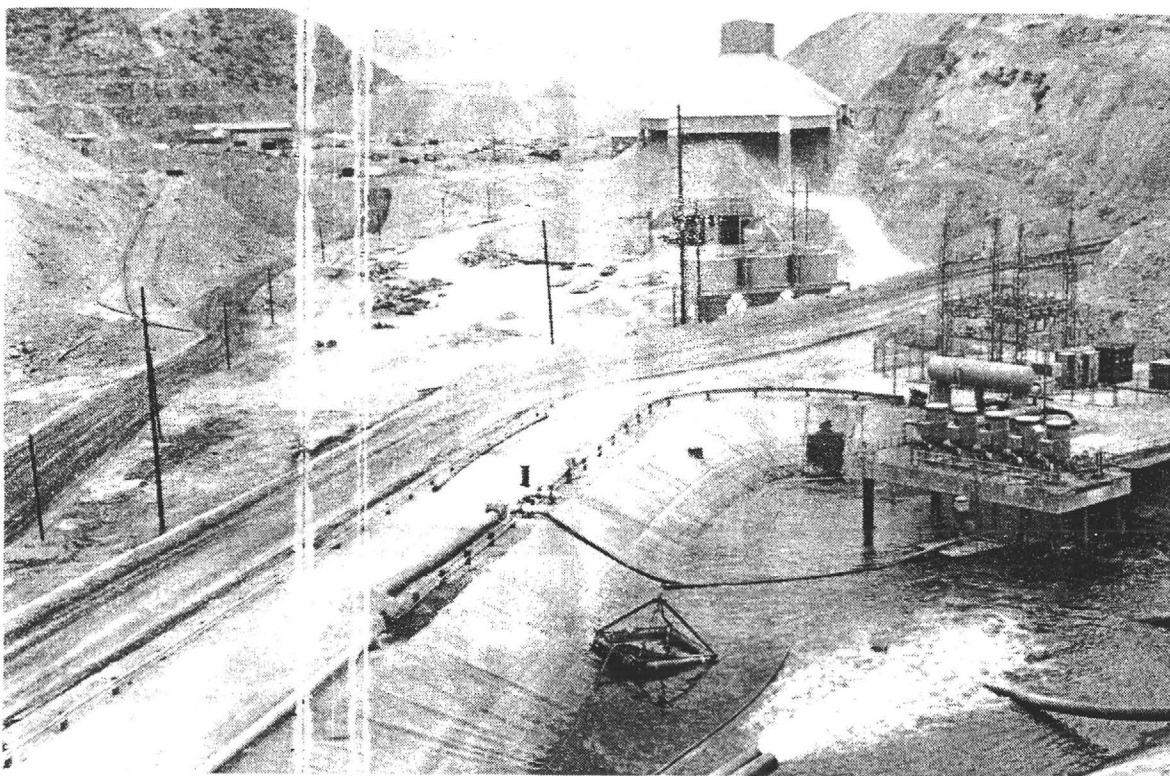


# **THE PRIMARY COPPER INDUSTRY OF ARIZONA IN 1991**



**DEPARTMENT OF MINES AND MINERAL RESOURCES**

**BY K. A. Phillips and N. J. Niemuth**

**ARIZONA DEPARTMENT OF MINES  
AND MINERAL RESOURCES**

**Leroy E. Kissinger, Director**

1502 West Washington  
Phoenix, Arizona 85007  
(602 ) 255-3791  
Toll Free in Arizona: 800-446-4259

**Board of Governors**

**Roy Miller - Phoenix**  
Chairman

**Ken C. Bennett, Phoenix**  
Member

**Clifford B. Altfeld - Tucson**  
Vice Chairman

**Edna Vinck - Globe**  
Member

**Doug Lindsay Sr. - Phoenix**  
Member

Cover: Solvent extraction pond at Metcalf. Ore transfer station in background.

# **THE PRIMARY COPPER INDUSTRY OF ARIZONA**

by K.A. Phillips and N.J. Niemuth

---

---

**Department of Mines and Mineral Resources**

**Special Report No. 18**



**State of Arizona**  
Fife Symington, Governor

Phoenix, Arizona  
February, 1993

---

## TABLE OF CONTENTS

---

INTRODUCTION	1
COPPER PRODUCTION IN ARIZONA - 1991	2
1991 OPERATIONS SUMMARY	3
STATUS AND PROGRESS	4
HIGHLIGHTS OF COMPANY OPERATION	
Arimetco	6
Asarco	6
Cyprus Minerals Company	7
Magma Copper Company	9
Oracle Ridge Mining Partners	10
Phelps Dodge Corporation	11
SEVERENCE TAX ON METALLIFEROUS MINERALS	12
PROPERTY TAX	13

### STATISTICAL TABLES

#### PRODUCTION

##### Arizona

Table 1	Copper and molybdenum production in 1991, by mine and company	14
Table 2	Leach copper production, by mine	16
Table 3	Company rank in 1991, by copper and molybdenum production	18
Table 4	Mine rank in 1991, by copper and molybdenum production	19
Table 5	Monthly and cumulative copper mine production	20
Table 6	Average copper content of ore produced	21
Table 7	Percent contained copper recovered	22
Table 8	Stripping ratios of open pit mines	23
Table 9	Production and value of copper, molybdenum, gold, and silver recovered from copper ore	24
Table 10	Nonfuel mineral production	26
Table 11	Copper mine capacity in 1991	27

##### United States

Table 12	North American copper smelter capacity in 1991	28
Table 13	United States copper production, by company	29
Table 14	Copper imports of the United States, by country	30
Table 15	Copper exports of the United States, by country	34

#### EMPLOYMENT

##### Arizona

Table 16	Employment and wages in Arizona copper mining and smelting	38
Table 17	Arizona employment and wages in 1991, by industry	40

##### United States

Table 18	Employment, earnings, and hours in copper mining in the United States and Arizona	41
----------	-----------------------------------------------------------------------------------	----

#### ECONOMICS

Table 19	Refined copper inventories	44
Table 20	Average monthly price of cathode copper	45
Table 21	Estimated copper production costs for the United States	46



## RESERVES

Table 22	Copper reserve base in 1991	47
Table 23	Historical Arizona and U.S. Copper mine production	52

## ILLUSTRATIONS

Figure 1	Producing copper properties 1991	2
Figure 2	Leach copper production 1982 - 1991	17
Figure 3	Copper production by company	18
Figure 4	Molybdenum production by company	18
Figure 5	Value of copper, molybdenum, gold, and silver recovered from copper ore	25
Figure 6	Direct and indirect impacts of the copper industry on the Arizona economy - 1991	39
Figure 7	Average weekly wages by industry	40
Figure 8	Copper production in the U.S. and Arizona	42
Figure 9	Worker productivity	43
Figure 10	Refined copper inventories	44
Figure 11	Average annual copper prices	45
Figure 12	Copper price in constant 1991 dollars	46

\* Throughout this report a "ton" means a short ton (2,000 pounds or 0.90718 metric ton). Specific statistics may vary slightly from table to table due to differences in source data.

---

## INTRODUCTION

---

The Arizona Department of Mines and Mineral Resources presents herein a report covering activity in Arizona's copper industry in the calendar year 1991. A brief review of operational highlights reported by the major producers and developers in the State, market and price developments that affected copper production, and discussions of Arizona severance taxes on metalliferous minerals are included.

The contained statistical tables include various production, employment, inventory, import/export, prices, costs, and ore reserve numbers for 1991. Production of recoverable copper is given for individual mines and by company. Figures showing the importance of copper in the mining industry are provided, as are data on the by-products of copper mining; gold, silver, and molybdenum. In addition, historical compilations are included for leach copper, average grade of ore produced, percent copper recovered, stripping ratios, and employment and earnings. Additional compilations indicating refined copper inventories in and out of the United States and average copper prices by month from 1982 through 1991 are provided. Also included are tables showing designed mine capacity and copper reserve base in Arizona plus cash production costs for the United States, 1983-1990.

The Department maintains an extensive reference library concerning the copper industry in Arizona. This repository includes information on individual mines and mining companies, United States Bureau of Mines and United States Geological Survey publications, other professional publications, periodicals, and earlier editions of this report. Additionally, experienced mining engineers are available for consultation, at no charge, on matters germane to the minerals industry.

The authors wish to express their sincere appreciation to the management and staff of each of Arizona's mining companies for graciously devoting time and effort to provide information for this report. Michael Greeley of the U.S. Bureau of Mines, Dr. George Leaming of the Western Economic Analysis Center of Marana, Arizona, and the American Bureau of Metal Statistics, Inc. of Secaucus, New Jersey also provided vital information.

Thanks are also due to the Arizona Department of Economic Security, the Arizona Department of Revenue, and the staff of the Joint Legislative Budget Committee for providing statistics and data.

A special gratitude is felt toward the preceding authors for providing the format and sources of statistical information and to Leroy E. Kissinger, Director of the Department of Mines and Mineral Resources, for providing the opportunity to author this report.

## COPPER PRODUCTION IN ARIZONA - 1991

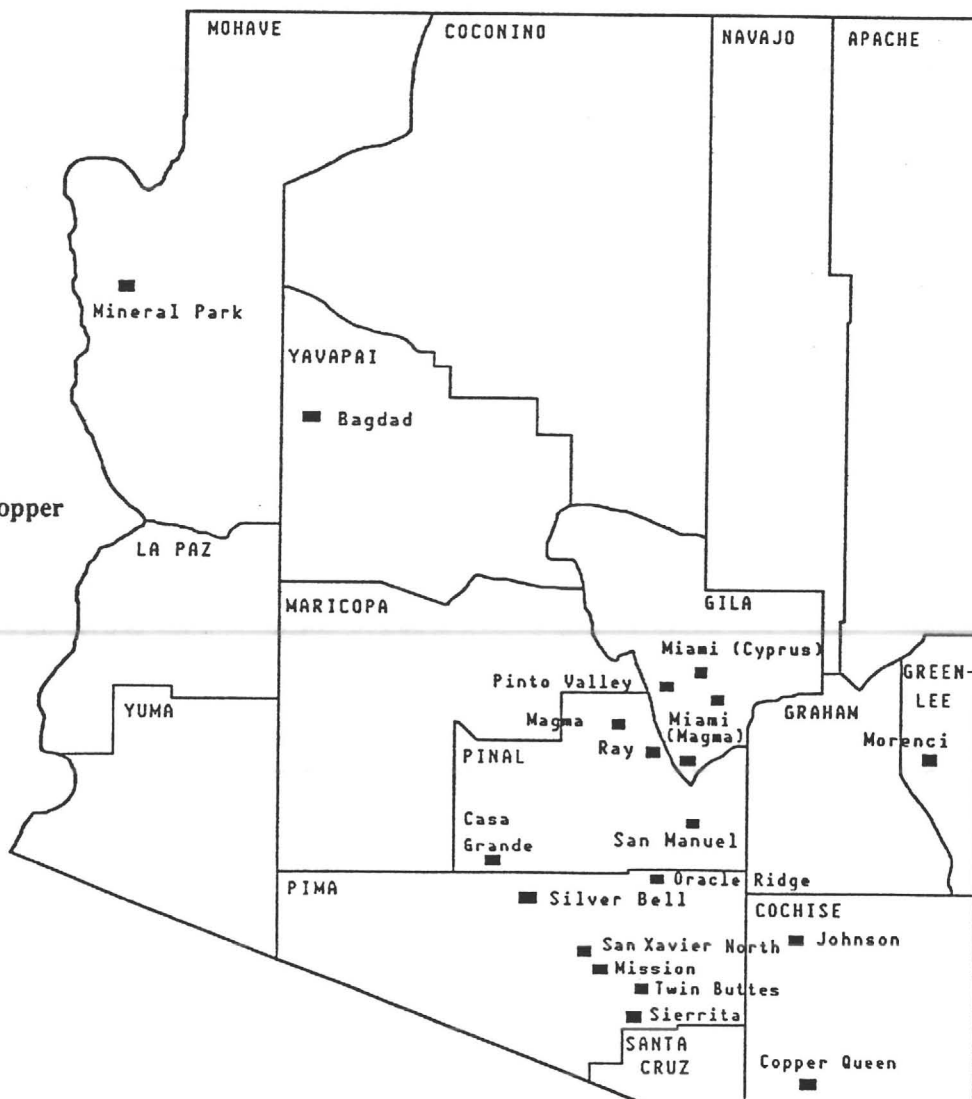
Arizona's copper industry produced 1,132,536 tons of copper in 1991 (Table 1). This is an increase of 4.2 percent above 1990, and is the highest production ever achieved in Arizona. Arizona's share of the United States total was 63 percent of U.S. copper production, up from 62.5 percent in 1990.

The gross value of non-fuel mineral production in Arizona in 1991 was down 6.3 percent from 1990 to \$2,876,211,000 (Table 10) as copper prices declined. Copper production represents 85 percent of this total; the by-products of copper production (gold, silver and molybdenum) represent an additional 4.2 percent (Table 9). The total contribution of the copper mines was therefore 89.2 percent of the gross value.

Copper was produced by 6 companies from 18 properties in 1991, and molybdenum was recovered as a co-product or by-product at 6 of these properties (Tables 3 and 4). Ten properties produced 95.8 percent of Arizona's copper, and 3 produced 89.1 percent of the molybdenum. The Morenci Mine of Phelps Dodge led in copper production with 30.2 percent of the total. Cyprus' Sierrita Mine produced 44.3 percent of the molybdenum.

More than 333,000 tons of copper representing 29.5 percent of the total was produced by leaching in 1991. Solvent extraction-electrowinning (SX-EW) produced 326,773 tons of cathode copper from these leach solutions (Table 1).

**Figure 1. Producing copper properties - 1991**



Stripping of waste, including some leachable material, was accomplished at the 10 operating open pit mines during 1991. The weighted average of the stripping ratios - waste to ore - was 1.49 to 1 (Table 8). This is comparable to the 1.57 to 1 in 1990 which probably indicates continued normal long-range mine planning.

The weighted average grade of sulfide ore mined in 1991 was 0.57 percent copper (Table 6).

