Much has been written in many languages on gems and precious stones. One of the most exhaustive treatments of a single mineral species in any language is Joseph E. Pogue’s memoir, *The turquoise: A study of its history, mineralogy, geology, ethnology, archaeology, mythology, folklore, and technology*, published in 1915 by the National Academy of Sciences.

This great work of 162 quarto pages, accompanied by 23 plates, has been out of print for several years. Fortunately, in 1972, the Rio Grande Press published a handsome reprint of the entire memoir with an introduction by Rex Arrowsmith, a list of turquoise mines in the United States, a new list of references, and 16 new color plates.


Mineralogists have long used the spelling *turquois*, but most dictionaries give it as *turquoise*. The name may have been given, not because the mineral came from Turkey, but because it was introduced into Europe from Persia by way of Turkey. In 1652, an English writer referred to it as *Turky stone*. In modern French, it is *turquoise*; in old French, it is *tourques*; in Spanish, it is *turquesa*, in German, it is *türkis* Pogue (1915, p. 129) gives names applied in many other languages.

In his memoir, Pogue (1915, p. 105-109) devoted an entire chapter to the problem of *chalchihuitl*. In early Spanish accounts there are numerous references to a green stone prized by the Aztecs of Mexico, which they called chalchihuitl. Later workers speculated as to just what mineral this might be. It seems likely that in Mexico it may well have been jade or jadeite, obtained from Guatemala, but in New Mexico much of it was green turquoise. The term had also been applied to a number of other minerals, such as blue and green smithsonite (or “calamine” of older writers), green jasper, and even emerald. Incidentally, by 1959 I found at least 16 different spellings of this word, chalchihuitl. In 1899 Blake gave the phonetic spelling as “char-chee-wee-tee” or as “chal-chi-hui-tee.” Hidden (1893) pronounced it “char-chi-a-tey,” which calls to mind the Aztec “chal-chi-hui-tl,” of many authors.

Turquoise is a hydrated basic phosphate of copper and aluminium, along with some iron, calcium, and silica. The mineral is generally massive and crystals are exceedingly rare. It occurs as thin seams or veins and often as nodules and grains. The fracture is
slightly conchoidal (shell-like) to uneven and experience has shown that turquoise is rather brittle, resembling ivory in consistency.

Hardness ranges from 5 to 6, about the same as feldspar. Thus turquoise is readily scratched by quartz, and in comparison with many gems and other precious stones it is relatively soft. The luster is somewhat waxy, although cut and polished material often has a slightly vitreous cast. In the mass turquoise is opaque, but very thin slices may be semitranslucent.

Desirable colors are blue and green. Such terms as sky-blue, bluish green, apple-green, greenish blue, robin’s-egg blue, and others are often applied. The mineral is porous and easily absorbs oil from the skin, becoming greasy and dirty. On outcrops and mine dumps, exposure to the air and water result in fading. Thus, little turquoise is visible on most of the old dumps; one has to do some digging! In describing the workings at Orogrande, New Mexico, Hidden (1893, p. 402) remarked:

At depths below twenty-five feet the turquoise when first found is of a magnificent, almost ethereal, tint of blue, but this rapidly fades after it is detached from its matrix and becomes dry. I have seen it as deep blue as indigo and then fade gradually to a ‘robin’s-egg’ shade.

It is rather remarkable that practically all of the important deposits of turquoise are located in arid or desert regions, and generally at shallow depths, rarely exceeding 100 feet. Small quantities have been found at greater depths, however. For example, some was found in a mine at Somerville, New Jersey, 1100 feet down an inclined shaft. At Bisbee, Arizona, it occurs on the 1200-foot level of a mine.

Turquoise is never a primary mineral; it is, rather, a secondary mineral, apparently formed by surface waters percolating through altered rocks containing apatite (source of the phosphate) and copper minerals. The origin of turquoise has been discussed by many writers; see Pogue (1915), Gustafson (1965), and Sigleo (1970). Sometimes the host rock is igneous, such as granite, monzonite, or monzonite porphyry, but sometimes the host rock is sedimentary, such as sandstone or shale, or even metamorphic, such as gneiss.

The blue color of some turquoise is probably due to the presence of copper; the green is probably due to iron. Fading of some stones may be the result of drying out.

The term turquoise matrix is applied to specimens containing foreign material of various colors—yellow, red, gray, black, even white—representing other minerals and rocks. Sometimes this foreign material enhances the value of the stone.

