



Department of Mines and Mineral Resources

1502 West Washington

Phoenix, Arizona 85007

(602) 255-3791 Toll Free in Arizona - 1-800-446-4259

Arizona Mining Update - 1991

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by K.A. Phillips, D. Bain, N.J. Niemuth, and R.R. Beard

Arizona continues to rank as the Nation's leading mineral producer. The value of mineral production in the State last year was in excess of \$3.3 billion (see table, p. 2). As it has since 1910, Arizona leads the Nation in copper production. A total of 2.158 billion pounds of copper was produced in 1990, 62% of the U.S. total. Arizona also ranks first in the Nation in mined gemstone production and is among the leaders in the production of molybdenum, silver, pyrite, and perlite. There are over 92 mines active, excluding sand and gravel operations, producing the above mentioned metals plus 17 industrial mineral commodities. The mining industry directly employs over 12,500 people. Estimates on development expenditures exceed \$100 million.

Space allows only a brief description of some aspects of the industry here. The Department may be contacted for further information. In August, 1991 the Department moved to new facilities at 1502 West Washington. Department hours are weekdays from 8:00 - 5:00. Publication lists are available upon request.

COPPER

The dominant trend in the State's copper industry during 1990 was the continued modernization of the industry's infrastructure in order to lower production costs. An important part of this process has been the widespread deployment of solvent extraction electrowinning (SX-EW) technology. This process produces cathode grade copper, which is directly marketable, from low cost leach solutions obtained from oxide ores or mine dumps.

Copper prices declined 9 cents to \$1.22/lb in 1990, but this decrease was offset by increased production resulting in a slight increase in value produced.

Cyprus Minerals Company

Cyprus Minerals Company's activity in Arizona, since its spin-off from AMOCO in 1985, has been characterized by aggressive expansion. Increased production and acquisition of new copper properties in the last few years have made Cyprus the Nation's second largest producer of copper. A good part of that increased production has come from their Arizona operations.

The Cyprus Miami facilities near Globe include the open pit copper mines, a concentrator that is on stand-by, an SX-EW plant, a smelter and acid plant, an electrolytic refinery, and a rod plant. The smelter has a capacity to handle 450,000 tons of concentrates per year. This smelter allows Cyprus, for the first time, to smelt most of its own concentrates, reducing the company's dependence on short term smelting contracts. The planned expansion of the smelter to 650,000 tpy of concentrates will make Cyprus self sufficient in smelter capacity. The rod plant at the same complex has a 265 million pound per year capacity that allows the company additional flexibility in providing copper to its customers. Over 115 million pounds of copper cathodes are produced annually at the Miami dump-and heap-leach and SX-EW operation.

Cyprus Sierrita, south of Tucson, consists of the Sierrita and the Esperanza open pit copper molybdenum mines, a 100,000 ton per day concentrator, a dump-leach SX-EW plant, a ferromolybdenum plant, and a rhenium plant.

At Cyprus Twin Buttes, in Pima county, the oxide ore is leached, while the sulfide ore is processed at the nearby Sierrita plant.

Four million pounds of copper are produced each year by in-situ leaching at the Cyprus Casa Grande operation in Pinal County. Additionally, the Casa Grande plant has a roasting capacity of 150,000 tons of copper concentrate annually. Refurbishing of the roasters at this facility has enabled a portion of the Sierrita mines's concentrates to be processed into cathode copper.

Asarco Inc.

Asarco operates the Ray, Mission, and Silver Bell mines, along with a copper smelter located at Hayden, Arizona.

In 1989 Asarco announced plans to invest \$54 million in a new SX-EW plant at Silver Bell, northwest of Tucson. The facility will be capable of producing 18,000 tons of copper cathode annually.

The Mission complex consists of the Pima, Eisenhower, and Mission mines that feed the Mission Mill. The Pima mine was purchased from Cyprus and the Eisenhower mine from Anamax in 1985. These pits have been combined to form the present Mission mine complex. In an effort to become less dependent on outside feed for its smelters, Asarco expanded production from the Mission super pit by 46 percent. The \$13.1 million project increases copper concentrate production by 95,000 tons to a total of 300,000 tons per year. Additional grinding capacity and new flotation cells were added, combined with a computer analysis system for flotation data.

