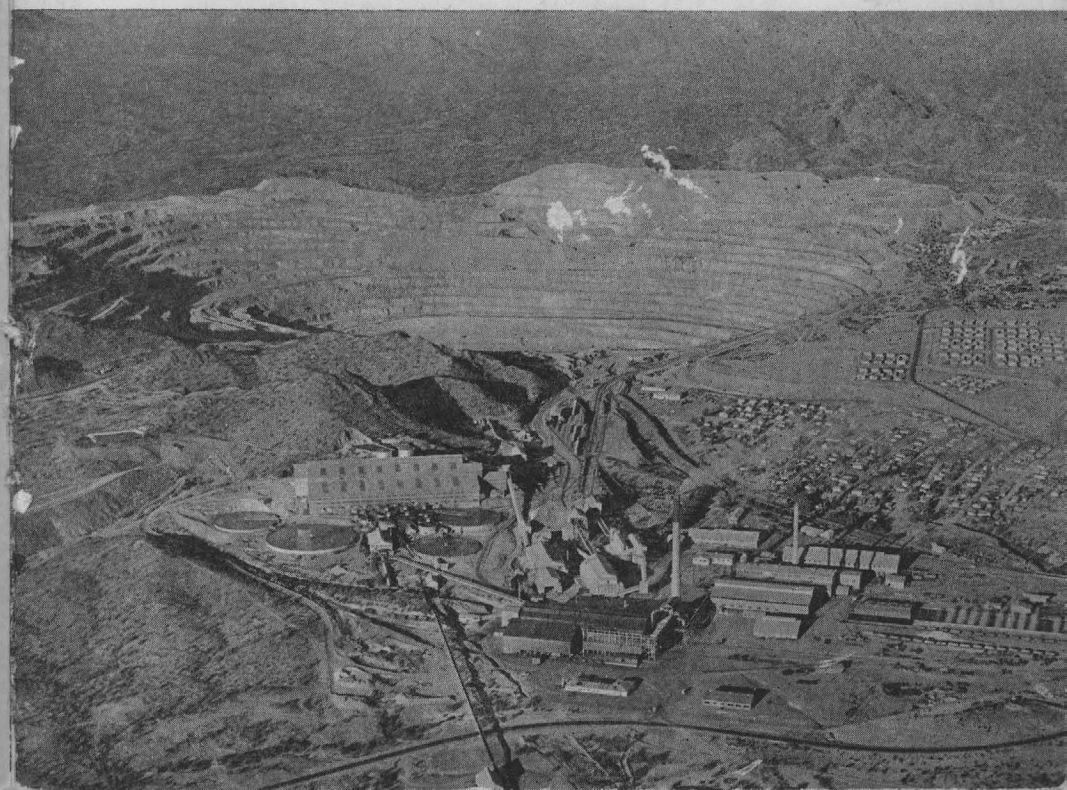
MINING
IN ARIZONA

Its Past - Its Present - Its Future

ARIZONA DEPARTMENT OF MINERAL RESOURCES



DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
PHOENIX, ARIZONA

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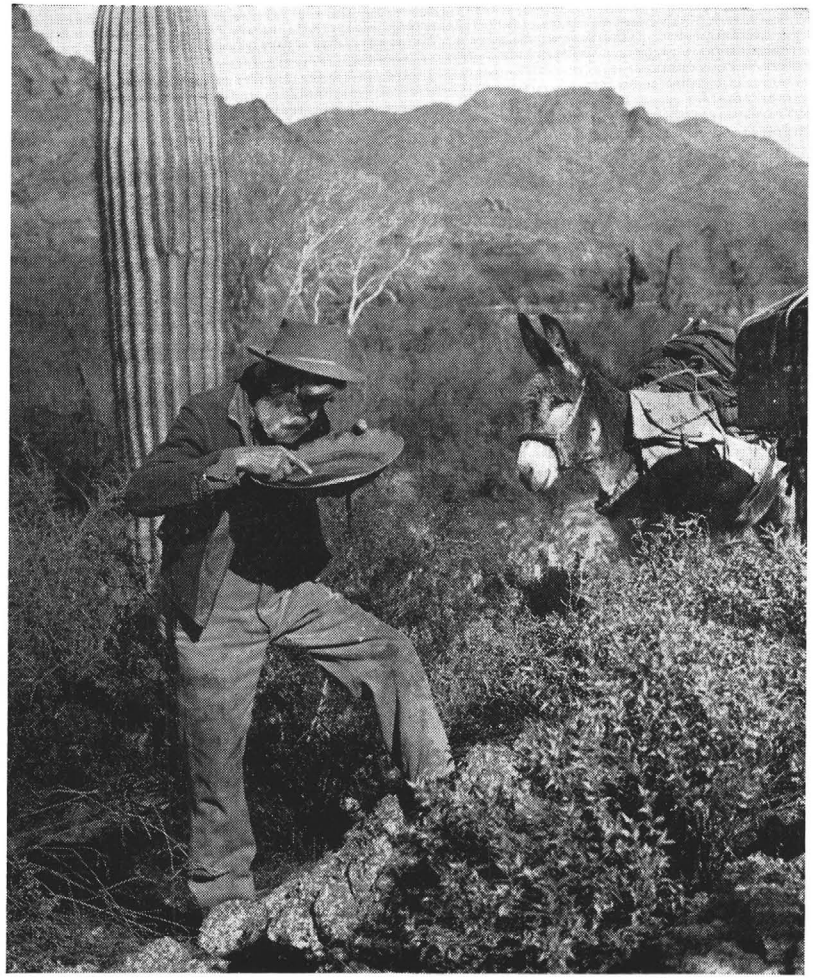
MAY, 1964



Superstition Mountain Monument

TABLE VII

MINERAL PRODUCTION OF LARGE AND SMALL PRODUCERS IN ARIZONA, 1962*

LARGE COPPER PRODUCERS[1]:	PRODUCTION	VALUE
Copper (lbs.)	1,263,291,179	$389,094,000
Gold (ozs.)	117,362	4,107,670
Silver (ozs.)	4,571,370	4,959,936
Molybdenum (in concentrates) lbs.	4,412,000	5,864,000
Total Value of Large Mine Production		$404,025,606
SMALL MINERAL PRODUCERS:		
Beryllium concentrate — short tons	1	(2)
Clays[3] — short tons	139,000	184,000
Copper (recoverable) lbs.	25,192,821	7,759,000
Gem stones	(4)	120,000
Gold (recoverable) troy ounces	19,845	694,330
Iron ore (usable)	(5)	(5)
Lead (recoverable) short tons	6,966	1,282,000
Lime — short tons	174,000	2,914,000
Mercury	(5)	(5)
Natural gas — million cubic feet	230	27,000
Petroleum (crude) — 42-gal. barrels	39,000	(5)
Pumice — short tons	756,000	1,640,000
Sand and Gravel — short tons	15,579,000	17,404,000
Silver (recoverable) troy ounces	882,630	957,064
Stone — short tons	4,333,000	6,616,000
Tungsten ore (60% WO_3 basis) short tons	15	14,000
Uranium ore — short tons	143,196	3,047,000
Vanadium — short tons	632	(5)
Zinc (recoverable) short tons	32,888	7,564,000
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite and fire clay), diatomite, feldspar, gypsum, helium, mica (scrap), perlite, pyrites, and values indicated by footnote[5]		$ 19.883,000
Total Value of Small Mine Production[6]		70,105,394
GRAND TOTAL, PRODUCTION VALUE		$474,131,000
PERCENTAGE DUE TO SMALL MINES		14.78%

1. Phelps Dodge, Kennecott, Inspiration, Miami, Magma (incl. San Manuel), Asarco's Mission Unit and Silver Bell, Pima, Bagdad, Duval's Esperanza, and Banner Mining Co.
2. Less than $500.
3. Excludes bentonite and fire clay; included with "Value of items that cannot be disclosed."
4. Weight not recorded.
5. Figure withheld to avoid disclosing individual company confidential data.
6. Revised figure.