According to S. H. Ball (1935, p. 1193-1194),

Through the ages the precious stone industry has seen notable changes both as to the principal gem mined and the country of its source. From about 25000 to 3400 B.C. the Baltic amber mines dominated the industry. For the next 1425 years the turquoise mines of the Sinai Peninsula were the most important gem mines in the world. From about 1925 to 800 B.C., the emerald mines of the Egyptian Red Sea coast were unrivalled.
Thereafter, until 1725 A.D., India and Ceylon, with their diamond, ruby, and sapphire mines, were the world’s leading gem producers. They lost this position to the Brazilian diamond mines, which in turn were supplanted in 1870 by the South African diamond mines.

A tabular view of these changes is given below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gemstone</th>
</tr>
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<tbody>
<tr>
<td>Present</td>
<td>Diamond of South Africa</td>
</tr>
<tr>
<td>1870</td>
<td>Diamond of Brazil</td>
</tr>
<tr>
<td>1725</td>
<td>Diamond, ruby, sapphire</td>
</tr>
<tr>
<td>800</td>
<td>of India and Ceylon</td>
</tr>
<tr>
<td>1925</td>
<td>Emerald of Egyptian Red Sea coast</td>
</tr>
<tr>
<td>3400</td>
<td>Turquoise of Sinai Peninsula</td>
</tr>
<tr>
<td>25000</td>
<td>Amber of Baltic coast</td>
</tr>
</tbody>
</table>

In an earlier paper entitled “Pharaohs mined turquoise in 3200 B.C.,” Ball (1927) had noted that the Egyptians mined turquoise in the Sinai, starting more than 5,100 years ago. Thus the Sinai
mines are the oldest turquoise mines in the world. Large expeditions dispatched from Egypt were highly organized and sometimes numbered 2,000 to 3,000 men, including high officials, a few engineers and prospectors, and many laborers. Strong military escorts, with as many as 734 soldiers, accompanied these expeditions. The tools used were largely of stone; copper tools, such as wedges, were not introduced until the 12th dynasty (2000 to 1788 B.C.). The expeditions continued until about 1100 B.C.

Probably the most important deposits in the world are those at Nishapur, Persia (Iran), the birthplace of Omar Khayyam, best known of the Persian poets. How early these deposits were mined is questionable, possibly as early as 2100 B.C., but certainly by A.D. 1000. For the next 800 years, Persia produced the bulk of the world's turquoise. Early mining was done exclusively by stone tools, later by picks and crowbars. Gunpowder was introduced about 1850.

Apparently some turquoise was produced in Russian Turkestan as early as the 10th century. Bokhara, Afghanistan, Arabia, Tibet, and China have also produced. In Europe, turquoise occurs in Germany, France, and Spain. Several States in Australia have deposits. In South America, deposits are known in Peru and Chile. Small quantities occur in the States of Zacatecas and Sonora, Mexico.
About 35 years ago, the author of a standard text in economic geology wrote: "It is interesting to note that turquoise was hardly known in the United States in 1890, but some comes from the southwestern states." The reader can judge for himself just how wrong this distinguished geologist was.

What seems to be the oldest well-documented record of turquoise in this country is two ornaments found by Dr. Emil W. Haury at Snaketown ruin in southeastern Arizona. It seems certain that these were made before A.D. 300 (Sigleo, 1970, p. 7).

The next oldest find is Roberts' (1929) discovery of turquoise pendants at Shabik’ esheche Village, in Chaco Canyon, New Mexico (7 miles upstream from Pueblo Bonito). This late Basket Maker site was built around 734-757 or 12 centuries ago (tree-ring dates from Bannister, 1965, p. 191-192).

A tremendous wealth of turquoise has been recovered by archaeologists at Pueblo Bonito, occupied during the period (See Bannister [1965, p. 179-183] for tree-ring dates). A.D. 900-1130 or 8 to 10 centuries ago The Hyde Expedition recovered more than 50,000 pieces of turquoise in 1897-99.

Pepper (1905) described and illustrated in color several inlaid items, including a jet frog with turquoise eyes, a buckle or breast ornament of jet inlaid with turquoise, a bone scraper inlaid with turquoise and jet, a number of carved birds, pendants, and beads, and more than 700 turquoise pendants.

One skeleton, for example, had associated with it a total of 5,891 beads and several pendants of turquoise, the largest pendant being 45 mm long. A still more gorgeously arrayed skeleton had 8,385 beads and more than 500 pendants; these had originally been worn as wristlets, anklets, and ornaments over the breast and abdomen; on the left wrist alone were found 2,388 beads and 194 small pendants. Near these skeletons was a remarkable cylindrical basket 6 in. high and 3 in. in diameter, onto which had been cemented a mosaic of 1,214 pieces of turquoise. Inside the basket were found 2,150 beads, 152 small pendants, and 22 large pendants, the largest of which measured 36 by 27 by 3 mm. Pepper concluded that Cerrillos was the chief source of this turquoise, that the burials represented persons of considerable rank, and that at this time the Chaco people were at the height of their esthetic arts. Judd (1925) also found at Pueblo Bonito a string of 2,500 turquoise beads which he described and illustrated in color (Northrop, 1959, p. 529-530).