The estimated capacity to produce copper at each of Arizona's principal operations totals 1.316 million tons annually (Table 11). By this estimate the mines, concentrators, and leach facilities operated at 86.1 percent of capacity in 1991.

The copper reserve base in Arizona is estimated to be over 13 billion tons containing over 67 million tons of copper (Table 22). At present mining rates, this amount, if economic, would represent 50 years of reserves.

---

## 1991 OPERATIONS SUMMARY

Operating properties	18
Operating companies	6
Operating smelters	3
Ore mined (including some oxide)	258,646,597 tons
Ore milled (sulfides)	171,221,185 tons
Waste/overburden removed	
(includes some leach material)	357,729,604 tons
Average stripping ratio	1.49:1 (waste:ore)
Copper produced	1,132,536 tons - 63.0% of U.S.
From sulfide ores	798,693 tons - 70.5% of AZ
Average sulfide grade	0.57% copper
From leaching	333,843 tons - 29.5% of AZ
By SX-EW	326,773 tons - 97.9% of leached
Molybdenum produced	35,050,734 pounds
Silver produced	4,651,000 troy ounces
Gold produced	51,248 troy ounces
Average employment	12,369
Average annual wage	\$37,418
Productivity (production workers)	115.6 pounds of copper per man-hour
	13.2 tons of ore per man-hour

---

## STATUS AND PROGRESS

---

In spite of weakening demand for copper worldwide, prices held firm within a small range above \$1.00 per pound. The average price for 1991 was 109.327 cents per pound (U.S. Producer Delivered) according to Metals Week. Worldwide warehouse inventories increased by almost 40 percent during the year. Inventories in U.S. warehouses and refineries increased only 4 percent. Production of copper on a worldwide basis continued to grow, as it has in the U.S. and Arizona. Despite the negative factors that would create gloom for the immediate future, prices held firm through the end of the year. The growth in the production of copper by SX-EW, along with other capital improvements, enables Arizona producers to keep their production costs low, and therefore, competitive with the rest of the world.

Major companies continued to expand production at current properties as opposed to opening new mines. Smaller companies were more aggressive in their efforts to bring new copper projects on stream. While the new projects are in historic producing districts, the innovation of new technology, principally SX-EW, has changed the economics to enable them to become productive. Arimetco was unable to conclude the agreement with Holcorp Gold on the Emerald Isle Mine in Mohave County, but decided it will operate the new SX-EW facility. Oracle Ridge Mining Partners started production during the year producing nearly 4.5 million pounds of copper from the underground Oracle Ridge Mine. AZCO continued the process of financing and permitting to bring their Sanchez Mine in Graham County to production. Construction may begin in early 1993 if permitting is completed.

### OPEN PIT MINING

---

Open pit mining is the principal method of producing copper. Loading equipment ranges from front-end loaders to electric shovels and haulage is by off-road trucks, sometimes in conjunction with conveyor belts. The installation of in-pit crushing facilities along with conveyor systems to transport the ore to the mills has been a major factor in the reduction of operating costs. The high capital investment to install these systems are absorbed by the long life of the mines involved.

In 1991, 10 open pits were mined. Six produced principally sulfide and oxide ore, and 2 produced principally oxide ore.

### UNDERGROUND MINING

---

San Manuel is the largest underground metal mine in the nation and utilizes the block-caving method of mining. This method consists of undercutting a block of

ore and allowing the ore to cave into draw points to be loaded onto trains for haulage to the shaft and hoisted to the surface.

Magma's Superior Mine produced 25.2 million pounds of copper from 250,500 tons of ore from underground operations at this historic underground facility. Magma utilizes the undercut and fill method of ore extraction in this mine.

### IN SITU MINING

---

In situ leaching of rubbleized copper bearing material remaining in mined out underground stopes has long been practiced in Arizona. At San Manuel, Magma has developed a formal program of leaching mined out block caving stopes that has reached production status. During the last few years all of the production from the Casa Grande Mine has been from a similar system developed by Noranda. Cyprus is continuing this project as well as tests of in situ leaching of non-rubbleized or virgin ground.

The U.S. Bureau of Mines is partially funding tests of in situ leaching of virgin ground at the Santa Cruz deposit near Casa Grande. The ore body, a deep seated acid soluble deposit, is owned by Asarco and Freeport-McMoran on a 50-50 basis.

### SOLVENT EXTRACTION

---

Historically, copper produced from leach solutions had been extracted by the cementation process (precipitation from solution by the replacement of copper in solution by metallic iron). This was an inexpensive method, but the cement copper produced had to be smelted and refined along with the flotation concentrates.

During the 1960's, Ranchers Exploration and Development Corporation pioneered the use of SX-EW produce copper at its Bluebird property near Miami. The obvious advantage of this method is that cathode copper of salable quality could be produced directly from leach solutions. The cost of smelting and refining is avoided.

During the relatively good years experienced by the industry after Rancher's introduction of SX-EW, interest in the process grew gradually. The disastrous 80's however, prompted an accelerated interest that continues today. Twelve plants operated during 1991 and plans are underway to expand or add new capacity. Production from the cementation process has fallen to 2 percent of leach production.

## CONCENTRATION

The majority of copper mineralization in Arizona is of the sulfide type and is not amenable to leaching without extraordinary means. Inspiration had success with its heap leach-ferric cure process on mixed oxide-sulfide ores and Kennecott pioneered the use of bacteria to convert sulfides to oxides in low-grade dumps. However, as shown in the 1991 Operations Summary, about 70.5 percent of the copper was produced by the flotation method of concentration. In addition much of the leached copper produced is from dumps of "waste" that was stripped from open pit mines to provide access to sulfide ore. Another aspect of the flotation process that makes it viable at some properties is the recovery of molybdenum by selective flotation. Molybdenum provides a significant portion of the revenues from some properties. Also, any precious metals in the ore follow the copper through the flotation process and smelting to the electrolytic refinery where they can be recovered from the anode slimes.

There are currently 9 flotation concentrators in operation in Arizona. Asarco is operating 3 - 1 at Ray and 2 at Mission, Cyprus is operating 2 - Bagdad and Sierrita, Magma is operating 3 - San Manuel, Pinto Valley, and Superior, and Phelps Dodge 2 at Morenci-Metcalf. A new 30,000 ton per day mill is being constructed at Ray.

Although efficiency is constantly being improved, the flotation process is not cheap. It requires crushing and grinding the ore, separation of the ore minerals from the gangue minerals in the flotation cells, smelting the concentrate, and refining the copper anodes from the smelter. The most significant recent advance in flotation is the improved recoveries resulting from the use of column flotation cells that have been installed in most concentrators.

## SMELTING

Of the 7 smelters remaining in Arizona in 1991 only 3 operated. Asarco's Hayden smelter and Cyprus' smelter at Miami have been brought into compliance with air pollution constraints and Magma's smelter at San Manuel has been retrofitted with an Outokumpu flash furnace to bring it into compliance. The smelter at Hayden that Asarco acquired from Kennecott met all significant environmental constraints when last operated in 1982. Magma's smelter at Superior and Phelps Dodge's smelters at Ajo and Morenci will require extensive retrofitting before they can be operated. Phelps Dodge is shipping concentrates to its Hidalgo smelter at Playas, New Mexico and to the Chino smelter at Hurley, New Mexico.

As an alternative to smelting, Cyprus Casa Grande has reactivated the roast leach electrowinning (RLE) plant built by Hecla. In this process a portion of the flotation concentrates from Sierrita are roasted to make them acid soluble and then leached with sulfuric acid. Soluble cathode copper is extracted from the leach solution by electrowinning. Cyprus upgrades the leach solutions in the solvent extraction plant before electrowinning. Acid is produced from the roaster gases and the process is essentially pollution free.

Planned upgrading and expansion of the Miami smelter will make Cyprus self-sufficient in the smelting of their own sulfide production. A fire at the smelter in early November moved the beginning of the upgrade and expansion of the facility from March 1992. The Isasmelt technology developed by Mount Isa Mining Company in Australia will be installed at Cyprus-Miami.

## PROGNOSTICATION

Prognosticators of gloom and doom for the mining industry continue to be less than accurate in their predictions of a glut of copper in warehouse inventories, in the resultant drop in price, and ultimately reduction in the production of copper. The boom expected by the development of Eastern Europe and the Third World continues to be slow in arriving, and may never take on giant proportions. However, industry optimists still believe growth of that magnitude will take place in those areas. The resultant demand for copper in the construction of new plants and infrastructure will be important to the red metal into the 21st century. That the copper price continues to be relatively strong in the face of lingering recession and growing inventories, indicates market strength that belies the normal analysis used by most prognosticators.

On the down side, the threat of increased environmental regulatory pressures, and the development of large high-grade copper deposits outside the United States, will keep severe pressure on the domestic copper industry to remain competitive.



---

## HIGHLIGHTS OF COMPANY OPERATIONS

---

### ARIMETCO INCORPORATED

**Corporate Headquarters - 6245 E. Broadway,  
Suite 350, Tucson, Arizona 85711  
Phone (602) 745-8882**

Arimetco owns and/or operates the Emerald Isle, Johnson Camp, Van Dyke, and Zonia copper properties and also has industrial mineral interests in Arizona.

---

#### **Emerald Isle**

**Kingman, AZ  
Phone (602) 565-4554**

The Emerald Isle Mine, which consists of in situ leaching and a precipitation plant, was shut down in the first quarter of 1990. Planning and permitting for an 8,000 pounds-per-day SX-EW facility and associated components began in mid-1991. The plant is expected to be operational in the spring of 1992. The SX-EW plant will be fed by a combination of solutions from a leach pad and an in situ leach of the pit.

---

#### **Johnson**

**Benson, AZ  
Phone (602) 586-2241**

The Johnson Mine contributed in excess of 60 percent of the company's production during 1991 and is expected to produce over 9 million pounds of copper during 1992. The addition of a second train in the solvent extraction plant has increased the flexibility and overall operational efficiency of the mine.

Until mid-year, production was entirely dependent on the leaching of copper from existing heaps. Mine planning to produce new ore began early in 1991 and development began in May of 1991. The first fresh ore was placed on the dumps in July. Mining at the rate of 10,000 tons per day is expected to continue from the Burro Pit and adjacent areas until the end of 1993.

---

#### **Van Dyke**

**P.O. Box 747  
Miami, AZ 85539  
Phone (602) 473-2421**

Arimetco reports that progress has been made during the year in formulating a development plan for its Van Dyke ore body, partially located under the town of Miami. Copper will be produced by injecting acid into

mined-out areas and treating recovered solutions in an SX-EW plant.

They have examined the possibility of initially using the existing Van Dyke shaft, which accesses the entire ore body and connects with all workings, as an extraction well. The advantage of using the shaft as a collection point for the injected fluids are many. The eventual access to the ore body through the shaft is viewed as a major advantage.

### ASARCO INCORPORATED

**Corporate Headquarters - 180 Maiden Lane, New  
York, New York 10038  
Phone (212) 669-1000**

Asarco's Arizona operation consists of a copper smelter at the Hayden Unit, major open-pit mines Mission and Ray, and a dump leaching/cementation operation at Silver Bell. With increased production from Mission, Asarco is able to produce 76 percent of the copper concentrate feed for its smelters. Asarco continued a \$375-million program to become self-sufficient in concentrates to feed its smelters.

Joint venture partners Asarco and Freeport-McMoran, continued the in situ leach research project at the Santa Cruz property in cooperation with the U.S. Bureau of Mines. This phase of the study consists of injection of saline solution to determine the hydrology of the deposit. The results are being evaluated.

Asarco also holds major reserves at the Chilito north of Hayden, at the Copper Butte and Buckeye deposits west of Ray, at Helvetia east of Mission, and at Sacaton East near Casa Grande.

---

#### **Hayden Smelter**

**Box 98, Hayden, Arizona 85235  
Phone (602) 356-7804**

The Hayden smelter consists of an INCO flash furnace smelter rated at 720,000 tons of charge per year for an estimated production of 175,000 tons of blister copper. An acid plant rated at 1,600 tons of sulfuric acid per day keeps sulfur dioxide emissions within air quality restraints.

---

#### **Mission**

**Box 111, Sahuarita, Arizona 85629  
Phone (602) 791-2920**

Mission consists of the consolidation of the Mission, Eisenhower, San Xavier, and Pima open-pit mines into one large pit referred to as the Mission complex.

section of the pit late in 1987 increased reserves and facilitated further efficiencies in pit design and mine planning.

Mining at Mission is conducted by electric shovels with truck haulage to the primary crusher and waste dumps. Some areas of the pit are back to final limits, allowing some waste dumping in the pit. The stripping ratio in 1991 was 3.92:1, waste to ore; a high ratio that reflects removal of large amounts of waste related to expansion.

The expansion of the Mission Mine was completed in the fourth quarter of 1991, more than doubling production capacity from mid-1980's levels, to 124,000 tons of contained copper per year. The addition of the refurbished Pima mill, now called the South mill, increased concentrator capacity to a total of 59,000 tons per day.

## **Ray**

**P.O. Box 9, Hayden, Arizona 85235**  
**Phone (602) 356-7811**

The Ray operation consists of an open-pit mine, dump leach and heap leach operations, and a 40,000 ton-per-year SX-EW plant at Ray and a 26,000 ton-per-day concentrator at Hayden.

Mining is conducted by electric shovels supplemented by front-end loaders utilizing truck haulage. The production rate is 100,000 tons per day of which 26,000 tons are sulfide ore sent to the mill, and 10,000 tons are silicate ore that is crushed and sent to the leach heaps. The remainder is low grade sent to leach dumps or waste sent to waste dumps. The stripping ratio in 1991 was 3.18:1, waste to ore, a high ratio that reflects mine development ahead of increased production. The mine plans are predicated on the sulfide operation and therefore silicate ore is stockpiled when in excess and fed from the stockpile to the crushers when short.

Sulfide ore is hauled by truck to the primary crusher at Ray where it is crushed and transferred to trains for the 20-mile haul to the mill.

Silicate ore is hauled to the primary crusher, then further reduced to minus 3/4 inch by secondary and tertiary crushers. It is then transported by conveyor where it is agglomerated with sulfuric acid while in transit to the heap leach area. Final haulage and placement on the heaps is by end-dump trucks.