*Compiled from the U.S. Bureau of Mines Area Report V-1963P1

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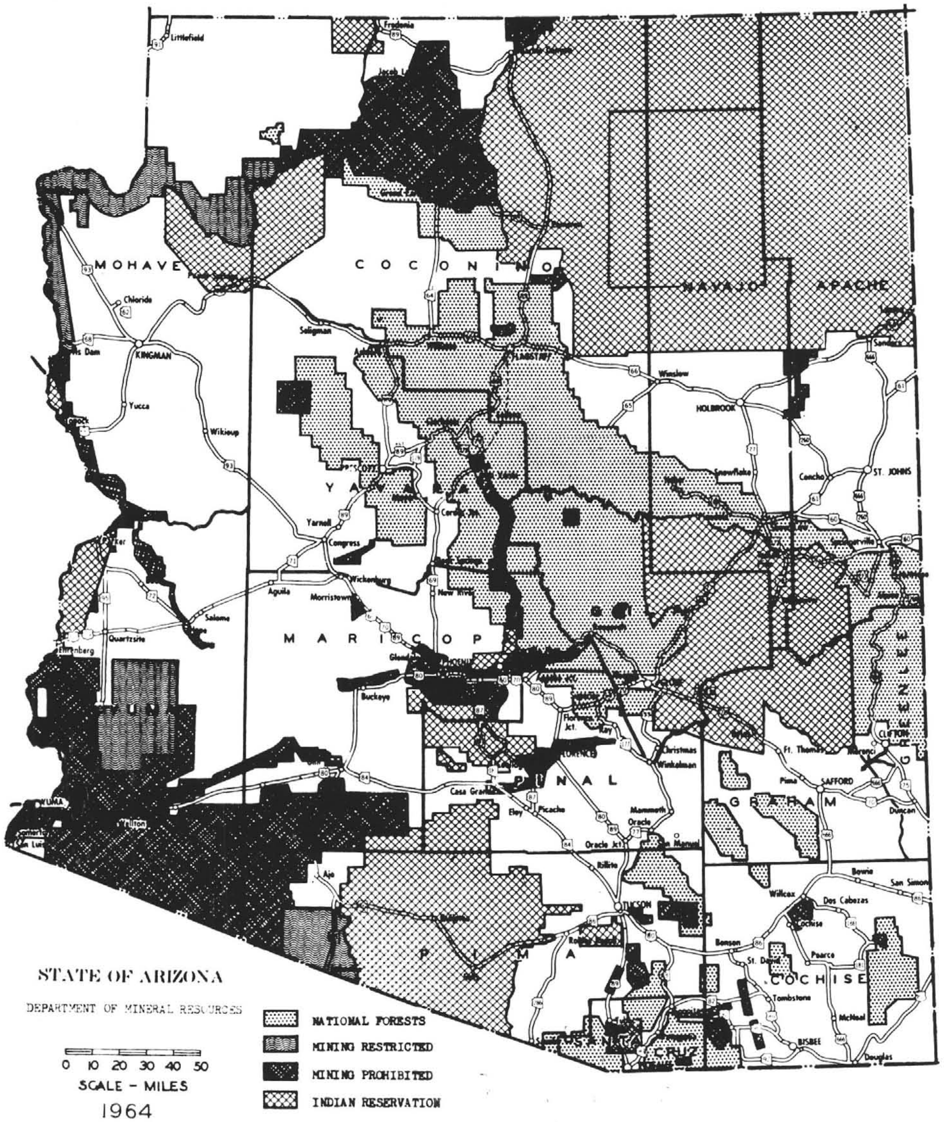


TABLE VI

VALUE OF MINERAL PRODUCTION IN ARIZONA, BY COUNTIES

YEARS 1958-59-60-61-62[1]

County	1958	1959	1960	1961	1962
Apache	$ 4,324,954	$ 4,253,943	$ 5,212,471	$ 5,001,845	$ 7,333,518
Cochise	38,065,293	31,963,199	44,255,697	48,857,698	51,289,505
Coconino	4,394,124	4,884,107	7,622,708	4,930,681	3,987,166
Gila	43,124,640	50,239,827	47,186,532	43,569,443	52,827,599
Graham	20,402	153,582	150,596	158,979	255,840
Greenlee	53,073,897	48,084,455	70,413,650	70,016,363	78,150,348
Maricopa	5,370,894	6,698,542	6,120,634	7,883,688	6,946,540
Mohave	950,678	982,759	346,651	831,854	576,745
Navajo	2,253,126	3,170,572	2,220,445	1,996,143	3,638,234
Pima	66,089,879	91,325,129	98,271,821	106,865,830	127,418,897
Pinal	78,450,806	61,236,788	106,722,094	107,827,684	110,131,864
Santa Cruz	1,266,720	1,130,477	816,087	636,840	530,975
Yavapai	16,399,450	21,643,699	26,710,885	25,879,720	29,095,274
Yuma	1,652,166	1,794,254	584,511	705,465	1,080,304
Undistributed	288,528	683,649	590,255	832,608	879,314
TOTALS[2]	$314,520,000	$326,862,000	$415,512,000	$425,995,000	$474,142,000

1. From U.S. Bureau of Mines Minerals Yearbooks.

2. Totals for years 1958-59-60-61 adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

The State flower is the pure white, waxy flower of the sahuaro cactus, which blooms in the late spring. Blooms are found on the tips of the sahuaro arms. Many sahuaros are more than 100 years old, and some attain a height of 50 feet.

The census of 1960 showed the population of Arizona to be 1,302,161; 74 percent higher than the census figure for 1950. The population as of July, 1963 has been estimated at 1,580,000. In 1900, it was 122,931. Arizona is the Nation's fastest growing state since the start of the century.

Population figures by counties are as follows:

	1960[1]	1963[2]		1960[1]	1963[2]
Apache	30,438	39,000	Mohave	7,736	10,000
Cochise	55,039	63,000	Navajo	37,994	46,000
Coconino	41,857	48,000	Pima	265,660	312,000
Gila	25,745	26,000	Pinal	62,673	68,000
Graham	14,045	16,000	Santa Cruz	10,808	13,000
Greenlee	11,509	12,000	Yavapai	28,912	31,000
Maricopa	663,510	810,000	Yuma	46,235	51,000

1. Census.

2. Estimate in Arizona Progress, Feb. 1964.

Mining In Arizona

Arizona is by far the greatest producer of non-ferrous, metallic minerals of any state in our Union. In 1963,

It ranked first in the combined dollar value of such metals.

It ranked first in copper production.

It ranked fifth in lead.

It ranked ninth in zinc.

It ranked second in silver.

It ranked third in gold production.

The following is a tabulation of the annual Arizona production of these metals for the years 1953 to 1963.

TABLE I

	Gold oz.	Silver oz.	Copper lbs.	Lead lbs.	Zinc lbs.
1953	112,824	4,351,429	787,050,000	18,856,000	55,060,000
1954	114,809	4,298,811	755,854,000	16,770,000	42,922,000
1955	127,616	4,634,179	908,210,000	19,634,000	45,368,000
1956	146,110	5,179,185	1,011,816,000	23,998,000	51,160,000
1957	152,499	5,279,323	1,031,708,000	24,882,000	67,810,000
1958	142,979	4,684,580	971,678,000	23,780,000	54,064,000
1959	124,627	3,898,336	860,594,000	19,998,000	74,650,000
1960	143,064	4,774,992	1,077,210,000	16,990,000	71,622,000
1961	145,959	5,120,007	1,174,106,000	11,874,000	59,170,000
1962	137,207	5,453,585	1,288,484,000	13,932,000	65,776,000
1963 P	139,200	5,401,000	1,317,400,000	11,760,000	51,160,000

P = Preliminary

HISTORY — GENERAL

In the period from 1858 to 1963 inclusive, Arizona's mines have yielded more than $9.4 billion, over 94 per cent of which came from its five principal metals: copper, lead, zinc, gold and silver. While all phases of the mining industry contributed to such achievement, it is to the pioneer prospector and miner we of this "machine age" owe an everlasting debt. He first found the veins and the orebodies. He blazed the trails, conquered the desert, braved its terrors, bridged the barrenness, scaled its difficulties and, in the end, wrested wealth from its age-long secrets and its hidden hoards.

