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THE MINERAL INDUSTRIES
OF ARIZONA

A Brief History of the Development
of Arizona’s Mineral Resources

Prepared by
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FOREWORD

In response to the demand for a brief historical review of the mineral industry in Arizona, the Arizona Bureau of Mines issued in 1951 the publication titled "The Mineral Resources of Arizona" as Bulletin 159 of its Mineral Technology Series. Inasmuch as the information contained therein has been much sought after, especially by high school students and laymen, in general, and as considerable advances have been made in mining in Arizona since 1951, it has been deemed expedient to give additional service by issuing this extensive revision of the earlier bulletin. It is hoped this revised work, carrying the title "The Mineral Industries of Arizona — A Brief History of the Development of Arizona's Mineral Resources" and identified as Bulletin 169, will serve as a ready reference for information of general interest concerning the nature, occurrence, mining history, and production of the more important economic mineral materials of Arizona.

J. D. FORRESTER, Director
Arizona Bureau of Mines
January, 1962

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EARLY-DAY MINING

J. D. Forrester in a recent University of Arizona publication entitled Arizona, Its People and Resources (1960) has divided the history of mining in Arizona into four periods; namely, Aboriginal, Spanish, Early American, and Modern-Day mining. He described the first two periods as follows:

The Aboriginal Period

The original Indians were agrarian peoples, who were engaged primarily in agriculture with little or no knowledge of, or apparent interest in, the use of metals, either for commercial purposes or for ornamentation. However, these early inhabitants learned in the course of time, of the benefits of such resources as salt, coal, building stone and pottery clay, and, also, of the applicability of particular nonmetallic substances for making mauls, knives, spear points, pigments, and ornamental beads. There is clear-cut archaeological evidence that mining enterprises, crude as judged by present standards but nonetheless effective and important to such prehistoric peoples, existed by 1000 A.D. Therefore, the aboriginal mining period is considered to extend from 1000 A.D. to about the middle of the sixteenth century.

John T. Hack has written of a coal mining industry which was well developed by the prehistoric Hopi Indians in the Jeddito Valley along the southern edge of Black Mesa, north of the present town of Holbrook, Arizona. He has noted that the early Hopi people apparently had discovered the use of coal as a means of securing heat at about the same time a similar discovery was made by the early inhabitants of England. By the beginning of the thirteenth century, the Hopi were exploiting the Jeddito Valley deposits to a marked degree.

The main coal seam, which is comprised of rather “bony” (impure) coal ranging from lignite to sub-bituminous, is a flat-lying bed in rocks of Cretaceous age. It is covered by varying amounts of younger rocks. The ancient mining method which was used is very similar to that of modern strip-mining. It was a procedure of removing the overburden and excavating the exposed coal. The waste (overburden and “bone”) was piled to the rear of the working area. The result was to leave a tract stripped of coal and overlying rock, and piled high with heaps of waste material. When the overburden was too thick to remove by the crude excavating and hauling devices, the mine area usually was abandoned. However, in at least one locality, there is evidence that underground mining by a primitive “longwall” method was pursued successfully.

The coal mines were operated through a period of about 300 years, and the total amount of coal extracted probably exceeded 100,000 tons. This is an amazing amount considering the primitive tools and equipment
then available. Coal was used for domestic heating and cooking and for the firing of pottery vessels, which was a companion industry.

The well-known archaeologist, Earl Morris, in his monograph “An Aboriginal Salt Mine at Camp Verde, Arizona” (Anthropological Papers of the American Museum of Natural History, Vol. XXX, Part III, New York, 1928) has described an aboriginal salt mine near Camp Verde in central Arizona. Here in comparatively unconsolidated manner, there are intercalated, essentially flat-lying layers of sands, gravels, clays, and various salt compounds. The early peoples worked these deposits, seeking supplies of sodium chloride, or common table salt.

In his study cited above, Morris described the methods of salt mining of the aborigines. When the natives found a promising salt stratum they followed where it led, often unsystematically. They used no timbers or pillars in such salt mining. These early miners, working between 1200 and 1400 A.D., apparently developed several mine levels and at least one subsurface shaft and they removed several thousand cubic yards of rock material. There can be no question that the ancient inhabitants of the region were engaged in a salt mining enterprise of important industrial nature. Indeed, it probably was the first of Arizona’s mining industries.

The aborigines also mined turquoise for making jewelry and similar artifacts. Prehistoric turquoise mines have been reported on the east side of Canyon Creek just above its confluence with the Salt River, on Turquoise Mountain in Cochise County, in the Mineral Park area of Mohave County, and in other locations throughout the state.

It is evident that the early aboriginal people of Arizona though following primarily an agricultural way of life, also practiced noteworthy mining industries as a part of their total existence. These prehistoric activities may be considered as harbingers of the great, present-day mining enterprises of Arizona.

The Spanish Period

The Spanish period extends essentially from the middle of the sixteenth century to the time of the Gadsden Purchase in 1853, when the region of Arizona was opened to occupancy by citizens of the United States. It is distinct from the earlier period for several reasons, but chiefly because it marked the beginning of the White man’s exploitation of Arizona’s mineral resources.