There seems to be no doubt that turquoise was an important item of trade in prehistoric time. For example, Ball (1941, p. 17, 25) states that

New Mexican turquoise reached Mexico City and the Mayan cities,
and that the early trade in Southwestern turquoise extended from the West Indies and Yucatan on the south to Ontario on the north . . . . . and from California on the west to Mississippi and Arkansas on the east.

He further noted that a mosaic plaque set with 3,000 pieces of turquoise was found by Earl Morris at Chichen Itza, Yucatan, and concluded that this turquoise had come from New Mexico. Pogue
(1915, p. 104) remarked:

No occurrence at all adequate as an important source has been discovered south of the present Mexican boundary. It therefore seems probable that the Aztecs and allied peoples, through trade with tribes to the north, obtained supplies of turquoise from the Cerrillos hills and perhaps other localities of the Southwest.

A number of writers have stated that the mining of turquoise antedates any other kind of mining in the United States. It seems likely that quarrying of chert may have preceded the mining of turquoise by several thousand years. Early man needed tools such as scrapers and projectile points before his thoughts turned to jewelry and ornaments.

Jones (1909, p. 1) observed "that no turquoise deposits of any note have ever been found in the west that did not show the evidence of prehistoric mining." Early man must have been a diligent prospector!

Prehistoric workings of turquoise deposits have been found in many districts of Arizona, California, Colorado, Nevada, and New Mexico. In Arizona the most extensive prehistoric workings are those in the Mineral Park area of the Wallapai district, Mohave County; others are known at Turquoise Mountain, Cochise County, and on the east side of Canyon Creek just above its confluence with the Salt River. In California there are extensive prehistoric workings in the Turquoise Mountains, San Bernardino County. Aboriginal mining was carried on in Colorado at the King mine, Conejos County, and also near Leadville in the St. Kevin district, Lake County. In Nevada prehistoric workings were found in Clark County and in Nye County.

More and lengthier papers have been written on the prehistoric workings of New Mexico than on those of any other State. Early workings have been found in four districts of three counties: the Burro Mountains and Eureka (or Hachita) districts, Grant County; the Orogrande (or Jarilla) district, Otero County; and the Cerrillos district, Santa Fe County.

Mount Chalchihuitl, in the Cerrillos district of Santa Fe County, has long been regarded as the site of the most extensive prehistoric mining operations known in America. Blake (1858) "was struck with astonishment at the extent of the excavations... it appears to be 200 feet in depth and 300 or more in width... at the bottom pine trees over a hundred years old are now growing. This great excavation is made in the solid rock, and tens of thousands of tons of rock have been broken out."

An early paper by Benjamin Silliman, Jr. (1881), entitled "Turquoise of New Mexico," gives a sketch of Mt. Chalchihuitl and a cross section showing shafts and tunnels. In the old workings fragments of ancient pottery, with a few entire vessels, had been found.

Associated with these were numerous stone hammers, some to be held in the hand and others swung as sledges, fashioned with wedge-shaped edges and a groove for a handle. A hammer weighing over twenty pounds was found while I was at the Cerrillos, to which the wyth was still attached, with its oak handle—the same scrub oak which is found growing abundantly on the hillsides—now quite well preserved after at least two cen-
turies of entombment in this perfectly dry rock.
Silliman was
deeply impressed with the enormous amount of labor which in
ancient times has been expended here. The waste or debris ex-
cavated in the former workings covers an area which the local
surveyor assured me extends by his measurement over at least
20 acres. On the slopes and sides of the great piles of rubbish
are growing large cedars and pines, the age of which . . . must be
reckoned by centuries.
However, Sterrett (1912, p. 1067) thought the earlier accounts
had been exaggerated; he made measurements of the main pit and
found it to be
Turquoise Mt. Mining District in
Cerrillos, from an 1883 photo-
tograph by William H. Brown.
about 130 feet deep on the upper side and about 35 feet deep on the lower side, the rim about 200 feet across, and the bottom nearly 100 feet across. The large dumps of waste rock removed from this are about 150 yards long by 75 yards wide and 1 to 30 feet deep. These dimensions . . . would give the dump an area of less than 2½ acres . . .