Long before the white man had set foot on much of this nation's area he had explored portions of Arizona. It was the lure of the metals — gold and silver — that prompted Coronado's famous expedition in search of the Seven Cities of Cibola, and in 1540, eighty years before the Mayflower left England, Coronado's Army Captain, Cardenas, stood on the brink of Arizona's Grand Canyon. Coronado, however, wanted his gold and silver already mined, smelted and minted. Consequently, he did no prospecting.

In 1583, thirty-seven years before the landing of the Pilgrim Fathers, a white man, Antonio Espejo, found silver ore in what is now Arizona. It was Arizona's first recorded mineral discovery. It is known that the Indians did little mining except for turquoise, salt, and possibly iron oxide for paint.

There appears to have been little prospecting following Espejo's discovery until about 1705, when Father Kino did some silver mining. About 1736, the rich silver deposits, Planchas de Plata, near the site of Nogales, stimulated mining, and in 1769, when Tucson became a Spanish settlement, it is known that the Spaniards mined gold and silver in the region. Gold placers at Quijotoa are said to have been worked in 1774.

From about 1824 to 1842, much of Arizona was covered by American trappers and explorers, among them Bill Williams, Pauline Weaver and Kit Carson. Apache raids prevented settlement and prospecting, however, until well after 1848, when that portion of Arizona north of the Gila River became part of

exist. The map is probably a fake, regardless of crude lettering, old and soiled paper, or other details which would seem to lend authenticity.

The rich ore that is supposed to have been obtained from a "lost" mine — and some were very rich — in all probability was "high-graded" (stolen) from some of the early-day rich mines then working.

To a tourist in good health, and accompanied by an experienced prospector, the search for a "lost" mine is a healthful and interesting diversion during the winter months. Such trips always have the possibility of discovering some overlooked mineralized out-crop of promise; a neglected, rather than a "lost" mine.

ARIZONA FACTS

The word "Arizona" is believed to have been derived from two Indian languages — Papago and Pima — and means "Little Spring." "Ari" means *small* and "Zonac" *spring*.

Arizona is the 48th state admitted to the Union, the seventh largest, and has an area of 113,956 square miles. The State was organized as a territory in 1863, and was admitted to the Union on February 14, 1912.

The State flag represents the copper star of Arizona rising from a blue field in the face of a setting sun. The lower half is a blue field, the upper half is divided into 13 equal rays which start at the center and continue to the edges of the flag, consisting of six yellow and seven red rays. A five-pointed copper star is superimposed on the center of the flag.

Arizona's State bird, the tiny cactus wren, likes to build his home in the protection of thorny desert plants. Because of this he often builds his nest in the arms of the giant sahuaro cactus. He builds several nests but lives in only one — the rest are decoys. He is a woody brown bird with a speckled breast.

Mineral Bldg., Fairground

Copper Company, Kennecott Copper Corporation, Magma Copper Company, Miami Copper Company, and Phelps-Dodge Corporation. The Mineral Museum is under the direction of the Department. Besides the minerals in the display, there is a fine collection of almost every type of rock found in Arizona. The Museum is valuable for study purposes as well as interesting and informative to visitors, regardless of their interest in mining as an industry.

"LOST" MINES

Arizona is rich in legends of many "lost" mines.

Perhaps 98 percent of the "lost" mines are pure fiction. They exist only in imagination. True, the stories are interesting, especially to new-comers, but they are likewise dangerous. Many lives have been lost searching for these mythical mines, and in addition, the communities are put to extra expense for posses and searching parties.

"Don't believe" is sound advice regarding lost mines. Forget the lost mines shown on the "old-map-my-grandfather-bought-from-an-old-Spaniard-he-befriended." It simply doesn't

the United States. That was also the year of the California gold rush, and while thousands of emigrants crossed Arizona enroute to the "gold diggins," few stopped to prospect. There are, nevertheless, well authenticated stories that Papago Indians had discovered gold near Gila City, Yuma County, in 1846, or two years prior to the California discovery.

Following the Gadsden Purchase in 1854, southern Arizona was actively prospected. In that year claims were located at Ajo. Mines were worked at Cerro Colorado, and in the Santa Rita Mountains south of Tucson. A few years later the Mowry mine was shipping rich lead ore. With the outbreak of the Civil War in 1861, and withdrawal of U. S. soldiers, the Apaches "took over" for some 10 years. Nevertheless, in 1862-63 the rich, gold placers of La Paz, Rich Hill and Lynx Creek were found and mined, and soldiers stationed at Fort Mohave discovered gold lodes near what is now Oatman. It was about that time, too, that many famous mines were discovered—Vulture, Planet, Castle Dome, and many of the rich mines of the Prescott region.

The '70's witnessed the discovery and development of many Arizona mining camps that are still yielding great mineral wealth. Globe-Miami, Silver King, Superior, Bisbee, Jerome, Tombstone, and Clifton-Morenci are among the mining districts founded in that period.

All these camps etched for themselves colorful pages in Arizona's early history, but perhaps the once-riotous Tombstone succeeded in leaving the most indelible impression.

"Instead of a mine, you'll find a tombstone," said a fellow soldier to Ed Schieffelin in 1877 as he set out from Fort Huachuca, near the Mexican border, to "look for stones." Schieffelin recalled the warning, and when he came across some rich-appearing ore, said to himself, "Here is my tombstone." That was how the camp received its name. Since then stories of its development, its frontier sheriffs who brought law and order to one of the wildest mining camps of the then very wild West, and its rugged inhabitants, have been the subject of a number of articles and books.

Untold centuries ago there was locked away in Arizona's mighty mountain vaults, stores of precious metals; a supply

sufficient and necessary for our increased commerce, industry and population. The doors of these vaults were fitted with time locks. Those already opened have given the world rich treasures. Others as yet unlocked await but the same combination—need, capital, science, brains, courage, faith, and work.

Table II is a summarized tabulation of Arizona's production of its five principal metals.

TABLE II

Production to the end of 1963

19,085,386	tons of copper	worth	$7,876,493,000
627,624	tons of lead	worth	122,249,000
938,753	tons of zinc	worth	226,255,000
13,016,104	ounces of gold	worth	343,059,000
375,288,241	ounces of silver	worth	295,123,000
	Total Value		$8,863,179,000

And that isn't all of the story. It is estimated that fifty per cent of the value of all of these metals has been expended in Arizona for wages, supplies, and state, county, city and school taxes. The balance has gone for out-of-state purchases, refining, marketing, and dividends to investors, many of the latter being citizens of Arizona.

and the Federal Bureau of Mines. These agencies can and will furnish data as to the geology and mining history of Arizona mining districts and of many mining properties. Many valuable bulletins, maps and pamphlets also are available, although a number of them are out of print and must be sought at a library or at such bureaus as the above.

An organization known as the Arizona Small Mine Operators Association, 508 Title and Trust Building, Phoenix, Arizona, furnishes many valuable services. Those interested in mining are advised to join. Dues are only $2.00 per year, including a subscription to its monthly publication, which disseminates mining news and information.

Mining conditions change. New facts are discovered each day in the advancement of mining and metallurgical technology. Today's waste rocks will be tomorrow's ore, and the demand for the metals will continue to mount.

ARIZONA DEPARTMENT OF MINERAL RESOURCES

This department, with offices in the Mineral Building at the Fairgrounds in Phoenix, is a state agency established to assist the more extensive exploration and development of the mineral resources of the State. The department engineers render assistance within the limitations of their public position. The department's files contain information on many properties, and its library includes many out-of-print U. S. Geological Survey and U. S. Bureau of Mines publications, all very valuable for reference. Technical trade journals, late information on pending legislation, market and price data, and other pertinent mining information are on file.

The Mineral Building, finished in 1919, houses a fine collection of minerals. For many years this valuable display was open to the public only during the 10-day period of the Arizona State Fair in November of each year. Early in 1953, the following mining companies provided funds to keep the exhibit open on a year-round basis with a curator and assistant: American Smelting and Refining Company, Inspiration Consolidated

THE FUTURE AND ARIZONA'S MINERALS

Arizona is not a "mined-out state." Not all of our ore deposits have been found. In recent years some ore bodies of great promise have been fully investigated and developed under modern exploration, mining and recovery methods. Recent research and exploration results promise further substantial additions to Arizona's copper production.

