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On the Cover

A collection of turquois cabochons in various quality grades with and without matrix, together with mother rock with turquois veins and two rough pieces of turquois. The necklace is of Persian style made in Tehran.

Photo by Dr. E. J. Gubelin

A Visit to the Ancient Turquois Mines in Iran

by

Dr. E. Gubelin, C.G.

The passion for gemstones is as old as the beginnings of human civilization, and turquois of gem quality was among the first and most coveted treasures of early mankind. Archaeological finds inform us of prospectors, caravans, merchants and goldsmiths specializing solely in turquois, so strong was the desire for its charms among the pompous kings, priests and nobles — particularly the ladies — of ancient societies.

The Pharaohs of the third dynasty of the Old Empire (ca. 2600 B.C.) sent their slaves to work the turquois deposits of the Sinai Peninsula, the first such occurrences known to history. A very well-preserved stone relief from Maghareh depicts Pharaoh Sechemchet swinging a bludgeon over the head of a captured, kneeling Bedouin sheik. This picture demonstrates well the difficulties the Egyptians must have encountered with the inhabitants of those areas where the turquois mines were situated. Archaeological investigations have disclosed their exact locations to have been in the deep waddies of Maghareh and Sarabit-el-Khadim in the dreadful desert east of the Red Sea.

During the Middle Empire (2050-1780 B.C.) turquois from Sarabit-el-Khadim was in favor and at this site, besides numerous votive inscriptions, was found a huge votive epigraph to the goddess Hathor left by a noble official of the reign of Pharaoh Amenemhet III (ca. 1800 B.C.). This epigraph formed part of a vast temple complex dedicated to the goddess, who was here worshipped as the "Holy Lady of Turquois."

Also the New Empire (1580-1080 B.C.), which held turquois in very high regard as a personal adornment of the members of the royal family and

Figure 1. **Clay tablet with inscriptions in a nondeciphered old south Semitic language, with eight words in two registers (I.L.N. April 17, 1965).**

the aristocracy, continued to work the turquois mines, employing such specialists as sculptors, witch doctors, and a supply crew, altogether numbering more than a thousand people. Work on the mines would begin in January and continue into the early summer months, when the glowing heat rendered all work impossible. The turquois, which was mined by primitive stone hammers and metal chisels from the walls of low galleries, was transported by slaves along neckbreaking paths through the rocky mountains and across the scorching desert of Marcha to a small, recently discovered harbor in the Red Sea south of Abu Zeneima. Other turquois deposits were mined at Abu Hamed and Um Bogma, as well as in the Waddy Shellal. During the New Empire, these mines were so completely exploited by the greediness of the Egyptian Pharaohs that more recent endeavors to operate them with modern mining equipment proved to be unprofitable. Thus, the exhaustion of the Sinai deposits coincided with the decline of Egyptian power during the period of the 20th dynasty (ca. 1000 B.C.). However, they are of unique interest not only because they were the earliest mining operations recorded in history, but more so because they helped to enrich our knowledge of early human civilization with a tremendously important contribution. Archaeological excavations at the sites of these ancient mining camps have unearthed texts — in clear distinction to old Egyptian texts — written with so-called "old-Sinaitic" characters. These characters, of which there exist 30 separate types, resemble the simpler hieroglyphic signs and may be considered a forerunner of the "old-semitic" alphabet. They were most likely written —if not invented—by those same miserable semitic slaves who worked the mines. Their alphabetic principle simplified the problem of literacy to such an extent that it gradually took the place of the more cumbersome syllabic and ideographic systems of Mesopotamia and Egypt *(Figure 1)*. Thus was the humble origin of the progenitor not only of the Arameic, Hebrew and South Arabic letters and of the Greek and Roman alphabets, but also of that alphabet familiar to all of us that is quotidianly written, printed and read a millionfold times in our modern day.

In view of the great popularity that turquois has enjoyed ever since it was worn by Queen Zur—the wife of Pharaoh Athotis, the second ruler of the first Egyptian dynasty (3400-3200 B.C.) — it is quite logical that this enchanting gemstone became the subject of numerous charming legends and that superstition attributed magical properties to it. The choice of turquois as the birthstone for December probably dates back to very early times. Many a Persian poet praised the virtues of the gem in enthusiastic verses. One such quotation claims that: "A turquois given with love ensures luck and happiness," and that the person who looks upon turquois in the first light of dawn will enjoy happiness for the whole day. In times when the horse was still the most important means of personal transport, turquois was esteemed as a charm of horsemen and was believed to protect the rider from every evil, rendering even his horse indefatigable. If this superstition were transplanted into our motorized era, the turquois would appear to be the most popular talisman of automobile drivers. In the Orient, people believe that turquois may avert the consequences of the "evil eye" and imagine that any alteration of its color prophesies ill fortune. During mediaeval times, turquois powder was often prescribed as specific therapy for loin pains. The gem itself was also quite famous for granting intrepidity and fearlessness to its owner and was thought to protect innocence and virtue. Thus, turquois is righteously valued as the true symbol of both luck and love.

In the course of the centuries turquois has been known under many names, such as "callais," "callaina" (as it was referred to in Pliny's Natural History), "callaite," "callainite" and others — all of which are derived from the ancient Greek term "Kalos lithos," meaning "beautiful stone." The Aztecs called it "chalchihuitl," which meant "green stone," and was a name simultaneously applied to many other green minerals; for example, jade, green onyx and others. In Persia, turquois is today known as "piruzeh," similar transliterations occurring in the languages of neighboring peoples; e.g., "firuzeh" in Arabic, "pirozah" in Armenian, and "biruza" in Russian. The name "turquois" is French and denotes a "Turkish stone." This misnomer is readily explained by the fact that the first stones did not reach Europe directly from Persia, but rather through the intercession of seafaring Venetians who purchased them at Turkish bazaars.

It was only very recently that turquois was discovered in crystal form. Until then it had been classified as an amorphous mineral, sharing this distinction among gemstones solely with the opal. Turquois crystallizes according to the rules of the triclinic system, but it normally occurs in the form of compact conglomerations of microscopic crystals presenting a massive appearance. Chemically, the mineral is a complex hydrophosphate of aluminum and copper, which corresponds to the chemical formula of $CuAl_6(PO_4)_4(OH)_5 \cdot 5H_2O$. The copper content does not exceed 10%, yet this is sufficient to impart its lovely sky-blue to Prussian-blue hue and thus to place it among the idiochromatic gemstones. A small percentage of the copper may be replaced by traces of iron and thus induce a greenish shade to the color – a shade that may be so predominant as to transform the blue hue of the gem to a yellowish-green tone. The most costly specimens are those of a pronounced and pure blue color with a well-arranged pattern of matrix. Turquois has a somewhat porous structure; therefore, its color is easily affected by pigmenting liquids, grease, oil and even dirt, in that the porosity of the stone allows for ready absorbability of these substances and consequently alters the color, giving it a paler or yellowish-green tint. The porosity, especially of the American specimens, has induced many attempts to improve the appearance of turquois by dyeing it with various chemical solutions and hardening it with a coat of plastic. This has often led to unpleasant situations between dealers and jewelers. The cutter and the wholesaler wish to improve their merchandise – in order to obtain better prices–whereas the jeweler must know whether or not the material is in its natural state – in order to protect his client and thus be worthy of his confidence. With the intention of clarifying this often ticklish situation, the trading codes of many countries demand that stones that are artificially treated, dyed or coated must be clearly designated as such.