In 1988 Asarco purchased the Pima Mill at the Mission complex, renamed it the Mission South Mill and completed its modernization. When running at full capacity by the end of 1991 total mill capacity for the Mission complex will be 59,000 tpd.

In November of 1986, Asarco purchased the Ray mine in central Arizona from Kennecott. The Ray operation employs over 700 people and consists of an open pit mine, concentrator, SX-EW plant, and a smelter that is idle. Following the purchase, Asarco modified the SX-EW plant, which allows Asarco to process low-grade sulfide dump solutions by solvent extraction, replacing copper precipitate production. Copper production at Ray totaled over 240 million pounds last year. Asarco is in the process of building an additional mill at Ray, a 60,000 tons per day portable in-pit crusher, and a 20,000 ton per day concentrator.

Magma Copper Company

Magma became an independent company separate from Newmont Mining Corporation in March, 1987. Composed of two divisions, their operations primarily include San Manuel, the largest underground copper mine in the

Nation, and Pinto Valley, an open pit copper-molybdenum mine.

In addition to being the Nation's largest underground metal mining operation, San Manuel includes a 62,000 ton per day concentrator, an open pit copper oxide mine with associated heap-leach and SX-EW plant, an 1,000,000 ton per year smelter with acid plant, and an electrolytic refinery and rod plant. The San Manuel unit produced approximately 265,000,000 pounds of copper in 1989.

A financing package was part of the deal by which Newmont Mining divested itself of most of the ownership of Magma Copper. A \$225 million project was completed to modernize the smelter and bring it into compliance with the Environmental Protection Agency's air quality standards and expand the SX-EW facility. The Kalamazoo mine, which is the down faulted portion of the San Manuel ore body, is in the process of development. Additional research and development is also being carried out by in-situ leaching of the deep portion of the oxide ore deposit whose copper would otherwise be uneconomic to recover.

The Pinto Valley division includes an open pit mine, a flotation plant, and leaching facilities. Processing of a 35 million ton mountain of tailings, left from the less efficient milling activity at Miami between 1911-35, is underway. The tailings are hydraulically mined with acidic water at the rate of 1,000 gallons per minute under a pressure of 300 pounds per square inch. The resulting slurry is then pumped to a thickening tank. From there, the aqueous solution containing the dissolved copper is sent to the on-site SX-EW plant. The tailings are used to fill an old open pit, reclaiming the 220 acres at the existing tailings site.

Rehabilitation of the underground Magma Mine at Superior was completed and production commenced in September, 1990. The planned production rate of 1500 tpd of ore should be achieved in 1991. Concentrates are shipped to the smelter at San Manuel.

Phelps Dodge Corporation

Phelps Dodge, active in the State since 1880, ranks first in copper production in Arizona and the Nation. The State's largest copper mine and flagship of the Phelps Dodge operations is Morenci. This giant produced over 670,000,000 pounds of copper in 1990, representing over 30% of the State's copper production. Recent expansion and modernization efforts included construction of a \$90 million SX-EW facility that consists of three SX units and one electrowinning tank house. An annual production of 170,000 tons of copper per year makes this the largest SX-EW facility in the country. Other improvements include introduction of in-pit crushers and conveyors that deliver crushed ore to the concentrator, eliminating the need for rail

haulage. With reserves of nearly a billion tons, Morenci will continue to be a world class producer well into the next century.

Another famous Phelps Dodge copper camp, the Copper Queen at Bisbee, is currently a small leach producer of precipitate copper. Phelps Dodge has also been drilling on their Cochise deposit located adjacent to and north of the Lavender Pit at Bisbee. Results announced to date indicate a resource of 170 million tons of 0.5 percent copper as sulfides, apparently amendable to leaching. A test heap leach is currently underway to determine extraction rates and quantities.

In addition to the major copper companies, Arimetco started SX-EW production at Johnson Camp and Oracle Ridge Mining Partners started concentrate production at Oracle Ridge.