Only a few percent of the State's 72,688,000 acres have been intensively prospected, or investigated by geophysical methods. Many marginal areas in the older and productive districts will yield mineral wealth in the future. There still are productive possibilities in many long-shut-down mines; and many oxide ores not now economical will become so when ways to treat them are found.

The undeveloped ore bodies may not be as rich as those already mined, but the lower grade may be offset by greater tonnage. And with the application of advanced mining and metallurgical practices they may offer rich rewards for venture capital. However, laws, regulations and taxes which tend to repel venture capital should be considered carefully in the light of the need of Arizona and the Nation for maintained mineral production and for new mines to take the place of those becoming depleted. Industrial demands must be met, and the nation's security and economic health must be protected.

Arizona seeks and welcomes new mining venture capital. To investors we say, "investigate before venturing," because mining is a highly specialized industry, requires special know-how, and usually involves more risk than trade or manufacturing. Those entering the mining business need the best available advice about the risks involved and the chances of profit to justify the venture.

Investors in mining now have several advantages over early-day venture capital. Legally, they are much better protected in their investments. Technically, they can enlist the aid of the Arizona State Department of Mineral Resources, the Arizona Bureau of Mines, the United States Geological Survey,

THE MAJOR METALS

The five major metals being produced in Arizona are gold, silver, copper, lead and zinc.

GOLD AND SILVER

Gold mining in Arizona did not start to any appreciable extent until after the acquisition of the territory by the United States from Mexico in 1848 and 1853.

In 1853, the only accessible parts of the Territory were around Tucson and Tubac, where several silver mines and one copper mine were opened, but little or no mining was done. The outbreak of the Civil War caused the withdrawal of troops and all mining ceased.

During the Civil War, troops came back and prospecting parties were organized. Rich placer gold deposits were found near the Colorado River at Gila City, La Paz, Quartzsite, and Rich Hill, and along Lynx Creek, Hassayampa River, and Big Bug Creek in the Bradshaw Mountains of Central Arizona. After the richer parts of the placers were exhausted, gold ledges were located and worked in the crudest manner.[1] The Vulture was the only large mine worked.

After the Civil War, troops were again withdrawn, and with the Apaches again rampant, little mining was done except around Prescott and Wickenburg. Peace was made in 1872, but with commodity prices high, gold was less attractive than silver and copper. A silver boom followed, and rich mines in the Bradshaws, Silver King, Globe and Tucson areas were discovered. The purchasing power of gold increased during 1884 to 1893 when silver de-monetization stopped practically all silver mining. The silver miners turned to the search for gold, and discovered the Congress and Octave deposits in the Bradshaw Mountains, the Mammoth, north of Tucson, the rich Harqua Hala, La Fortuna, and King of Arizona mines in the desert of Yuma County, and numerous others. Better concentration methods and the cyaniding process encouraged the reopening of old mines.

1. J. B. Tenney, Ariz. Bureau of Mines Bull. 137, p. 16, Aug. 15, 1934.

Commodity prices turned upward near the close of the century, gold mining again became less attractive and, except for short periods, stayed so until the start of the depression in 1929. However, the rich vein deposits of the Gold Road, Tom Reed, United Eastern, and others in the Oatman district and the older mines of the Bradshaw Mountains and Yuma County were producing—the latter on a reduced scale except for the North Star Mine. The Commonwealth silver mine also produced.

The depression of the Thirties caused a return to active gold prospecting. $35.00 gold in 1933 further stimulated the search and there was activity in most of the old gold camps and some new. Activity slowed some, as commodity prices rose following the depression,and stopped with the World War II order L-208 closing all gold mines because of labor shortage.

Before the advent of the big porphyry copper producers in 1912, the gold lode mines and placers were accounting for 75 percent of gold production in Arizona. From 1912 until 1942, the gold mines and placers still accounted for almost half of Arizona's gold production, but since then, production from gold lode mines and placers has dropped to below 3 percent of the total. In 1942 the annual production from these mines had dropped from 156,000 ounces to a mere trickle of 1,000 ounces, a loss of 155,000 ounces, or almost five and one-half million dollars. The loss in silver was over 1,050,000 ounces, which had a value (including seignorage) of almost one and one-half million dollars. Although the gold mines were permitted to re-open after World War II, the deterioration of the mines, due to the long shut-down, and the rapid increase in mining costs together with the rapid decline in the purchasing power of the dollar, prevented their doing so. Today there is not one bona-fide gold or gold-silver mine in operation in Arizona, except for the few producing siliceous fluxing ores for the copper smelters. Because of the federal government's control of gold prices, the producers have not enjoyed the inflationary benefits which other commodities have enjoyed. Result, there has been no incentive for them to re-open their old gold mines or explore for new ones. The out-flow of gold from the United States in recent years has raised the hopes of gold miners for an early

Twenty-seven producing oil and gas wells have been developed to date in Arizona. The number is small, but as knowledge of underlying strata has increased, there also has been increased expectation of more favorable results from future drilling. At present, there are 9 producing oil wells, 7 producing gas wells, 1 shut-in gas well, and 5 wells in various stages of drilling, in Arizona.

HELIUM

The 1963 output of helium was 437,418,000 cubic feet. This was significantly greater than in 1962, and its value was nearly double the value of the mineral fuels produced in 1963. The helium production came from nine wells in the Pinta Dome field in Apache County, owned by Kerr-McGee Oil Industries, Inc. This company extracted the helium in the plant which it completed in 1961 for recovery of Pinta Dome helium.

Four helium wells were completed in 1963. In addition to the 9 wells now producing, there are 13 shut-in helium wells in Arizona.

has been crushed and sized for roof coatings. Marble also was produced in Pima, Yuma and Yavapai Counties. Onyx marble has been produced in Coconino, Maricopa, Pima and Yavapai Counties. Dimension limestone, crushed limestone and very recently some dimension slate also have been produced in Arizona.

Crushed stone, used for concrete, road material, railroad ballast, and smelter flux, has been the chief source of income for Arizona stone producers.

The following production figures tell the story of the phenomenal increase in stone production in Arizona:

	Tons	Value
1889-1949 (Ariz. Bur. Mines)		$14,234,000
1949-1954	1,493,323	1,764,958
1955-1959	9,321,000	14,514,000
1960-63 (1963 Preliminary)	16,290,000	22,719,000
Total Value 1889-1963		$53,231,958

MISCELLANEOUS NON-METALLICS

Barite, fluorspar and nitrogen compounds have been mined in Arizona, but not in recent years.

MINERAL FUELS

Small amounts of coal were mined, and coal exploration continued in the Black Mesa area of the Navajo and Hopi Indian Reservations in Arizona, in 1963. In 1963, 33 oil wells were completed, and two oil and one gas discovery were made. This compares with 54 completed wells, 1 oil and 9 gas discoveries, in 1962, the most active year to date.

Petroleum production increased from 39,000 barrels in 1962 to 67,582 barrels in 1963, a figure still below the 73,000 barrels produced in 1961.

Production of natural gas increased from 230 million cubic feet in 1962 to 959 million cubic feet in 1963.

return to economic conditions favoring gold mining. The increase in silver price to the monetary value of $1.293 following cessation in 1963 of government purchases and sales of silver, has stimulated interest in silver and silver-lead mines.

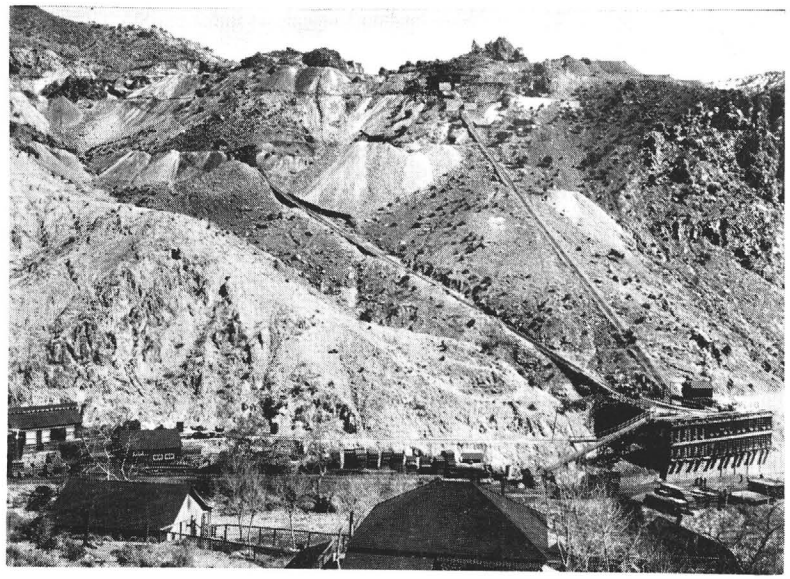
From the average ton of Arizona copper ore mined in 1962, $0.11 in gold and silver were recovered. This gold and silver content tends to decrease, as does the copper as mines get deeper. For example, the value of the gold and silver recovered from copper ores in 1941 was $0.354 per ton of ore mined. For each ton of copper ore mined in 1941, 0.0059 ounces of gold and 0.207 ounces of silver were recovered, and in 1962 these figures dropped to 0.0015 ounces and 0.058 ounces respectively.

