



STATE OF ARIZONA

DEPARTMENT OF MINES AND MINERAL RESOURCES

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ARIZONA MINING UPDATE - 1988

by Nyal J. Niemuth and Diane Bain

Arizona continues to rank as the Nation's leading non-ferrous metal producer. The value of mineral production in the State last year was in excess of \$2 billion. As it has since 1910, Arizona leads the Nation in copper production. A total of 1.7 billion pounds of copper was produced in 1987, 3/4 of the U.S. total. Arizona also ranks first in the Nation in gemstone production and is among the leaders in the production of gold, molybdenum, silver and uranium. There are over 87 mines active, excluding sand and gravel operations, producing the above mentioned metals plus seventeen industrial mineral commodities. The mining industry directly employs over 11,000 people.

COPPER

The dominant trend in the State's copper industry during the last few years of depressed prices has been reorganization of the industry's structure. This has included the closing of marginal mines, consolidation of producing companies, concessions by labor unions, and other steps necessary for efficient production. 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 and/or mine dumps. Significantly higher copper prices since the fourth quarter of 1987, 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 July 1985, has been characterized by aggressive expansion. Cyprus purchased Duval's copper-molybdenum operations in Arizona consisting of the Esperanza, Mineral Park, and Sierrita mines from Pennzoil in April 1986; purchased the Lakeshore property from Noranda in July 1987; obtained a 20 year lease on the Twin Buttes mine from the Park Corp. in early 1988; and purchased Inspiration Consolidated Copper Company's operations from Inspiration Resources Corporation this July. Cyprus continues to operate the Bagdad facility which consists of an open pit copper-molybdenum mine, a 54,000 ton per day concentrator and a dump leach which feeds an SX-EW plant. The combined output of these mines will increase copper production and make Cyprus the Nation's second largest copper producer with an expected annual output of 525 million pounds by 1989.

Part of the increased production will come from the Casa Grande (formerly Lakeshore) operation where 10 million pounds of copper are expected to be produced by in-situ leaching in 1988. Additionally, the Casa Grande plant has

a roasting capacity of 150,000 tons of copper concentrate annually. Refurbishing of this facility is under way so that a portion of the Sierrita Mine's concentrates can be treated.

At Twin Buttes, in Pima County, production is expected to exceed 25 million pounds this year. Oxide ore will be heap leached while the sulfide ore will be processed at the nearby Sierrita plant. The recently purchased Inspiration facility includes the open pit copper mines, a concentrator, an SX-EW plant, a smelter and acid plant, an electrolytic refinery, and a rod plant. The Inspiration Smelter has a capacity to handle 450,000 tons of concentrates per year. The smelter will allow 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 which will allow the company additional flexibility in providing copper to its customers. Cyprus predicts that 125 million pounds of copper cathodes will be produced next year at the Inspiration dump-leach and SX-EW operation.

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

Asarco Incorporated

Asarco operates the Ray and Mission mines, along with a copper smelter located at Hayden, Arizona. In addition, dump leaching continues at their Silver Bell Mine northwest of Tucson.

The Mission complex consists of the Pima, Eisenhower and Mission mines which 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 is expanding production from the Mission super pit by 46 percent. The \$13.1 million project will increase copper concentrate production by 95,000 tons to a total of 300,000 tons per year. Additional grinding capacity and new flotation cells will be added, combined with a computer analysis system for flotation data.

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 which is idle. Following the purchase Asarco began a modification of the SX-EW plant which will allow Asarco to process low-grade sulfide dump solutions by solvent extraction, gradually replacing copper precipitate production. Copper production at Ray totaled 213 million pounds last year.

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 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 242,178,000 pounds of copper last year.

A financing package was part of the deal by which Newmont Mining divested itself of most of the ownership of Magma Copper. The \$225 million package is being spent to modernize the smelter and bring it into compliance with the Environmental Protection Agency's air quality standards, expand the SX-EW facility and continue development of the Kalamazoo mine which is the down faulted portion of the San Manuel ore body. 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. Plans are under way for processing a 35 million ton mountain of tailings left from the less efficient milling activity done between 1911-35. The tailings will be hydraulically mined with acidic water at the rate of 1,000 gallons per minute under at a pressure of 300 pounds per square inch. The resulting slurry will then be pumped to a thickening tank. From there, the aqueous solution containing the dissolved copper will be sent to the on-site SX-EW plant. The tailings will be 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.