MINERAL PRODUCTION IN ARIZONA - 1990

COMMODITY	QUANTITY	VALUE
Nonfuel ¹		
Clay (tons)	140,162	\$2,318,000
Copper (pounds)	2,157,790,000	2,657,649,000
Gemstones ²		3,300,000
Gold (troy ounces)	160,756	62,191,000
Sand & gravel (tons)	27,915	92,166,000
Silver (troy ounces)	5,562,164	26,836,000
Stone-crushed (tons) ^e	5,500,000	13,500,000
Other ³		218,190,000
Fuel		
Coal (tons) ⁴	12,600,000	250,000,000
Uranium (pounds)	1,250,000	12,000,000
	TOTAL	\$3,338,150,00

1/ Nonfuel figures from U.S. Bureau of Mines

2/ ADMMR estimate

3/ Cement, gypsum, lime, molybdenum, perlite, pumice, salt, sand & gravel (industrial), dimension & specialty stone

4/ Source: Peabody Coal

5/ Source: Energy Fuels

e/ U.S. Bureau of Mines estimate

COAL

Coal ranks second to copper in economic importance in the State. Over 12,600,000 tons of coal, with an estimated value of \$250 million, are mined annually from the Kayenta and Black Mesa mines. Surface mining is done on reservation land leased from the Navajo and Hopi Tribes by Peabody Coal. Peabody is the Nation's largest coal producer and the Kayenta mine in northeastern Arizona is their largest operation.

The coal deposits occur on Black Mesa, a prominent structural basin feature of the Colorado Plateau, in the Cretaceous Wepo Formation. Peabody Coal has 35-year leases on 64,858 acres. Mining and reclamation proceed at the same rate; approximately 500 acres annually.

The Kayenta mine, employing over 700 people, is located in central Navajo County. The coal from the Kayenta mine is carried by conveyor belt 15 miles to storage silos. From there it is transported by automated trains to the Salt River Project's Navajo Generating Plant 80 miles away. The Black Mesa mine produces about 4.5 million tons annually. Here, coal is powdered and mixed with water prior to transport by the world's longest, and the Nation's only, coal slurry pipeline. The 272-mile journey to the power plant at Laughlin, Nevada takes three days.

The Peabody operations at Black Mesa are model reclamation programs. As an area is mined, the topsoil is removed and stored. After mining is completed, the topsoil is returned and the land is contoured. The resultant reclaimed land surface, used for grazing, is more productive than the original land.

GOLD

The Cyprus Copperstone open pit mine remained Arizona's largest gold producer with production of over 100,000 ounces. At the beginning of 1991 reserves were 3.2 million tons averaging 0.069 oz/ton, sufficient to extend mining till 1993. Malartic Hygrade U. S. Inc. operator of the Congress mine changed its name to Republic Goldfields Inc. during 1991. Operation of the company's new 350 TPD CIP mill is expected to produce in excess of 30,000 ounces annually.

Magma Copper Company's newly created gold division acquired the recently closed McCabe mine. Two major changes were made prior to the restarting operations. The mining method was changed from shrinkage stopes using chute loading to shrinkage stopes using drawpoint mucking to accommodate the wet, sticky nature of the ore. The mill was changed from a cyanide leach to flotation,

producing a sulfide concentrate containing gold and copper for processing at the San Manuel smelter.

Fischer Watt Gold Co. Inc. drove a decline on the small, but high grade Mystic property. Following favorable results a gravity plant is being constructed to treat the ore.

Bema Gold Corporation acquired Norgold Resources to acquire its principal asset the Yarnell mine. The deposit, containing approximately 275,000 ounces, is expected to reach production in late 1992 as an open pit heap leach operation.

URANIUM

Lower uranium prices (NUEXCO spot price \$8.40/lb. as of 11-91) continue to negatively influence this industry segment. Energy Fuels Nuclear Inc., the State's only producer, continues to develop the Arizona One deposit while the Hermit, Kanab North, and Pine Nut mines remain on standby.