Douglas Johnson (1903, p. 88) declared that
the extent of the workings in Mt. Chalchihuitl is truly marvelous. It seems almost incredible that such a mass of rock could have been removed by a primitive people, without the aid of modern mining appliances.

Gustafson (1965, p. 17) suggests that
The large open pit on the west side of Mount Chalchihuitl was probably developed first, because substantial amounts of rock could be quarried by digging away the hillside.

The age of these earliest workings has not been closely determined, so far as I know, beyond the fact that they are certainly several centuries old. We used to think that surface quarrying started around A.D. 1000, but no pottery this old has been found here, according to Sigleo (1970).

It is interesting to note that as late as 1888, rather primitive techniques were still being used, for Kunz (1890, p. 582) wrote

Considerable mining of a desultory character has been carried on at the turquoise mines near Cerrillos, New Mexico, by the Indians and hunters, who obtained the turquoise in a primitive manner by building fires against the wall rock and then cracking off large masses by throwing water on it. This method, however, invariably destroys the color.

In Arizona, prehistoric workings at Turquoise Mountain, Mohave County, were described by Blake (1899); excavations were in the form of trenches, cuts, and pits as well as tunnels and drifts. Blake noted an abundance of stone implements; a photograph illustrates numerous stone hammers and mauls, from 4 to 5 inches to 9 to 10 inches in length, weighing 4 to more than 15 pounds each.

In Clarke County, Nevada, according to Morrissey (1968, p. 3-4), there is interesting evidence of a lapidary shop. George Simmons found fragments of turquoise float at Crescent Peak in 1889 or 1890.

Following a trail up the side of Crescent Peak, he came to the source which proved to be the abandoned remains of a mine worked by the aborigines. Larger fragments of turquoise lay scattered about, together with abandoned stone chisels, wedges, and hammers.

Below the mine workings Simmons found a leveled terrace on which there had apparently been workshops and quarters for the miners. Remains were found of rude dugouts with collapsed roofs of logs and brush. At one end of the site was a kitchen midden of broken pottery; at the other end was evidence of a lapidary shop with rubbing and polishing stones and a huge quantity of tiny turquoise fragments. From a study of the growth rings in the logs found in the fallen roofs, and a study of the implements, archaeologists estimated the mine must have been worked and abandoned 200 years before Columbus
reached America...
The presence of the lapidary shop argued for an intelligence [sic] which realized the economy of transporting finished, or partly finished, turquoise from the site, rather than the rough ore with its waste rock. It is thought to indicate the miners may have been Aztecs or Toltecs.

In Colorado stone hammers and deerhorns have been found in prehistoric workings. And, significantly, a group of mines in San Bernardino County, California, was named the Stone Hammer mines, obviously from the prehistoric tools found in the vicinity.

It is interesting that so many of the early writers referred to the early New Mexico, Arizona, and Nevada Indians as Aztecs. For example, Farrington (1903, p. 171) states that "fragments of Aztec pottery, vases, cooking utensils, stone hammers, etc., are found at the mines..." And, as late as 1911, Sterrett wrote that "a large number of the turquoise deposits so far found in the Southwest were worked by the ancient Aztecs, and a few by the Aztecs under Spanish rule." I do not believe that Aztecs or Toltecs ventured this far north to engage in mining operations.

Spectrographic analysis of trace elements may help in determining the source of prehistoric turquoise. A recent unpublished master's thesis by Anne M. C. Sigleo (1970) is worth citing in this connection. She made analyses of turquoise samples from 8 New Mexico archeological sites (4 Chaco Canyon, 2 Prewitt, and 2 Zia Pueblo) and from 25 mines (7 New Mexico, 7 Arizona, 7 Nevada, and 4 Colorado).

The trace-element content (Sigleo, 1970, p. 71-73) suggests that some of the Chaco Canyon material came from certain mines in Arizona and Colorado. An artifact from Prewitt may have come from Arizona. One specimen found in a ruin at Zia Pueblo may have come from Cerrillos and one may have come from Nevada.

She concludes (p. 75) that "there is no apparent evidence for extensive mining activity in the Cerrillos area prior to the Pueblo IV Period (approximately 1300 to 1700 A.D.).""

As I wrote in 1959, judging from the chronicles and narratives of the early Spanish explorers,

it would appear that the Indians of New Mexico, Arizona, and northern Mexico had an abundance of turquoise in the form of beads, pendants, and various inlaid ornaments. The mineral also was employed in the decoration of houses, both on interior walls and on exteriors, such as doorways. Furthermore, the mineral served as an item of trade.