Low grade muck is hauled to prepared leaching areas and non-mineral muck is hauled to waste dumps by end dump trucks. All leach solution are now fed to the SX-EW plant. Previously stockpiled native copper ore is being reclaimed and fed to the mill in small proportions as is smelter slag.

A \$12-million project was started in 1988 to maintain production capacity as the hardness of the ore increases as the pit deepens. A 60,000 ton per day portable

in-pit crusher and conveying system will replace the 30,000 ton-per-day primary crusher at the pit and a 20,000 ton-per-day concentrator will be built at the mine site. Concentrates will be hauled by rail to the smelter at Hayden.

The difficult permitting process for the Ray Mine expansion was satisfactorily concluded in late 1991. Scheduled start up of the new mill was delayed until 1992. Copper output will increase by 58 percent to 182,000 tons per year as a result of this expansion. The project is scheduled for completion in 1992.

## **Silver Bell**

**Marana, Arizona 85653**  
**Phone (602) 622-6551**

Silver Bell consists of an open-pit copper mine presently on stand-by status, while the dump leaching and the precipitation plant have continued to operate. Mining was stopped in 1984 because of high operating costs. Asarco plans to build a SX/EW plant that when complete in 1994 will produce 18,000 tons of refined cathode copper per year at substantially lower costs. In late 1991 the company began the permitting process for reactivation of the mine and construction of the SX-EW plant.

## **CYPRUS COPPER COMPANY**

**Corporate Headquarters - 1501 W. Fountainhead Parkway, Tempe, Arizona 85282**  
**Phone (602) 929-4400**

Cyprus was Arizona's second largest producer of copper in 1991 and continues to be the largest producer of molybdenum.

Cyprus Copper Company maintains its corporate headquarters in Arizona and operates 5 copper producing mine complexes in the State: Bagdad, Casa Grande, Miami, Mineral Park and Sierrita. In addition to its copper-molybdenum properties, Cyprus operates Arizona's largest gold mine, the Copperstone north of Quartzsite.

In March 1988, through a 15-year lease, Cyprus acquired the Twin Buttes property formerly operated by Anamax. In July 1988 they acquired the entire Inspiration operation at Miami, including the mines, concentrator (inactive), SX-EW plant, smelter, acid plant, electrolytic refinery, and rod plant.

Cyprus continues to increase its copper leaching capabilities with the expansion of leaching operations at Bagdad, Mineral Park, and Sierrita. Cyprus had the second copper SX-EW unit in the world at Bagdad and produced the first cathodes to meet the stringent specifications for trading on the London Metal Exchange and COMEX. The company currently produces 210 mil-



lion pounds, or approximately 33 percent of their normal annual copper production, from SX-EW technology.

## **Bagdad**

---

**P.O. Box 245, Bagdad, Arizona 86321**  
**Phone (602) 633-2241**

The Bagdad operation consists of an open-pit copper-molybdenum mine, a 75,000 ton-per-day concentrator, a dump leach operation, and an SX-EW plant. Mining is conducted by electric shovels using truck haulage to the primary crusher and dumps. The stripping ratio in 1991 was 0.80: 1, waste to ore.

The sulfide ore is transported from the primary crusher at the mine, a distance of 6,400 feet, to the coarse ore stockpile at the concentrator, by conveyor belts. There it is crushed further, ground by autogenous and ball mills, then copper and molybdenum concentrates are produced. Column cells are utilized in the molybdenum flotation circuit.

Pregnant solutions from the leach dumps are collected behind dams and pumped to the SX-EW plant at approximately 1.8 grams of copper per liter. The barren solutions are returned to the dumps after the copper has been extracted.

## **Casa Grande**

---

**P.O. Box C-9, Casa Grande, Arizona 85222 -**  
**Phone (602) 623-1539**

Casa Grande consists of an in situ leaching operation, an SX-EW plant, and a RLE plant that treats concentrates from other Cyprus properties.

Block-caved stopes in the oxide ore body are being leached and development of a leaching operation in virgin ground is underway using high pressure pumps to inject sulfuric acid solution into holes drilled from the old underground workings. Pregnant solutions are collected in sumps underground and pumped to the SX-EW plant.

The roasters and acid plant of the RLE plant originally built by Hecla and refurbished by Cyprus are treating approximately 160,000 tons per year of copper concentrates from other Cyprus operations. The pregnant solutions go to the SX-EW plant and the acid produced from the roaster gases is used for the leaching operations.

## **Miami**

---

**P.O. Box 1559, Claypool, Arizona 85532**  
**Phone (602) 473-7150**

The Miami property consists of 3 open-pit copper mines formerly called Inspiration, an SX-EW plant, a 24,000 ton-per-day concentrator that is currently on

standby status, a smelter, an acid plant, an electrolytic refinery, and a 135,000 ton-per-year rod plant.

Ore is mined at the rate of 50,000 tons per day with electric shovels and hauled by truck to high grade, low grade, and waste dumps. The stripping ratio in 1991 was 0.57:1, waste to ore. Soon after Cyprus acquired the property the construction of the second, nearly identical, solvent extraction train was completed, increasing the capacity of the plant to 8,000 gallons per minute. The cathodes from both the electrowinning and electrorefining sections are fed to the continuous-cast rod plant to produce 5/16 inch copper rod on reels holding three and one-third miles of rod each. In 1991 the Miami rod mill produced 252 million pounds of copper rod, approximately 93 percent of capacity, mostly from Cyprus-produced cathode.

A 3-year pilot project with Arizona Ranch Management has been underway to test and evaluate the use of cattle as a tool to promote vegetative growth, to control dust, and curtail erosion on tailings at the Miami operation. Costs of reclamation were substantially reduced by the use of livestock in a reclamation process. Cattle are used on bare tailing material to prepare a base to stabilize the tailings and to promote plant growth.

A project to make Cyprus independent of outside smelting continued in 1992. An increase in capacity from 450,000 tons to 650,000 tons of concentrate per year was completed in July 1992 at the Miami smelter. The \$106-million project increased smelting capacity by about 50 percent. Their new ISASMELT furnace began operation with production planned to gradually increase until full annual capacity of 650,000 tons is reached in 1993.

## **Mineral Park**

---

**P.O. Box 6249, Kingman, Arizona 86401**  
**Phone (602) 565-2226**

Mineral Park consists of an open-pit copper-molybdenum mine, a 15,000 ton-per-day concentrator, and a precipitation plant. Mine and mill are both on stand-by status. Production comes from conducting dump and in pit leaching with recovery via the precipitation plant.

## **Sierrita/Twin Buttes**

---

**P.O. Box 527, Green Valley, Arizona 85622**  
**Phone (602) 791-2950 & (602) 625-4800**

The Sierrita property consists of an open-pit copper-molybdenum mine, a 95,000 ton-per-day concentrator, a ferromolybdenum plant, a rhenium plant, a dump leaching operation, and an SX-EW plant. Mining is conducted using electric shovels and truck haulage to the crushers and dumps. The stripping ratio in 1991 was 0.91:1, waste to ore.

Production was started at the Twin Buttes Mine in 1988 providing additional feed to the Sierrita mill. The stripping ratio in 1991 was reduced significantly to 2.15:1. Sulfide ore is transported to the Sierrita concentrator by a 6.8-mile conveyor. Twin Buttes contributed over 40 percent of the copper produced at the Sierrita concentrator in 1991. The SX-EW plant at Twin Buttes is fed with solutions from leaching tailings.

More than three quarters of Cyprus' molybdenum concentrate from the Thompson Creek (Idaho), Bagdad, and Sierrita operations is processed at Sierrita's roasters to produce molybdenum oxide and ferromolybdenum that are shipped to customers worldwide.

### **MAGMA COPPER COMPANY**

**Corporate Headquarters - 7400 N. Oracle Road,  
Tucson, Arizona 85704  
Phone (602)575-5600**

In 1987, after nearly 20 years as a wholly owned subsidiary of Newmont Mining Corporation, Magma once again became an independent corporation. Magma embarked on and continues an extensive expansion and modernization program to become competitive in the copper market and meet environmental constraints.

Magma's Arizona operations include the San Manuel, Pinto Valley, Miami, and Superior mines. The company also operates the McCabe gold mine near Mayer and a railroad. The McCabe Mine produces gold-copper concentrates that are shipped to the San Manuel smelter for treatment. The railroad operation consists of 2 segments, a 29-mile line from San Manuel, and a 28-mile line from Superior, that both connect to the Santa Fe Southern Pacific system.

Magma reports that production, cost reduction, and productivity have all improved dramatically since Magma became an independent company in 1988. New development projects and purchase of a major high quality ore body have supplemented Magma's reserves to ensure copper production into the next century.

Company highlights for 1991 include the achievement of record operating performance, the signing of a historic fifteen-year labor contract, the implementation of employee gainsharing programs, the refinancing of the company's debt, and the reorganization of its balance sheet.

The expansion and modernization program that began in 1987 included a major expansion of the San Manuel smelter and refinery as well as several different leaching, solvent extraction, and electrowinning projects. These projects suffered a series of technical start-up problems that resulted in initial production and cost disappointments.

An innovative 15-year labor contract was signed in October 1991. The contract is tailored to the needs of the

company, unions, employees, and management, and is dedicated to employee involvement, high productivity, low production cost, and greater employment security.

### **San Manuel**

**P.O. Box M, San Manuel, Arizona 85631  
Phone (602) 385-3100**

San Manuel consists of a underground copper-molybdenum mine, a 62,000 ton-per-day concentrator, an open-pit oxide copper mine, a heap leach, an in situ leach, an SX-EW plant, a 1,000,000 ton-per-year smelter, a 3,000 ton-per-day acid plant, a 300,000 ton-per-year electrolytic refinery, and a 180,000 ton-per-year rod plant.

Mining at San Manuel uses the block-caving method. After development of the grizzly and haulage levels, caving is initiated by undercutting the ore block. The caved ore is drawn through the grizzlies to the haulage level. Haulage to the production shafts is by 23-ton trolley locomotives pulling ten 15-17 ton ASEA cars or fifteen 12-13 ton rotary dump cars. After hoisting to the surface the ore is hauled by rail about 8 miles to the mill in 100-ton cars in groups of 35 to 40 pulled by 125-ton diesel-electric locomotives.

Three years ago Magma was facing the planned closure of the San Manuel underground mine. Currently, a feasibility study is underway to assess the financial viability of mining the nearby Kalamazoo ore body. Preliminary results indicate that the development of the ore body could extend the San Manuel underground mine's life by 11 years - from 1997 to 2008.

Utilization of high-performance production techniques developed in the Kalamazoo ore body pilot production project have helped increase the San Manuel underground production by 22 percent from 184 million pounds in 1988 to 222 million pounds in 1991, while reducing net cash operation cost by \$ 0.24 per pound from \$1.06 in 1988 to \$0.82 in 1991.

Mining at the open-pit oxide mine is accomplished with front-end loaders with truck haulage at the rate of 28,000 tons of ore and 65,000 tons of waste per day. Ore is placed on the polyethylene-lined leach pads and some of the waste is dumped in the subsidence area. Any sulfide ore encountered is hauled to a railroad siding and added to the feed going to the concentrator. Copper is recovered from the leach solutions at the SX-EW plant that uses the ISA process of plating the copper on stainless steel sheets rather than on copper starter sheets. The solutions from the in situ leaching are also fed to this plant that was expanded to a capacity of 75,000 tons of copper per year.

Electrowon cathode production has increased considerably since 1988. In 1991, 130 million pounds were produced, 51 percent above the 86 million pounds

produced in 1988. This increase is partly attributable to increased production at San Manuel's in situ leaching operations that employ well-to-well leaching. Cathodes from the electrolytic refinery and the SX-EW plant are melted and cast into continuous rods at the rod plant.

The San Manuel smelter accounts for 25 percent of U.S. copper smelting capacity. The Outokumpu flash smelting furnace, with a design capacity of 3,000 tons of concentrate per day, is the largest single furnace smelter in the industry. An oxygen plant and modifications to the acid plant were a part of Magma's modernization program. The technical problems associated with the smelter were resolved by mid-1990 and the facility has operated consistently above design capacity. In 1991 the smelter processed over 1 million tons of new concentrate, 42 percent more than in 1988.

In the spring of 1992 Magma announced plans to increase its smelter capacity by up to 20 percent to take advantage of a growing worldwide "smelter bottleneck." Attempts to build new smelters by Mitsubishi Materials and Outokumpu have been thwarted by environmental concerns. As a result, copper smelting charges are skyrocketing. In early 1990, the average smelting and refining charge was 15 cents per pound. By spring of 1992 smelters were charging about 35 cents per pound for custom processing.

To take advantage of this trend, Magma hopes to increase its smelting capacity by 5 percent, or 30 million pounds of copper, in 1992. The feasibility of constructing a new acid plant that could increase smelting capacity by another 15 percent is being examined. Magma reports that more than one quarter of Magma's copper throughput is derived from custom smelting and refining.

### **Pinto Valley/Miami**

---

**P.O. Box 100, Miami, Arizona 85631  
Phone (602) 425-7611**

Magma's Pinto Valley Division consists of the Pinto Valley and the Miami mines. At Pinto Valley mining is accomplished with electric shovels and truck haulage to the 63,000 ton-per-day concentrator. A dump leaching and an 8000 tons-per-year SX-EW plant are also in operation. The concentrates and cathodes are shipped to San Manuel.

The management team at Pinto Valley has been restructured and a new mine plan has been developed to address declining ore grades. The new plan theoretically reduces the mine life, but is economically more attractive. Opportunities to exploit additional oxide ore zones are being studied to increase production of electrowon copper.

Miami consists of an in situ leach of the inactive Miami block-cave area, a hydraulic mining, leach reprocessing operation of the Number 2 tailings, and a

10,000 ton-per-year SX-EW plant. In April of 1988, following favorable metallurgical tests, a feasibility study, and permitting, the company began the project for the reclamation and leaching of mill tailings associated with the old Miami underground mine. The tailings are reclaimed using hydraulic monitors to produce a slurry of tailings and water. Sulfuric acid is added to slurry to dissolve the contained copper and the resulting pregnant leach solution is processed through the Miami Unit's SX-EW plant. The remaining tailings are thickened and transported for disposal through an overland pipe to an inactive Miami pit. During 1991, approximately 3.9 million tons of tailings were mined, producing nearly 9 million pounds of copper. Production from the project is expected to continue until 1998.