INDUSTRIAL MINERALS

Although copper accounts for 2/3 of the State's mineral production by value, mining in Arizona continues to be a diversified activity. Industrial minerals mined in the State last year include calcium carbonate as limestone and marble for mineral filler and as raw material for lime and cement plants, bentonite for bleaching and clarifying of edible oils, sand and gravel for construction aggregate, tile and brick clay, salt, cinders, pumice for laundry uses and light weight aggregate, zeolites for molecular sieves, stone, perlite for filters, gypsum for wall board and agriculture, silica flux, pyrite and micaceous hematite for pigment, and hydrofrac sand. Although sand and gravel lead this industrial mineral group, both in volume and value of production, many market niches exist for the specialized industrial mineral producer. One example of this is the current popularity of "stone washed" jeans. Pumice used for scouring the denim is mined near Flagstaff by Arizona Tufflite and near Williams by Mountain Mining. The tremendous range in employee and capital requirements for the industrial minerals commodities vary widely enough to accommodate a family-run operation such as Arizona Tufflite, as well as large corporate producers.

Chemstar Lime operates the largest lime plant west of the Mississippi River at Nelson near Peach Springs. Their lime plant with two rotary kilns is rated at 1800 tons of lime per day and supplies lime to many of the State's copper mines along with other users throughout the West. They operate a second smaller plant near Bisbee.

Georgia Marble, a major producer of filler grade limestone with mines in Wyoming and the southeastern United States, acquired family owned and operated Andrada Marble Company near Tucson. They have announced plans to expand both production capacity and product lines.

Pfizer Minerals division acquired Calcium Products of Arizona's Santa Rita Quarry and marble filler mill. Pfizer has announced plans to upgrade the plant and expand capacity.

The Arizona Department of Mines and Mineral Resources project to survey and quantify consumption of industrial minerals in Arizona's market area continues. The object of this project is to encourage exploration, development, and production of industrial mineral deposits in Arizona that can supply southwestern United States and northern Mexico markets.

GEMSTONES

Arizona is the leading state in the value of mined gemstones in the United States. Approximately \$2.8 million worth of commercial gemstone production is reported for Arizona annually. Turquoise, peridot, and petrified wood account for most of the value, with amethyst, chrysocolla, azurite, malachite, fire agate, and apache tears making up the remainder.

Turquoise, a hydrous phosphate of aluminum and copper, is the leading gemstone produced in Arizona. Prized for its color, turquoise is the traditional gemstone used in Southwestern American Indian jewelry. It is mined as a by-product at a number of Arizona porphyry copper deposits. The best quality material is sold by the piece, and the remainder sold or processed for sale by weight.

Peridot is the gem variety of the mineral olivine. The translucent green material comes from the Peridot Mesa area of the San Carlos Apache Indian Reservation east of Globe. Arizona material is suitable for faceting and is of the finest quality in the world. Occurring in Quaternary basalt, the olivine is mined by shallow drilling and blasting of productive zones followed by hand breaking, screening, and sorting.

Petrified wood, although occurring in nearly every state, is best known as an Arizona gem material. Petrified wood is a fossil in which a mineral material, usually silica, has replaced the original cellular structure of the wood. Petrified wood occurs in all Arizona counties, but that occurring in Navajo and Apache counties in the Triassic Chinle Formation of northeastern Arizona supplies nearly all of the gem market. Commercial production comes only from private lands.

RECREATIONAL PROSPECTING

Rockhounding continues to be a popular recreational activity in the State. The resultant impact on the Arizona tourism industry is hard to determine, but undoubtedly is significant. The gem show in Quartzsite, for example, is the largest in the world, drawing in excess of a hundred thousand visitors. The prestigious Tucson Gem And Mineral Show attracts visitors and dealers from around the world. More than 20 additional gem shows are held in the State annually and 61 organized earth science clubs are currently active.

Gem material collected by the rockhound hobbyist is not included in the official reported gemstone production, but it is likely that rockhound production is higher than the reported mine production. A portion of rockhound-collected material goes directly into collections, but much of it is sold privately or at gem shows.

Gold panning as a recreational activity has seen increased interest in the last few years. Perhaps this can be linked to interest generated by tourists and the current popularity of outdoor recreational activities. A Department publication, *Gold Panning in Arizona*, is available to provide information to the general public on this subject.