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 530,539,000 pounds of copper, representing over 30% of the State's copper production in 1987. Recent expansion and modernization efforts include construction of a \$90 million SX-EW facility that consists of three SX units and one electrowinning tank house. An annual capacity 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 planning for a 50% expansion of this facility. Other improvements include introduction of in-pit crushers and conveyors. These will deliver crushed ore to the concentrator and will eventually lead to elimination of 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, however, that may soon change. Phelps Dodge has 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. If drill results continue favorable, development of a new open pit mine, heap leach, and SX-EW facility may begin in 1989.

COAL

Coal ranks second to copper in economic importance in the State. Eleven and one-half million tons, with an estimated value of \$230 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 conveyer 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. This coal is powdered and mixed with water and then transported in the world's largest, and the Nation's only, coal slurry pipeline. The 273-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 two mines, the 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 deposits under development. Along with at least four other companies, Energy Fuels continue to conduct geophysical, geochemical and drilling programs on the Arizona Strip. The mines and exploration targets are small, but extremely high-grade uranium deposits hosted in collapse breccias within Permian and Pennsylvanian sediments of the Grand Canyon series. Late in 1987 Energy Fuels announced discovery of another deposit, the Arizona One, located thirty miles south of Fredonia.

GOLD

Opening of a major new gold mine called Copperstone near Quartzsite in western Arizona by Cyprus Minerals Inc. dominated precious metals news during 1987. The new facility, an open pit mine with an agitation leach mill, poured its first dore in November. Production is expected to total more than 60,000 ounces of gold annually and will more than double Arizona's gold output. Low grade ore is being stockpiled on pads to be heap leached later. Development of an underground mine is being considered for the deeper portion of the deposit. The discovery of Copperstone has additional significance in that it is the first major detachment hosted deposit to reach production in Arizona. Success in finding and developing this deposit type is fueling additional exploration activity in western Arizona.

Other gold properties in production include the Portland Mine operated by Western States Minerals and the U.S. Mine of Roddy Resources. Three underground deposits, the Congress mine, Gold Bug, and McCabe underwent continued exploration and development during 1987. Echo Bay Mining shipped development ore from the Congress in 1988 as gold bearing silica flux, while mill construction continued. Ivy Minerals has completed their underground

development at Gold Bug as well as construction of a combination gravity-cyanide mill and begun production. Stan West anticipates completion of their 500 ton per day flotation-cyanide mill by the third quarter of 1988 with production to follow from the McCabe mine. Exploration drilling identified significant resources at the Van Deeman and United Verde Extension mines. The accompanying map shows additional properties and areas that have recently received or are continuing to receive exploration and development activity.

Additional gold properties continue to be productive on either a seasonal or short term basis. These include placer operations, reprocessing of tailings by agglomeration followed by heap leaching, and lode mining for use as copper smelter silica flux or treatment by custom gravity mills. Recreational placer mining for gold occurs statewide, but is especially popular in central Arizona in the Bradshaw Mountains and in the Patagonia area of southern Arizona.

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 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. 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 the large corporate producers.

GEMSTONES

Arizona ranks number one in the value of gemstone production in the United States. Approximately \$2.8 million worth of commercial gemstone production was reported for Arizona according to preliminary figures released by the U.S. Bureau of Mines for 1987. Turquoise, peridot, and petrified wood account for most of the value, with amethyst, chrysocolla, azurite, malachite, fire agate, and apache tears 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.

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 hundreds of thousands of visitors. Twenty-three 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.

LAW CHANGES CLAIM MONUMENTATION REQUIREMENTS

The statutes governing the monumentation of unpatented mining claims were changed by the Arizona State Legislature last year. The new regulations went into effect August 17, 1987 and affect lode, placer, and millsite claims.