Similar to malachite, azurite and chrysoprase, turquois is a secondary mineral – a product of the disintegrating, weathering atmospheric action on rocks and adjacent ore deposits – that fills fissures, cracks and cavities in rocks near the earth's surface. It owes its formation to the dissolving and altering effects of meteoric waters, which slowly break and decompose hard rocks and deposit them again later to form the sedimentary rocks. Although weathering processes caused by rain and vadose surface waters are spread over the whole world, turquois occurs in relatively few places only; and while in the course of the centuries turquois has been found in many countries (Afghanistan, Arabia, Australia, Chile, China, Ethiopia, Germany, Peru, Sudan, Siberia, Tibet and Turkestan), only Iran and the southwestern United States may today boast of turquois deposits that are of commercial importance. Persian turquois has a finer, purer blue, is less porous than the American turquois, and

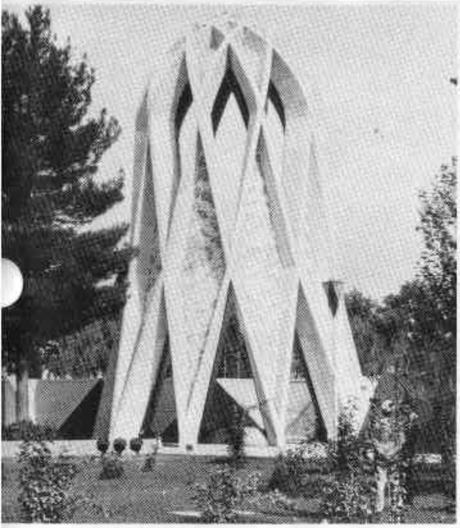


Figure 2. **Shrine erected above the grave of the Persian poet, Omar Khayyam (+1120 A.D.) displays modern architectural conceptions.**

Figure 3. **The ruins of Toos, which was a flourishing town in medieval times.**

determines the standard of quality by which all other turquois is judged. Undoubtedly, the very ancient mines of the northeastern province of Khorassan in Iran still hold their old romantic appeal and certainly still produce the most beautiful turquois. It is not known when these deposits were first worked, but, as may be learned from old Persian poems, they were in operation at least as early as the 4th century of the Islamic era (900-1000 A.D.). (The Moslem calendar dates from the year of Mohammed's Hegira; i.e., flight from Mecca to Medina, in A.D. 622.) There are hundreds of large and small mines, some of which continue to be worked, whereas many others have been abandoned. The principle sources of the finer-quality turquois are found concentrated in the vicinity of the village of Maaden. This village lies in the range of Kuh-i-Binalud, which rises to the north-northwest of the old town of Nishapur, famous in the 12th and 13th centuries A.D. for its beautiful Islamic ceramics. It is also the birthplace of the celebrated Persian poet Omar Khayyam (+1120 A.D.) *(Figure 2)*.

The author and his wife undertook an Art Study Tour through Iran last autumn and profited from a visit to the fascinating pilgrims' town of Mashad, which is the Mecca of the Shiite moslems, to organize an excursion to those turquois deposits that lie approximately 100 miles to the northwest of Mashad and 40 miles north-northwest of Nishapur. This trip was a particularly worthwhile undertaking not only in the interests of study, but also because of the exotic beauty of the landscape. The journey led through fertile, cultivated country as well as through sandy deserts, and along the route there were famous monuments and crumbled ruins of towns that were destroyed 750 years ago by Genghis Khan's mongol hordes *(Figure 3)*. Among the ruins it was still possible to find potsherds of

Figure 4. The dromedary is still the most important means of transportation, especially for the nomads.

Figure 5. Egg-shaped domes and slender minarets — artistically adorned with glazed tiles — bear witness to the highly developed sense of art of the Iranian peoples.

old and once-beautiful ceramics, the glaze of which already displayed that delicate iridescence which the collector welcomes as a sign of advanced age.

Picturesque villages were alive with playing children and veiled women fetching water and chatting at the wells, while small caravans of slowly trotting dromedaries carried agricultural produce to some markets *(Figure 4)*. At each village slender minarets or egg-shaped domes — covered with turquois-blue glazed tiles — of well-proportioned small mosques pointed gracefully into the cloudless turquois-blue sky *(Figure 5)*. On three separate occasions cholera-infested areas had to be transgressed, involving long delays and violent discussions at the blockades, which, however, were always lifted when the letter of introduction from Mashad's Minister of Information was produced. Thanks to the far-reaching influence of this highly cooperative gentleman, the local chief of police of Nishapur was waiting at the entrance to his town with his powerful Landrover, a much more reliable car than the taxi from Mashad with which to negotiate the rough and stony tracks into the rifted mountains of the Kuh-i-Benalud range. Kuh-i-Benalud is a mighty range that extends from west to east between Kotshan and Nishapur and that divides into three different chains of mountains: Kuh-i-Heidari, Kuh-i-Qurnub and Kuh-i-Benalud. This range includes numerous mountains, hills and peaks — the highest of which reaches an altitude of approximately 12,000 feet above sea level — separated by deep gorges, breathtaking canyons and broad, lovely valleys. Some of the valleys were resplendent with beautiful small green fields and tall poplars that lined the Landrover's narrow stone track. This track meandered carelessly, following the crooked silvery line of a tiny adjacent stream. Thus, the car skirted delightful valleys, passed huge rock-salt mines and traveled through deep-cut gorges and over high passes to the Abdurrezza mine, which is situated at an altitude of 5000

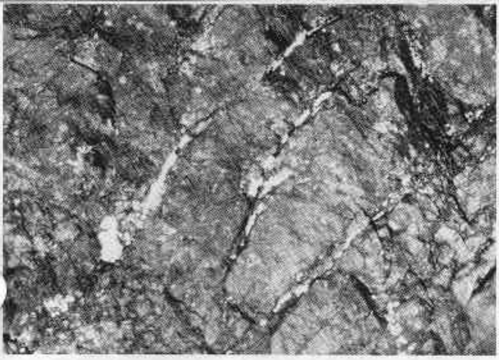


Figure 6. **Irregular veins of turquois (white) filling fissures in the brecciated trachyte rocks (dark).**

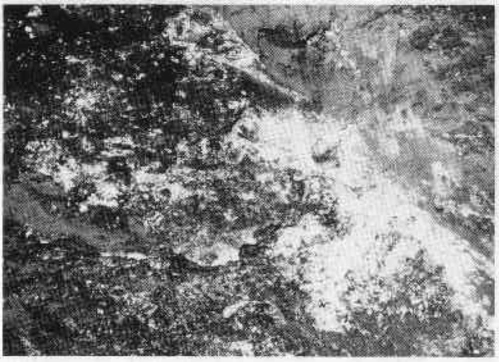


Figure 7. **Shapeless patches of turquois (white), either filling cavities or lining the surface of the brown to red-brown trachyte rocks (dark).**

feet in the southern flank of mount Ali Mirsai near the village of Maaden. This village serves as mining center for the operation.

The area of the Kuh-i-Benalud in which the turquois deposits are found consists of a complex of stratified Tertiary sandstones and nummulitic limestones superimposed on a bed of clay slates, interstratified with mighty deposits of rock salt and gypsum. These latter formations outcrop especially along the southern foothills of the range. Intrusion of these old sedimentary rocks by porphyric trachytes and diabasic rocks of younger eruptive origin has partly altered the original sedimentary complex of strata. These intrusions and the effect of metamorphosis on them may readily be recognized in the vicinity of the turquois deposits. There the trachytes display a brecciated appearance and macroscopic apatite prisms may be observed in their bodies. Within the decomposed and the brecciated parts of the trachytes, turquois appears and forms a system of irregular, narrow veins two millimeters to several centimeters thick, filling crevices and fissures in the volcanic rocks *(Figure 6)*. In the trachyte breccia, turquois fills the spaces between the trachyte factions *(Figure 7)*, which are cemented together by limonite — a brown iron ore — that also coats and permeates the turquois. Limonite, a mineral of older age but also lining the crevices, accompanies turquois along its vascular channels. This type of deposit is most characteristic of turquois that is formed in acid igneous rocks rich with alkali feldspars. The latter rocks contain copper minerals and apatite and have suffered from radical alterations in composition, in the course of which the feldspars were changed into kaolin and sericite. Hydrothermal metamorphosis accompanying the formation sericite, as well as the geotectonic effects of shearing and cracking, opened a track for downward seepage of surface waters, thus favoring the formation of turquois, for turquois is thought to have been caused by circulating rain waters that had penetrated the rocks. The disintegration of apatite in out-cropping neighboring rocks provided the necessary phosphoric acid ($H_3 PO_4$), whereas aluminum came from those feldspars that underwent alteration into kaolin and sericite. The copper content, which is a constitutional pigment, originated from copper ores that happened to accompany the turquois mother rocks. It is thought that vadose meteoric waters first oxidized the copper sulfides into sulfates, from which in their turn kaolin and clay minerals absorbed the copper oxide, whereas free sulfuric acid (H_2SO_4) favored the decomposition of the apatites. These petrological considerations seem to afford the best qualitative explanation for that hypothesis that seeks to account for the fact that turquois is often found pseudomorphous after feldspar and that it is the noble product of a complicated weathering process, in which meteoric rain waters play an important role. This hypothesis also corroborates the assertion that turquois is a young gemstone that owes its formation to alterations occurring near the surface of the earth. Consequently, turquois is rarely found in depths of more than about 30 feet.