COPPER

For more than 80 years the copper mines of Arizona have poured a ceaseless stream of metal into the nation's industries. The state has for 50 years ranked as the leading copper producer in the United States; its output, up to the end of 1963, amounting to 19,085,386 tons of copper worth $7,876,493,000. For the past five years Arizona has produced more copper than all the other states combined. There is no reason to believe that she cannot continue as the leader for many years to come. Nature has made her one of the world's most important sources of copper.

The record of Arizona's steady growth and progress is closely linked with the development of her copper industry. This development has been achieved through decades of courageous perseverance in the face of repeated discouragements. Thousands have spent a lifetime in helping to develop the mines and to build the communities with their schools, banks, churches, public buildings, and their roots extend down into the earth, to the bodies of copper-bearing ore which nourish them.

From 1880 to 1910, copper mines in Arizona were of the "bonanza" or high-grade type. Such properties as the Old Dominion at Globe, the Copper Queen at Bisbee, the United Verde at Jerome, and those at Clifton-Morenci were the major producers during this period. The Copper Queen is the only one of



Copper Mining About 1900

these which is still a producer of a substantial amount of high-grade copper ores. Morenci now produces low-grade ores from the second largest open pit mine in the United States. Old Dominion and United Verde mines were exhausted more than ten years ago. Beginning about 1910 and through the next 50 years, the low-grade "porphyries" were the chief copper producers. However, the Magma Mine at Superior has been a high-grade producer since 1910, and is still operating as such. The United Verde Extension Mine at Jerome was another high-grade producer that operated from 1916 to 1938.

In 1962, the copper mining and smelting industry payroll in Arizona amounted to $108,559,132. This figure does not include fringe benefits which are adding over 25 percent to the annual labor cost of the copper mining and smelting industry.

It is estimated that Arizona copper mines spend over $30,000,000 annually in Arizona for Arizona-grown or manufactured supplies and equipment, thus contributing substantially to the cities where supply, machinery, and transportation headquarters are located.

from Coconino County. The Atchison, Topeka & Santa Fe Railway Co. produced the largest tonnage, but Superlite Builders Supply Co., makers of concrete blocks, produced material of highest total value. Standard Pozzolan Co. continued to mine and process pozzolanic pumice north of Flagstaff for use in concrete at Glen Canyon Dam. For the ten years preceding 1963, the U. S. Bureau of Mines reported Arizona production of 3,900,000 tons of pumice worth $8,800,000.

SAND AND GRAVEL

Sand and gravel are products of all States in the Union, and Arizona is no exception. Records of Arizona production were first reported statistically in 1917, and the following tabulation shows the tremendous increase since then:

	Tons	Value
1917-1948 (Ariz. Bur. Mines)		$ 15,668,000
1949-1954 (U.S. Bur. Mines)	15,423,000	11,770,000
1955-1959 (U.S. Bur. Mines)	61,640,000	43,400,000
1960-1963* (U.S. Bur. Mines)	64,057,000	66,114,000
1917-1963 Total Value		$136,952,000

* 1963 Preliminary

STONE

Commercial stone in Arizona is broadly classified as dimension stone and crushed stone.

Dimension stone is used in buildings, walls, pavements, curbs, flagging and ornaments. Commercial shipments of sandstone have been made from Coconino, Navajo and Yavapai Counties. Coconino sandstone of various colors now is quarried near Ash Fork and Drake. Granite rock for building and monumental purposes has been quarried in several Arizona localities, chiefly near Prescott, Phoenix, Casa Grande and Salome. Volcanic tuff also has been quarried in several counties for buildings.

Marble has been quarried in Cochise County over a period of many years, in the Dragoon Mountains and earlier in the Chiricahua Mountians. In recent years, much of the production

MICA

The mica produced in Arizona has been of the scrap variety. Four operators in Maricopa, Mohave, Pima and Yuma Counties have accounted for most of it. In recent years, the bulk of the production has been by the Buckeye Mica Co. with mill at Buckeye. Although some mica has been produced for many years, published records are incomplete. It is estimated that for the period 1951-1963 the value of mica production exceeds $600,000.

PERLITE

Perlite deposits near Superior first became of interest in 1924, and commercial production commenced in 1946. Production was small from 1946 to the end of 1948, and was even less in the following years, due to technical problems connected with its use; but beginning with 1951, it started back up. The U. S. Bureau of Mines reported perlite production from 1954 to 1957 inclusive, totaling 42,179 tons valued at $305,396.

Production dropped in 1958, due largely to the closing of the Superior Industries Inc., and Lee's Perlite Industries, Inc. operations in Pinal County. Figures have not been published for years after 1957, but there was an increase in 1959 and perlite popping plants were operated at Phoenix by Perlite Industries of Arizona, Inc., and at Tucson by Tucson Perlite, Inc. The same plants operated in 1960.

Since 1960, Arizona Perlite Roofs, Inc., successor to Perlite Industries of Arizona, Inc., and Harborlite Corp. have been the principal producers of Arizona perlite. Expanded perlite was produced from purchased material by Supreme Perlite, Inc., at Phoenix, for use mainly in plaster. Expanded perlite also is used for insulation, concrete aggregate and soil conditioning.

Production of Arizona perlite to the end of 1963 has exceeded $1,000,000 in value.

PUMICE

Arizona in 1962 produced 756,000 tons of pumice valued at $1,640,000. This was 33 percent of the Nation's output and more than any other state produced. Over 96 percent of it came

The mining industry is Arizona's largest taxpayer. In 1963, $29,446,000 was paid for property and production (sales) taxes within the state. No other industry contributes nearly as much in taxes. Mining alone carries about 12.8 percent of the State property tax load.

The railroads and truck lines receive a large volume of business through the movement of copper ores and metal as well as supplies and equipment. Copper mining brought the railroads to Arizona and has furnished the bulk of the freight which has kept them going and expanding.