Soon after the conquest of Mexico by Cortez, the Spanish explorers entered Arizona in quest of the gold, silver, and other mineral riches that had been reported to them as fabulous in quantity and richness. Fray Marcos de Niza in 1539 led the first expedition. His glowing, though false reports, resulted in the expedition led by Francisco Vasquez de Coronado in 1540 in search of the legendary Seven Cities of Cibola. These expeditions were doomed to failure because the Indians had not developed metal commodities, and, as these substances were not important
in their cultures, they had never accumulated them. Thus, there was no wealth of the precious metals which the conquistadors could plunder.

It was not until 1582, when Antonio de Espejo prospected near the headwaters of the Verde River that actual mining of silver ore was done. Although historical records do not indicate what quantities of ore were produced by Espejo's venture, it is an important occasion, if for no other reason than that it marks the beginning of metal mining in Arizona.

Juan de Onate is reported to have found rich silver ore during an expedition in 1604 along the Santa Maria and Bill Williams rivers. However, it was not until 1705, when Father Kino did some prospecting for silver near the present Mexican border, that further active mining was done. Frank P. Knight, in his "Mining in Arizona" (Department of Mineral Resources, State of Arizona, January, 1958) argues that the Planches de Plata silver deposits near Nogales stimulated mining beginning about 1736. When the Spanish settled Tucson, they mined gold and silver, and it is reported that gold placers existed at Quijotoa in 1774.

According to G. M. Butler, "Arizona and Its Heritage," University of Arizona Bulletin, Vol. VII, No. 3 (April 1, 1936), it is impossible to estimate closely how much mineral wealth was removed while the Spaniards and Mexicans controlled the region of Arizona, but it is certain that there was appreciable mining before the Declaration of Independence by the United States. Butler writes: "There is a tradition that $60,000 worth of silver utensils once decorated the altar of San Xavier Mission and that this metal was mined in the Santa Rita Mountains. The padres at Tumacacori Mission certainly directed silver mining operations in those mountains, and the Spaniards are known also to have operated in the Arivaca district and in the Baboquivari, Patagonia, Tucson, and Catalina mountains. There is some evidence that they or the Mexicans mined as far north as the Sierrita Mountains south of Tucson."

After the Mexican Revolution of 1822, the Mexican military garrisons which protected the Spanish-Mexican prospectors in the Arizona region were withdrawn, and the area was subjected to increased depredations by Apaches and outlaws. Mining waned thereafter until about 1849, when other military forces concerned with the United States-Mexican Boundary Commission were established in the Territory.

THE EARLY AMERICAN PERIOD

The first important mining in Arizona after the Gadsden Purchase was for gold and silver. During the early days, from 1858 to 1875, base metals were of little interest in this region which then was remote from the centers of population and lacking in transportation facilities. Prior to the completion of railroads across southern Arizona in 1881 and northern Arizona in 1882, a few small-scale copper mining and smelting operations were conducted under adverse conditions. For example, during
1873, in the Clifton-Morenci district, the high grade surface oxidized ores were packed down steep trails on burros to Chase Creek and smelted in an adobe furnace to black copper using charcoal as fuel. Supplies were brought in by ox teams and the copper was hauled out on the return trip to the main line of the Santa Fe Railroad which was being constructed from the east. The first railhead that was used was at Independence, Kansas; it later was moved to La Junta, Colorado, and finally to Las Vegas, New Mexico.

In 1878, Arizona’s first railroad was completed to transport ore from the Longfellow mine to a smelter at Clifton, a distance of 4 1/2 miles. A gravity incline delivered the ore from the mine to the railroad on Chase Creek, a vertical drop of 900 feet. When this railroad first operated, mule haulage was used to return the empty cars to Chase Creek. In 1880, a locomotive was purchased in Pittsburg and was transported from the eastern seaboard to San Francisco via Cape Horn, thence to Yuma by the Southern Pacific Railroad and from there to Clifton by ox team. In 1883, Clifton was connected with Lordsburg, New Mexico, and a branch of this line was extended to Morenci. Such were the conditions of operating base metal mines in the early days.

MODERN-DAY MINING

From the standpoint of value of production, Arizona’s leading metal was gold during the period 1858 to 1877; silver from 1878 to 1887; and copper from 1887 to the present time.

Although Arizona does not have the largest known copper deposit in the world, or even the greatest one in the United States, it does have within its borders ten important districts, each of which has a significant annual production. It is the number of such enterprises, rather than the output from one very large deposit, that has given to Arizona its leadership in the production of copper in the United States which it has held since 1910.

The geographic distribution of these copper-bearing areas is depicted on the accompanying map which shows the large copper mining districts of the Southwest. With Ray, Arizona, as its center, it will be noted that a circle of a radius of 175 miles has been circumscribed around a region which embraces fourteen significant copper districts; twelve of which are in Arizona, one in western New Mexico, and one in northern Sonora, Mexico. These mining regions occur within a belt where intense faulting, folding, and igneous intrusions have occurred and which lies southwest of a line projected through Morenci and Jerome, Arizona.

Bordering this belt on the northeast is the Colorado Plateau area of Arizona, which is comprised of relatively flat-lying strata, where non-metallic minerals, very significant amounts of uranium-vanadium ores, coal, and some base metals have been mined. It is also in this area that comparatively recent discoveries of petroleum, natural gas, and helium
gas have been made. In 1954 a successful gas well was drilled and in 1958, the first commercial oil well of Arizona began production in northwestern Apache County. To date, three producing petroleum, three natural gas, and two oil and gas wells have been discovered, all of which are located in northwestern Apache County. Six successful helium gas wells, which are currently shut-in awaiting commercial development, have been drilled near Navajo Springs in south-central Apache County.

