

The cutting, engraving, and the methods used in obtaining uncut material and in the sale of cut gems are described at considerable length. There are three tables, listing indices of refraction, specific gravity, and hardness. These tables are adapted from R. T. Liddicoat's *Handbook of Gem Identification.* Two colored plates add considerable interest to the text. There is a good index. The book will undoubtedly appeal strongly to the German public and gem trade. It should also serve as a very helpful reference work to all interested in gemology.

An Interesting Discussion of An Ancient Art

by FRED. O. COPELAND

I went up four flights in an elderly Montreal elevator to see a thing that has not doubled in price in thirty years. It is an object so steady in its continued popularity that you'd think it the first object to have risen in price; and risen to dizzy heights since the art of its making now threatens to vanish from the world. It is a coat-of-arms cut deep in the black onyx of a signet ring.

Unique in North America, it is reported that only one man in Canada can do this, and his peculiar mingling of artist and artisan is almost wiped out in the rest of the world. But here in its last stand this ancient art exists; appropriately across the street from the last fragment of Montreal's first fortification wall of the French regime interwoven in the foundation of the Bank of Montreal. You can hear the phantom drum of the heraldry of Old France keeping time to your steps as you enter a narrow doorway marked, "Gemologist." Suddenly you stand in an Aladdin's Cave.

An Interesting Discussion of An Ancient Art, Cont.

Instantly precious gems in their original, out-of-the-earth form nudge your elbow. For so tiny is this old shop you are crowded against an old-fashioned glazed showcase within which the gems glow with a prehistoric glitter. It is one of those rare places where the real experts of the world are the unassuming little men who have been dealing for centuries in one little commodity about which they know everything.

Hanging negligently on the walls were two large color-painted coats-of-arms on paper. The northern light from the window of an adjoining little workshop fell over an elderly man seated before a dainty, buzzing lathe. He got up and came forward in a white gown banded tight about the neck like that of a surgeon's; one of the few men of his skill in North America.

Quiet of eye, quiet of hand, he told me of the romance of his march to success in an unique art much of which he had devised himself over a span of fifty years. When he was fifteen years old he entered a shop of his present profession on Brewer street, London. He at first swept out and made afternoon tea for the workers. While learning the trade he attended night school in modeling and drawing. Others started learning with him. One by one they threw up their hands in despair, declaring they never could master the exacting work. But he persisted till he mastered it. One of Canada's oldest jewelry houses called him to Montreal. During the few years he worked for the house he perfected himself in his work, received a certificate of his standing, then opened a shop of his own that has lasted these many years.

"I think I am about the last," he smiled. "When I realized the art was dying I tried one apprentice after another. They all gave up after a year or so, declaring they never could master it. So I've quit trying to teach another apprentice."

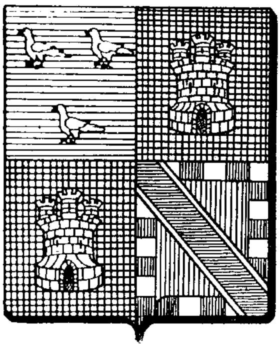
"But are there none in the old world?" I asked in wonder.

"Seven years ago I went over to look for some in London. I found one man left there doing this work; he was over 65. At Birmingham I found three; two were over 65 and one was over 80. Some of this work still comes through from Germany but it is inferior to the precision of mine. And you'll see coats-of-arms cut on gold, but the image wears off. I made one recently for a customer who insisted on 22 carat gold; it won't last long. When cut on onyx it will remain sharp for generations."

The supply of onyx comes from South America. Formerly it was jet-black, but this can no longer be obtained. The jeweler took from the showcase a slab of uninteresting slate-gray stone. It was present-day onyx. However, he dyes it a permanent coal-black that can not be detected from the old natural jet-black.

I wish you could see a coat-of-arms being cut on onyx. Black onyx permits an image more elegant and dignified in appearance than it does on its rival bloodstone, since the latter is greenish in color with blood-red splashes of red jasper which tangle to quite a degree with the cut image of the coat-of-arms.

Laying out the tools, we find they are drills like dentist's drills but with cutting tips so tiny scarcely can the human eye detect them. The jeweler has to make these himself. The steel of the drills will not cut onyx. They have to be made of a certain softness of steel that will allow diamond dust to imbed itself on their cutting edge, then they will cut into the onyx. The diamond dust is far different in appearance than you'd think. In its heavy but tiny steel bowl it is mixed with oil and appears as a dark-grey paste. After the small oval of jet-black polished onyx has been set in the gold ring mounting, the gold circlet is imbedded in a plump de **MONTCALM**



• A French Shield showing colors indicated by different type lines.

piece of cork and wound with tape, allowing only the onyx face showing. This provides a firm finger-hold which is immeasurably important as you will see. The face of the onyx is smeared with chalk dust and grease, and with a brass drill fixed in an electrically driven lathe the jeweler "pencils" on the onyx oval the silhouette of the shield of the coat-of-arms. He does it free-hand, pressing the onyx face in a lateral position against the buzzing drill point, and by eye alone reducing the image from a large painted coat-of-arms to this tiny replica on the onyx. And now with a change to a diamond dust pointed drill comes the almost painful skill of cutting the permanent shield outline, the figures or "charges" on the shield, the heraldic helmet or casque on the shield's top with its manteling, then above all the crest which is usually one of the charges on the shield. And below all comes the motto usually on a floating ribbon, the perfectly cut letters so infinitesimal it takes a magnifying glass to read them.

Most mottoes are in Latin. One used by several families in England with different coats-of arms reads, *Vincit qui Patitur* (He wins who waits). In rare cases it is in French, and an example of it appears on the badge of England's most distinguished Order of the Garter, *Honi soit qui mal y pense* (Evil be to him who evil thinks). Fancy, then, what one slip means in the cutting of a coat-of-arms. Every touch of the onyx to the diamond dust coated drill is free-hand, offering innumerable opportunities for a slip since the onyx is held as free in the hand as a brush by an artist. But it is far more exacting than this latter, for on onyx even one error can not be repaired; all must be thrown away. Seemingly no more perfection of artist and artisan exists.

Not only does the jeweler cut this elaborate coat-of-arms into hard stone, but he also indicates the color of the shield and charges of the painted coat-of-arms. If the shield is d'argent or silver color the open areas are left clean. D'or or gold-color is indicated by tiny dots. Gueules or red is depicted by fine vertical lines, d'azur or blue by fine horizontal lines, sable or black by fine crossed lines, verte or green by diagonal lines from right to left. The color of the charges in the shield is indicated in the same way, and they occur as images of the animal and vegetable kingdoms as well as conventional figures.

Both the shields and charges in heraldry originated in France and spread to other countries. And in former days it was part of the education of every youngman-about-town to know how to read coats-of-arms.

It takes the jeweler four hours to cut a crest; one of the charges on a shield which is often used alone on a signet ring. An entire week is required to cut a complete coat-of-arms. It costs $60; only $10 more than thirty years ago. And he turns out 150 to 200 signet rings a year, thus attesting to the continued popularity of wearing the badge of one's family name.