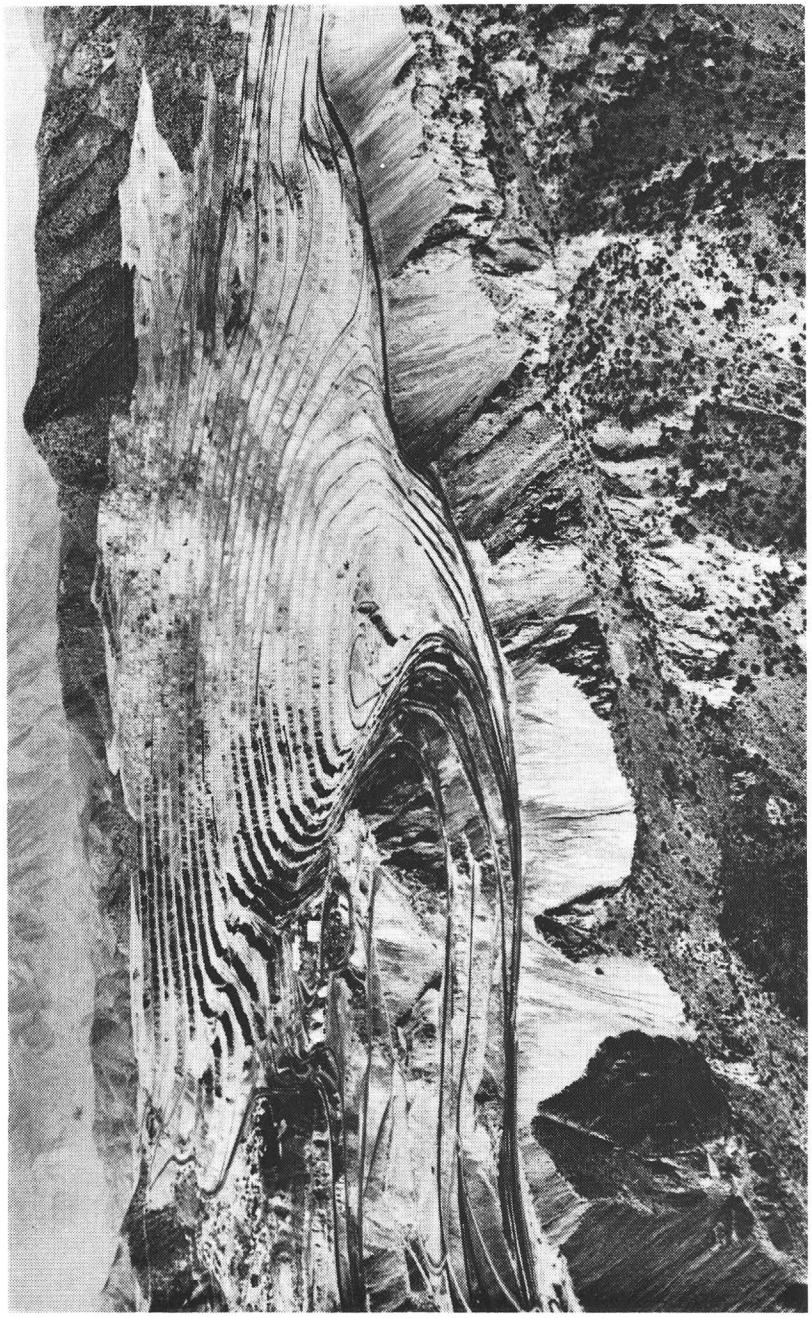
Agricultural, lumber and livestock producers in non-mining portions of Arizona derive a large share of their income from the copper industry.

The copper companies are heavy purchasers of electrical power which is generated at irrigation storage dams. The large power purchases by the copper mining companies have made cheaper power and increased water supply for agriculture and industry.

The copper mining industry has a vital and far-reaching effect on the State's economy and is one of the few industries which creates new and indestructible wealth. It is equally vital to the nation's security, and it is necessary that this country keep its domestic mines in operating condition at all times.

Copper ores and minerals are of no practical value until they have been converted into metallic copper. They earn no interest, furnish no employment, produce no benefits to anyone. An active mining industry is the agency which converts them into tangible assets and, in the process of conversion, the benefits derived therefrom are distributed widely among other industries and businesses. The direct and indirect beneficiaries of the copper industry are countless. It has been estimated that an average of 13.5 persons (including the miner himself) is dependent upon each mine and smelter employee's wages.

In the past four decades the average grade of copper ore in Arizona has been steadily declining from a content of 50 pounds per ton of ore to about 18 pounds per ton. This, together with steadily increasing wages, which have more than quadrupled



Open Pit Copper Mine

The Arizona Bureau of Mines estimated the value of feldspar produced in Arizona in the period 1923 - 1961 at $4,750,000.

GEM STONES

Turquoise, tourmaline, opal, agate and other gem stones have been produced in Arizona, and all counties have contributed. The value of production through 1963 is estimated to be approximately $1,750,000.

GYPSUM

Arizona's gypsum production, which is used mostly in cement, but also in wallboard and soil conditioning, increased from 6,686 tons in 1951 to 96,000 tons in 1956. The output comes from the Arizona Gypsum Corporation's properties near Feldman, Pinal County, and Camp Verde, Yavapai County, and the National Gypsum Company's property near Feldman. The latter company ships to its wallboard plant at Phoenix, built in 1955.

The value of gypsum production in Arizona to the end of 1962 is estimated to be $4,400,000.

LIME

Lime for building purposes has been produced in Arizona since 1894. The lime plant at Nelson at the northwest corner of Yavapai County, now owned by the U. S. Lime Products Division of Flintkote, is said to have furnished most of the lime used in the rebuilding of San Francisco after the earthquake and fire of 1906. Since 1915, the larger proportion of the lime produced in Arizona has been used in the flotation process at large copper concentrators, and most of this has come from the Paul Lime Plant at Paul's Spur in Cochise County, and from Hoopes & Company in Gila County. Some copper companies make lime for their mills from limestone quarried at their own properties.

The total value of lime produced in Arizona is approximately $37,000,000.

The Arizona Bureau of Mines estimates the total value of Arizona asbestos produced from 1914 through 1961 at approximately $15,820,000. Figures are not available for subsequent years.

CEMENT

The first cement plant in Arizona was built by the Arizona Portland Cement Company at Rillito, Pima County. The plant was started up in December, 1949, with a capacity of 2,000 barrels per day. Capacity was increased to 4,000 barrels per day in 1951 and to 7,000 barrels per day in 1955. Present capacity is about 8,000.

The next of the two Arizona cement plants was built by the Phoenix Cement Co. at Clarkdale to meet its commitment to supply 3 million barrels of cement to the Glen Canyon Dam project. The plant was started in operation in the fall of 1959. Its initial capacity was 5,000 barrels per day. An additional kiln installation was completed in mid-1961 to bring plant capacity to about 2,600,000 barrels per year.

CLAYS

Clays have been produced in Arizona since 1894. A white bentonite or bleaching clay from open pits near Sanders, Apache County, has been of chief importance in the past. In recent years clays in Pima County for clay products and in Yavapai County for cement have been of principal value, with lesser amounts from Apache, Gila and Maricopa Counties.

According to the Arizona Bureau of Mines the value of Arizona clay production from 1925 through 1961 was over $26,000,000.

DIATOMACEOUS EARTH

Diatomaceous earth is mined and processed near San Manuel in Pinal County, for use in insecticides, building blocks, paint and acoustical tile.

FELDSPAR

High quality potash feldspar is mined and ground near Kingman, Mohave County, by International Minerals and Chemicals Corp., for use in glass and pottery.

during the same period, naturally leads to higher production costs, in spite of technological improvements in mining and metallurgy.

The copper industry also has been plagued by the competition of foreign copper produced from African and South American mines of higher average grade, using labor commanding but a fraction of the wages paid in this country. From 1932 to 1940, Congress imposed a 4-cent copper tariff every two years. The price of copper averaged 10.11 cents per pound in this period, so that on an ad valorem basis the duty was roughly 40 per cent. A 4-cent tariff with a 32-cent copper price would be only 12½ percent ad valorem. Nevertheless, the present tax has been reduced to 1.7 cents per pound of copper, or an ad valorem tax of only about 5 percent, which is but one-eighth of the original 40 percent.

Recent Developments

Arizona has attained a copper production capacity of some 700,000 tons of copper per year, but the producers are continuing the search for new ore-bodies to keep up with the expanding demand for the metal, and for improved methods of extracting copper from their deposits. Kennecott Copper Corporation has recently completed an expansion project costing over forty million dollars, which has increased their ore production at Ray by fifty percent. The company has also purchased 120 claims north and east of Safford where drilling has discovered a large copper mineralized area. Phelps Dodge Corporation has explored and acquired copper property nearby.

The American Smelting & Refining Company completed its Mission Project, 15 miles southwest of Tucson in 1961 at a cost of $34 million. The mine produces over 15,000 tons of ore per day.

Inspiration Consolidated Copper Company started production at its Christmas property in Gila County in 1962. The property is equipped to produce at the rate of 4,000 tons of ore per day.

Duval Corp. expects to complete the development and equipment of its Ithaca Peak property for production by the

end of 1964. This project in the Mineral Park district north of Kingman is expected to cost $28,000,000.

The Anaconda Co. in April, 1964, exercised its option to lease extensive, partially explored and developed copper properties in the Pima and Helvetia districts south of Tucson. The properties are expected to be exploited on a large scale.

Exploration for copper deposits continues to be actively pursued by the copper companies and a number of other companies and individuals.

The major copper-producing mines and smelters in Arizona in 1963 are listed in Table III.