**Copper**

In nature, copper most commonly occurs combined chemically with other elements, notably sulphur and iron. The more important copper minerals resulting from these combinations of elements are chalcocite, composed of copper and sulphur, and chalcopyrite, which contains copper, iron, and sulphur. Bornite is another important copper, iron, and sulphur mineral. These minerals are referred to as the copper sulphides.

Some of the large open-pit mines, and many of the underground mines, have produced significant quantities of copper from the oxidized copper minerals of which the more important are malachite, chrysocolla,
and cuprite. The oxidized copper minerals occur most commonly in the upper zones of copper deposits.

The bulk of Arizona's current production of copper is obtained from low-grade ores which average less than one per cent of copper. Advances in the technology of mining and metallurgical methods since 1905 permit such ores to be mined on a large scale by open-pit and underground caving methods and to be concentrated by the flotation process. The concentrate, so obtained, is further treated by smelting and refining methods resulting in the production of essentially pure copper and the recovery of the gold and silver and other economic compounds present in such ores. Leaching methods are used also, to a lesser but increasing extent, mainly for the extraction of oxidized copper from its ores.

Gold

The total value of gold produced in Arizona during 1858–1961 amounted to more than 337 million dollars. From this standpoint, gold ranks as Arizona's second metal for the whole period, although during 1943–1959, both zinc and lead exceeded it in value of output. The reason for this change in the position of gold is that during and since World War II general business conditions and inflationary pressures caused greater demands and higher prices for the base metals, whereas the price of gold remained constant. Most of the gold produced currently in Arizona is a by-product from base-metal ores, and the value of its annual output is less than half of what it was prior to 1942.

Silver

The value of the silver produced in Arizona from 1859 through 1961 amounted to 280.8 million dollars and this amount places silver as the third ranking metal in value of past production. Silver was second only to gold in its influence on the early history of mining in Arizona. During the period 1878 to 1887, the mining of silver bonanzas, such as Tombstone and Silver King, brought the value of its output in the State above that of gold.

After 1903, the yield of silver in Arizona came predominantly as a by-product from ores of copper, lead, and zinc rather than from siliceous silver ores. In 1959, the Iron King Mine of Yavapai County and the Bisbee District of Cochise County, were the leading sources of silver in Arizona.

Zinc

Arizona's fourth metal, in total value of past production, is zinc, the production of which has amounted to $212,514,000 since 1900. Sphalerite, a sulphide, is the important ore mineral of zinc.

Appreciable production of zinc in Arizona started at the beginning of the current century and much later than that of gold, silver, and
copper. The first 40 years, 1900–1939, furnished only 7.5 per cent of the output as compared with 92.5 per cent during the past 20 years. The chief reason that zinc did not become important to Arizona earlier is the complex nature of western zinc ores and the problems encountered in treating such ores prior to the advent of the flotation process.

The ores of Missouri, Kansas, and Oklahoma zinc districts contain sphalerite and galena, a lead sulphide mineral, as coarse crystals. The separation of such sphalerite from galena has been readily accomplished for many decades by methods based on the difference in the specific gravity of the minerals.

Western zinc ores are, however, much more complex in character in that the crystals are much finer in size, and several sulphides of different metals occur in the same ore. Commercial separation of the various sulphides by methods based on the difference in the specific gravity of the sulphides were very inefficient and, in general, unsuccessful. The first successful application of the flotation process for such separations was about 1925. This method, together with a higher average price for zinc, which has been 12.6 cents per pound for the past 20-year period as compared with an average price of 7.8 cents per pound for the preceding 40-year period, explains the large production of zinc in Arizona during recent years.

**Lead**

Lead is Arizona’s fifth metal in value of total production which has amounted to $119,689,000 since 1894. The most important mineral of lead is galena, a chemical combination of lead and sulphur.

For at least 40 years prior to 1894, and probably earlier, surface deposits of high-grade silver-bearing lead ores were mined chiefly for their silver content. The lead mineral contained in such ores was mainly cerussite, which is a lead carbonate, an oxidation product of galena. These ores were smelted in small-scale operations and, during this period, lead had little value except for local use. It is recorded that during the Civil War, lead produced at the Mowry Mine in the Patagonia District was used for bullets.

From 1894 until 1934, the value of the average annual production of lead amounted to only $600,000 as compared with about 3.5 million dollars per year during the past 26 years.

One reason that the yearly value has markedly increased during the past 26 years is the increase in the market price of the metal. During the 40-year period from 1894 through 1933, the average price of lead was 6.1 cents per pound as compared with 9.7 cents per pound over the past 26 years and an average price of 14.6 cents per pound during the past 9 years.

The second reason for the increased output over the past 26 years is the application of the flotation process to the separation of lead and zinc minerals found in the complex ores of the Rocky Mountain region.
**Other Metals**

Molybdenum, tungsten, manganese, mercury, vanadium, and uranium ores have been mined in Arizona although the combined value of such production is small as compared with that of the five major metals which have been described above.