After this relatively young turquois had been formed in the Benalud mountains, the vast deposits were further subjected to weathering actions and partial decay, in the course of which the hard-rock casings of the turquois veins were shattered and turquois pieces scattered among the masses of rock debris on slope terraces and of talus hills at the foot of the mountains. In these secondary deposits, turquois is found as broken fragments of splintery or rounded shapes, and often they are coated with a white crust of weathered substance that must first be scratched off or broken away before the pleasant blue core may be cut.

The Abdurrezza mine *(Figure 8)*, which the author and his wife visited, was operated by a complex system of ramifying galleries and cross drifts at different levels connected with each other by shafts, through which the miners would descend or climb by means of wobbly ladders.

All these tunnels were made by blasting, whereas the actual mining of the turquois is more tedious a task and involves working with mammoties and picks, with hammer and chisel. The hard, brownish rock walls of the galleries are beautifully marked by a great number of irregular white to blue veins of varying thickness, but occasionally there are quite large patches of turquois material, from which larger pieces may be cut. The rock fragments are then placed in small lorries that are pushed to and emptied onto a platform in front of the entrance to the mine *(Figure 8)*. There the turquois is freed from the adhering rock and collected in special bins by children, who are engaged in great numbers in the turquois industry. When, as a result of too much blasting, the primary deposits seemed to "run dry," increased attention was paid to the secondary deposits in the detritus masses at the foot of the mountains. Working methods were found to

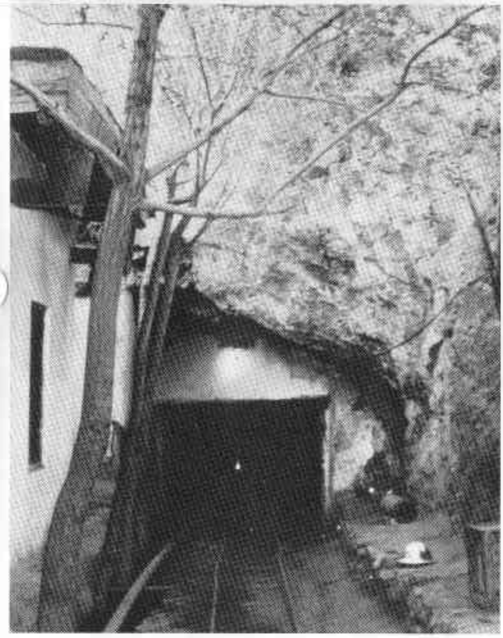


Figure 8. Entrance of the Abdurrezza Mine, which consists of a system of drifts branching out at various levels.

be much simpler, because here the turquois pieces are found lying loose in the rubble. These loose pieces have already undergone natural mineral segregation and concentration and are called "Khâkî turquois." They are recovered by children — and occasionally by women — simply by dispersing the debris and collecting the loose pieces by hand. It has been found that the best quality turquois is concentrated at the tops within six feet of the surface of the talus and debris hills, which reach heights of 15 to 100 feet. The gathered pieces are then taken to the village where they are washed and rubbed in water in order to remove the whitish coat, a process that inevitably unmasks the lovely blue core. "Khâkî turquois" is claimed by many to be the finest quality turquois.

About 300 people are working the mines in the mountains near Nishapur, their daily wages ranging from 30 to 60 rials (35 to 70 cents) — a small amount compared to the difficulty of their task. The material extracted from the mines and that collected by the children is transported in small vans or in Landrovers to Nishapur and from there by rail to Mashad, where it is tested by specialized cutters and polishers and, if found suitable, is placed at the disposal of expert stone cutters.

Besides the deposits of Kuh-i-Benalud in the Province of Nishapur, turquois is also found in several other places in Iran: at Khab Zeri, near Basiran; at Zebekuh, at Tabbas; at Turshiz, north of Tabbas (all in the province of Khorassan, close to the frontier of Afghanistan); in the south of Mashad, in the province of Kerman; and also near Taft, in the province of Yezd on the Persian Gulf. But all these deposits are of minor commercial value.

The art of cutting and polishing turquois has its center in Nishapur and Mashad and surrounding areas. More than 100 lapidary workshops exist in Mashad itself, employing altogether more than 1000 cutters. The lapidists' workshops are usually located in old caravanserais and in the cellars or lofty attics of old houses. In these workshops boys of eight or nine years of age are to be seen working next to old and experienced men from sunrise to sunset, sitting behind hand-operated cutting

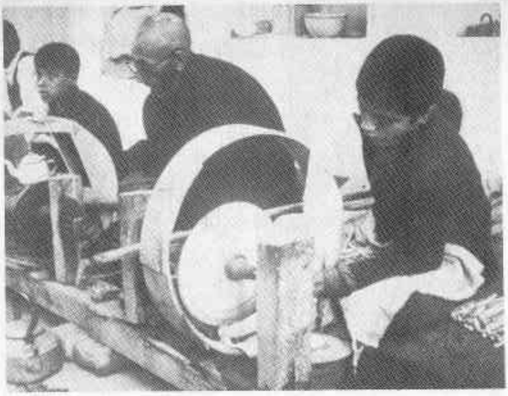


Figure 9. General view of a lapidaries' workshop at Mashad. Young boys work beside old men cutting, grinding and polishing turquois.

laps and polishing lathes *(Figure 9)*. The cutting of turquois is carried out in the same ancient, traditional manner that has been practiced for hundreds of years. The machines are very similar to those employed by the lapidaries in Ceylon and India and consist of a cutting disc of pewter or copper charged with emery and fixed to one end of a grooved wooden drum. The drum rests in the legs of a wooden bench turned upside down. The lap is rotated backward and forward by means of a bow, the string of which is wound around the barrel *(Figure 10)*. The cutter makes a picturesque figure squatting on his haunches, moving the bow to and fro, and looks almost as if he might be playing some musical instrument. With uncanny skill he presses the rough gemstone against the cutting or polishing wheel, which he coats from time to time with a home-made abrasive. After the turquois has received a rough cut (usually oval or circular cabochon), it is then rubbed on a finely-grained sandstone extracted from the Sisar mountains. Finally, the gem is polished on a lathe covered with resin or on a strap of leather charged with alumina powder *(Figure 11)*.

Persian turquois is famous for its fine sky-blue to Prussian-blue color, which normally is homogeneously distributed over the whole gem. However, many pale or greenish to yellowish-green varieties are also found. The amount of brown to black matrix—i.e., cicatrization of turquois by limonite — may sometimes assume remarkable proportions. According to quality, the following grades of turquois are distinguished in Persia:

Angushtary:	sky-blue to Prussian-blue turquois with uniform coloration and without matrix.
Barkhaneh:	sky-blue to greenish-blue specimens, occasionally patterned with fine veins of matrix.
Arabi:	paler gems with patchy coloration, or those with much matrix. (This type is being purchased by Arab merchants or exported to Arabia.)

In Iran, the sky-blue qualities with evenly distributed coloration are appreciated much more than the deeper-blue hues, which, particularly when they are prettily veined with matrix, are preferred in the West.

All turquois deposits in Iran are owned by the Iranian Government and the principle markets are Mashad and Tehran. From there beautiful turquois is sent to all parts of the world. Pro-

Figure 10. The cutter holds the turquois with his left hand pressing the stone against a vertical lap while he is moving the bow to and fro with his right hand.