TABLE III

MAJOR ARIZONA COPPER MINES, 1963

Open Pit Mines

Mine	County	Operator	Tons Ore Mined
Morenci	Greenlee	Phelps Dodge Corp.	17,141,000
New Cornelia	Pima	Phelps Dodge Corp.	9,370,000
Ray	Pinal	Kennecott Copper Corp.	7,123,102
Inspiration	Gila	Inspiration Cons. Copper Co.	5,487,483
Esperanza	Pima	Duval Corp.	4,364,029
Lavender Pit	Cochise	Phelps Dodge Corp.	5,347,000
Copper Cities	Gila	Miami Copper Co.	3,149,260
Silver Bell	Pima	Amer. Smelting & Refin. Co.	2,954,100
Mission	Pima	Amer. Smelting & Refin. Co.	7,289,100
Bagdad	Yavapai	Bagdad Copper Corp.	2,094,670
Pima	Pima	Pima Mining	1,992,725
		Total Tonnage	66,312,469

Underground Mines

San Manuel	Pinal	San Manuel Mining Co.	12,555,000
Magma	Pinal	Magma Copper Co.	310,039
Copper Queen	Cochise	Phelps Dodge Corp.	715,000
Daisy & Palo Verde	Pima	Banner Mining Co.	321,493
Christmas	Gila	Inspiration Cons. Copper Co.	638,775
Miami	Gila	Miami Copper Co.	*
		Total Tonnage	14,540,307

* Underground mining discontinued June 26, 1959.

NON-METALLIC MINERALS

ASBESTOS

Gila County is the only area in the United States which produces high-grade, low-iron-content, chrysotile asbestos. These Arizona deposits once were the only low-iron chrysotile deposits known in the Western Hemisphere, but now the Cassiar deposit in British Columbia is a strong competitor. The Cassiar asbestos is cheaper to mine, but Arizona has advantageous transportation costs and lower iron content.

The depression picture that gripped this asbestos industry after December 31, 1958, when the U. S. Government stopped purchase of fiber for stockpiling, has changed, and three modern processing mills have been erected as a result of the aggressive leaders of several asbestos companies searching for, and finding, new markets for their products. The asbestos companies which have built these modern fiberizing mills are Jaquays Mining Corporation, Metate Asbestos Corporation and Le Tourneau Asbestos Company. The mills are located at Globe.

Most of Arizona asbestos is short fiber, grading through crudes Nos. 4 to 7. Only a very small percentage is longer fiber, high-priced crude Nos. 1, 2 and 3 grades. The very low iron content of the Gila County chrysotile makes it eminently suitable for electrical insulation uses.

The period of Government purchases from 1952 to 1958 resulted in the opening and reopening of a number of asbestos mines. The largest of these were the Regal, Phillips, Crown, Chrysotile and Rock House. The bulk of the recent Arizona production has come from the Regal and Chrysotile mines of the Jaquays Mining Co.

In the period from 1952 to 1958, the Government purchased 3,240 tons of Nos. 1 and 2 crude asbestos at a cost of $3,845,314, and 1,897 tons of No. 3 crude costing $758,424. In 1960, contracts were made for the purchase for the National stockpile of 500 tons of No. 2 crude at $918.30 per ton.

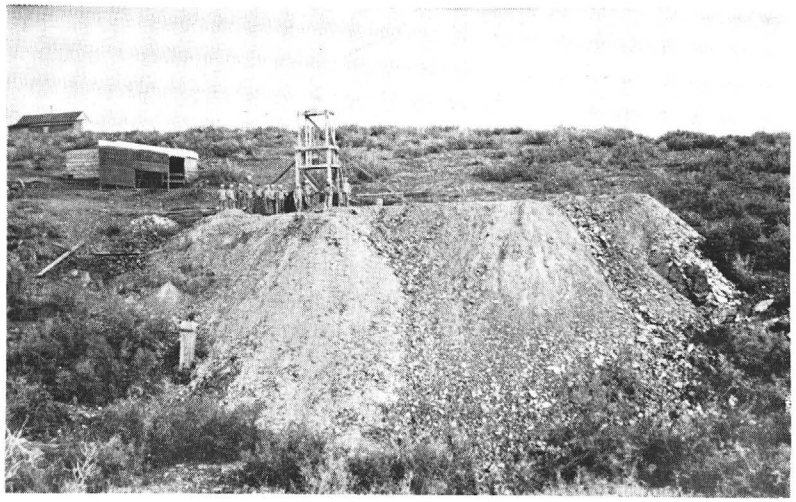
The term "rare metals" is often a misnomer insofar as it may imply scarcity. Uranium and lithium are more widespread in the earth's crust than is zinc; thorium than lead; and beryllium and ridibium than tin. Indeed, spectrographic analyses of rocks and minerals are demonstrating that many so-called rare elements are rare only in the sense that they are neither well known or easily recognized. Today's tremendous advances in technology are calling more and more for new substances having special qualities. Singly or in combination, these unfamiliar elements are now important articles in everyday use. Arizona now produces substantial amounts of uranium. Because of its varied and widespread mineralization, this state could easily become an important source for more of these rare elements.

There are 8 copper smelters, 1 each at Morenci, Ajo, Douglas, San Manuel, Superior and Miami, and 2 at Hayden (Kennecott's and Asarco's). Inspiration Consolidated Copper Company operates an electrolytic refinery at Inspiration, in addition to its smelter at Miami.

LEAD AND ZINC

The first production of lead in Arizona reported statistically by the Arizona Bureau of Mines, was in 1894, and that of zinc, in 1905. However, there are records of actual production of both metals prior to that time. For example, some lead was mined in the Bisbee or Warren District prior to 1880. Some silver-lead ore was shipped during the period 1882 to 1893 from the San Xavier, Fortuna, Banner, Chloride and other mines of the Pima District. Mineral deposits, including lead carbonate and other silver-lead ores, were discovered in the Aravaipa District before 1880. In the Mammoth (St. Anthony) District, production of lead or zinc was not reported until 1934, though silver and gold had been shipped from the district as early as 1880. The Johnson Camp Area in Cochise County had been worked as a source of copper ores from 1881, but it was not until 1941 that zinc concentrates were produced. Likewise the Magma (Superior) District saw the famous Silver King Mine discovered in 1873, but it wasn't until 1916 that the Magma Mill treated lead-zinc ores. The Big Bug District in Yavapai County had its first production of gold and silver and a little copper in 1906, but it did not begin to produce lead and zinc until 1938. The Seventy-Nine lead deposit in the Banner District was first located in 1879, but the record of its production of lead and zinc began in 1913.

The Arizona Bureau of Mines reports the production of the Harshaw, Patagonia, Palmetto, Tyndall, Wrightson and Oro Blanco Districts in Santa Cruz County from 1858 to 1933 to have been approximately 19,500 tons of copper, 25,000 tons of lead, $1,315,000 in gold and $4,637,000 in silver. The oldest mine is the Mowry. Other notable producers were the Duquesne in the Patagonia District, the Flux, Hardshell and Trench in the



Early Lead-Zinc Mine

Harshaw District, and the Montana Mine in the Oro Blanco District. The Montana Mine, operated by the Eagle-Picher Mining Company, ranked as the largest producer of lead and zinc in Arizona from 1935 to 1939 inclusive.

The Iron King Mine (Yavapai County) has been the principal lead and zinc producer since 1951. Its output in 1962 was 4,869 tons of lead and 15,735 tons of zinc. This was 70 percent of the lead and nearly one-half of the zinc output of the State, and the mine is one of the larger producers in the Nation. The Old Dick Mine of the Cyprus Mines Corporation is the State's second largest zinc producer, followed by the Atlas Mine of the B. S. & K. Co. These three mines account for nearly all of Arizona's lead-zinc production.

Low metal prices, due to competitive low-cost foreign production, have closed all but these three and a few small producing lead-zinc mines.

Before the year 1947, because of the failure of foreign producers of lead and zinc to furnish our domestic needs, Arizona was encouraged to open up and develop its lead-zinc mines. In 1949 it attained a production of 33,568 tons of lead and 70,658 tons of zinc from a total of 181 mines. A flood of lead

to 1945 it was obtained largely from complex ore operations in the Mammoth District in Pinal County, but more recently it has been recovered from uranium ores of the northeastern part of the State. The U. S. Bureau of Mines has not reported the quantity or the value of Arizona's production since 1947.