### **Superior**

---

**P.O. Box 37, Superior, Arizona 85273  
Phone (602) 689-2444**

Superior consists of an underground mine, a 3300 ton per day flotation mill, and an inactive copper smelter. Concentrates are shipped by rail car to the San Manuel smelter for treatment. This deep, hot, high-grade mine reopened in 1990 with a planned production rate of 1500 tons of ore per day. Superior produced 25 million pounds of copper in 1991. The work force has operated at productivity levels higher than before closure. A mine fire in the fourth quarter of 1991 resulted in lower operating performance than was expected.

## **ORACLE RIDGE MINING PARTNERS**

### **Oracle Ridge Mine**

---

**P.O. Box 7, San Manuel, Arizona 85631  
Phone (602) 576-1412**

Oracle Ridge Mining Partners consists of South Atlantic Ventures Ltd. of Vancouver, British Columbia, mine operator with a 70 percent interest, while the remaining 30 percent is owned by Continental Materials of Chicago, Illinois.

The underground Oracle Ridge Mine is located 15 miles north-northwest of Tucson on the east flank of the Santa Catalina Mountains. A new column flotation mill started operation on February 28, 1991 and the first saleable bulk flotation copper-silver-gold concentrate was produced on March 4, 1991 from ore stockpiled during previous operations in 1980-1982 and underground development in 1990. Modifications were made to the mill in 1991 to substantially improve recovery. Concentrates are shipped to Asarco's Hayden smelter 53 miles to the north.

## **PHELPS DODGE CORPORATION**

**Corporate Headquarters - 2600 North Central Avenue, Phoenix, Arizona 85004- 3015  
Phone (602) 234-8100**

Phelps Dodge is the nation's largest copper producer, accounting for about 33 percent of the nation's production from its mines in southeastern Arizona and southwestern New Mexico. Facilities in Arizona consist of the 2 operating properties Morenci and Copper Queen, along with New Cornelia, a closed open-pit mine, mill, and smelter complex located at Ajo. In conjunction with its Arizona operations, it operates 2 mines, Tyrone and Chino, near Silver City, New Mexico, 2 smelters, Hidalgo and Chino, both in New Mexico, and a 420,000 ton-per-year refinery located at El Paso, Texas.

In 1991 Phelps Dodge's U.S. mines and facilities produced 621,800 tons of copper; 518,100 tons for the company and the balance for the accounts of minority interest owners. This production included a record 234,100 tons of copper from SX-EW plants, approximately 197,800 tons of which were for the company's account. Copper produced by SX-EW accounted for 37 percent of Phelps Dodge's total production in 1991, compared with 31 percent in 1990. Soon, SX-EW is expected to contribute nearly 50 percent, or about 250,000 tons, of annual production.

### **Morenci**

**Morenci, Arizona 85540  
Phone (602) 865-4521**

Phelps Dodge's Morenci Mine is the largest copper producer in North America and the second largest copper producer in the world. The operation consists of 2 open pits, 2 concentrators, and an SX-EW plant. The 2 pits, Morenci and Metcalf, are located on portions of the same deposit. Phelps Dodge owns an 85 percent interest in the Morenci Mine; the remaining 15 percent is owned by Sumitomo Metal Mining Company, Ltd. and Sumitomo Corporation. Morenci employs nearly 2,000 people. During 1991 Morenci produced a record 342,000 tons of copper, accounting for more than half of all copper produced by Phelps Dodge in the United States.

The operation consists of the combined Morenci-Metcalf open pit copper mine, the 60,000 ton-per-day Morenci concentrator with a molybdenum circuit, the 40,000 ton-per-day Metcalf concentrator, 3 SX plants, and an EW tankhouse. The 650,000 ton-per-year smelter with a 2,400 ton-per-day acid plant remain inactive and will require extensive modifications to meet air quality restraints if ever reactivated.

Mining is conducted with electric shovels and truck haulage utilizing a computer controlled Modular Mining Truck Dispatching System for maximum efficiency.

During 1989 the completion of the in-pit crushing and conveying system eliminated rail haulage completely. The trucks dump into the 2 semi-mobile primary crushers in the pit and the crushed ore is conveyed to the coarse ore stockpile by conveyor belt. Each concentrator is fed by conveyors running under the stockpile. Both concentrators are standard flotation mills except that column flotation cells have been installed in the cleaner circuit of each.

All mined material other than ore is classified as leach material and is taken to one of several leach dumps. There are 3 widely-spaced solvent extraction plants to upgrade the solutions before they are pumped to the centrally located tank house for electrowinning.

Construction continued on the \$112-million Northwest Extension project, which will add 70,000 tons of SX-EW production per year. Upon completion of this project in 1992, the Morenci SX-EW facilities will be the largest in the world, with an annual production capacity of 170,000 tons of high cathode copper.

Two other substantial capital programs at Morenci that continued during 1991 included reentry into the Metcalf pit and extension of the ore crushing and conveying systems.

### **Copper Queen**

**Highway 92, Bisbee, Arizona 85603  
Phone (602) 432-3621**

The company's Copper Queen facility consists of a dump leaching and precipitation operation at the mined-out Lavender pit. Additional copper resources are available in the adjacent 210-million-ton Cochise deposit. Although metallurgical work has been done, it is unlikely to be developed without construction of a new SX-EW facility that would require improvement in the copper market.



## SEVERANCE TAX ON METALLIFEROUS MINERALS

The Severance Tax on metalliferous minerals is a tax on the production or extraction of metalliferous minerals from the earth, not on the sales of such minerals. A brief discussion of the tax is provided here; for more complete information contact the Arizona Department of Revenue, 1600 W. Monroe, Phoenix, Arizona 85007, phone (602) 255-3381. Citations used below are from the Arizona Revised Statutes.

### Tax Base

The severance tax is levied on the "net severance base" of all metalliferous minerals produced after 1982 (42-1462). The "net severance base" is the greater of the following 2 values (42-1464, Laws of 1982, Chapter 230, Section 12):

1. The "weighted mineral value", or
2. A specified percentage of the old sales tax base (the gross value of production less out-of-state processing costs). This value will be referred to as the "Arizona value" after June 30, 1985.

The "weighted mineral value" is essentially the cost of extracting the minerals from the earth and delivering them to the site where they will be processed.

The "weighted mineral value" is determined as follows (42-1464):

1. Divide the mining costs by the production costs.
2. Multiply the quotient computed in (1) above by the gross value of production.

### Definitions:

*mining costs*: represent the cost of extracting the minerals from the earth and delivering them to the site where they will be processed further (42-1461)

*total production costs*: include most of the major costs incurred in mining and processing minerals until the point of sale (42-1461).

*gross value of production*: is determined by multiplying the recoverable units of a metallic product by the price per unit of the product; the price per unit does not include the cost of manufacturing, fabricating or otherwise transforming a refined mineral product, when these activities occur prior to sale of the product (42-1461).

Although metalliferous minerals will no longer be taxed on the old sales tax base, the value of minerals produced after 1982 may not fall below a specified percentage of the old tax value (42-1464, Laws of 1982, Chapter 230, Section 12). The old tax value included not only the cost of extracting the minerals from the earth, but most of the major in-state costs of producing the minerals. This value was determined by multiplying

the recoverable units of a metallic product by the price per unit and deducting the out-of-state processing costs from the result (42-1464; Laws of 1982, Chapter 230, Section 12; 41-1461).

### Tax Rate

2.5% of the net severance base.

### Purpose

To aid in defraying the necessary and ordinary expenses of the state, cities, and counties to reduce or eliminate the annual tax levy on property for state, city and county purposes and to reduce the levy on property for public school education (Laws of 1982, Chapter 230, Section 17).

Eighty percent of the collected taxes are distributed in the same manner as the transaction tax (i.e. 25 percent to the cities, 33.6 percent to the counties, and 41.4 percent to the State). The remaining 20 percent of the collected taxes are deposited each year in the State's general fund and are appropriated for public education purposes (42-1465; Laws of 1982, Chapter 230, Section 16).

Source: *State of Arizona Tax Handbook - 1990*, Joint Legislative Budget Committee.

### Severance tax paid to the State of Arizona on metalliferous minerals\*

Fiscal Year	Net Collections
1990-91	\$30,103,041
1989-90	29,552,883
1988-89	30,906,899
1987-88	19,268,473
1986-87	11,979,174
1985-86	13,990,039
1984-85	10,101,077
1983-84	9,814,062
1982-83	4,045,392

Source: Arizona Department of Revenue, Annual Reports.

\* The net collections figures cited last year were in error. The Department regrets any inconvenience this may have caused.

---

## PROPERTY TAX

---

The following has been excerpted from *Appraisal Manual for Mines and Natural Resources* by Donald E. Ross of the Arizona Department of Revenue which was effective as of January 1, 1988 and is revised annually.

The Natural Resource Unit of the Division of Property Valuation and Equalization is assigned the responsibility of valuing producing and nonproducing mines and oil, gas, and geothermal interests. Arizona Department of Revenue mine valuation regulations R15-4-201 through R15-4-206 are incorporated into this manual.

Arizona Revised Statutes (ARS Section 42-201.8) states:

*"Producing mine or mining claim" means any mine or mining claim from which any coal, mineral or mineral substance, other than clay, sand, gravel, building stone or any mineral substance normally processed into artificial stone, has been extracted for commercial purposes at any time during a period of one year prior to the first Monday in January of the tax year."*

A producing mine includes the land utilized for mining purposes together with structures and facilities necessary to sustain mining operations. It also includes equipment used directly in the process of extracting ores or minerals from the earth for commercial purposes, including equipment required to prepare the materials for extraction and the handling, loading or transportation of such extracted material to the surface. Mining includes underground, surface and open-pit operations for the extraction of ores and minerals.

If mining operations cease, real and personal property associated with a mining operation will continue to be valued by Centrally Valued Properties for a period of three years. The nonoperating mine will be retained in the legal class 1 for the first year after mining operations are terminated. The legal class designation used for the next two years will depend on the use of the property, which could be class 4 if the property remains idle.

Three years after mining operations have ceased, the valuation of the nonproducing mining property will be transferred from the Centrally Valued Properties' jurisdiction to the Locally Valued Properties' jurisdiction. From this point on, the county assessor is responsible for classifying and valuing the subject property. Such property will be classified according to its current use. If the real and/or personal property is idle at the expiration of the three-year period, it normally will be classified legal Class Four property.

The Natural Resource Unit of the Centrally Valued Properties Section of the Arizona Department of Revenue is responsible for determining annually the

value of all producing mines as of the first day of January of the tax year. Property within the context of a producing mine excludes manufacturing operations such as a rod plant. In summary, the value of taxable producing mine property for Arizona property tax purposes includes land, supplies inventories, ore reserves, construction work in progress, personal property and improvements.

### Summary of Procedures

Producing mines are taxed on the basis of their assessed value multiplied by the local tax rate which produces the tax due. The assessment ratio for 1988 is 28% of the full cash value or market value. The full cash value is determined by the mineral property appraiser after correlating the three approaches to value, namely the income, cost and market approaches.

The income approach consists of discounting two different future income streams as developed by (1) the mining company and (2) by the Department utilizing a single rate factor. The Department has developed a method in which a five-year history, expressed as a profit margin, is combined with the future production schedule to produce a future income stream. The historical data are expressed on a production basis, not on a sales basis. This five-year margin method avoids the problems of predicting the future price of copper and other metals. It is supported in the literature and has been approved by the Arizona Supreme Court. The past is only a valid indicator of the performance level of a relatively stable operation and should not be used for new or dying mines. The historical data are averaged to flatten the effects of the peaks and it is generally accepted as standard for financial reporting, and the Securities and Exchange Commission reports.

Cost approach values are determined by computing the reproduction cost new less depreciation for the physical assets. Straight line depreciation is utilized along with appreciation or inflation factors as developed by the Department. Economic and functional obsolescence can be allowed for by the appraiser if warranted.

Comprehensive field notes are written for each mine annually. Contacts with the mining industry are maintained in order to keep abreast of development in technology and discount rates. Technical papers and literature are collected, indexed, and placed in the listing of references for each mine appraisal report. Detailed production statistics are maintained in order to analyze the historical performance for the mine.