Blake (1899, p. 281) described the journey of Fray Marcos de Niza northward through Mexico and Arizona to Cibola (Zuni, New Mexico) in 1539. Esteban (or Estevan), the Negro or Moor, who went with the party, gave the good friars great trouble and anxiety by his greed in collecting turquoises and objects of value from the natives. Estevan appears to have been always ready to press on in advance, an explanation of which may probably be found in his desire to get the first pick of the gems. He was loaded with them on his arrival at the outposts of Cibola, where he was killed and his turquoises confiscated.

Castaneda stated that when "Esteban reached Cibola, he arrived
there laden with a large number of turquoises and with some pretty women, which the natives had given him” (translation by Hammond and Rey, 1940, p. 198).

The first modern discovery of turquoise in the United States was by W. P. Blake in 1858 at Cerrillos. Blake (1899, p. 283) states:

Before my visit to New Mexico in 1858, and the finding at Santa Fé of green turquoise in use for necklaces by some of the Pueblo Indians, the occurrence of turquoise in America had not been announced or known.

Dates of modern discoveries or rediscoveries in various States are as follows:

- 1858. New Mexico
- 1870-75. Nevada
- 1878. Colorado
- 1883. Arizona
- 1884. Texas
- 1897. California
- 1902. Alabama
- 1904. New Jersey
- 1911. Virginia

Both Wisconsin and Wyoming have been credited with a little production in 1963. Turquoise was found in Zacatecas, Mexico, about 1903.

Dealers and Indian traders who buy and sell both raw (rough) and cut turquoise and finished jewelry as well are often asked to identify specimens and tell customers just which mine they came from. Some dealers and traders can tell the source of better quality material, particularly if a distinctive matrix is present, but Rex Arrowsmith (1972) notes that the lower grades of material “all tend to look more alike.”

Actually, turquoise turns out to be a rather widespread mineral in the Southwest. Even I was surprised recently to learn how many mines and prospects in various mining districts have yielded some production. For example, turquoise occurs in at least six counties in Arizona, in five counties in California, in five in Colorado, in eight in Nevada, and in six in New Mexico.

A valuable feature of the 1972 Rio Grande Press edition of Pogue’s 1915 memoir is the alphabetical list prepared by Arrowsmith of currently operating but some abandoned mines and prospects. This list of 22 unnumbered pages gives names and synonyms of mines, prospects, claims, areas, and districts. Names of many mines have been changed through the years, and these synonyms are extensively cross-referenced.

There are 106 names of Nevada mines and 51 names of prospects, claims, and areas (many synonyms). A total of 20 names have been used for New Mexico mines, plus 28 names of claims, etc. Arizona ranks next with 9 mines and 17 areas, followed by Colorado with 6 mines and 14 claims and areas. Occurrences of turquoise are known also in Alabama, California, New Jersey, Texas, Virginia, Wisconsin, and Wyoming.
From top to bottom: intersecting veinlets of turquoise in matrix - New Azure Mine, Burro Mts., New Mexico; veinlet of turquoise in matrix - Cameo Claim, Little Hachita Mts., New Mexico; turquoise matrix - Los Cerrillos, New Mexico (all from Pogue, 1915).
In his narrative of the expedition led by Captain-General Francisco Vázquez de Coronado in 1540, Castañeda notes that the Indians at Cicuye (Pecos) presented Captain Alvarado and his soldiers with quantities of turquoises, "which are found in abundance in that region" (Hammond and Rey, 1940).

Fray Gerónimo de Zárate Salmerón was probably the first Spaniard to actually visit the Cerrillos mines in 1629. The next year Fray Alonso de Benavides observed that the Indians had necklaces and earrings of turquoises.

Jones (1904, p. 273) wrote that it is said that some twenty Indians were killed, about 1680, by the caving of a large portion of the works [at Mount Chalchihuitl]; this was claimed to be one of the chief causes which led to the general uprising of the Pueblos, that shortly afterward drove the Spaniard from the country.

Other accounts stated that the whole top of the mountain caved in, burying about 80 Indian miners. The Pueblo Revolt of 1680 is well established, historically. Some writers have claimed that the revolt was caused in part by the enslavement of the Indians in mining, but most historians deny it. "There is no evidence that mining was successfully carried on, even on a minor scale" during the 17th century, according to Scholes (1935, p. 79).

In 1967, Fray Augustín de Vetancurt, in his Crónica, mentions a bald and rocky mountain near San Marcos (Cerrillos) where the Indians extracted turquoise.