The amended law requires placement of the location monument for new lode mining claims to be on the centerline of the claim instead of "... at the corner of the claim, ...". The location monument must still be "...within the boundaries of the claim, ...". The corner and end center monumenting requirements for lode claims remain unchanged. This change applies to lode claims located on Federal Mineral Lands and to Type A Claims located on Arizona State Trust Lands.

The amendment changes the boundary monumenting requirements for placer and millsite claims but not lode claims by eliminating the need for end center monuments. The amendment also eliminates the use of "... a monument of the survey of the United States ..." as an acceptable alternative to a mining claim monument if the position of the two were to have coincided. Thus erecting monuments is now always required.

These changes affect mining claims located on or after August 17, 1987 on both Federal Lands and on State Trust Lands in Arizona. Claims located previously do not have to be changed.

DEPARTMENT ACTIVITY

Leroy E. Kissinger replaced retiring John H. Jett as Director of the Arizona Department of Mines and Mineral Resources (ADMMR) in March of this year.

Plans are under way to obtain a new location for the Arizona Mineral Museum which is part of ADMMR. The Museum has over 10,000 cataloged specimens

in the permanent collection, one of the finest collections in the Southwest. Its displays feature Arizona minerals, lapidary exhibits, and prospecting information.

The Department is currently assisting the Securities Division of the Arizona Corporation Commission in their investigations of fraudulent mining promotions. With the current high precious metals prices have come a 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. 190, Tucson, Az 85701 (602) 628-5399. A list of publications is available upon request.

TABLE 1
MINERAL PRODUCTION IN ARIZONA - 1987

COMMODITY	QUANTITY	VALUE
Nonfuel 1/		
Clay (thousand tons)	212	\$ 1,482,000
Copper (tons)	856,974	1,370,942,000
Gem stones		2,836,000
Gold (troy ounces)	48,991	21,752,000
Gypsum (thousand tons)	262	1,832,000
Lime (thousand tons)	539	22,431,000
Molybdenum (thousand pounds)	15,939	51,802,000
Pumice (thousand tons)	4	26,000
Sand and gravel (thousand tons)	38,200	140,500,000
Silver (thousand troy ounces)	3,217	23,161,000
Stone-crushed (thousand tons)	5,200	22,400,000
Other - cement, perlite, salt, sand and gravel (industrial), dimension and specialty stone		102,478,000
Fuel		
Coal (thousand tons)	11,500	230,000,000 2/
Uranium (thousand pounds)	2,100 3/	35,175,000 4/
TOTAL	---	\$2,026,835,000

1/ Nonfuel preliminary figures from U S Bureau of Mines

2/ ADMMR estimated figures

3/ Energy Fuels figures

4/ Calculated using Nuexco exchange value of \$16.75/lb

TABLE 2

1987 ARIZONA COPPER MINE PRODUCTION 1/

COMPANY/MINE	POUNDS RECOVERABLE COPPER
<u>ASARCO, INC.</u>	
Mission Complex	117,195,000
Ray Unit	213,346,000
Silver Bell	12,800,000
<u>CYPRUS MINERALS CO.</u>	
Bagdad	182,102,000
Casa Grande	4,145,000
Mineral Park	4,405,000
Sierrita	157,943,000
<u>INSPIRATION CONSOLIDATED</u>	
Inspiration	105,555,000
<u>MAGMA COPPER CO.</u>	
San Manuel	242,178,000
Pinto Valley	151,100,000
<u>PHELPS DODGE CORP.</u>	
Copper Queen Branch	2,730,000
Morenci	530,539,000
TOTAL FOR ARIZONA	1,724,068,000