**Table 1. Copper and molybdenum production in 1991, by mine and company**

[Leaders (--), no production. (xx), not applicable]

Company Mine Ore/process type	Copper ore mined (tons)	Copper ore milled (tons)	Recoverable copper (pounds)	Recoverable molybdenum (pounds)	Waste removed (tons)
<b>Arimtco International Inc.</b>					
<b>Johnson (1</b>					
Heap leach/SX-EW	684,150	--	5,897,741	--	--
<b>Company total</b>	<b>684,150</b>	<b>--</b>	<b>5,897,741</b>	<b>--</b>	<b>--</b>
<b>Asarco Inc.</b>					
<b>Mission</b>					
Sulfide	13,795,700	13,795,700	172,042,541	--	54,072,200
<b>Ray</b>					
Sulfide	10,616,000	10,616,000	149,453,000	--	49,697,000
Oxide	4,993,000	--	--	--	--
Heap leach/SX-EW	--	--	62,276,000	--	--
Dump leach/SX-EW	--	--	22,962,000	--	--
<b>San Xavier North</b>					
Sulfide	450,100	450,100	4,863,968	--	817,500
<b>Silver Bell</b>					
Dump leach/cement.	--	--	8,059,617	--	--
<b>Company total</b>	<b>29,854,800</b>	<b>24,861,800</b>	<b>419,657,126</b>	<b>--</b>	<b>104,586,700</b>
<b>Cyprus Copper Co.</b>					
<b>Bagdad</b>					
Sulfide	28,774,000	26,712,000	196,852,000	11,679,000	23,119,000
Dump leach/SX-EW	--	--	22,391,000	--	--
<b>Casa Grande</b>					
In-situ/SX-EW	--	--	6,864,000	--	--
<b>Miami (1</b>					
Oxide	26,495,000	--	--	--	15,067,000
Heap leach/SX-EW	--	--	121,224,000	--	--
<b>Mineral Park</b>					
In-situ/cementation	--	--	1,000,000	--	--
Dump leach/cement.	--	--	2,800,000	--	--
<b>Sierrita</b>					
Sulfide	30,619,000	28,809,000	134,014,000	15,532,000	21,003,000
Dump leach/SX-EW	6,715,000	--	9,337,000	--	--
<b>Twin Buttes</b>					
Sulfide (2	7,256,000	5,867,000	96,774,000	1,428,000	19,425,000
Oxide	1,789,000	--	--	--	--
Vat/SX-EW (3	--	--	37,597,000	--	--
<b>Company total</b>	<b>101,648,000</b>	<b>61,388,000</b>	<b>628,853,000</b>	<b>28,639,000</b>	<b>78,614,000</b>
<b>Magma Copper Co.</b>					
<b>Miami</b>					
In-situ/SX-EW	--	--	10,496,000	--	--
No. 2 Tailings/SX-EW	--	--	8,850,000	--	--
<b>Pinto Valley</b>					
Sulfide	22,659,339	22,659,339	146,261,172	1,388,000	32,976,071
Dump leach/SX-EW	--	--	15,189,000	--	--

**Table 1. Copper and molybdenum production in 1991, by mine and company — continued**

Company Mine Ore/process type	Copper ore mined (tons)	Copper ore milled (tons)	Recoverable copper (pounds)	Recoverable molybdenum (pounds)	Waste removed (tons)
<b>San Manuel</b>					
Underground sulfide	18,753,661	18,761,357	221,861,238	4,023,734	--
In-situ/SX-EW	--	--	24,674,000	--	--
Open Pit-Sulfide	47,644	7,220	113,710	--	--
Open Pit-Oxide	13,076,711	--	--	--	15,048,633
Heap leach/SX-EW	--	--	66,888,000	--	--
<b>Superior</b>					
Sulfide	250,500	250,500	25,167,574	--	--
<b>Company total</b>	<b>54,787,855</b>	<b>41,678,416</b>	<b>519,500,694</b>	<b>5,411,734</b>	<b>48,024,704</b>
<b>Oracle Ridge Mining</b>					
<b>Oracle Ridge</b>					
Sulfide	171,792	192,969	4,483,042	--	4,200
<b>Company total</b>	<b>171,792</b>	<b>192,969</b>	<b>4,483,042</b>	<b>--</b>	<b>4,200</b>
<b>Phelps Dodge Corp.</b>					
<b>Copper Queen</b>					
Dump leach/cement.	--	--	2,280,000	--	--
<b>Morenci (4)</b>					
Sulfide	44,500,000	43,100,000	445,500,000	1,000,000	107,000,000
Oxide	27,000,000	--	--	--	19,500,000
Dump leach/SX-EW	--	--	238,900,000	--	--
<b>Company total</b>	<b>71,500,000</b>	<b>43,100,000</b>	<b>686,680,000</b>	<b>1,000,000</b>	<b>126,500,000</b>
<b>Subtotals by process type</b>					
Flotation	177,893,736	171,221,185	1,597,386,245	35,050,734	308,113,971
Leach	80,752,861	xx	667,685,358	--	49,615,633
Dump/SX-EW	xx	xx	317,629,000	--	xx
Heap leach/SX-EW	xx	xx	256,285,741	--	xx
In-situ/SX-EW	xx	xx	42,034,000	--	xx
Vat agitation/SX-EW	1,789,000	xx	37,597,000	--	xx
SX-EW total	xx	xx	653,545,741	--	xx
Dump/cementation	xx	xx	13,139,617	--	xx
In-situ/cementation	xx	xx	1,000,000	--	xx
Cementation total	xx	xx	14,139,617	--	xx
<b>Arizona total</b>	<b>258,646,597</b>	<b>171,221,185</b>	<b>2,265,071,603</b>	<b>35,050,734</b>	<b>357,729,604</b>

(1 Although some of this production is from old dumps, it is undifferentiated and reported as heap leach.

(2 Sulfide ore is concentrated at Sierrita.

(3 Includes production from ore stockpiles, reclaimed sulfide tailings, and newly mined ore.

(4 Includes Sumitomo's 15%. All waste is low-grade material that is dump leached.



**Table 2. Leach copper production, by mine**

[Copper production in thousand pounds. Includes copper recovered by precipitation or SX-EW from material dump, vat, heap, or in-situ leached. Leaders (--), no production]

Company/Mine	1982	1983	1984	1985	1986	1987
<b>Arimetco International Inc.</b>						
Emerald Isle	--	--	--	--	--	--
Johnson (1	9,702	--	8,803	6,200	--	--
Van Dyke (2	--	--	--	--	--	--
<b>Asarco Inc.</b>						
Ray (3	22,420	20,033	20,457	23,706	56,639	68,543
Silver Bell	8,687	10,374	9,152	8,800	6,814	12,800
<b>Cyprus Copper Co.</b>						
Bagdad	13,173	13,282	14	14,259	13,958	16,470
Casa Grande (4	45,611	3,244	15,401	13,514	7,100	4,145
Miami (5	50,000	78,988	79,549	85,136	98,747	105,555
Mineral Park (6	3,191	3,101	2,718	3,798	4,251	4,405
Ox Hide (5	1,572	--	--	--	--	--
Sierrita/Esperanza (6	9,354	6,367	8,500	10,000	8,770	7,943
Twin Buttes (7	60,796	50,649	50,239	19,824	--	--
<b>Magma Copper Co.</b>						
Copper Cities	2,046	--	--	--	--	--
Pinto Valley/Miami	26,958	24,632	25,602	23,947	22,252	22,724
San Manuel (8	--	--	--	--	21,923	51,278
<b>Phelps Dodge Corp.</b>						
Copper Queen	4,545	5,200	3,493	4,144	3,454	2,730
Morenci	75,735	69,158	60,312	53,228	56,261	45,249
New Cornelia	661	--	920	402	--	--
<b>Total</b>	<b>334,451</b>	<b>285,028</b>	<b>285,160</b>	<b>266,958</b>	<b>300,169</b>	<b>341,842</b>
<b>Percent of primary copper produced (9</b>	<b>19.6</b>	<b>18.8</b>	<b>18.0</b>	<b>15.0</b>	<b>17.1</b>	<b>19.8</b>

(1) Arimetco acquired Johnson Camp from Cyprus in August, 1989.

(2) Operated by Kocide 1988-89. Acquired by Arimetco in 1990.

(3) Asarco purchased Ray from Kennecott November 18, 1986.

(4) Noranda Lakeshore through 6/31/87; Now Cyprus Casa Grande July, 1988.

(5) Sold by Inspiration to Cyprus July 1, 1988.

(6) Cyprus purchased Sierrita/Esperanza and Mineral Park from Duval April 1, 1986.

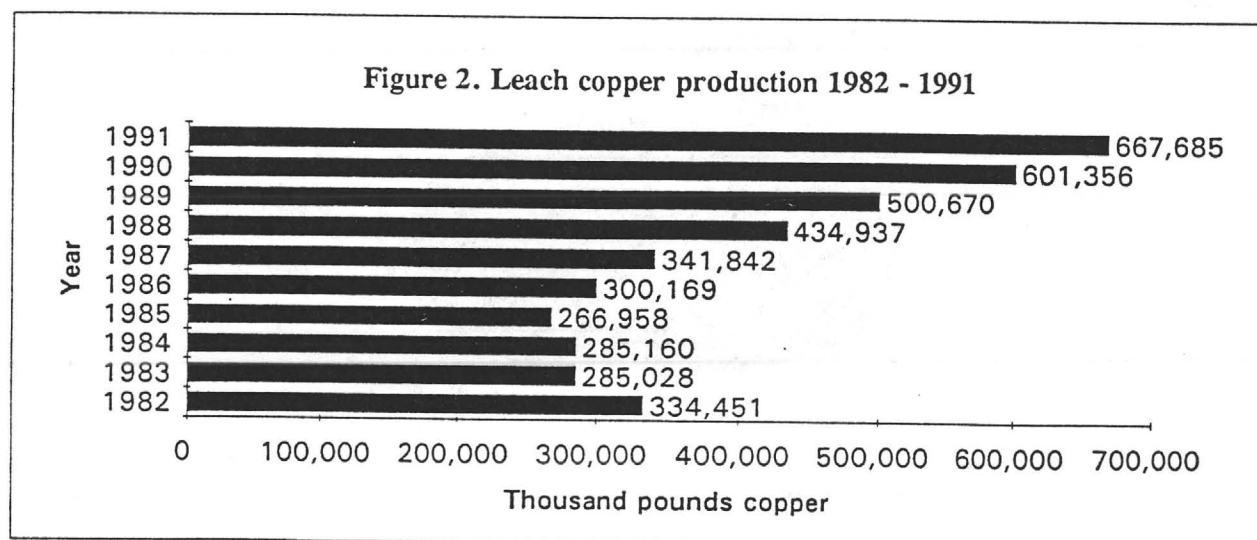
(7) Operated by ANAMAX. Acquired by Cyprus March, 1988.

(8) Open pit, heap leach, SX-EW start-up in spring of 1986. Some in-situ production.

(9) Leach copper compared to total copper produced as reported in this report, Table 1.

Table 2. Leach copper production, by mine — continued

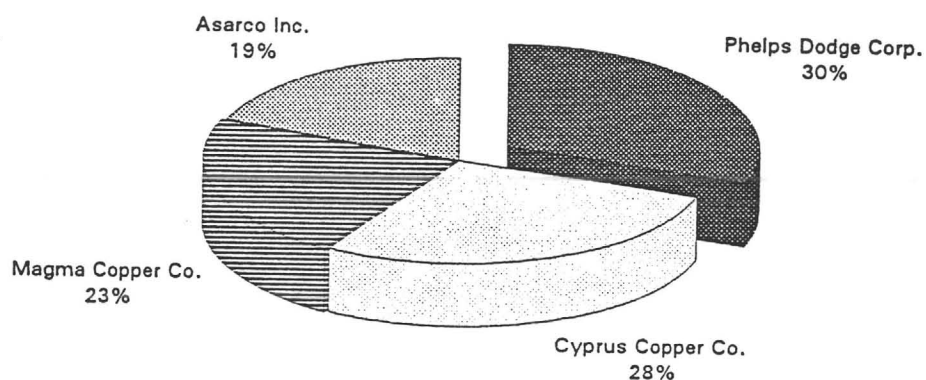
Company/Mine	1988	1989	1990	1991
<b>Arimetco International Inc.</b>				
Emerald Isle	--	48	26	--
Johnson (2)	--	--	2,852	5,898
Van Dyke (3)	67	654	--	--
<b>Asarco Inc.</b>				
Ray (4)	76,966	79,933	81,797	85,238
Silver Bell	8,660	10,017	8,480	8,059
<b>Cyprus Copper Co.</b>				
Bagdad	19,100	22,262	23,419	22,391
Casa Grande (5)	4,300	5,000	2,500	6,864
Miami (6)	115,293	124,367	121,702	121,224
Mineral Park (7)	4,500	3,338	4,000	3,800
Ox Hide (6)	--	--	--	--
Sierrita/Esperanza (7)	8,556	8,400	9,383	9,337
Twin Buttes (8)	--	18,800	30,919	37,597
<b>Magma Copper Co.</b>				
Copper Cities	--	--	--	--
Pinto Valley/Miami	23,413	21,013	31,955	34,535
San Manuel (9)	62,956	68,855	80,400	91,562
<b>Phelps Dodge Corp.</b>				
Copper Queen	2,700	4,762	3,100	2,280
Morenci	108,426	133,221	200,823	238,900
New Cornelia	--	--	--	--
<b>Total</b>	<b>434,937</b>	<b>500,622</b>	<b>601,356</b>	<b>667,685</b>
<b>Percent of primary copper produced (9)</b>	<b>23.1</b>	<b>24.9</b>	<b>27.7</b>	<b>29.5</b>



**Table 3. Company rank in 1991, by copper and molybdenum production**

Copper			Molybdenum		
Rank	Company	Percent	Rank	Company	Percent
1	Phelps Dodge Corp.	30.32	1	Cyprus Copper Co.	81.71
2	Cyprus Copper Co.	27.76	2	Magma Copper Co.	15.44
3	Magma Copper Co.	22.94	3	Phelps Dodge Corp.	2.85
4	Asarco Inc.	18.53			
5	Arimetco Int. Inc.	0.26			
6	Oracle Ridge Mining	0.20			

**Figure 3. Copper production by company**



**Figure 4. Molybdenum production by company**

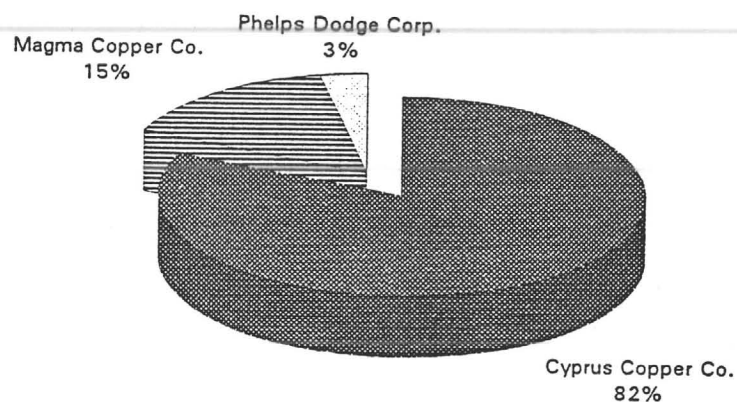


Table 4. Mine rank in 1991, by copper and molybdenum production

Rank	Mine/Company	Production (pounds)	% of total
<b>Copper</b>			
1	Morenci/Phelps Dodge Corp.	684,400,000	30.2
2	San Manuel/Magma Copper Co.	313,536,948	13.8
3	Ray/Asarco Inc.	234,691,000	10.4
4	Bagdad/Cyprus Copper Co.	219,243,000	9.7
5	Mission/Asarco Inc.	172,042,541	7.6
6	Pinto Valley/Magma Copper Co.	161,450,172	7.1
7	Sierrita/Cyprus Copper Co.	143,351,000	6.3
8	Twin Buttes/Cyprus Copper Co.	134,371,000	5.9
9	Miami/Cyprus Copper Co.	121,224,000	5.4
10	Superior/Magma Copper Co.	25,167,574	1.1
11	Miami/Magma Copper Co.	19,346,000	0.9
12	Silver Bell/Asarco Inc.	8,059,617	0.4
13	Casa Grande/Cyprus Copper Co.	6,864,000	0.3
14	Johnson/Arimetco International Inc.	5,897,741	0.3
15	San Xavier North/Asarco Inc.	4,863,968	0.2
16	Oracle Ridge/Oracle Ridge Mining	4,483,042	0.2
17	Mineral Park/Cyprus Copper Co.	3,800,000	0.2
18	Copper Queen/Phelps Dodge Corp.	2,280,000	0.1
<b>Total</b>		<b>2,265,071,603</b>	<b>100.0</b>
<b>Molybdenum</b>			
1	Sierrita/Cyprus Copper Co.	15,532,000	44.3
2	Bagdad/Cyprus Copper Co.	11,679,000	33.3
3	San Manuel/Magma Copper Co.	4,023,734	11.5
4	Twin Buttes/Cyprus Copper Co.	1,428,000	4.1
5	Pinto Valley/Magma Copper Co.	1,388,000	4.0
6	Morenci/Phelps Dodge Corp.	1,000,000	2.9
<b>Total</b>		<b>35,050,734</b>	<b>100.0</b>