Figure 11. Boy polishes a turquois on a drum buff padded with moist lambskin.

duction has never been very steady. Some pertinent figures from the first few productive years after World War II are included in the following table:

Year	*Approximate Weight of Rough Turquois*	*Approximate Value*
1947	7,500,000 grams	$45,000
1948	8,700,000 grams	$70,000
1949	6,600,000 grams	$40,000
1950	4,800,000 grams	$18,000
1951	6,700,000 grams	$70,000

Increasing popularity and rising demand over the past few years, however, have been a boost to Iran's turquois industry. It is now estimated that about twenty million rials (approximately $250,000) worth of these gems are exported each year, bringing in return much-needed and welcome foreign exchange. The biggest foreign customers for Persian turquois are the United States and France. Americans are mainly interested in the size of the stones, being satisfied simply with large pieces and paying little attention to their shade, purity of color, or veins of matrix. Customers from France are much more selective and quite often difficult to satisfy. Turquois is still present in Iran in such abundant quantities that it is not at all necessary to simulate it with such a number of various kinds of imitations. Yet there are already so many cheap imitations on the market that both jeweler and public are losing confidence in the real stone. Consequently, interest in this delightful and unique natural gemstone is declining. It is to be hoped that through the endeavors and initiative of honest jewelers and gemologists alike all such imitations will forever be banned from their premises in favor of the unsurpassable virtues of the genuine gemstone, so that the words of praise bestowed on this enchanting native gem by a Persian poet many generations ago may always hold true: "Turquois is a precious stone, so beautiful and pure in color and with such outstanding virtues that it was deigned by Allah to be worn by people of noble hearts."

The Black Opals of Lightning Ridge

by
John Hamilton

PART II

In White Cliffs, a man called Murphy was buying opal for the greatest buyer of all time, T. C. Wollaston.

Years later, Murphy wrote of his first meeting with black opal, "On November 11, 1903, Charlie Nettleton, prospector of the Lightning Ridge opal field, came to me at White Cliffs with a parcel of an entirely new variety of opal, very dark, although it did have some good color. He had sent 100 ounces to Sydney and had been offered 10s. for it, since it was considered too dark for commercial value. Personally, I thought the opal had possibilities and wanted Mr. Wollaston to see it, so I bought it. Charlie returned to the Ridge to await further news. When Mr. Wollaston received the parcel, he endorsed my opinion and said to go on buying the opal and that he would introduce it. I then wrote to Nettleton telling him I was prepared to buy all they produced. I continued buying by mail, then decided to visit the field myself. I arrived there on April 8, 1905, and bought $1250 worth. There could not have been more than 30 men there at the time, and I was the first buyer to visit the field."

Wollaston was to write of his first meeting with black opal "Who indeed, can hope to capture and describe this amazing, glad-eyed, responsive thing, cribbed in its dark cage, yet exultant there beyond measure, and trembling with a gratitude which we thrill to watch? In one small stone what varying heaven-lit scenes — mountains and lakes and curtains of Arctic fire; there is Pilatus piercing through golden hail, against the dark storm cloud, his sacred summit agleam with molten emerald, and there the Rigi bristling with crimson daggers, and at the foot that matchless lake, its shadowed greens slashed with brilliant bars of purple — the pathway of the King!

"Or surely this is Kiluea, fearful in mysterious beauty, its sleeping fires partly veiled over with sullen hues of cooling iron till Old Faithful bursts out in sudden splendor and throws aloft his meteoric showers, while a surging wave of glory sweeps across the awesome pool!"

Wollaston had suffered a bad attack of black-opal fever. His agents in London could find only one dealer who would handle black opal, and then only in small lots of $224.

In 1906, Wollaston went to London and worked for two years convincing dealers and jewelers that a new and magnificent gem had been discovered in Australia.

He followed this up by visits to America. He persuaded a jeweler on Fifth Avenue, New York, to feature a display of black opals in settings with diamonds and other precious stones, and slowly the world began to realize the worth of black opal. Wollaston drily remarks of this period, "For several years it was uphill work indeed to create a demand and persuade the market to take the gem to its bosom, which goes to show how dull and unresponsive the heart can be which beats there."

In 1910, success was achieved and black opal began to find a steady and increasing sale that has continued to this day.

By 1908, through Wollaston's hard work overseas, the demand for black opal produced another big opal rush at Lightning Ridge.

Lightning Ridge pioneer "Lucky" Fred Bodel outside his stone-and-tin shack. Bodel came to the opal field more than 60 years ago before opal was found at the Ridge.

Fourteen hundred miners were camped at the place they called Nettleton's Flat, and the silence of the outback was broken by the thudding of a thousand picks.

Lightning Ridge was established.

"We Dug Them out like Potatoes"

Fred Bodel will not tell his age. He will, however, admit to 45 of his 80 years, and most of those years has been spent at Lightning Ridge. He lives by himself in a shack made of piles of loose stones, pieces of corrugated iron and supported by a rough timber frame, with a chimney made out of beaten-out kerosene tins. He is the last of the pioneers of Lightning Ridge. They call him *Lucky Fred.*

Bodel was working around Lightning Ridge, as a general hand on a sheep station, before opal was discovered there. He gave up working with the sheep when opal was discovered.

In 1907, he caught a lifelong attack of black-opal fever when he and his partner bought a claim, now known as the New Chum Diggins, from a man called Ned Plunk for $3. It was one of the richest patches ever found at the Ridge. Plunk had found nothing for his efforts and was glad to get rid of it at the price. The two new owners of the claim set to work cutting through the bank of opal underground dirt until suddenly they came upon a fault — a break in the formation resulting from earth movement. In this fault they found an immense haul of opal. "We dug them out like spuds (potatoes). I've never seen *nobbies* so thick before or since," says Bodel.

Murphy, the opal buyer, bought the whole of the great find. He would come to the partner's camp every evening and buy the day's production, which would be spread for his appraisal on an upturned butter box.

The demand in those days was for stones with red fire. The miners threw away green stones. Now the greens bring up to $90 a carat.

Bodel and his partner received $500 for the opal they took from the twenty-by-eight-foot patch. Today, the opals they won from that patch would be worth more than $2,250,000.

In 1929, Bodel was indirectly responsible for finding one of the biggest opals ever to be won from the Ridge. He had tossed a penny with a friend, Jack Nichols. Heads, Nichols was to start a new shaft — tails, he was to clean out an old one. The coin fell heads. Nichols walked over to the spot where the penny had fallen and marked out a shaft around it. The day was Friday, and Nichols, like many of the oldtime miners, was a superstitious man and regarded it as bad luck to start a shaft on Friday. He went home and spent the evening trying hard to get Bodel to come into partnership with him on the new shaft. Bodel refused. He preferred to work on the old shaft. A few days later, and fifteen feet down the new shaft, Nichols found the Pandora Star, which Bodel describes as having been "big as a man's forearm and shaped much the same." Today, it is said to be in the United States and worth well over $150,000.

In spite of the fortunes and misfortunes that Bodel has experienced, he lives on in his shack at Lightning Ridge. He is still mining for black opal, for that elusive patch of *nobbies* that could be but a pick stroke away. Opal fever, it seems, is even worse than the traditional gold fever.

Lightning Ridge has a permanent population of about 250 people. This swells to 400 or more during holidays when amateur prospectors invade the town. Many of the now-permanent residents were former visitors who came on holidays to do a little prospecting

Mrs. Flo Smith shovels opal dirt into her "dry puddler," which separates the opal from the dirt.

and stayed on to become opal gougers.

To become an opal miner is a simple matter. The prospector purchases a Miner's Right for $2.25 and then pegs a claim 100 x 100 feet.