1/ Source: ADMMR survey of producers

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ARIZONA'S PRINCIPAL MINES

METAL MINES

Company - Mine Name

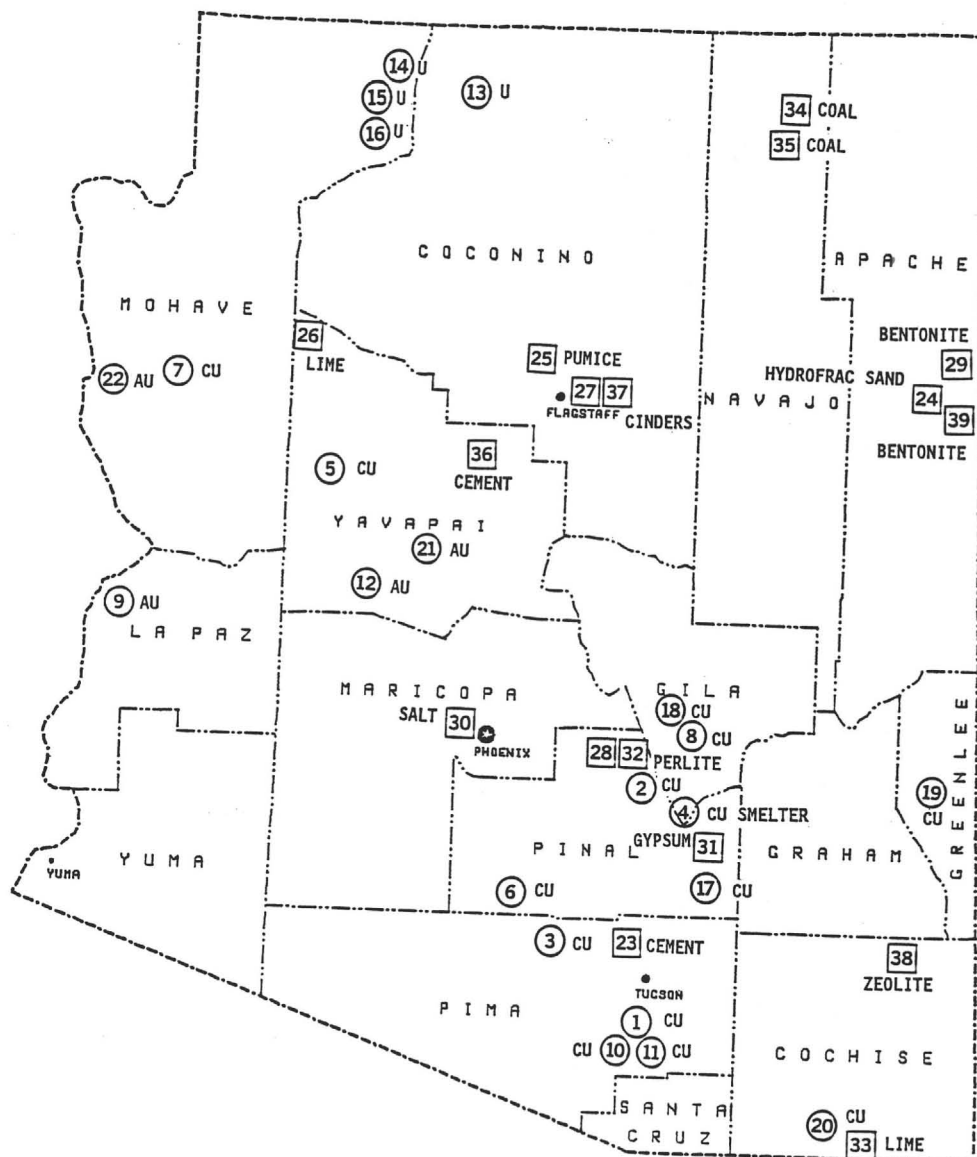
- 1 ASARCO - Mission
- 2 ASARCO - Ray
- 3 ASARCO - Silver Bell
- 4 ASARCO - Hayden smelter
- 5 Cyprus - Bagdad
- 6 Cyprus - Casa Grande
- 7 Cyprus - Mineral Hill
- 8 Cyprus - Inspiration
- 9 Cyprus - Copperstone
- 10 Cyprus - Sierrita
- 11 Cyprus - Twin Buttes
- 12 Echo Bay - Congress
- 13 Energy Fuels - Pigeon
- 14 Energy Fuels - Kanab North
- 15 Energy Fuels - Hermit
- 16 Energy Fuels - Pine Nut
- 17 Magma Copper - San Manuel
- 18 Magma Copper - Pinto Valley
- 19 Phelps Dodge - Morenci
- 20 Phelps Dodge - Copper Queen
- 21 Stan West - McCabe
- 22 Western States - Portland