**Table 5. Monthly and cumulative copper mine production**

[Percentage change column shows change from corresponding period in prior year]

	1987		1988		1989		1990		1991	
	Tons	% Change	Tons	% Change	Tons	% Change	Tons	% Change	Tons	% Change
January	71,816	-8.1	77,612	8.1	81,455	5.0	84,172	2.0	93,712	11.3
February	65,448	-3.1	73,465	12.2	79,227	7.8	78,045	-2.8	86,205	10.5
March	72,674	-0.2	82,552	13.6	91,491	10.8	85,658	-7.4	90,468	5.6
April	67,637	-3.8	76,379	12.9	79,549	4.2	88,073	9.3	86,126	-2.2
May	69,843	-4.9	77,872	11.5	82,315	5.7	91,460	9.7	101,955	11.5
June	68,985	-5.2	75,089	8.8	78,643	4.7	92,701	16.3	95,312	2.8
July	68,090	-8.0	77,316	13.5	80,152	3.7	92,258	13.6	97,937	6.2
August	69,596	-2.6	82,747	18.9	84,995	2.7	90,685	5.4	100,611	10.9
September	69,498	-4.0	77,467	11.5	80,169	3.5	89,107	9.7	93,623	5.1
October	71,478	-6.1	79,386	11.1	82,790	4.3	93,941	11.7	99,787	6.2
November	75,349	7.3	76,173	1.1	77,303	1.5	93,320	18.8	94,279	1.0
December	76,930	8.9	80,906	5.2	81,502	0.7	93,037	11.8	93,590	0.6
Cumulative year to date										
January	71,816	-8.1	77,612	8.1	81,455	5.0	84,172	2.0	93,712	11.3
February	137,264	-5.8	151,077	10.1	160,682	6.4	162,217	-0.4	179,917	10.9
March	209,938	-3.9	233,629	11.3	252,173	7.9	247,875	-2.9	270,385	9.1
April	277,575	-3.9	310,008	11.7	331,722	7.0	335,948	0.0	356,511	6.1
May	347,418	-4.1	387,880	11.6	414,037	6.7	427,408	1.9	458,466	7.3
June	416,403	-4.3	462,969	11.2	492,680	6.4	520,109	4.2	553,778	6.5
July	484,493	-4.8	540,285	11.5	572,832	6.0	612,367	5.5	651,715	6.4
August	554,089	-4.5	623,032	13.3	657,827	5.6	703,052	5.5	752,326	7.0
September	623,587	-4.5	700,499	12.3	737,996	5.4	792,159	5.9	845,949	6.8
October	695,065	-4.7	779,885	12.2	820,786	5.2	886,100	6.5	945,736	6.7
November	770,414	-3.6	856,058	11.1	898,089	4.9	979,420	7.5	1,040,015	6.2
December	847,344	-2.6	936,964	11.2	979,591	4.5	1,072,457	7.9	1,133,605	5.7
Average	70,612	-2.6	78,080	10.6	81,633	4.5	89,371	7.9	94,467	5.7

Source: U.S. Bureau of Mines

**Table 6. Average copper content of ore produced**

[Copper content reported as percent of total copper. Percentage in parenthesis is approximate and not used to calculate weighted average. Leaders (--), no production. (UG), underground. (OP), open pit. (do.) ditto]

Company/Mine	Ore type	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
<b>Arimetco International Inc.</b>											
Johnson (1)	Oxide	0.40	0.40	0.71	--	--	--	--	--	--	0.40
<b>Asarco Inc.</b>											
Mission (2)	Sulfide	(0.75)	(0.75)	(0.75)	0.65	0.70	0.67	0.73	0.70	0.72	0.72
Pima (2)	do.	0.48	--	--	--	--	--	--	--	--	--
Ray (3 (4	do.	0.80	1.19	1.13	0.99	0.99	0.89	1.00	0.97	0.88	0.84
do.	Oxide	--	--	--	1.17	1.23	1.15	1.11	1.13	1.05	0.95
San Xavier (2)	Sulfide	(0.65)	(0.51)	(0.51)	(5	(5	(5	(5	0.55	0.54	0.67
<b>Cyprus Copper Co.</b>											
Bagdad	do.	0.50	0.50	0.45	0.44	0.45	0.48	0.45	0.49	0.53	0.44
Esperanza (7	do.	0.29	--	--	--	--	--	--	--	--	--
Lakeshore	Oxide	1.00	(1.00)	(1.00)	--	--	--	--	--	--	--
Miami (6	Sulfide	0.58	0.53	0.55	0.60	0.54	--	--	--	--	--
do.	Oxide	--	--	0.50	0.49	0.57	0.59	0.52	0.49	0.44	0.48
Mineral Park (7	Sulfide	--	--	--	--	--	--	--	--	--	--
Sierrita (7	do.	0.30	(0.30)	0.34	0.33	0.34	0.33	0.30	0.31	0.31	0.28
do.	Oxide	--	--	--	--	--	--	--	--	--	0.15
Twin Buttes (8	Sulfide	0.78	0.57	--	--	--	--	3.39	1.90	0.99	0.99
	Oxide	1.06	0.93	0.86	0.84	--	--	1.22	1.13	0.99	0.90
<b>Magma Copper Co.</b>											
Pinto Valley	Sulfide	0.46	--	0.44	0.45	0.45	0.36	0.37	0.46	0.44	0.40
San Manuel UG	do.	0.66	0.64	0.64	0.61	0.62	0.62	0.63	0.64	0.65	0.69
San Manuel OP	do.	--	--	--	--	--	--	--	--	--	1.08
do.	Oxide	--	--	--	--	0.58	0.64	0.61	0.56	0.55	0.59
Superior	Sulfide	4.32	--	--	--	--	--	--	--	5.26	5.44
<b>Oracle Ridge Mining Partners</b>											
Oracle Ridge	do.	--	--	--	--	--	--	--	--	--	1.79
<b>Phelps Dodge Corp.</b>											
Morenci/Metcalf	do.	0.71	0.73	0.81	0.86	0.84	0.82	0.88	0.79	0.74	0.78
do.	Oxide	--	--	--	--	--	--	--	--	--	0.46
New Cornelia	Sulfide	0.64	0.60	0.55	--	--	--	--	--	--	--
<b>Weighted average (9</b>		0.59	0.65	0.70	0.62	0.61	0.58	0.60	0.62	0.58	0.57

(1) Arimetco acquired Johnson from Cyprus in August, 1989.

(2) Combined as Mission complex in 1985.

(3) Ray acquired from Kennecott, November 18, 1986.

(4) Grade reported for Ray is an average of oxide and sulfide together for 1982.

(5) Data for San Xavier included with Mission for 1985-1988.

(6) Acquired from Inspiration, July 1, 1988.

(7) Acquired from Duval, April 1, 1986.

(8) Includes Amax's share of Palo Verde deposit for 1979-1982. Acquired by Cyprus, March 1988.

(9) Weighted average grade of ore based generally on assay of total copper.

**Table 7. Percent contained copper recovered**

[Reported as percent of total copper. Percentage in parenthesis is an estimate.

Leaders (---), no production. (nd), no data. (do.), ditto]

Company/Mine	Ore type	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
<b>Arimetco International Inc.</b>											
Johnson (1)	Oxide	--	62	(62)	--	--	--	--	--	--	80
<b>Asarco Inc.</b>											
Mission (2)	Sulfide	85	80	(80)	92	91	89	87	84	86	87
Pima (2)	do.	89	--	--	--	--	--	--	--	--	--
Ray (3)	do.	70	(70)	83	81	82	84	83	81	84	84
do.	Oxide	nd	nd	nd	64	59	62	61	60	63	68
San Xavier	Sulfide	78	79	(80)	83	82	84	81	79	79	81
<b>Cyprus Copper Co.</b>											
Bagdad	do.	83	83	92	91	93	90	91	84	70	87
do.	Oxide	--	--	52	51	54	42	46	90	91	nd
Miami (4)	Sulfide	68	86	80	76	66	69	--	93	91	48
Mineral Park (5)	do.	--	--	--	--	--	--	--	--	--	nd
Sierrita (5)	do.	98(?)	(88)	89	92	91	89	87	86	87	87
Twin Buttes (6)	Sulfide	--	--	--	--	--	--	87	83	84	87
do.	Oxide	87	(80)	80	(80)	--	--	--	72	71	nd
<b>Magma Copper Co.</b>											
Pinto Valley	Sulfide	95	--	88	80	84	82	84	82	86	84
San Manuel	do.	89	86	90	90	90	85	86	82	85	89
Superior	do.	(93)	--	--	--	--	--	--	--	94	97
<b>Oracle Ridge Mining Partners</b>											
Oracle Ridge	do.	--	--	--	--	--	--	--	--	--	82
<b>Phelps Dodge Corp.</b>											
Morenci/Metcalf	do.	68	71	70	86	76	74	72	73	77	77
New Cornelia	do.	85	78	76	--	--	--	--	--	--	--

(1) Arimetco acquired Johnson from Cyprus in August, 1989.

(2) Combined as Mission complex in 1985.

(3) Ray unit acquired from Kennecott November 18, 1986.

(4) Percent recovery by leaching since 1986. Acquired from Inspiration July 1, 1988.

(5) Acquired from Duval April 1, 1987.

(6) Recovery includes ANAMAX's share of Palo Verde 1981-1984. Acquired by Cyprus in March, 1989.

**Table 8. Stripping ratios of open pit mines**

[Waste:ore. Leachable rock included with waste at some mines. Leaders (--), no data]

Company/Mine	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
<b>Arimetco International Inc.</b>										
Johnson (1)	--	0.03:1	--	--	--	--	--	--	--	--
<b>Asarco Inc.</b>										
Eisenhower (2 (3)	0.67:1	0.57:1	1.26:1	--	--	--	--	--	--	--
Mission (3)	1.62:1	2.52:1	1.32:1	0.74:1	0.84:1	1.05:1	2.02:1	1.41:1	2.87:1	3.92:1
Pima (3)	1.42:1	--	--	--	--	--	--	--	--	--
Ray (4)	2.30:1	2.72:1	2.11:1	2.27:1	2.12:1	1.99:1	2.10:1	1.70:1	1.90:1	3.18:1
Sacaton	0.70:1	0.35:1	0.10:1	--	--	--	--	--	--	--
San Xavier (3)	2.90:1	0.96:1	1.97:1	(5	(5	(5	(5	6.72:1	6.05:1	1.82:1
Silver Bell	--	1.09:1	1.17:1	--	--	--	--	--	--	--
<b>Cyprus Copper Co.</b>										
Bagdad	1.45:1	1.53:1	0.94:1	0.42:1	0.54:1	0.77:1	1.96:1	1.23:1	1.17:1	0.80:1
Miami (6)	1.42:1	0.27:1	1.72:1	1.50:1	1.82:1	2.04:1	2.01:1	0.96:1	0.55:1	0.57:1
Mineral Park (7)	--	--	--	--	--	--	--	--	--	--
Sierrita (7)	0.55:1	0.33:1	0.76:1	0.55:1	0.19:1	0.40:1	0.67:1	0.77:1	0.79:1	0.91:1
Twin Buttes (8)	2.05:1	1.14:1	--	--	--	--	34.60:1	8.37:1	4.38:1	2.15:1
<b>Magma Copper Co.</b>										
San Manuel	--	--	--	--	1.70:1	2.46:1	2.32:1	2.45:1	1.80:1	1.20:1
Pinto Valley	1.80:1	--	0.79:1	1.01:1	1.21:1	1.32:1	1.39:1	1.53:1	1.27:1	1.46:1
<b>Phelps Dodge Corp.</b>										
Morenci/Metcalf	0.79:1	0.64:1	0.90:1	0.68:1	0.76:1	1.10:1	1.13:1	1.22:1	1.81:1	1.78:1
New Cornelia	1.21:1	0.30:1	0.58:1	--	--	--	--	--	--	--
<b>Weighted average</b>	<b>1.31:1</b>	<b>0.57:1</b>	<b>1.10:1</b>	<b>0.88:1</b>	<b>0.96:1</b>	<b>1.21:1</b>	<b>1.49:1</b>	<b>1.46:1</b>	<b>1.57:1</b>	<b>1.49:1</b>

(1) Arimetco acquired Johnson from Cyprus in August, 1989.

(2) Mining was done by Asarco, includes ANAMAX's share of ore.

(3) Combined as Mission Complex in 1985.

(4) Ray Unit acquired from Kennecott, November 18, 1986.

(5) Data for San Xavier included with Mission.

(6) Acquired from Inspiration July 1, 1988.

(7) Sierrita, Esperanza, and Mineral Park acquired from Duval April 1, 1986.