Prospecting for opals can be done in three ways:

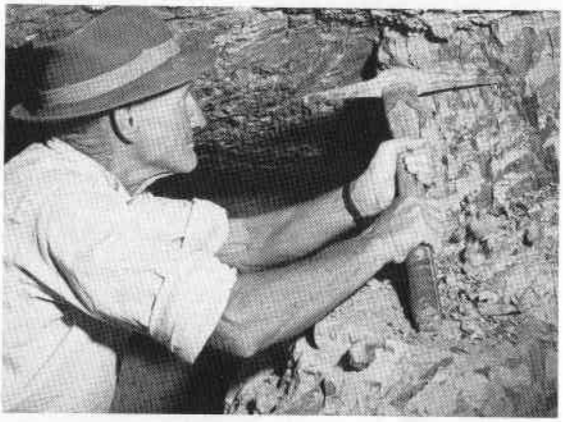
Noodling. The miner works slowly through the abandoned mullock of an old digging. In the early days of Lightning Ridge prospectors discarded many stones that are now worth a small fortune.

Puddling. The miner draws from abandoned shafts piles of opal dirt that are either fed through a small crusher driven by a petrol engine, which pushes the dirt through a wire basket that catches any opal (called *dry puddling*), and *wet puddling,* which separates the opal from the clay by washing with water.

Digging a Mine. The miner either digs or blasts his way through the surface crust of desert sandstone until he reaches opal dirt running in a grayish band at varying depths beneath the sandstone. When he reaches the opal dirt he drives shafts into it, working his way cautiously forward, gouging with a pick through the crumbling clay. He knows he is *on to* opal when his pick makes a distinct *click* on contact with a *nobby.*

There are six opal dealers on the field, ready to buy if you strike opal. One such dealer is Len Cram, who lives with his wife and two children in a modern house he has built on a small hill overlooking the little township of Lightning Ridge. He readily admits, "Opals are in my blood." Ten years ago he went to the opal field in Queensland from a coastal city in New South Wales and since that time he has lived and worked with opals. He came to Lightning Ridge three years ago and started as a miner; however, he was unsuccessful, so he started as a dealer with a bank of $675. Now, his turnover exceeds $13,500 a year.

Every week, opals worth $6,750 on



An opal miner at work underground. He is gouging away at the crumbling seam of opal dirt. If his pick "clicks" when he is gouging, he knows he is on to solid opal.

an average are being produced at Lightning Ridge.

Len Cram has started his own company called *Lightning Ridge Opals*, and has gone into the export business. In a small shed at the back of his house he cuts and polishes rough opals that will eventually grace the velvet shelves of jewelers' display windows throughout the world. The cutting and polishing require a deft touch and skill. A stone can be destroyed if the cutter takes a fraction too much off the surface.

Cram says, "The future of Lightning Ridge is assured. The price of opal is going up steadily and there is a potential opal field of 40,000 to 60,000 acres. The work that has been done around Lightning Ridge over the years has only scratched the surface."

About three dozen miners are at present producing the world's supply of black opal. They range from veterans like Fred Bodel to comparative youngsters like Mrs. Flo Smith (Smithy), who came to Lightning Ridge for a holiday five years ago and stayed on. Now she works up to eight hours a day at dry puddling, shoveling opal dirt into the wire basket. It is hard and dusty work, but she has managed to find something for her efforts. Only recently, she found a stone valued at $2,700 on the field. For instance, if it reaches New York, through the hands of dealers and jewelers, its price will have increased to about $22,000 before it is worn by a customer.

However, the residents of Lightning Ridge have become aware of another potential source of revenue leading from black opals — tourists. Practically each mullock dump now being worked has a little sign "Opals for Sale."

Coachloads of tourists are now arriving in this isolated small town and there are plans to fly tourists direct from the cruise ships that call at Sydney, to spend a weekend in the outback as opal gougers.

The local shire council has installed electricity. It has a bore deep under-

Construction underway on an unusual form of accommodation for tourists — a "Tramotel," being built at Lightning Ridge from the bodies of old trams (street cars), converted to self-contained motel units.

ground that has resulted in a constant supply of hot artesian water; enough to supply the swimming pool that has been constructed 100 yards away.

Mr. Harold Hodgess is busy erecting what could be a unique type of motel. He is converting old tram (street cars) bodies brought from Sydney into self-contained motel units with verandas and lawns. He calls it a *tramotel.* It will solve a widespread need, since the one and only hotel, the *Diggers' Rest*, has only two bedrooms.

Lightning Ridge has most of the amenities – hospital, school, butcher, baker, garage, post office, stores and a police station.

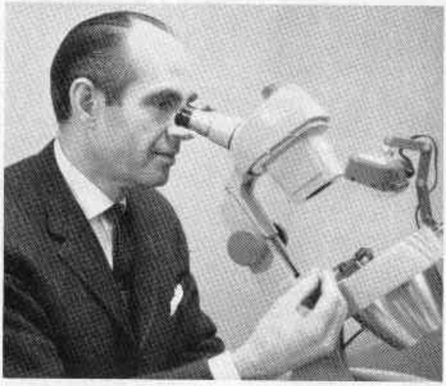
Whether the tourist wants to look at the history of the Ridge and see old workings such as *Dead Man's Claim,* the *Revolver Mine* and the *Ladybird Mine,* or hire a pick and shovel and go *noodling,* Lightning Ridge is now ready to welcome him.

Statistics prove that it will be there for a long time to come.

(continued on page 31)

Opal dealer Len Cram examines a black opal found by Mrs. Flo Smith at Lightning Ridge.

Developments and Highlights



at the GEM TRADE LAB in New York

by
Robert Crowningshield

Solution-Grown Synthetic Rubies

Figure 1 shows the results of exposure to short ultraviolet of six natural rubies (bottom), six ordinary Verneuil synthetic rubies (top) and three solution-grown synthetic rubies (center). The transparency to short ultraviolet of the solution-grown synthetics equals or even surpasses that of ordinary synthetics. We feel that we have seen at least two different types of solution-grown synthetic rubies and their short ultraviolet transparency seems to be similar.

Biwa Pearls

A hank of ten strands of pearls imported as "natural" was found to be fresh-water cultured. They were as nearly round and as beautifully selected as many from the Persian Gulf region. In fact, they were silver tasseled, much as pearls from that area are prepared for market *(Figure 2)*.

Tanzanian Blue Kyanite

A rough blue kyanite specimen from Tanzania gave us the unusual absorption spectrum shown in *Figure 3*. The stone transmitted light beyond 7000 Å, with two prominent bands in this area. A region of intense absorption around 6000 Å reminds one of the spectrum for ruby.

Salininha Green Beryl

We have had several occasions to identify green beryl from the Salininha

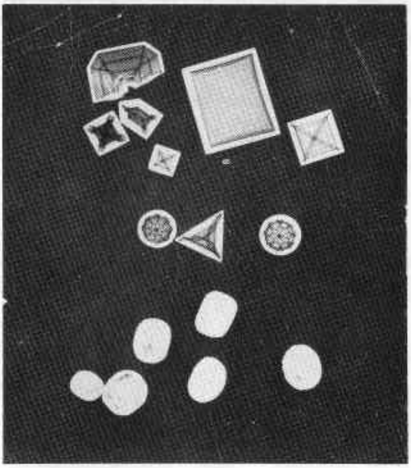


Figure 1

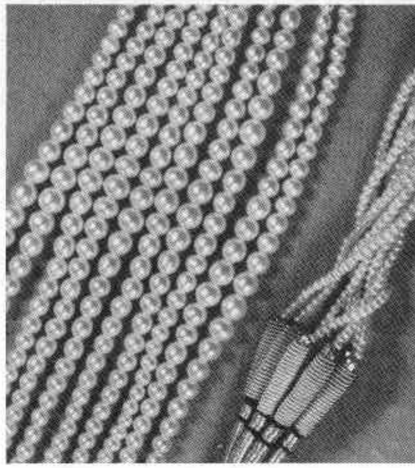


Figure 2

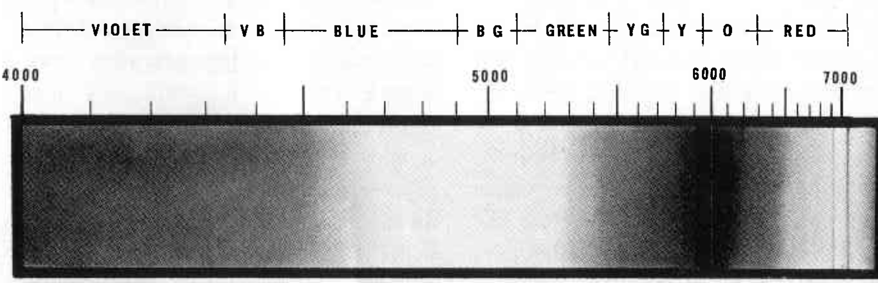


Figure 3

Mine in Bahia, Brazil. *Figure 4* is a photograph of a well-made platinum-and-diamond bracelet with eight of these stones. Whether or not they should be called emerald is still a matter of some world-wide dispute.