Available records for the minor metals are incomplete, and the totals cited are based to a considerable extent upon estimates.

**Molybdenum**

Prior to World War I, molybdenum was employed chiefly for chemicals. During World War I, and since, its applications have greatly expanded and include its addition to iron and steel alloys for the purpose of improving the properties of such products. During the past 20 years, the demand for this purpose has more than doubled. More recent applications, in the form of metal or compounds, include those of catalysts, lubricants, vacuum tubes, and other electronic and electrical uses.

In recent years, from one-third to one-half of the world's output of molybdenum has been obtained as a by-product of copper mining operations. Essentially all of Arizona's current output of molybdenum is a by-product from copper ores which generally contain not over one pound of molybdenum per ton.

Arizona's total yield of molybdenum amounts to 38,000,000 pounds, valued at about 39.5 million dollars. Approximately 70 per cent of this total value has been obtained during the past nine years.

**Uranium**

The Colorado Plateau, of Utah, Colorado, Arizona and New Mexico, is the major uranium district of the United States. Production from this region has been particularly significant since 1942 when uranium became important as a source material for nuclear energy. During the period 1955–1961, the value of uranium mined in Arizona amounted to 37 million dollars.

**Manganese**

Manganese is an indispensable metal used as a purifying agent in the manufacture of steels and also in the placing of superior wearing surfaces on manganese alloy steels.

Arizona's output of manganese ores and concentrates has amounted to 348,300 tons valued at $23,531,000.

The Artillery Peak area of west-central Arizona contains manganese deposits rated as among the first four or five largest low-grade manganese ore bodies in the United States. These deposits have been operated intermittently and are regarded as an important resource for the future.

**Tungsten**

Tungsten alloys and tungsten carbides are extremely hard and are employed for superior cutting tools which retain their hardness at ele-

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vated temperatures. Arizona’s total output of tungsten has amounted to seven million dollars. Since 1956, when the U. S. Government’s stock-piling program ended, the State’s production has been almost negligible.

MERCURY

The State’s total production of mercury is valued at approximately $1,120,000. The principal known deposits are in the Mazatzal, Phoenix, Dome Rock Mountains, and Copper Basin districts.

VANADIUM

The total value of vanadium produced in Arizona through 1947 is estimated at $460,000. Prior to 1945 it was obtained largely from gold-mining operations in the Mammoth Mines, near San Manuel, but more recently it has been recovered from uranium ores of the northeastern part of the State.

Nonmetallic Minerals

Although most of the nonmetallic substances mined in Arizona have been used locally, some of them, such as asbestos, bentonite, feldspar, fluorspar, sodium sulphate, and barite have found their chief markets outside the State. As the population has increased and industrial demands have expanded, particularly in the Pacific Coast Region and in the Southwest, the output of nonmetallic minerals has shown a marked growth, especially during the past ten years. The estimated yield of such minerals up to, and including, 1950 was 78 million dollars, whereas the output from 1950 through 1959 amounted to 159 million dollars. By commodities, the values of the total past production (through 1959) of nonmetallic minerals have been approximately as follows:

<table>
<thead>
<tr>
<th>COMMODITY</th>
<th>PERIOD INCLUDED</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand and Gravel</td>
<td>1917–1961</td>
<td>$106,750,000</td>
</tr>
<tr>
<td>Cement</td>
<td>1905 and 1949–1961</td>
<td>60,005,000</td>
</tr>
<tr>
<td>Stone</td>
<td>1889–1961</td>
<td>44,041,000</td>
</tr>
<tr>
<td>Lime</td>
<td>1894–1961</td>
<td>31,205,000</td>
</tr>
<tr>
<td>Clay (bentonite)</td>
<td>1925–1961</td>
<td>24,500,000</td>
</tr>
<tr>
<td>Asbestos</td>
<td>1914–1961</td>
<td>15,820,000</td>
</tr>
<tr>
<td>Clay products</td>
<td>1894–1961</td>
<td>11,000,000</td>
</tr>
<tr>
<td>Feldspar</td>
<td>1923–1961</td>
<td>4,750,000</td>
</tr>
<tr>
<td>Pumice (volcanic cinders)</td>
<td>1949–1961</td>
<td>7,373,000</td>
</tr>
<tr>
<td>Gypsum</td>
<td>thru 1961</td>
<td>4,108,000</td>
</tr>
<tr>
<td>Barite</td>
<td>1929–1961</td>
<td>2,614,000</td>
</tr>
<tr>
<td>Gemstones</td>
<td>thru 1961</td>
<td>1,526,000</td>
</tr>
<tr>
<td>Miscellaneous clays</td>
<td>1949–1961</td>
<td>1,725,000</td>
</tr>
<tr>
<td>Sodium sulphate</td>
<td>1920–1961</td>
<td>865,000</td>
</tr>
<tr>
<td>Perlite</td>
<td>1946–1961</td>
<td>828,000</td>
</tr>
<tr>
<td>Fluorspar</td>
<td>1902–1961</td>
<td>583,000</td>
</tr>
<tr>
<td>Mica</td>
<td>1949–1961</td>
<td>417,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>$318,110,000</td>
</tr>
</tbody>
</table>

[ 11 ]
A Summary of the Production of Metals and Mineral Commodities in Arizona

As previously mentioned, for the past fifty years Arizona has led the United States in the production of copper, and during the past several years has exceeded all other states in the combined value of copper, zinc, lead, silver, and gold produced.