In the Cerrillos mining district, turquoise occurs in two chief areas: on Mount Chalchihuitl, 2.4 miles N.N.E. of Cerrillos, and on Turquoise Hill, 5.5 miles N.N.E. of Cerrillos. The workings on Turquoise Hill (long known as Turquesa) were at first called the Castilian (or Castillian) mine and later designated as the Tiffany mine. Contrary to popular belief, the mine was never owned by the New York Tiffany firm, but it may have purchased some of the turquoise from time to time.

In 1892, Kunz reported that for the first time in the history of America, turquois of fine color, in many respects equal to the Persian, was mined at the Castilian mine between Los Cerrillos and Santa Fe, New Mexico, of which over $10,000 worth was sold in 1890. These stones are well received by the gem trade, as the Persian mines have proved less and less prolific for many years past.

The following year Kunz (1893a) wrote that during the early part of 1890 the Castilian mine had been leased and a number of men put to work; a shaft had been sunk 75 feet and thousands of stones obtained in two years. "Many of them are of fine blue color, quite equal to the best Persian, and material has been obtained choice enough to insure a sale amounting to fully $200,000. A single stone has been sold for about $4,000.

Considerable secrecy has been maintained as to the output of the productive portion of these deposits. However, with the possible exception of the mines in the Burro Mountains, the Cerrillos district has modernly been the most productive in this country. As the first important domestic occurrence to be de-
veloped, it was largely instrumental in replacing the Persian turquoise on the American market. The ‘Tiffany mine’ is reputed to have produced a higher proportion of high-grade gem material than any other deposit in the United States; its choicest stones have been equalled in this country only by those from the Burro Mountains and some localities in Nevada. (Pogue, 1915, p. 54-55).

In his report for 1911, Sterrett (1912, p. 1070) noted that litigation due to claims dating back to a Spanish land grant of 1728 had tied up the development of the Tiffany mine, where two of the larger tunnels, 450 and 225 feet long, had been driven during the last year or two. The best material from the Tiffany mine had a fine dark sky-blue color with an even texture, but there was some pale blue and some greenish blue.

The next most productive district in New Mexico is the Burro Mountains of southwestern New Mexico, where “Turquoise John” E. Coleman rediscovered prehistoric workings near Tyrone in 1875. (Apparently Robert and John Metcalf had found these old pits in 1871 but because of danger of Indians did no further work.) Coleman’s claims were acquired in 1882 by M. W. Porterfield and T. S. Parker, who organized the rather quaintly named Occidental and Oriental Turquoise Mining Company. Other properties were acquired by the Azure Mining Company in 1891; controlling interest was held by several New York jewelry firms, chiefly L. and M. Kahn and Company and M. Rothschild. It was in 1893 that F. Vogel, superintendent of the Azure Mining Company opened the famous Elizabeth pocket, one of the most productive in the country, containing turquoise which was equal to the finest Persian material. The best stones were said to be deep blue and slightly translucent. In 1909 the total value of production at the Azure mine was said to have been between $2 million $4 million.

Good descriptions of the Burro Mountains deposits are given by Zalinski (1907) and Gillerman (1964). The other two New Mexico districts—Eureka (Hachita) and Orogrande (Jarilla)—produced some turquoise, also.

The interested reader will find a wealth of curious information on the mythology, folklore, and superstitions connected with turquoise in Pogue (1915, p. 110-128). It may be noted that in a footnote he rather unkindly defines mythology “as the superstitions of the ancients,” and “folklore as the superstitions of the ignorant of today.”

The ancients in many lands held turquoise in high regard. It has long been highly valued by Egyptians, Arabians, and Persians; it was reputed to insure success and preserve the wearer from accidents. Presumably many believed that it cured various diseases, including hernia, flatulence, dyspepsia, epilepsy, cancerous sores, poisoning, scorpion sting, snake bite, and even insanity. Some thought it restored vision, cured cataract, and protected one from drowning and lightning. And it protects one from the “evil eye” in Iran and Turkey.

The fact that some stones from certain mines were subject to fading probably led to some of the early superstitions and the in-
Pipe bowl of brass studded with turquoises from Persia (Pogue, 1915).

vesting of the mineral with supernatural power. As I noted in 1959 (p. 534),

For centuries, apparently, there was rather general belief that the color of the stone depended on the health of its owner. It was further believed by some that turquois lost its color if worn by lewd or immodest persons and that the fidelity of a lover could be tested by this means.

The fact that the color could be deepened or improved artificially was discovered at an early date. In the 13th century a Persian writer observed that the color could be altered by the application of butter or mutton fat. It is said that the natives near the great mines of Nishapur, in Persia, often carry stones in their mouths before offering them for sale. Blake (1883, p. 199) noted that the Indians of the Southwest soaked their turquoise in tallow or grease. Inferior stones may be stained with Prussian blue . . . . , and a patent was once granted on a process which involved immersion in baths of various chemicals to give a permanent blue color.