Figure 4

Odontolite

It was only last year that we added the first specimen of odontolite to our collection. Recently, we received an antique cross to identify the opaque blue stones. With the refractive index much like that of turquois, it is a matter of

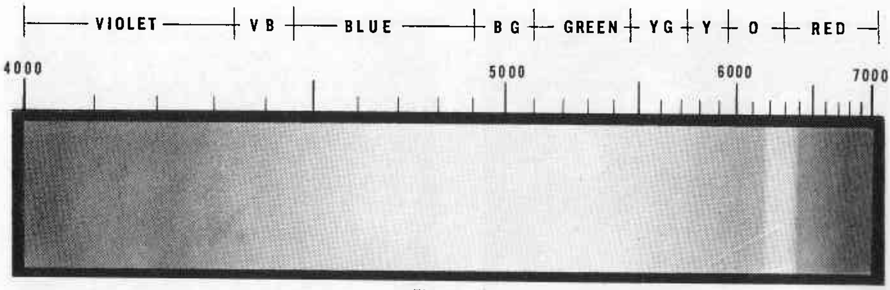


Figure 5

some comfort that the absorption spectrum is somewhat characteristic *(Figure 5)*.

Diamond Discolored by Water

We were asked to examine a small diamond in an engagement ring that the customer said had become yellow gradually within about 18 months. The jeweler suspected coating; however, since the stone was less than half a carat in weight, it did not seem likely. We inquired about the type of water in the midwestern town where the client lives, and were advised that it is very hard. Our examination disclosed a very resistant brownish-yellow coating that would not wash off, but with hot acid the stone regained its fine colorless body color. We have heard of iron-rich water discoloring a diamond over a period of time, but this is the first time we have encountered it.

Emerald-Green Jadeite

One of the handsomest stones we have seen in many years was a nearly transparent emerald-cut, emerald-green jadeite in a platinum-and-diamond ring. The dealer had the stone only a few days after showing it in his display at an antique show when it was sold.

Acknowledgements

We are indebted to many people for specimens. From student **Roger Kaller,** Riverhead, L. I., we received a most important selection of stones for student study. Of the several hundred stones, at least 20 different classifications and species were represented.

From ex-student **Joe Datoli** we received a nice apatite cat's-eye. It is representative of the material coming on the market in abundant quantities. India is said to be the source. He also gave us an attractive gray-white quartz cat's-eye from Brazil.

We are grateful to GIA graduate **Russell Charles,** Harrisburg, Pa., for a selection of amber, the subject of a concentrated study that Mr. Charles is undertaking.

Parapatetic student **Stephen Rocklin** sent us two rare minerals, bornite and a nice specimen of yellow millerite, as well as specimens of dyed jadeite, a grossularite cabochon and a handsome pink grossularite crystal.

Our thanks to student **Irving Michaels** and **Mr. Charles Butler,** of Michaels, New Haven, Conn., for several

odd-shaped pieces of jadeite and nephrite. The stones were in papers and the hardness had apparently been noted by the eminent gem authority, George F. Kunz, since his signature and "O.K." appeared on several of the papers. Evidently, the specimens — some polished and others only ground to shape — were used as hardness points. Whether they were used as is or in some instrument is not known. *Figure 6* illustrates one of the unpolished pieces.

From student **Robert Dunnigan** we received a text and slides on early Norse jewelry that he purchased during one of his recent selling trips to Minnesota.

Student **Aldo del Noce** gave us several natural emeralds for student demonstration, two of which had excellent 3-phase inclusions.

Mr. Robert M. Flood, president, Linde Products division of Union Carbide Co., kindly donated several synthetic-emerald-overgrown beryls for student study.

While searching for specimens to photograph for the annual AGS Conclave in Atlanta we saw some truly emerald-green tourmalines, shown to us by **Mr. Jean Naftule,** North Bergen, N. J. Although small and not in great supply, they were most exciting to see. We are also indebted to Mr. Naftule for loaning us specimens of Tanzania corundums to photograph for the Conclave. Similarly, we wish to thank **Mr. Sal LaSalle** of Wm. V. Schmidt Co.; **Ralph Esmerian,** R. Esmerian, Inc.; **Alfred Engle,** Brazilian Importing Co.; and **Melvin Strump,** Superior Gem Co., for loaning stones for photography.

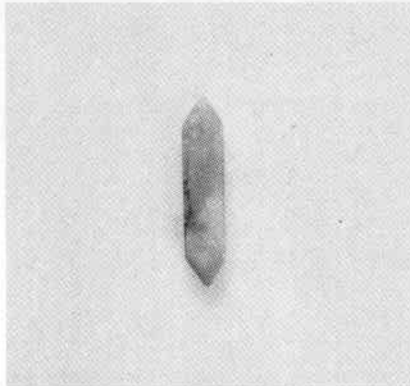
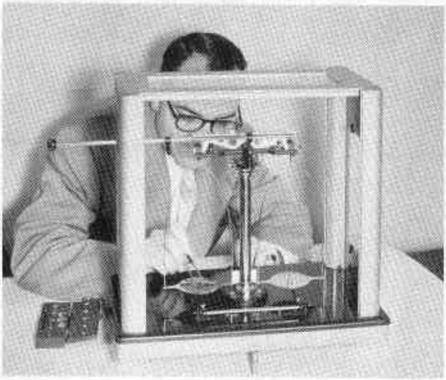


Figure 6

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

Oddly Shaped Natural Pearl

We described a very unusual natural pearl in the Winter, 1959-60, edition of *Gems & Gemology* (Volume IX, No. 12, page 357). Last month, the owner of the same pearl pictured in *Figure 2* of that issue brought in another equally unusual specimen. Our first reaction was that it must be artificial, since the nacreous end *(Figure 1)* of this oddly shaped concretion, which was rounded at one end and pointed at the other, gave the impression that it had been induced by man. However, an X-radiograph, supported by reaction to ultraviolet light, confirmed that it was indeed a whole pearl and wholly natural. It is unique in our experience and, we suspect, unique in the pearl world. This is one of those rare items on which it is impossible to place any meaningful value, since it is unique and irreplaceable. The only value that could be ascribed to it is one in relation to its beauty compared to that of other natural pearls. On this basis, since it fails to meet the beauty standards of a magnificent, natural, wholly nacreous pearl, it has to suffer somewhat by comparison. In our opinion, when there is no other criterion, the relationship of beauty to that of materials of established value is the only criterion that can be used. In the absence of a great demand by collectors, it seems that there is really no other basis on which to judge.

Flux-Fusion Synthetic Ruby

Recently, we had the opportunity to examine crystals and cut stones of a flux-fusion synthetic ruby. Two of the crystals are shown in *Figure 2,* and a close-up *(Figure 3)* of one shows the typical wisplike inclusions characterizing this product. In *Figure 4*, the flux-fusion wisps and the other kinds of solidified inclusions in the veillike form are shown. *Figure 5* shows the flux-fusion type of solid inclusions under higher magnification. Very natural-looking inclusions are illustrated in *Figure 6*. As yet, we are not at liberty to disclose the source, nature, or prospects for marketing this new synthetic material.