NON-METAL MINES

(excluding sand and gravel)

- 23 Arizona Portland Cement - Rillito
- 24 Arizona Silica Sand - Houck
- 25 Arizona Tufflite - Crown
- 26 Chemstar - Nelson
- 27 Flagstaff Cinders - Wildcat Hill
- 28 Harborlite - Superior
- 29 Harshaw-Filtrol - Cheto No. 2
- 30 Morton Salt - Southwest
- 31 National Gypsum - Feldman
- 32 Nord Sil-Flo - Chicago
- 33 Paul Lime - Paul Lime
- 34 Peabody Coal - Kayenta
- 35 Peabody Coal - Black Mesa
- 36 Phoenix Cement - Clarkdale
- 37 Superlite Builders - Darling
- 38 Union Carbide - Bowie Chabazite
- 39 United Catalyst - Cheto No. 1

- - Metal Mine
□ - Non-metal Mine



ARIZONA EXPLORATION ACTIVITY

MINE	COMMODITY	COMPANY
COCHISE COUNTY		
1 COCHISE	COPPER	PHELPS DODGE CORP.
2 GOLD CAMP	GOLD	DRACO GOLD MINES INC.
3 GOLD PRINCE	GOLD, SILICA	QUEENSTAKE RESOURCES LTD.
4 TURQUOISE	SILVER, GOLD	SANTA FE PACIFIC MINING
GILA COUNTY		
5 MIAMI TAILINGS	COPPER OXIDE	MAGMA COPPER COMPANY
LA PAZ COUNTY		
6 COPPERSTONE	GOLD	CYPRUS COPPERSTONE INC.
7 HAROUAHALA	GOLD	BILLITON MINERALS INC.
MARICOPA COUNTY		
8 CAVE CREEK	GOLD	KELDOR RES./LECTUS DEV.
9 EL TIGRE	GOLD	CAN-EX RESOURCES LTD.
10 MYSTIC	GOLD	TERRA MINES/ FISCHER WATT
11 NEWSBOY	GOLD, SILVER	WESTMONT MINING LTD.
12 SILVER CROSS	GOLD	AMCA RESOURCES LTD.
13 TONOPAH BELMONT	GOLD	LAKEHORE MINERALS INC.
14 VULTURE	GOLD	A. F. BUDGE MINING LTD.
MOHAVE COUNTY		
15 ARIZONA CHE	URANIUM	ENERGY FUELS NUCLEAR INC.
16 BLACK DYKE	GOLD	WESTERN STATES MINERALS
17 BURRO CREEK	GOLD	ARIZONA SILVER CORP.
18 CYCLOPIC	GOLD	HECLA MINING INC.
19 FRISCO	GOLD	GERLE GOLD LTD.
20 GOLD BUG	GOLD	IVY MINERALS INC.
21 MOSS	GOLD	HARRISON MINING
22 PILGRIM	GOLD	GEXA GOLD CORP.
23 ROADSIDE	GOLD	IVY MINERALS INC.
24 SECRET PASS	GOLD	FISCHER WATT GOLD CORP.
25 VAN DEEMAN	GOLD	ARIZONA STAR RESOURCES
PINAL COUNTY		
26 KALAMAZOO	COPPER	MAGMA COPPER COMPANY
27 SANTA CRUZ	COPPER OXIDE	US BUREAU OF MINES
SANTA CRUZ COUNTY		
28 MARGARITA	GOLD	NEWFIELD MINERALS LTD.
29 ORO BLANCO	GOLD	ECHO BAY MINES INC.
YAVAPAI COUNTY		
30 CONGRESS	GOLD	ECHO BAY MINES INC.
31 MCCABE	GOLD, SILVER	STAN WEST MINING INC.
32 RICH HILL	GOLD PLACER	FISCHER WATT
33 UNITED VERDE EXT.	GOLD, SILICA	A. F. BUDGE MINING LTD.
YUMA COUNTY		
34 OAKLAND	GOLD, SILVER	HOMESTAKE MINING COMPANY