In a paper entitled “Artificially stained turquoise from New Mexico,” Kunz (1886) recounts that he had become suspicious upon receiving “small lots of exceptionally fine blue color for American turquoise.” He scraped the back of several stones of the same depth and found that they had been artificially stained with Prussian blue, which dissolves in ammonia. The simplest test was to wash the stone in alcohol to remove any grease, and lay it in ammonia. The blue color either partially or wholly disappeared, and the stone resumed its natural greenish blue.

A stone worth 100 to 200 dollars, if found to be stained would depreciate to only one-hundredth part of its original
value. This deception is to be regretted since it will cast suspicion on any fine turquoise that may be found in this country in the future.

IMITATIONS, CUTTING, AND PRECAUTIONS

According to Spencer (1946, p. 218), "Imitations of turquoise are easily made and have been rampant ever since the time of the ancient Egyptians. Thomas Nicols (1652) writes: 'The Venetians have a very pretty way by which they will neatly imitate this gemm, and that is with Venice glasse, prepared with a convenient skie-coloured tincture.'"

The three chief categories of imitations are (1) glass or enamel, with a decidedly glassy or vitreous luster; (2) synthetic compounds, often with identical chemical composition, which are difficult to distinguish, especially if the matrix is faked; and (3) substitutes. These include other minerals such as vivianite or odontolite (bone turquoise), variscite, lazulite, lapis lazuli, chrysocolla, greenish chalcedony and jasper, malachite, azurite, and still others.

Being an opaque mineral, turquoise is never facetted as are such minerals as the diamond, ruby, sapphire, emerald, and many other transparent stones. It is characteristically cut in the form of a cabochon, with a flat base and a convex top. Various shapes are employed and the top may range from convex to flat. It is also used as beads, either as irregular nuggets and nodules (often tumbled) or cut as disks. An interesting fact is that the setting of stones in silver is of relatively recent origin in this country. It is reliably reported that the craft of Navajo silversmithing was not initiated until around 1860 and that the setting of turquoise in silver did not start until around 1882. Furthermore the combination of coral and turquoise was not introduced until 1938 and did not become common until 1951. David L. Neumann noted that the Zuni Indians have always been lapidaries, not silversmiths.

Their lapidary skill is not a modern art, like the silversmithing of the Navajos. Their stone-cutting experience is pre-Spanish, that is to say, prehistoric. They were workers in turquoise, jet, and shell centuries before the first Navajo effort with metal. The Zunis set turquoise as inserts, or mosaic, in stone or made disk beads. Shell material employed was clam or snail, such as abalone.

Kunz (1893b, p. 763-764) commented that

'Turquoise has always been known as an unstable gem. Even the finest Persian stones are liable to change occasionally with scarcely any warning, the alteration probably being due to the turquoise coming in contact with acid exhalations from the skin or with fatty acids or alkalies in soap, although wearers of turquoise are especially warned to remove the rings while washing their hands. Recent observations also indicate that turquoise is liable to injury from perfumes.

A few years later, Kunz (1902, p. 761) observed that

'Several of the companies give a guaranty that if one of their stones changes color within six months after its purchase from a retail jeweler, they will replace it with a new one. This is a great improvement on the old method of the Persian dealers, who
were wont to decamp to parts unknown as soon as their turquoises were sold. In order to protect themselves against false claim the several companies have adopted the system of marking each of their stones by cutting a trade-mark on the back, an A for the American Turquoise Company, a circle for the Azure Company, a cross for the American Turquoise and Copper Company, a T for the Toltec, an arrow for the Himalaya, etc.

Pogue (1915, p. 135) gave the value of production of turquoise in the United States for each year from 1883 to 1912, and Aitkens (1931, p. 9) carried this forward to 1921, after which the canvass of producers of precious and semiprecious stones was discontinued for several years. The total for these 39 years (1883-1921) is $2,092,272. This represents the value as purchased by dealers; the value of cut and polished stones would, of course, be several times as great. Production had practically ceased by 1921 and ten years later Aitkens stated that turquoise was out of vogue and that many mines had closed. Later, turquoise came into vogue again.

I have collated figures for the period 1922-1963, and very incomplete returns suggest a minimum of about $1 million for this period. There was no canvass 1922-1934 and in 1964 it was discontinued. Thus, the official figures as reported to the U. S. Geological Survey in early years and to the U. S. Bureau of Mines in later years give a grand total of U. S. production for the period 1883-1963 of a little more than $3 million.