IRON

Arizona's iron occurrences are varied. Four areas of hematite-magnetite deposits, in Gila-Navajo, Yavapai, Maricopa and Yuma Counties, have had considerable attention, but production to date has been very small. Claims have been located on large areas of sands containing magnetite in Pinal, Yavapai, Maricopa, Yuma, Mohave and other counties. A deposit of these sands southeast of Florence has been the supplier of magnetite concentrates for a 75-ton sponge iron and steel plant constructed near Coolidge, Arizona in 1960-61. This plant is equipped for use of the Madaras process. Production to date has been small.

Two of the major copper companies have plants for making sponge iron for use in precipitating copper from leach solutions.

There is a large amount of iron in the copper slag dumps in Arizona. This no doubt will be recovered in the future.

RARE METALS

Of the 92 chemical elements of which the earth is composed, 68 may be classed as metals. Perhaps half of these are commercially important, although only about 20 are used now.

It has been said that development of metals got an impetus during the war that would have taken 50 years of peacetime effort to accomplish. Many new uses for metals and new alloys have passed the experimental stage, and many more will be discovered. That statement applies particularly to the more obscure metals, the newcomers to important industrial use. Among these are lithium, caesium, gallium, selenium, germanium, indium, columbium, beryllium, tantalum, thorium and uranium.

of ore produced in 1962 was 0.26 percent (5.2 pounds) U_3O_8 per ton, or about the same as in the previous two years.

The total value of uranium ore produced in Arizona from 1956-1963 inclusive was $44,000,000.

MISCELLANEOUS METALS

TUNGSTEN

Tungsten is an important metal with the highest melting point of any metal. Its carbides and alloys are very hard and wear-resistant even at elevated temperatures.

Arizona was a relatively small producer of tungsten from 1910 to 1956, when the government ceased purchases of tungsten for the National stockpile. Since 1956, production of Arizona tungsten ores has practically ceased. The mines are unable to compete with low-priced tungsten imported chiefly from Korea, Portugal, Bolivia, Australia and Peru. Total value of Arizona ore production from 1910 to date is approximately $6,000,000.

MERCURY

Mercury (quicksilver) is the only metal that is liquid at common temperatures. It also has high specific gravity, high electrical conductivity and other valuable properties.

Quicksilver deposits have been worked in the Dome Rock Mountains near the western boundary of Arizona; in Copper Basin, southwest of Prescott; in the Phoenix Mountains; and in the Mazatzal Mountains, north of the Roosevelt Dam. From 1910 to 1928, none of these reported appreciable production. At best, the yield probably did not exceed a few hundred 76-pound flasks, with a total value of perhaps $25,000. Total Arizona production has been about 9,000, 76-pound flasks worth about $1,300,000. The major production was during World War II and the Korean War.

VANADIUM

"One of the important uses of vanadium is in the production of high quality steels. The total value of vanadium produced in Arizona through 1947 is estimated at $460,000." Prior

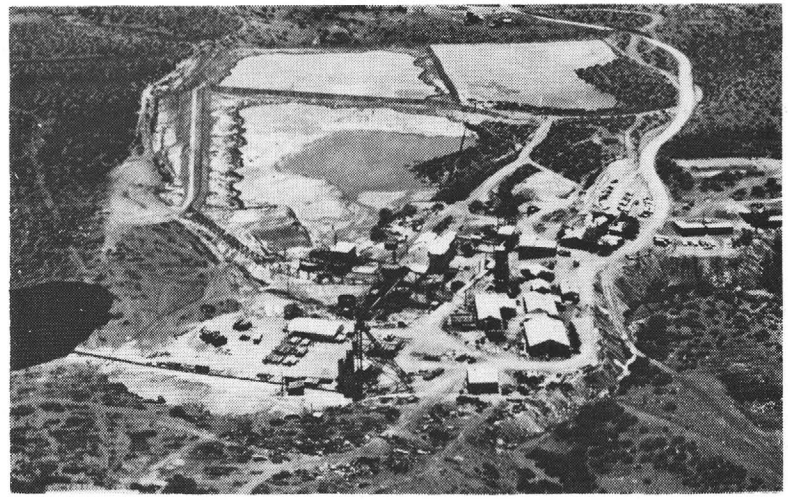
and zinc imports from 1952 to 1959 caused metal prices to collapse, and over 100 mines were compelled to shut down. Others have closed since. The Iron King has been the only large lead-zinc mine able to operate continuously since 1952, and this mine was kept going only because of its income from gold, silver and copper by-products.

Arizona's average annual production of lead and zinc is shown in Table IV.

TABLE IV

	Tons Lead Annual Rate	Tons Zinc Annual Rate
1894-1910	2,075	1,045*
1911-1935	6,376	2,678
1937-1941	12,520	9,900
1942-1946	18,400	30,233
1947-1952	25,388	56,734
1953-1959	10,566	28,145
1960-1963	6,820	30,990

* Annual Rate from 1905-1910.



Same Lead-Zinc Mine About 60 Years Later

MOLYBDENUM

The metal molybdenum, used as an alloying metal in the steel industry, ranks with gold and silver as a valuable by-product of Arizona copper ores. The chief mineral of molybdenum is molybdenite (MoS_2). The metal molybdenum was in short supply in 1951, and the Government took steps to increase production. Now molybdenite is separated from the copper and waste minerals in the mills of most of the Arizona copper mines. It is an important constituent of copper ores at the Ithaca Peak property north of Kingman now being developed and equipped.

Wulfenite (lead molybdate, $PbMoO_4$) was mined from 1916 to 1944, in the Mammoth District in Pinal County.

Arizona's recorded production of molybdenum from 1916 to 1963 inclusive is 52,500,000 pounds with a value of $55,600,000. In 1951 the production was 1,173,000 pounds, more than the entire period from 1916 to 1934. Molybdenum production in 1963 was 5,480,000 pounds valued at $7,313,000 and was 17 percent above the previous high year of 1961.

MANGANESE

Low grade manganese ore occurs in Arizona in a quantity estimated by the United States Geological Survey at 200,000,000 tons with about 4% manganese. It is not visionary to predict utilization of this ore in the future when one remembers that the United States is largely dependent upon foreign sources for its manganese.

Government purchases of manganese ores from 1953 to 1955 resulted in a stockpile at Wenden, Arizona of over 300,000 tons of ore containing less than 20 percent manganese. This ore will have to be up-graded before it is usable in the steel industry.

Under a later carlot program, additional Government purchases of Arizona manganese ore and concentrates were made until 1959. The quota on the carlot program was reached, and purchase of ore for the Government stockpile was halted on August 5, 1959. Production in 1959 was reported from 82 mines

in 9 counties. Yuma and Maricopa counties were the largest producers, followed by Pinal, Pima and Mohave. There were attempts in 1960 and 1961 to continue in business by shipping to steel plants, but they were not successful and no mines reported production in 1962-63.

A summary of Arizona production is given in Table V. The figures are approximate.

TABLE V

Manganese Ore and Concentrates

		Long Tons	Value	Per Ton
	Years 1915-1952	75,000	$ 1,956,000	$26
Wenden—	Years 1953-1954	152,000	10,743,000	70
Carlot—	Years 1955-1959	262,000	21,591,000	82
	Year 1960	1,626	40,000	25
	Years 1961-1963*	—	—	
		490,626	$34,330,000	$70

* Figures not available, small amount in 1961 only.

URANIUM

The use of uranium as a source of atomic energy is well known.

Discoveries of uranium-bearing minerals have been made in all counties of Arizona, but production has come mainly from Apache, Navajo and Coconino Counties. With one exception (the Orphan mine at Grand Canyon), present production is from mines in northern Apache and Navajo Counties. The only uranium processing plant in Arizona is at Tuba City. Most of its ore supply is now from the Orphan mine.

The more important of the areas no longer producing are the Cameron in Coconino County, the Globe in Gila County and the Santa Maria in Yavapai and Yuma Counties.

In 1962, uranium ore production was reported from 31 operations, compared with 42 in 1961 and 86 in 1958. The grade