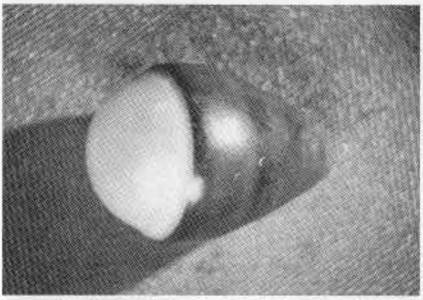


Figure 1

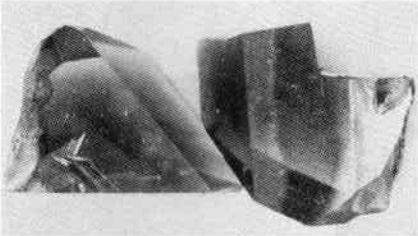


Figure 2

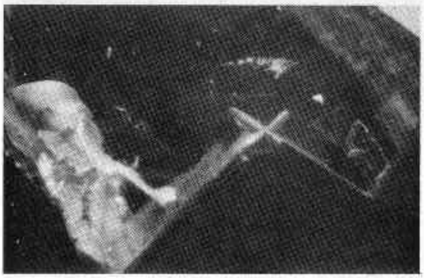


Figure 3

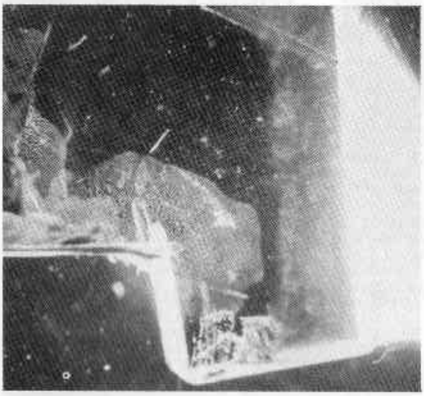


Figure 4

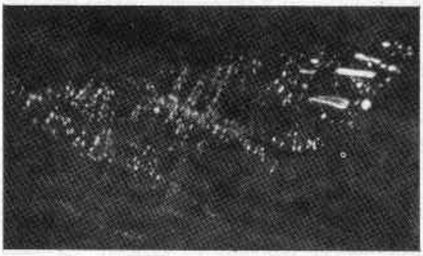


Figure 5

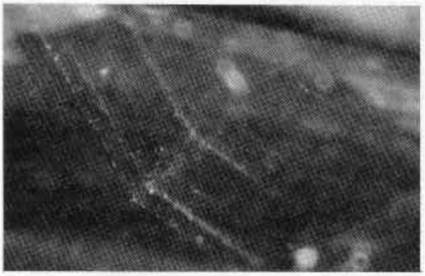


Figure 6

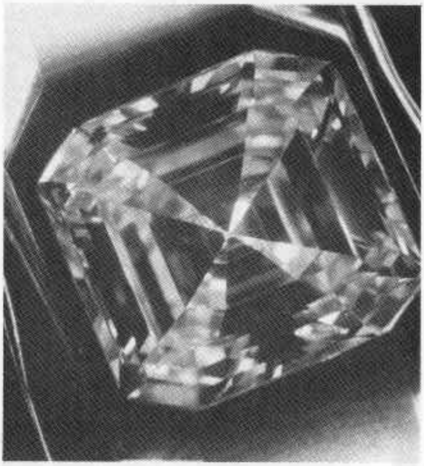


Figure 7

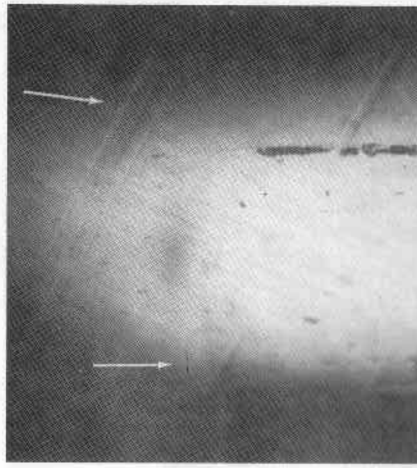


Figure 8

Is it From the Jonker Rough?

Shown in *Figure 7* is an old-fashioned emerald-cut diamond, said to be the smallest of the stones cut from the famous *Jonker* rough in the late 1930's. Since its color and other characteristics seemed to fit the only description we were able to get, it is entirely possible that this is indeed a stone cut from that famous rough.

Interesting Twinning in Star Ruby

We were asked to examine a damaged star ruby that was heavily twinned in a most interesting fashion. Across the summit of the stone were a number of ridges and grooves that we attributed to the twinning. In the portions of the twinned sections where the orientation made them harder than the host mass, the twinned sections stood up as ridges. On the other hand, the same twinned section, in the positions where its orientation made it softer than the host mass, formed grooves in other portions of its surface trace. This is pictured, unfortunately rather poorly, in *Figure 8*. Arrows indicate in the top a ridge, and at bottom (separated by an area in which the hardness of the twinned section and the host are equal), a depressed area where the twinned portion presents a softer direction to the polishing wheel.

Coated Diamond

Figure 9 shows two spots of coating on a diamond – one of the few coated diamonds that we have encountered in Los Angeles. Most of the coating problem seems to be confined to the vicinity of New York City. *Figure 10* shows the coating only very vaguely in the center of the photograph, but it covers a considerably larger area. This was taken under 200 x.

Color-Zoned Sapphire

We received a loose stone for routine testing that created immediate interest on initial examination. It was a very large, deep-blue, oval faceted stone

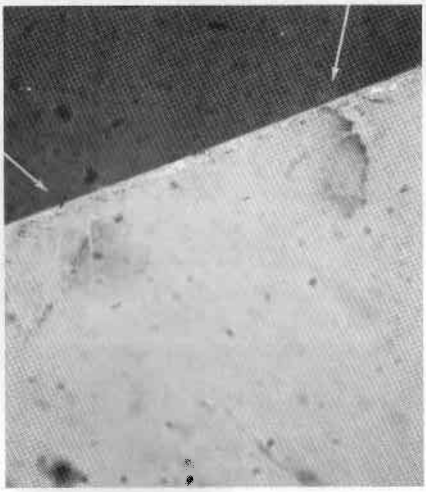


Figure 9

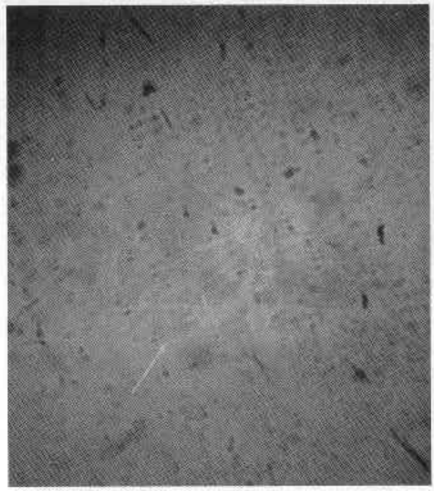


Figure 10

with an exceedingly thin crown. The deep blue of the facets on the crown had a luster that seemed almost semi-metallic, so that the immediate reaction was that it was probably a garnet-topped doublet. Examination under magnification showed that the natural-looking inclusions seemed to be confined entirely to the very thin crown, adding to the suspicion gained from eye inspection that the stone was probably a doublet. However, there was absolutely no evidence of any red cast that might be expected from a garnet-and-glass doublet, and both crown and pavilion gave R.I. and birefringence readings one would expect from corundum. Immersion in a suitable liquid showed a colorless pavilion and a very deep-blue crown. Careful examination under magnification, with the stone immersed, satisfied us that it was a very strongly color-zoned sapphire. A report to this effect was issued, but surprisingly, a week or so later, a letter was received saying that the stone was the subject of a law suit, and that a qualified jeweler was satisfied that the stone was a doublet. He informed us that the stone was being returned to us for further examination. In order to prove the point to the jeweler, who clearly questioned our report, we took a series of photographs to identify the stone to his satisfaction. *Figure 11* shows that the crown is indeed very dark in relation to the pavilion section; this is undoubtedly what led other testers to feel that it was probably a doublet. However, increasing the magnification materially, one can see in *Figure 12* that there is actually a zone of parallel layers below the dark area, showing that there is not an abrupt line of demarkation, as would be the case in a doublet. *Figure 13* shows, in fact, that one of

