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ARIZONA MINING UPDATE

Circular No. 29, July, 1990

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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 3.4 billion. As it has since 1910, Arizona leads the Nation in copper production. A total of 1.854 billion pounds of copper was produced in 1989, 60% of the U.S. total. Arizona also ranks first in the Nation in gemstone mine production and is among the leaders in the production of molybdenum, silver, and uranium. There are over 97 mines active, excluding sand and gravel operations, producing the above mentioned metals plus 17 industrial mineral commodities. The mining industry directly employs over 12,000 people.

COPPER

The dominant trend in the State's copper industry during 1989 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.

Significantly higher copper prices, averaging \$1.31/lb in 1989, according to preliminary figures released by the U. S. Bureau of Mines, combined with the restructuring of operations, is resulting in record earnings for Arizona's copper producers.

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 its own concentrates, eliminating the company's dependence on short term smelting contracts. 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 SW-EX 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 last year has enabled a portion of the Sierrita mines's concentrates to be processed into cathode copper.

Asarco

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

In July 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 and is scheduled to restart ore processing in mid-1990.

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 200 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 only producing underground copper mine in the State, 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 800,000 ton per year smelter with acid plant, and an electrolytic refinery and

rod plant. The San Manuel unit produced approximately 250,000,000 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 just 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 done 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. The company has also been diamond drilling on the Cactus deposit located near the Pinto Valley mine and plans to conduct metallurgical and feasibility studies.

Dewatering of the underground Magma mine at Superior is being done in order to evaluate the feasibility of reopening this classic old producer that has been shut down since 1982. At this time it appears likely that production will resume late summer, 1990.

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 operation's is Morenci. This giant produced almost 600,000,000 pounds of copper in 1989, 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 100 million pounds of copper per year makes this the largest SX-EW facility in the country. Production costs of less than 30 cents per pound have already prompted construction for a 50% expansion of this facility. 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 amenable to leaching. A test heap leach is currently underway to determine extraction rates and quantities.

COAL

Coal ranks second in economic importance in the State. Twelve million 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 500 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. Peabody is currently in the process of installing a coal-blending facility at the Kayenta unit. 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 largest, 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.

URANIUM

Energy Fuels Nuclear Inc., the Nation's largest uranium producer, operates three mines, Hermit, Pigeon, and North Kanab, located in northern Arizona. The underground mines' direct-shipping ore is trucked to Energy Fuels' mill near Blanding, Utah. The company currently has another three Arizona deposits awaiting development. However, uranium prices are currently less than \$10/lb., the lowest price in 15 years. This situation is slowing exploration for and development of these small, but high-grade uranium deposits hosted in collapse breccias within Permian and Pennsylvanian sediments of the Grand Canyon series.

GOLD

The Cyprus Copperstone open pit mine remained Arizona's largest gold producer with production of over 70,000 ounces. The company ceased development of the underground portion of the deposit after lower than anticipated grades and poor ground conditions were encountered. State gold output declined from the year before as 3 mines ceased production. Western States Minerals discontinued leaching of the heaps as recovery diminished at the Portland mine. Stan West Mining terminated its mining efforts after 6 months production at the McCabe mine when the mine did not reach the break even point. Lower than expected mine production and mill recovery, along with ore dilution were among the problems. Echo Bay Mining suspending shipment of gold bearing silica flux from the Congress mine while continuing to stockpile ore. In mid summer the sale of the property to Malartic Hygrade Resources was announced. Underground development continued while construction of a 350 ton per day CIP mill began. The new mill should reach

production in mid-1990 with an estimated annual output of 30,000 ounces.

Exploration activity identified two significant properties. Norgold Resources and Asarco conducted a drilling program on the Yarnell mine located near the Congress mine in Yavapai county. A geological resource of 8 million tons grading .045 oz./ton has been announced and a feasibility study is underway. At the Gold Bar and Gold Band property, located 35 miles south of Wilcox, Oneida Resources conducted a mapping and trenching program. A follow up drill program reported impressive intercepts. Placer Dome Mining agreed to participate as manager of a joint venture on the property in May and exploration continued. Preliminary results announced at the end of the year indicated 9 million tons of .035 oz./ton.

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, lime, bentonite, sand and gravel, tile and brick clay, salt, cinders, pumice, zeolites, stone, perlite, gypsum, cement, silica flux, pyrite (for pigment), hydrofrac sand, and diatomite. 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.

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 the pound.

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, 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.

MINERAL PRODUCTION IN ARIZONA - 1989

COMMODITY	QUANTITY	VALUE
	Nonfuel 1/	
Clay (tons)	211,000	\$2,010,000
Copper (pounds)	1,781,880,000	2,592,723,000
Gemstones	--	3,300,000
Gold (troy ounces)	91,595	35,264,000
Sand and gravel (tons)	33,800,000	133,500,000
Silver (troy ounces)	4,920,000	27,236,000
Stone-crushed (tons)	5,300,000	26,200,000
Other - cement, gypsum, lime, molybdenum, perlite, pumice, salt, sand and gravel (industrial), dimension and specialty stone	--	368,824,000
	Fuel	
Coal (tons)	12,000,000	\$250,000,000 2/
Uranium (pounds)	2,500,000	25,000,000 3/
TOTAL		\$3,454,057,000

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

2/ Source: Peabody Coal

3/ Source: Energy Fuels

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 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.

DEPARTMENT ACTIVITY

Negotiations have been completed for purchase by the State of the Shrine Temple at 15th Avenue and Washington to house the Arizona Mineral Museum and the ADMMR offices. The Museum, which is part of ADMMR, has over 10,000 cataloged specimens in the permanent collection. Its displays feature Arizona minerals, lapidary exhibits, and prospecting information. The move into the new facilities will take place as soon as remodeling is completed, probably in mid 1991.

The Department has added a series of open-file reports on industrial minerals to its publications this year. *Industrial Minerals in Arizona's Paint Industry*, *Industrial Minerals in Arizona's Wallboard Joint Cement Industry*, and *Industrial*

Minerals in Southern California's Wallboard Joint Cement Industry, all by Ken A. Phillips, are now available. Additionally, the first map in a planned series on the metallogenic provinces of Arizona was published last year. This preliminary 1:1,000,000 scale map, compiled by P.F. O'Hara, N.J. Niemuth, and G. Ryberg covers the Basin and Range and Transition Zone. *Gold Panning in Arizona*, by Diane Bain, will be released by the end of August for the recreational gold panner.

The Department continues to assist the Securities Division of the Arizona Corporation Commission in their investigations of fraudulent mining promotions. An unfortunate consequence of the 1980's high precious metal prices is the proliferation of mining scams. These often involve an investment scheme in which units of ore or bullion are offered by an investment firm at a greatly discounted price. A high return on investment is generally "guaranteed", but delivery is unlikely. Another popular scam involves extracting large amounts of precious metals from abundant material, often cinders or tailings, using a "proprietary" process. The Department seeks assistance from the public in identifying these fraudulent promotions.

In conclusion, mining continues to be an important and dynamic economic activity in Arizona. Space has allowed only a brief description of some aspects of the industry here. For further information on mining or prospecting in Arizona contact the Arizona Department of Mines and Mineral Resources at either: Mineral Building, Fairgrounds, Phoenix, AZ 85007 (602) 255-3791, or 416 W. Congress, Rm 162, Tucson, AZ 85701 (602) 628-6340. A publication list is available upon request.