(8) Acquired by Cyprus March, 1988.

Source: "Minerals Yearbook - Area Reports: Domestic," U.S. Bureau of Mines; companies' annual reports; "E&MJ International Directory of Mining and Mineral Processing Operations;" Arizona Department of Mines and Mineral Resources; company submitted data beginning in 1985.



**Table 9. Production and value of copper, molybdenum,  
gold, and silver recovered from copper ore**

Year	Copper ore (tons)	Copper (1 (lb./ton ore) (cents/lb.)	Copper (1 (pounds) Value (2 (\$)	Molybdenum (1,000 lbs.) Value (\$1000)	Gold (troy ounces) Value (3 (\$)	Silver (troy ounces) Value (4 (\$ )	Value of copper, gold, silver, and molybdenum (\$)
1972	165,914,825	10.22 50.617	1,695,858,000 858,392,446	27,126 46,791	102,526 5,987,518	6,614,957 11,143,226	922,314,190
1973	181,311,945	9.57 58.865	1,735,012,000 1,021,314,814	37,657 59,372	102,376 10,013,397	7,164,988 18,325,173	1,109,025,384
1974	178,913,296	9.00 76.649	1,609,808,000 1,233,901,735	28,346 57,067	90,206 14,488,424	6,308,721 29,701,332	1,335,158,491
1975	168,750,152	8.91 63.535	1,502,978,000 954,917,072	25,030 61,411	82,759 13,364,751	6,190,805 27,354,196	1,057,047,019
1976	194,136,559	9.85 68.824	1,912,430,000 1,316,210,823	31,073 89,148	97,961 12,276,473	7,308,395 31,816,805	1,449,452,101
1977	168,641,401	10.11 65.808	1,705,240,000 1,122,184,339	34,574 120,497	87,874 13,032,593	6,696,415 30,957,660	1,166,295,089
1978	178,204,491	10.20 65.510	1,817,670,000 1,190,755,617	33,029 150,142	92,508 17,905,108	6,611,781 35,709,502	1,244,520,369
1979	203,977,408	9.39 92.334	1,914,501,095 1,767,735,441	35,101 213,065	99,549 30,622,766	7,454,306 82,699,941	2,094,081,895
1980	169,650,401	8.97 101.416	1,521,850,812 1,543,400,219	36,299 324,150	71,533 43,814,606	5,640,703 116,376,559	2,027,741,384
1981	216,787,430	9.89 83.744	2,143,898,000 1,795,385,941	35,600 273,052	95,496 43,891,299	7,565,368 79,575,340	2,191,904,580
1982	146,124,870	11.62 74.31	1,697,500,000 1,261,415,000	22,099 100,673	61,050 22,949,000	6,301,000 50,090,000	1,435,127,000
1983	152,902,150	9.78 76.53	1,495,208,000 1,144,285,000	23,934 79,459	61,991 26,284,000	4,492,000 51,383,000	1,301,411,000
1984	145,278,431	10.89 66.00	1,582,549,000 1,044,483,000	23,184 78,827	51,548 18,591,200	4,093,000 33,320,000	1,175,151,000
1985	159,547,970	11.14 65.60	1,778,334,456 1,166,571,000	30,428 98,827	52,053 16,585,000	4,885,000 30,007,000	1,311,990,000
1986	153,439,000	11.42 66.05	1,752,525,000 1,157,543,000	29,382 75,607	63,334 23,370,000	4,202,000 22,987,000	1,279,507,000
1987	166,113,000	10.38 79.52	1,724,068,000 1,370,924,000	15,939 51,802	48,430 21,694,000	3,530,000 24,745,000	1,469,165,000

**Table 9. Production and value of copper, molybdenum, gold, and silver recovered from copper ore — continued**

Year	Copper ore (tons)	Copper (1 (lb./ton ore) (cents/lb.)	Copper (1 (pounds) Value (2 (\$)	Molybdenum (1,000 lbs.) Value (\$1000)	Gold (troy ounces) Value (3 (\$)	Silver (troy ounces) Value (4 (\$)	Value of copper, gold, silver, and molybdenum (\$)
1988	175,261,000	10.76 119.00	1,885,112,000 2,243,283,000	29,132 78,074	60,981 26,972,000	4,766,000 31,157,000	2,379,486,000
1989	196,684,000	10.22 129.01	2,009,782,000 2,592,723,000	29,795 99,545	44,959 17,283,000	5,312,000 29,367,000	2,738,918,000
1990	213,168,000	10.20 121.80	2,174,574,000 2,648,631,000	29,334 82,429	36,041 13,842,000	5,272,184 26,809,000	2,771,711,000
1991	258,646,597	8.76 107.93	2,265,071,603 2,444,692,000	35,051 82,370	51,248 18,554,000	4,651,017 18,790,000	2,564,406,000

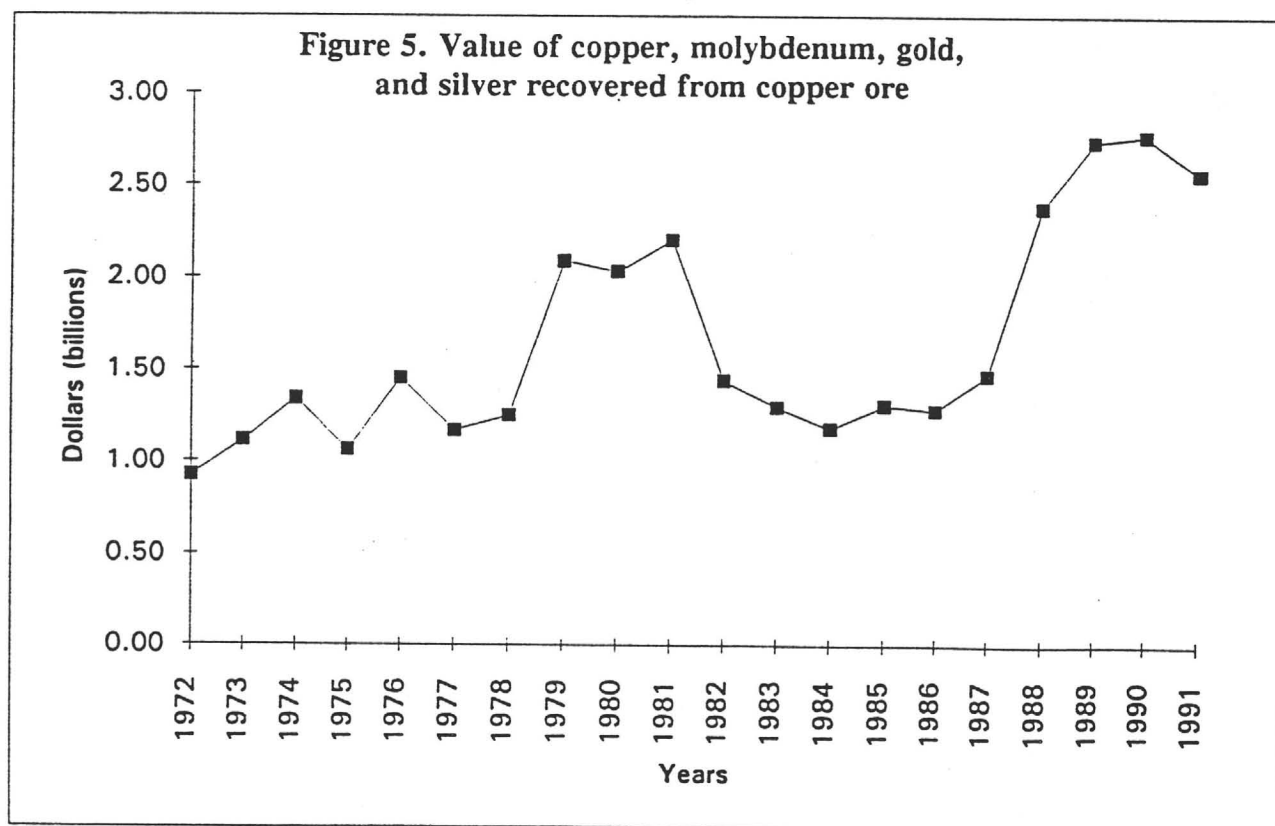
(1 Excludes precipitate copper from dump and in-place leaching prior to 1982.

(2 E&MJ average annual price, U.S. producer cathode for 1972-88. Metals Week annual average price, U.S. producer refiner for 1989 - 1991.

(3 Handy and Harmon average annual gold price.

(4 E&MJ average annual N.Y. market price for .999 fine silver for 1972-88. Metals Week's Handy and Harmon annual average quotation for 1989-1991.

Source: Table 1, this publication; "State Mineral Summaries," U.S. Bureau of Mines.



**Table 10. Nonfuel mineral production**

[(na), not available. (w), withheld, value included in combined value data. (xx), not applicable]

Mineral	Units	1990		1991	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	short tons	154,502	\$2,318	251,781	\$3,830
Copper (1	short tons	1,078,911	2,657,649	1,128,845	2,468,255
Gem stones	xx	na	2,098	na	3,173
Gold (1, 2	troy ounces	160,753	62,191	181,748	67,247
Iron oxide pigments	short tons	w	w	20	22
Sand and gravel (construction) (2	short tons	27,915,000	92,166	22,500,000	79,400
Silver (1	troy ounces	5,562,071	26,836	4,758,304	19,212
Stone (crushed) (3	short tons	5,300,000	13,500	7,060,000	32,842
Combined value of cement, diatomite (1990), gypsum (crude), iron ore (usable, 1991), lead (1991), lime, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial), and stone (dimension) and values indicated by symbol w	xx	xx	207,591	xx	198,230
<b>Total</b>	xx	xx	<b>3,064,349</b>	xx	<b>2,872,211</b>

(1 Recoverable content of ores, etc.

(2 Quantity and value for 1991 are estimates.

(3 Quantity and value for 1990 are estimates.

Source: "The Mineral Industry of Arizona in 1991," U.S. Bureau of Mines.

**Table 11. Copper mine capacity in 1991**

[Figures generally represent a current estimate of the production capacity of primary recoverable copper in concentrates, precipitates, and cathodes. Figures do not represent smelter or refinery capacity. Capacities for closed operations are historic and not necessarily immediately available]

Mine/Company	Annual capacity (tons copper)	Basis
Morenci/Phelps DodgeCorp.	342,000	Recent production figure
Ray/Asarco Inc.	182,000	Design capacity & ore grade
San Manuel/Magma Copper Co.	157,000	Recent production figure
Sierrita & Twin Buttes/Cyprus Copper Co.	138,000	Recent production figure
Mission/Asarco Inc.	120,000	Design capacity & ore grade
Bagdad/Cyprus Copper Co.	110,000	Recent production figure
Pinto Valley/Magma Copper Co.	88,000	Recent production figure
Miami/Cyprus Copper Co.	61,000	Recent production figure
New Cornelia/Phelps Dodge Corp.	40,000	Historic data
Superior/Magma Copper Co.	20,000	Company annual report and/or 10K
Mineral Park/Cyprus Copper Co.	17,000	Historic data
Miami & No. 2 tailings/Magma Copper Co.	10,000	Recent production figure
Christmas/Cyprus Copper Co.	8,000	Historic data
Oracle Ridge/Oracle Ridge Mining	6,000	Design capacity & ore grade
Johnson/Arimetco International Inc.	5,000	Design capacity & ore grade
Silver Bell/Asarco Inc.	4,000	Leaching only
Van Dyke/Arimetco International Inc.	3,000	Design capacity & ore grade
Casa Grande/Cyprus Copper Co.	3,000	Recent production figure
Copper Queen/Phelps Dodge Corp.	2,000	Leaching only
<b>Total</b>	<b>1,316,000</b>	

Source: Arizona Department of Mines & Mineral Resources' file data; companies' annual reports and form 10-Ks; professional publications.

**Table 12. North American copper smelter capacity in 1991**

<b>Company Smelter</b>	<b>Smelter location</b>	<b>Annual capacity (Tons of material)</b>
<b>United States</b>		
Asarco Inc.		
El Paso Smelter	El Paso, TX	450,000
Hayden Smelter	Hayden, AZ	720,000
Hayden-Ray Smelter	Hayden, AZ	360,000
Chemetco Inc.	Alton, IL	150,000
Copper Range Co.	White Pine, MI	70,000
Cyprus Copper Co.		
Cyprus Miami Mining Corp.	Claypool, AZ	408,000
Kennecott Corporation		
Kennecott Utah Copper	Garfield, UT	820,000
Magma Copper Co.		
Smelting and Refining Division	San Manuel, AZ	1,050,000
Phelps Dodge Corp.		
Chino Mines	Hurley, NM	550,000
Tyrone Branch	Playas, NM	750,000
<b>Total</b>		<b>5,328,000</b>
<b>Canada</b>		
Falconbridge Ltd.	Falconbridge, Ontario	495,000
Hudson Bay Mining and Smelting Co. Ltd.	Flin Flon, Manitoba	340,000
Inco Ltd.	Copper Cliff, Ontario	1,800,000
Noranda Mines Inc.		
Gaspé Smelter	Murdochville, Quebec	240,000
Horne Smelter	Rouyn-Noranda, Quebec	900,000
<b>Total</b>		<b>3,775,000</b>
<b>Mexico</b>		
Compania Minera De Cananea, S.A.	Cananea, Sonora	277,000
Industrial Minera Mexico, S.A.	San Luis Potosi	42,000
Mexicana De Cobre, S.A. De C.V.	Nacozari, Sonora	672,000
<b>Total</b>		<b>991,000</b>
<b>North American total</b>		<b>10,094,000</b>

Source: "Non-ferrous Metal Data 1991," American Bureau of Metal Statistics Inc.