The total value of all mineral output obtained in Arizona from 1858 to 1961 has amounted to $8,483,533, distributed as follows:

<table>
<thead>
<tr>
<th></th>
<th>Value in Dollars</th>
<th>Per Cent of Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>7,102,961,000</td>
<td>83.73</td>
</tr>
<tr>
<td>Gold</td>
<td>337,361,000</td>
<td>3.98</td>
</tr>
<tr>
<td>Silver</td>
<td>280,789,000</td>
<td>3.31</td>
</tr>
<tr>
<td>Zinc</td>
<td>212,514,000</td>
<td>2.50</td>
</tr>
<tr>
<td>Lead</td>
<td>119,689,000</td>
<td>1.41</td>
</tr>
<tr>
<td>Other metals</td>
<td>110,160,000</td>
<td>1.30</td>
</tr>
<tr>
<td>Nonmetallic minerals</td>
<td>318,110,000</td>
<td>3.75</td>
</tr>
<tr>
<td>Mineral fuels</td>
<td>1,949,000</td>
<td>0.02</td>
</tr>
<tr>
<td>Total through 1961</td>
<td>8,483,533,000</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Referring to the preceding tabulation, the value of copper produced in Arizona from 1874 through 1961 was more than seven billion dollars; it was derived from the production of 35.6 billion pounds of copper. This amount would be sufficient to form a solid cube of copper with an edge of 400 feet, which is 40 feet longer than the distance between the goal posts on a college football field.

It is interesting to note that, of the total production of copper in Arizona over a period of 85 years, nearly half was achieved during the past 21 years, and nearly one-quarter during the past nine years.

This very notable record of production over the past 21 years was made by advances in technology, the change for many properties in the method of mining from underground to open-pit, and the discovery and development of new ore bodies. These new ore bodies included San Manuel, Pima, Esperanza of the Duval Sulphur and Potash Company, and the Mission mine of the American Smelting and Refining Company, all within a distance of fifty miles from Tucson. The further development of known ore bodies, such as those of Silverbell of the American Smelting and Refining Company and of the Banner Mining Company added also to the yield.

How long this impressive record of production will continue depends primarily upon new discoveries which in the future will depend upon the vigor of exploration. Considering the record of the past 21 years, it may be stated that in all probability Arizona will retain first position in the production of copper in the United States for the foreseeable future.
A RESUME OF HISTORICAL EVENTS RELATED TO MINING IN ARIZONA

YEAR (A. D.)
1000 Archeological evidence indicates that as early as 1000 A.D. and up to the middle of the sixteenth century, crude mining operations were carried out by the prehistoric people who inhabited the land now known as Arizona. Mineral substances such as salt, coal, building stone, pottery clay, and turquoise were mined.

1530 Nuño de Guzman, President of the Governing Board of New Spain, heard of the Seven Cities of Cibola far to the north, whose streets were “paved with gold and silver.” He founded San Miguel de Culiacán in Mexico.

1536 Alvar Nuñez Cabeza de Vaca and the Negro, Estevanico, reached San Miguel de Culiacán with fresh rumors of Cibola.

1539 Viceroy Mendoza sent Fray Marcos de Niza and Estevanico to find the Seven Cities of Cibola. Niza was the first white European to enter Arizona and the expedition reached the Zuni pueblos. Estevanico was slain by the Indians, and Niza returned with imaginative tales of gold and silver utensils.

1540 Coronado’s expedition entered Arizona and found the Seven Cities of Cibola merely to be seven Indian villages with no metallic riches.

1557 Bartolome de Medina of Pachuca, Mexico, invented the Patio process of silver amalgamation.

1582 Antonio de Espejo discovered a deposit said to be silver ore, the first in Arizona, near the headwaters of the Verde River. This was possibly the ore occurrence which later became the famous United Verde mine. He discovered also the Verde River salt deposits.