For various reasons, little reliance can be placed on these figures. As Carter (1965, p. 268) noted, gem mining is now operated by individuals rather than companies and by more amateurs than professionals. Due to this trend, production statistics and location of deposits have become increasingly difficult to obtain. Production figures have always been incomplete since amateurs rarely report their finds and data are frequently estimated.

Years ago, Governor M. A. Otero observed that “it is openly asserted that the true value of turquoise mined [in New Mexico] since 1890 has been greatly under estimated.”

For example, note the discrepancies in production values reported for the years 1891-96 by (1) the U. S. Geological Survey and (2) Governor Otero in his report to the Secretary of Interior in 1899.

<table>
<thead>
<tr>
<th>Year</th>
<th>U. S. G. S.</th>
<th>Gov. Otero</th>
</tr>
</thead>
<tbody>
<tr>
<td>1891</td>
<td>$150,000</td>
<td>$150,000</td>
</tr>
<tr>
<td>1892</td>
<td>175,000</td>
<td>175,000</td>
</tr>
<tr>
<td>1893</td>
<td>143,146</td>
<td>200,000</td>
</tr>
<tr>
<td>1894</td>
<td>34,000</td>
<td>250,000</td>
</tr>
<tr>
<td>1895</td>
<td>50,000</td>
<td>350,000</td>
</tr>
<tr>
<td>1896</td>
<td>40,000</td>
<td>475,000</td>
</tr>
<tr>
<td>Total</td>
<td>$592,146</td>
<td>$1,600,000</td>
</tr>
</tbody>
</table>

The U. S. G. S. figures are for the entire United States; Gov. Otero’s figures are for New Mexico alone, principally from Cerrillos.
Other sources claim that the Cerrillos district produced a total of about $9 million and the Burro Mountains district about 5 million for a total of $14 million for these two districts, not including the Eureka (Little Hatchet Mts.) and Orogrande (Jarilla Mts.) districts.

A recent publication of the Nevada Bureau of Mines (Morrissey, 1968, p. v) boasts that Nevada has been the major producer of turquoise in the United States. It is difficult to obtain accurate figures, but there is good evidence to indicate that this State has produced more than $30 million worth of turquoise in the raw state, which, of course, has a value many times that as a finished and polished gem stone.

I am inclined to think that the $30 million figure for Nevada is greatly exaggerated, although Nevada production certainly has exceeded that of other states since about 1935.

In some early years, price of turquoise was often given per carat, but most of the later official reports give price per pound. Generally it was not stated whether this meant the troy pound or avoirdupois pound (1 pound troy = 0.823 pound avoirdupois). Incidentally there are 1,800 carats in 1 pound troy.

In 1893, turquoise from the Azure mine in the Burro Mountains, New Mexico averaged $5 per carat; in 1903 it was bringing $5 to $10 per carat; and in 1907 the range was $6 to $25 per carat referred to selected high-grade material where as in later years the price was down to $10 per carat again.

It must be concluded that in early years the prices given per carat refered to selected high-grade material where as in later years the prices given per pound were for low grade materials.

Shifting to price per pound, we may note that during the period 1907-1963, the price ranged from a low of 20 cents (for Arizona Low-grade material in 1958) and $1 (for New Mexico that year) to as much as $100 (for Colorado in 1954).

There are numerous references to low-grade ore “oiling grade (chalk) turquoise” which required considerable treatment before cutting.

U. S. averages for a single year ranged from a low of 77 cents per pound in 1958 to a high of $10.26 in 1911. Scattered figures for yearly averages per pound are given in the following table.

<table>
<thead>
<tr>
<th>Year</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1907</td>
<td>$6.62</td>
</tr>
<tr>
<td>1908</td>
<td>5.00</td>
</tr>
<tr>
<td>1909</td>
<td>5.20</td>
</tr>
<tr>
<td>1910</td>
<td>5.09</td>
</tr>
<tr>
<td>1911</td>
<td>10.26</td>
</tr>
<tr>
<td>1958</td>
<td>$0.77</td>
</tr>
<tr>
<td>1959</td>
<td>3.94</td>
</tr>
<tr>
<td>1960</td>
<td>3.75</td>
</tr>
<tr>
<td>1961</td>
<td>7.55</td>
</tr>
<tr>
<td>1962</td>
<td>3.87</td>
</tr>
<tr>
<td>1963</td>
<td>5.53</td>
</tr>
</tbody>
</table>

In contrast to these figures, in 1950 Neumann reported that good turquoise in the rough was priced at $4 to $9 a troy ounce. With 12 troy ounces to a pound, the price per troy pound would thus range from $48 to $108.
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