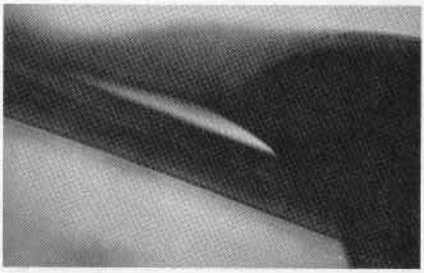


Figure 11

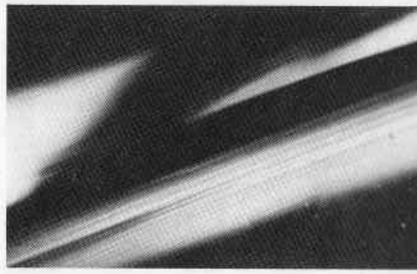


Figure 12

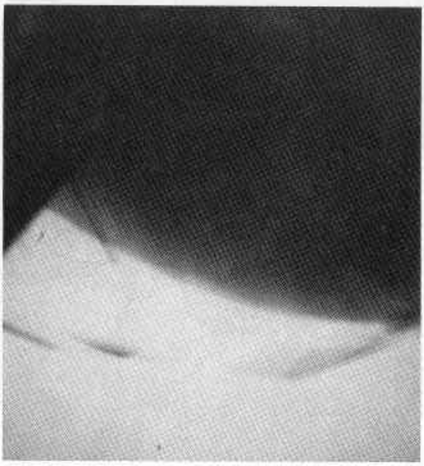


Figure 13

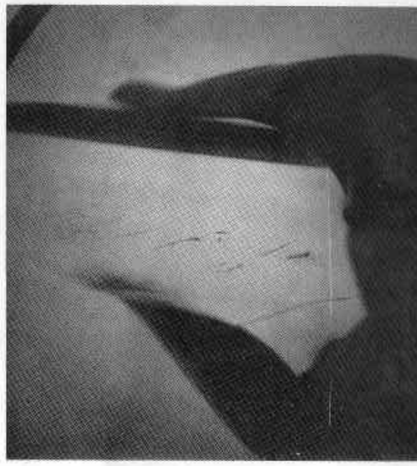


Figure 14

the dark areas, actually extends into the lighter area. In *Figure 14* there is color zoning in the white area far below the major color concentration.

Deep-Red Topaz

One of the fascinating things about the colored-stone field is the occasional stone that defies description and that is unlike anything ever encountered in one's experience. In the course of the preparation for a forthcoming talk, Glenn Nord asked for many stones from importers throughout the country. One of the gemstones that he was describing was topaz. In the course of his investigations he sought out the finest in all colors of this lovely gemstone. The highest price we had encountered for topaz was only on the order of $100 per carat, but he received one listed at $300. The amazing thing was that the price couldn't be faulted, for it was applied to a deep-red stone, without visible flaws, showing the most intense and appealing color it has ever been our pleasure to appreciate. The stone could only be described as breathtaking.

We Appreciate

The strands of garnet, chalcedony, rock crystal and ruby beads received from **Mrs. Elizabeth Gips Wallace** of San Francisco. They will be used to advantage in our colored-stone course.

Our gratitude to **John Holtzclaw**, Alva, Oklahoma, for the gift of a natural ruby and a sapphire.

Our thanks to **Percy K. Loud** for the very generous gift of gemstones. They will be of great value to us in test sets and for display purposes.

We wish to thank the following individuals and firms for the loan of quality grades of topaz, aquamarine, garnet and tourmaline for photography purposes: **Arthur Azevedo**, San Francisco; **Steve Stein**, Los Angeles; **George Houston**, Los Angeles; **Superior Gem Co.**, N.Y.; **Ralph Esmerian**, R. Esmerian, Inc., N.Y.; and **Krementz & Co.**, Newark, N.J.

Book Review

GEM TESTING by B. W. Anderson, BSc, FGA. Published by Temple Press Books, Ltd., London. 377 pages. Numerous black-and-white illustrations. Price: $9.95.

This is a belated review of the 7th edition of one of the classics of our gemological literature, B. W. Anderson's *Gemtesting,* which appeared in its 7th edition a year ago. The 7th edition represents changes inspired by six years of developments in the gem field, plus a number of very interesting, provocative and valuable additions by an outstandingly creative gemologist. Most of the changes in this valuable new edition represent up-dating based on such items as the new synthetic emeralds that have come on the market since 1958, plus some excellent new illustrations, rewriting of some chapters, and the addition of a very interesting section on the use of magnetism in gem testing.

The number of illustrations in the book have been increased almost a third, and the quality of the reproductions has been improved considerably. Basil Anderson has added some very interesting ideas in his section on magnetism, contained in the chapter on the garnet family. He has worked out an empirical formula, stated as the magnetic loss in weight $\times$ 100 divided by $\sqrt{}$ weight as representing the magnetism of a given stone. Under this rating he has divided those stones that are subject to magnetism into three categories: strongly, moderately, and weakly magnetic. In a number of situations, this provides a very valuable means of separation between what are in some cases rather difficultly separated gemstones. For example, orange metamict zircon from spessartite, sinhalite from brown peridot, black diamond from imitations, and, of course, hematite from its imitations, plus red spinel from pyrope. Anderson used a method based on determining the degree to which the weight of a gemstone on a balance was offset by the pull of magnetism. This is a very interesting test, and one worthy of the imaginative approach of B. W. Anderson.

We recommend highly the 7th edition of *Gemtesting* to all gemologists engaged in any phase of gemtesting or gem appraising. This is an outstanding new edition of one of the finest gemological texts.

A Memorial Tribute to Fred J. Cannon

His family, his army of friends and admirers, the students, governors and staff of the Gemological Institute of America, and the jewelry industry, as a whole, suffered a grievous loss with the death of Fred J. Cannon, GIA Secretary-Treasurer. Since long before his first election as Secretary-Treasurer in 1949, and later his election in 1953 as GIA Governor, Fred Cannon's services to the Gemological Institute had been many and important. They will be remembered and appreciated as long as GIA exists.

He is survived by his wife, Ruth; two sons, James and William; his brother, Roger; and five grandchildren. Fred passed away unexpectedly late Saturday, May 7th. He was thought to be well on the road to recovery from a blood clot in his leg, which had occurred shortly after his return from the annual GIA Governors meeting in Atlanta.

After serving in the armed forces during World War I, Fred J. Cannon came to the West Coast. He and his brother Roger were associated in business for many years with Herbert Slaudt in the firm, Koke-Slaudt & Company. Later, they formed the Slaudt-Cannon Agency Company. Not many years ago, he and his long-time associate, Kelly Schaefer, formed a new company, Cannon-Schaefer Agency. Their company represented the eleven western states for such firms as Church & Company, Jabel Ring Manufacturing Company, Juergens & Andersen, Meyer Koulish Company, Lester & Company and Wefferling-Berry & Company. Cannon-Schaefer sold to retailers over most of the area west of the Mississippi. Fred was well known to many jewelers and beloved by the host of retailers who knew him well. He continued to maintain a heavy schedule of traveling right up until his fatal illness.

In addition to his service to the Institute as an advisor to Robert M. Shipley in the early days, for many years Fred Cannon had served on the Institute's Executive and Finance Committees, as well as providing unfailingly wise counsel in his capacity as Secretary-Treasurer and as a GIA Governor. Over these many years, he likewise served in key advisory positions with the American Gem Society.

Fred Cannon was one of that rare breed among suppliers in any field who are regarded not as salesmen, but as advisors. Retailers all over the West turned to him for ideas, asking him what merchandise he felt they should have, and consulting him whenever a major or even a minor change was under consideration. This man was truly one of the pillars of the jewelry industry. Respected, loved or admired by all who knew him, Fred J. Cannon will live on in our hearts.

(continued from page 19)

In 1960, Australia exported opals worth $2,250,000. Three years later the figure had risen to $6,000,000. Last year it was $6,750,000. The production rate has been increasing at the rate of $450,000 a year for the past four years.

Nettleton's faith in the mysterious black stone is now more than justified. Also the faith of Wollaston, who tried so hard before succeeding in convincing the world that here was something unique.

As the poet Robert Burns once wrote:

"Ask God why He made the gem so small
And so huge the granite.
Because God meant that man
Should place a higher value on it."