1691 Padre Eusebio Francisco Kino entered Arizona and explored and developed the Papago country for twenty-five years.

1705 Kino reportedly engaged in the mining of rich silver ores which presumably were in the Santa Rita Mountains.

1736 The famous Bolas de Plata silver deposit at Arizonac in northern Sonora was discovered.

1750 Some copper ore was mined at Ajo.

1774 Placer operations for gold were begun in the Quijotoa district.

1777 Arivaca was mentioned as a mining community.

1792 The legal ratio between gold and silver in the United States was established at 16 to 1.
1801 Copper ore was mined at Santa Rita, New Mexico.
1823 Mexico obtained its independence, and the missions were abandoned.
1853 The Gadsden Purchase from Mexico included that part of Arizona and New Mexico south of the Gila River.
1854 Charles D. Poston began a search for gold and silver near Tubac.
1855 Mexican troops left Tucson and Tubac and were replaced by Americans. Rich copper ore was hauled from Ajo to San Diego for shipment to Swansea, Wales.
1856 The Santa Rita silver mine near Tubac was opened. Explorations of the Santa Rita and the Cerro Colorado Mountains were conducted.
1857 Numerous prospectors began to enter Arizona. Gold ore was found in Mohave County near the Colorado River.
1858 The Mowry lead-silver ore body in the Patagonia Mountains was found. Also, the Gila City or Dome placers near Yuma were discovered.
1859 Rich silver ore was mined at the Heintzelman Mine in the Cerro Colorado Mountains.
1861 The Civil War started, and the resultant withdrawal of troops from the Arizona area was followed by Apache depredations.
1862 Confederate troops occupied Tucson but were driven out by the California Column under General A. H. Carleton. Military posts were established at Camp Verde, Fort McDowell, and Fort Whipple. The La Paz gold placers were discovered by Pauline Weaver.
1863 The Castle Dome district near Yuma became known. Many placer and lode deposits of gold were discovered in the Prescott region. The Moss deposit in the Oatman district, the Vulture deposit near Wickenburg, and the Planet deposit near the Bill Williams River were discovered. The Moss and Vulture were lode gold deposits, and the Planet was copper. Many lode gold deposits were discovered in Mohave County. Arizona was made a Territory, with Prescott as the capital, chiefly because of gold discoveries.
1864 Henry Clifton rediscovered copper deposits in eastern Arizona.
1865 Small-scale Mexican copper operations were carried on at Cananea, Sonora.
1867 The Capital of Arizona was moved from Prescott to Tucson.
1871 The Federal government, determined to end the Apache problem, sent a large number of troops to Arizona, which finally resulted in the surrender of Geronimo in 1886.
1872 The town of Clifton was founded by Metcalf and Stevens.
1873 The United States Mint, by act of Congress, discontinued the coinage of silver dollars, which was followed by a financial and industrial panic. The Silver King deposit in the Superior district was found by Mason and Copeland. Also, the Silver Queen (Magma) deposit was discovered. The Lesinsky brothers built a one-ton per day capacity furnace at Clifton to smelt high-grade copper ores. The Detroit Copper Company was founded, and mining operations were started at Morenci.

1874 Globe became a booming silver camp. The McCracken silver-lead deposit was discovered in Mohave County. Mining operations in the Richmond Basin silver district, northeast of Globe, were started.

1876 The United Verde ore body was discovered at Jerome by M. A. Ruffner. The Mineral Park district of Mohave County was active.

1877 John Dunn, an Army scout, made the first location in the Warren district. Ed Schieffelin began prospecting in the Tombstone area.

1878 Arizona's first railroad was completed from the Longfellow mine to a smelter at Clifton, a distance of 4½ miles. The first locations made at Tombstone were recorded. The Bland-Allison bill, passed by the Congress, again made silver legal tender.

1879 Silver mining operations started at Tombstone.

1880 Railroad reached Benson and Lordsburg from the west and the first copper was produced from the Copper Queen mine at Bisbee. Dr. James Douglas made his first visit to Bisbee. Silver-copper ore was mined from the Silver Queen mine, which is now the Magma mine, at Superior.

1881 The Old Dominion Copper and Smelting Company started operations at Globe.
The Phelps Dodge Corporation acquired the Atlanta claim at Bisbee.
Mining operations started in the Mammoth district. A small-capacity furnace for smelting copper ores was placed in operation at the present site of Miami.

1882 The Atlantic and Pacific Railroad was completed across northern Arizona.
The United Verde Copper Company was organized.
A small-capacity smelter was erected at Morenci.

1883 Some copper mining was undertaken at Ray.
A small-capacity smelter was erected at Jerome.

1885 The Copper Queen Consolidated Mining Company was formed, and it constructed a concentrator and smelter at Bisbee. The Territorial Legislature authorized the founding of the University of Arizona.
1886  The rich copper ores at Morenci were exhausted, and a concentrator was erected there by William Church to treat ore which averaged 6.5 per cent of copper. Six furnaces were in operation at Globe.

1887  The Congress gold deposit in Yavapai County was discovered by Dennis May. J.S. MacArthur and the Forrest brothers, residents of Glasgow, Scotland, patented the cyanide process which revolutionized metallurgical methods used for the treatment of gold ores.

1888  The Harquahala gold deposit in Yuma County was discovered.

1890  The Sherman silver-purchase bill was enacted by Congress.

1893  The demonitization of silver was followed by a disastrous business recession. The efforts of prospectors turned from the finding of silver to the location of gold deposits.

1894  The Railroad to Jerome was completed.

1895  The Fortuna gold deposit, southeast of Yuma, was discovered.

1896  The King of Arizona gold deposit, northeast of Yuma, was found. The election of William McKinley as President assured the continuation of the gold standard.

1899  Ray Copper Mines, Ltd., an English company, attempted to
      The Lake Superior and Western Development Company of Michigan purchased the Costello rights of the Irish Mag claim adjacent to the Copper Queen at Bisbee, Arizona. Development work on the Irish Mag led to the discovery of a large high-grade copper ore body in 1899 which, in turn, led to the forming of the Calumet and Arizona Mining Company.

1900  The Phelps Dodge Corporation erected a smelting plant at Bisbee, and shortly thereafter, the Calumet and Arizona also built a smelting plant at Douglas to treat ore from the Irish Mag mine at Bisbee. Gold-ore discoveries were made in the Oatman district of Mohave County. John R. Boddie, Captain Huie, and others organized the Cornelia Copper Company to work the Ajo copper deposit.

1903  The Phelps Dodge Corporation obtained control of the Old Dominion mine at Globe.


1905  Waldemar Lindgren's report on the Morenci district was published by the U. S. Geological Survey.

1906  Philip Wiseman and Seeley Mudd obtained an option on the mining properties at Ray. J. Parke Channing examined the copper deposits at Miami, and exploratory shafts were started.
1907  Daniel C. Jackling undertook extensive exploration work at Ray.
1908  The Miami Copper Company and the Inspiration Consolidated Copper Company were organized.
      The Tom Reed Gold Mines Company started operations on the Tom Reed vein in the Oatman district.
1909  The Sacramento Hill ore deposit at Bisbee was explored by drilling.
      The ore deposit at Ajo was explored by drilling. The Cornelia Copper Company was reorganized as the New Cornelia Copper Company.
      Louis S. Cates was placed in active charge of the Ray operation.
1910  The Chino Copper Company started large-scale stripping operations at Santa Rita, New Mexico.
      The Magma Copper Company was organized for operations at Superior.
      The American Smelting and Refining Company completed a smelter at Hayden.
      Production of copper on a large scale was started at Ray.
      The Calumet and Arizona Mining Company explored the Ajo deposit by drilling.
1912  Arizona was admitted to the Union as the forty-eighth state.
      Development operations were started in the United Verde Extension ore body by James S. Douglas.
1915  A large gold-bearing ore body was developed in the United Eastern Mine at Oatman.
      A smelter was erected at Miami by the International Smelting Company.
      The flotation process was introduced at Inspiration, and this operation was the first large-scale application of flotation in the United States.
      The Arizona Bureau of Mines was established by the State Legislature as a unit of the University of Arizona.
1916  The United Verde Extension Mining Company started mining the bonanza copper-ore body at Jerome.
1917  Production of copper started from the large-scale leaching plant at Ajo.
      The United Eastern Mining Company purchased the Big Jim Mine in the Oatman District.
      The New Cornelia Copper Company purchased the property of the Ajo Consolidated Copper Company.
1918  Steam-shovel work was started at Sacramento Hill at Bisbee.
1923  The Copper Queen concentrator, south of Bisbee, was placed in operation to treat Sacramento Hill ore.
1924  The concentrator at Ajo was started to treat New Cornelia sulphide ore. 
The erection of a smelter was completed by Magma Copper Company at Superior. 
Ray Consolidated Copper Company and the Chino Copper Company were merged and, in 1926, both properties were absorbed by the Nevada Consolidated Copper Company.

1926  Large-scale operations by leaching methods were started by the Inspiration Consolidated Copper Company.

1928  A drilling program was started on the Clay ore body at Morenci. 
This ore body currently is Arizona’s largest producer of copper.

1929  Start of the great business recession. 
Louis S. Cates became President of the Phelps Dodge Corporation.

1930  The price of copper declined from 18 to below 10 cents per pound.

1931  The Phelps Dodge Corporation and the Calumet and Arizona Mining Company were merged.

1932  The price of copper declined to less than 5 cents per pound, and copper operations were drastically curtailed.

1933  The price of gold increased from $20.67 to $25.56 per troy ounce.

1934  The price of gold was further increased and was pegged at $34.95 per troy ounce by the U. S. Government with resulting increase of activity in gold mining.

1935  The price of newly mined silver in the United States was increased to 77.57 cents per troy ounce by government action.

1937  An extensive development operation on the Clay ore body at Morenci by open-pit methods was started.

1939  With the start of World War II and the increased prices for copper, lead, and zinc, the mineral industries of Arizona were operating at maximum production.

1940  Government stockpiling of metals stimulated the entry of South American and African copper into the United States.

1942  Large-scale production of copper was started from the Clay ore body at Morenci. 
Most operations at gold mines in the United States were prohibited by government order to conserve labor and supplies.

1943  Arizona’s production of metals was the highest since 1929. The United States Bureau of Mines, on the recommendation of B. S. Butler and N. P. Peterson of the University of Arizona and the U. S. Geological Survey, respectively started exploratory drilling on the San Manuel copper deposit, which resulted in the discovery of one of the very large copper deposits of Arizona.
1944 The production of copper decreased 7 per cent, owing in part to a shortage of labor, but the productions of lead and zinc were the highest in the State’s history.

1945 The end of World War II. The output of lead and zinc continued to increase.

1946 Interest in the use of Arizona’s nonmetallic minerals increased.

1947 The exploration program at San Manuel, which started in 1943, resulted in the proving of over 450 million tons of low-grade ore in the deposit.

1948 High prices for metals continued to stimulate high production records for copper, lead and zinc. A change in mining from underground to open-pit methods was completed by the Inspiration Consolidated Copper Company and was in progress at the Ray Division of the Kennecott Copper Corporation.

1949 The stripping operation at Ray in order to change from underground to open-pit methods of mining was completed and production of copper by open-pit operations commenced. The Arizona Portland Cement Company constructed and started to operate a cement plant of 2000 barrels per day capacity at Rillito, about 17 miles northwest of Tucson.

1950 Interest in the production of tungsten, manganese, and other critical metals and minerals increased owing to political world conditions.

1952 The production of copper was begun from the Pima Mine. This copper deposit, located in the Mineral Hill area, 20 miles south of Tucson, was the first notable copper deposit discovered in Arizona by geophysical methods of exploration.

1954 As early as 1865, copper was produced in the Silver Bell area of Pima County and continued intermittently by underground methods of mining until 1930. In 1948, the American Smelting and Refining Company, after further exploration, decided to undertake to obtain the Silver Bell ores by open-pit methods of mining and concentration by flotation, and production was begun in 1954.

The Banner Mining Company acquired the Mineral Hill property in the San Xavier district of Pima County, 18 miles southwest of Tucson, in 1952. Claims for this property were located about 1882 and the property was worked intermittently by various owners until 1951. Upon acquiring the property, Banner conducted further exploration which resulted in locating a new ore body by geophysical methods of prospecting. A concentrator having a capacity of 400 tons per day was erected, and production of copper was started in 1954.
1956 San Manuel Copper Corporation started to operate a 35,000-ton capacity flotation concentrator for the production of copper.

1957 Sampling and metallurgical testing were conducted on an iron-placer deposit in southern Pinal County.

1959 The Esperanza Mine, owned by Duval Sulphur and Potash Company, and located four miles southwest of the Twin Buttes mines in Pima County began producing copper. The ore, mined by open-pit methods, is concentrated by flotation in a 12,000-ton capacity plant.

The Miami Copper Company terminated underground mining at its Miami Mine after 48 years of continuous operation. Leaching of acid soluble copper from the mined-out areas and from the low-grade area have been continued.

The Kennecott Copper Corporation announced that after three years of exploring a new low-grade copper deposit, northeast of Safford, Arizona, by drilling, and geological and geophysical surveying, it was purchasing mining claims in that area.

The Phelps Dodge Corporation and the American Metal Climax, Incorporated, became interested also in the Safford area. The Phelps Dodge Corporation started a drilling program there. A new cement plant of the American Cement Corporation was completed and started to operate at Clarkdale, Arizona.

1961 After seven years of exploration, development, and construction, the Mission Project of the American Smelting and Refining Company, located 15 miles south of Tucson, began the production of copper during the summer of 1961. The ore, mined by open-pit methods, is being treated by flotation in a 15,000-ton capacity concentrator.
ARIZONA BUREAU OF MINES
J. D. FORRESTER, Director

T. G. CHAPMAN, Director Emeritus  H. W. FERCK, Assistant Mineralogist
R. T. MOORE, Assistant Geologist  G. H. ROSEVARE, Metallurgist
R. T. O’HARE, Assistant Mineralogist  E. D. WILSON, Geologist

SERVICES AVAILABLE FROM ARIZONA BUREAU OF MINES
THE UNIVERSITY OF ARIZONA, TUCSON, ARIZONA

The Arizona Bureau of Mines, which functions as a part of the University of Arizona, Tucson, is conscious of its opportunities and responsibilities to render continuing service about mineral resources to the people of Arizona; accordingly it has a program of operation designed to contribute as many sound benefits as possible. The broad objectives of this program are to:

1. Prepare and publish bulletins and circulars containing authoritative information on a wide range of topics of interest to prospectors, miners, and others concerned with the development of Arizona's mineral resources and industries. The bulletins are distributed free of charge to residents and at cost to non-residents of Arizona upon request.

2. Classify mineral and rock specimens. Besides identifying rocks and giving the composition of minerals, the Bureau makes qualitative tests for important elements and answers inquiries concerning the probable market for and the economic value of material similar to samples submitted. This service is furnished free of charge providing the specimens originate within the State of Arizona; a charge of $1 per specimen is made for samples submitted from outside the State. When quantitative chemical analyses, spectographic analyses or detailed microscopic determinations are desired, they are furnished at rates established by law, a schedule of which will be submitted on request.

3. Conduct laboratory and pilot-plant metallurgical testing of mineral substances in cooperation with industries and individual mine operators in the State. Such tests are conducted on the basis of nominal charges to compensate for wear and depreciation of equipment needed in the experimentation.

4. Make geologic investigations of mining districts and counties and compile geologic maps and reports. Geologic maps of each county, on a scale of 1:375,000, have been issued. As a product that will result from the compilation of data for the county map issues, a new Geologic Map of the State, as a whole, will be established on a scale of 1:500,000. It is hoped that this map can be finished in 1962.


6. Develop well-log storage facilities and a library of oil and water wells drilled in Arizona.

7. Conduct state-wide commodity studies as to modes of occurrence and potential industrial value of various mineral materials.

8. Collect and file all items relating to Arizona mines and minerals that appear in Arizona newspapers and in many technical periodicals.

9. Act in liaison wherever opportune with the mineral industry, the University, the Federal Agencies, and the people of Arizona about mineral occurrences in the State.

The basic philosophy which obtains in the operation of Arizona Bureau of Mines is that of providing for the people of Arizona mineral services which cannot be readily secured elsewhere. That is, the Bureau gives advice and service which cannot be obtained conveniently from commercial sources. Competition with industrial concerns is not engaged in and therefore, any work of this nature, such as assaying, is not pursued. An inquiry addressed to the Director, Arizona Bureau of Mines, the University of Arizona, Tucson, will bring a prompt response if further information is desired about the services which are available.

All communications should be addressed and remittances made payable to the Arizona Bureau of Mines, The University of Arizona, Tucson, Arizona.