**Table 13. United States copper production, by company**

[Copper content (tons) of mine production unless otherwise noted.  
Leaders (--), no production. (na), not available]

Company	1987	1988	1989	1990	1991
Arimetco International Inc. (1)	--	--	--	2,254	4,858
Asarco Inc.	194,800	206,000	235,700	266,400	279,900
Cominco American Inc./Dresser Minerals (2)	1,925	1,671	1,489	1,586	1,385
Copper Range Co. (3)	53,053	45,802	52,061	51,104	59,498
Cyprus Copper Co.	173,537	233,242	293,451	312,102	313,498
The Doe Run Company	13,018	22,936	20,220	13,261	10,894
Hecla Mining Co. (4)	289	481	460	250	423
Apex Mine	--	--	--	45	na
Coeur Mine (5)	58	47	50	43	na
Galena Mine (6)	121	125	129	113	248
Lucky Friday Mine	110	309	281	49	175
Inspiration Consolidated Copper Co. (2)	35,582	(7)	(7)	(7)	(7)
Kennecott Corp. (8)	60,000	245,000	244,000	251,000	251,000
Magma Copper Co. (9)	197,013	200,753	214,388	232,458	262,000
Montana Resources	30,856	53,155	39,634	37,245	47,421
Noranda Lakeshore Mines, Inc. (10)	1,152	--	--	--	--
Oracle Ridge Mining (11)	--	--	--	--	2,241
Phelps Dodge Corp.(U.S. mines) (10)	468,900	494,500	500,500	548,400	518,100
Tennessee Chemical Co.	4,560	--	--	--	--
Refiners (12)					
Asarco Inc.	447,700	484,700	492,800	482,400	492,800

(1) Data from Arimetco International Inc. 1991 annual report.

(2) Refined production.

(3) Magmont mine.

(4) Includes Hecla's share of production from each mining property.

(5) Operated by Asarco. Shows Hecla's share of 5%.

(6) Operated by Asarco. Shows Hecla's share of 25%.

(7) Starting in 1988, Cyprus Miami Mining.

(8) Reported production of refined copper plus unrefined copper sales. Includes only Kennecott's share from jointly owned properties.

(9) Refined copper contained in concentrates produced and SX-EW production. 1991 data from company form 10-K.

(10) Includes copper produced from purchased ores.

(11) Data reported by company to Arizona Department of Mines and Mineral Resources.

(12) The total for this concern is to a large extent a duplication of the reports of other producers.

Source: "Non-ferrous Metal Data 1991," American Bureau of Metal Statistics Inc., Arizona Department of Mines and Mineral Resources file data.

**Table 14. Copper imports of the United States, by country**

[Copper content in short tons. Leaders (--), no data]

	1987	1988	1989	1990	1991
<b>Ore, Concentrates, Mattes &amp; Cement</b>	<b>12,765</b>	<b>9,101</b>	<b>52,264</b>	<b>159,762</b>	<b>68,750</b>
Canada	4,093	178	--	--	--
Mexico	6,753	6,822	47,581	142,236	52,926
Bolivia	7	--	--	--	--
Chile	--	34	3,931	--	--
Peru	1,474	55	--	66	--
Ireland	--	1	--	--	--
Monaco	--	--	76	--	--
Portugal	--	--	--	17,460	3,786
Sweden	--	--	661	--	--
United Kingdom	--	--	3	--	--
Indonesia	--	--	--	--	11,984
Japan	--	--	--	--	--
Mozambique	--	--	12	--	--
Australia	438	2	--	--	--
Papua New Guinea	--	2,009	--	--	--
Other Countries	--	--	--	--	54
<b>Blister &amp; Anodes</b>	<b>47,991</b>	<b>108,505</b>	<b>85,117</b>	<b>48,806</b>	<b>66,537</b>
Canada	15	--	207	2	2
Mexico	15,457	1,145	7,325	17,271	1,668
Chile	21,532	53,206	37,161	15,389	30,783
Peru	2,921	3,282	3,254	3,948	19,775
Germany	95	--	--	38	125
Switzerland	--	2	--	--	--
Japan	2,189	32,150	24,580	3,854	13,088
Cote D'Ivoire	--	5,647	--	--	--
Namibia	--	--	--	141	--
South Africa	5,782	9,815	--	--	--
Tanzania	--	--	1,088	--	--
Zaire	--	3,258	10,681	8,163	1,096
<b>Refined Cathodes &amp; Shapes</b>	<b>556,973</b>	<b>367,150</b>	<b>334,884</b>	<b>288,441</b>	<b>318,108</b>
Canada	231,078	195,996	199,312	203,171	218,172
Mexico	611	46	181	81	--
Brazil	--	1,319	20,085	11,247	27,566
Chile	159,915	91,211	85,358	62,334	54,909
Peru	46,716	14,848	10,186	2,672	5,871
Venezuela	--	137	--	110	--
Austria	--	495	21	10	--
Belgium	702	1,396	--	--	82
Finland	--	441	--	--	--
Germany	34,680	5,573	310	170	301
Netherlands	7,043	5,567	2,680	--	4,043
Norway	205	390	61	761	--
Poland	--	714	--	--	--
Portugal	--	--	--	1,091	--
Spain	--	3,530	--	242	1,108
Sweden	16,788	4,157	--	1,104	858
Switzerland	--	385	--	287	1
United Kingdom	--	--	21	--	--

**Table 14. Copper imports of the United States, by country — continued**

[Copper content in short tons. Leaders (--), no data]

	1987	1988	1989	1990	1991
Yugoslavia	4,629	2,199	--	--	--
China	165	845	71	153	--
Hong Kong	--	711	--	--	--
Japan	661	--	3	--	4,957
Syria	--	--	--	20	--
Taiwan	300	--	--	--	--
Niger	--	--	912	--	--
South Africa	5,046	1,985	1,193	830	165
Zaire	26,446	35,143	12,607	3,469	--
Zambia	21,834	--	--	689	--
Other Countries	154	62	15	--	2
<b>Copper Waste &amp; Scrap</b>	<b>36,510</b>	<b>40,952</b>	<b>34,808</b>	<b>39,579</b>	<b>31,685</b>
Canada	28,302	28,860	21,350	25,723	21,591
Bahamas	23	37	17	22	--
Barbados	67	72	56	80	43
Costa Rica	214	224	594	582	896
Dominican Republic	592	648	515	450	377
El Salvador	167	--	--	106	303
Guatemala	94	205	267	491	242
Haiti	--	--	49	41	62
Honduras	41	53	38	57	203
Jamaica	62	194	207	363	621
Mexico	5,890	8,036	3,933	4,013	3,590
Netherlands Antilles	94	139	31	109	36
Panama	431	977	703	655	433
St. Vincent	--	--	14	33	--
Trinidad	93	209	336	151	187
Brazil	--	--	--	194	--
Chile	--	79	5,296	4,024	1,111
Surinam	--	48	--	15	--
Venezuela	--	628	648	1,661	1,177
Finland	--	--	--	--	64
France	24	119	--	11	--
Germany	--	111	325	--	--
Netherlands	--	--	304	466	85
United Kingdom	24	42	1	58	112
Japan	--	--	--	79	--
South Korea	124	48	7	28	--
Malaysia	30	--	--	61	22
Singapore	79	--	--	--	--
Taiwan	25	27	--	--	--
Ghana	--	--	--	23	--
Other Countries	134	196	117	159	530
<b>Copper Alloy Waste &amp; Scrap (1</b>	<b>48,703</b>	<b>55,146</b>	<b>87,435</b>	<b>108,809</b>	<b>107,100</b>
Canada	32,661	31,120	42,720	69,333	60,439
Bahamas	37	--	67	--	--
Barbados	41	--	35	--	--
Costa Rica	40	--	146	168	119
Dominican Republic	464	962	1,177	1,174	1,515
Guatemala	82	137	346	290	319



**Table 14. Copper imports of the United States, by country — continued**

[Copper content in short tons. Leaders (--), no data]

	1987	1988	1989	1990	1991
Haiti	--	142	118	189	159
Honduras	2	107	68	--	--
Jamaica	136	204	353	595	250
Mexico	11,570	14,180	22,825	24,542	29,981
Netherlands Antilles	257	249	340	560	632
Nicaragua	--	--	--	195	709
Panama	784	739	935	735	1,060
St. Vincent	--	--	58	--	--
Trinidad	155	306	332	261	280
Chile	116	1,992	3,690	214	41
Columbia	--	--	--	2,665	2,262
Guyana	--	--	--	365	480
Peru	629	144	--	--	600
Venezuela	208	1,040	6,772	4,915	4,144
Belgium	43	1,675	1,577	--	--
Finland	--	--	--	177	1
France	24	--	206	212	350
Germany	303	251	234	230	220
Italy	163	--	21	--	--
Netherlands	41	--	--	--	--
Portugal	--	--	33	--	--
Sweden	78	--	21	--	129
Switzerland	51	--	47	--	--
United Kingdom	321	290	302	138	893
China	--	82	150	--	--
Hong Kong	--	145	102	21	--
Japan	57	210	336	212	100
South Korea	153	--	95	78	--
Malaysia	54	--	47	267	306
Philippines	--	--	15	--	--
Singapore	114	--	195	153	220
Taiwan	36	358	3,835	202	185
Australia	--	--	--	--	153
Marshall Islands	--	--	--	163	15
Other Countries	83	813	219	854	1,538
Master Alloys	814	889	743	1,017	742
Unwrought Alloys	15,812	11,547	4,487	1,506	2,785

**COPPER AND COPPER ALLOY IMPORTS OF BRASS MILL PRODUCTS (2)**

Strip, Sheet & Plate					
Copper	33,997	37,167	37,859	39,266	36,448
Copper Alloy	114,376	99,981	81,235	70,763	59,029
Foil					
Copper	46,708	44,945	33,957	43,190	42,723
Copper Alloy	29,912	22,677	27,216	26,311	24,037

**Table 14. Copper imports of the United States, by country — continued**  
 [Copper content in short tons. Leaders (--), no data]

	1987	1988	1989	1990	1991
<b>Wire</b>					
Copper Alloy	23,833	25,028	22,143	22,353	18,661
<b>Rod, Bar, &amp; Other</b>					
Copper	31,391	31,474	29,617	31,155	25,580
Copper Alloy	64,579	74,634	75,622	61,137	44,345
<b>Tube &amp; Pipe</b>					
Copper	100,021	91,924	72,896	46,565	28,822
Copper Alloy	57,224	59,493	66,882	57,430	51,209

(1 Copper alloy content.

(2 Thousands of pounds.

Source: "Non-ferrous Metal Data 1991," American Bureau of Metal Statistics, Inc.

**Table 15. Copper exports of the United States, by country**

[Copper content in short tons. Leaders (--), no data. (na), not available at time of publication]

	1987	1988	1989	1990	1991
<b>Ores, Concentrates, Mattes &amp; Cement</b>	<b>137,512</b>	<b>239,438</b>	<b>304,288</b>	<b>287,597</b>	<b>267,161</b>
Canada	2,013	9,367	15,212	20,604	44,126
Jamaica	--	--	--	--	197
Mexico	4	2,151	921	1,482	3,200
Brazil	--	--	18,335	15,675	40,372
Belgium	--	--	265	--	--
Bulgaria	--	--	5,026	--	6,492
Finland	7,968	1,967	7,982	4,461	7,765
France	--	--	110	33	--
Germany	976	45,808	15,419	153	183
Italy	--	--	--	165	226
Spain	--	--	15	104	3,064
United Kingdom	--	--	555	575	372
Yugoslavia	4,113	--	6,211	--	--
China	2,723	10,316	4,028	19,539	42,287
Hong Kong	--	--	4	12,233	57
Indonesia	--	--	136	--	85
Israel	--	--	4	38	126
Japan	109,737	149,762	178,088	188,280	82,666
Korea, South	5,681	13,225	37,734	20,744	13,069
Malaysia	--	--	170	95	--
Philippines	--	3,511	4,117	3,089	19,676
Taiwan	4,162	3,291	9,605	64	2,977
Australia	--	--	251	185	43
Other Countries	135	40	100	78	178
<b>Blister &amp; Anodes</b>	<b>13,600</b>	<b>36,023</b>	<b>6,083</b>	<b>7,077</b>	<b>23,468</b>
Canada	922	10,818	3,494	3,842	14,660
Mexico	303	584	139	218	55
Chile	--	--	472	--	--
Germany	--	5,241	42	21	109
Italy	--	--	5	52	--
Spain	5	1,164	--	59	87
United Kingdom	--	--	43	--	37
China	--	--	--	--	119
Hong Kong	784	740	627	759	607
India	--	--	--	42	--
Japan	4,706	--	180	885	1,084
Korea, South	5,122	16,279	30	81	2,079
Saudi Arabia	--	--	114	--	--
Singapore	112	217	122	127	2
Taiwan	521	588	606	893	4,584
Thailand	--	--	46	--	--
Egypt	--	--	32	--	--
Ghana	--	--	39	66	16
Other Countries	1,125	212	124	32	29
<b>Refined Cathodes &amp; Shapes</b>	<b>20,304</b>	<b>64,574</b>	<b>147,106</b>	<b>232,769</b>	<b>298,211</b>
Canada	4,943	4,238	5,215	2,236	2,075
Costa Rica	--	--	436	866	971
Dominican Republic	46	--	93	8	--

**Table 15. Copper exports of the United States, by country — continued**

[Copper content in short tons. Leaders (--), no data. (na), not available at time of publication]

	1987	1988	1989	1990	1991
El Salvador	--	--	108	129	265
Honduras	--	--	291	75	5
Mexico	4,674	9,409	8,097	6,214	7,939
Brazil	501	56	19	80	--
Chile	--	--	70	--	--
Venezuela	134	--	1,429	5,216	2,359
Belgium	391	234	21	2,442	337
France	535	1,660	760	1,567	1,316
Germany	514	1,456	1,430	1,068	2,043
Italy	218	4,984	652	748	1,306
Netherlands	276	9,583	731	3,714	3,416
Switzerland	49	137	249	115	81
United Kingdom	1,185	2,729	1,197	1,090	1,937
China	--	3,905	15,727	3,911	15,278
Hong Kong	458	592	644	1,580	2,923
Indonesia	--	--	--	2,088	773
Japan	3,036	14,877	53,374	113,720	143,635
Korea, South	2,063	6,755	1,374	8,668	13,326
Malaysia	--	512	--	2	880
Philippines	--	106	2	21	--
Singapore	2	1,410	1,328	1,580	4,070
Taiwan	1,178	1,776	53,729	72,930	87,425
Thailand	--	--	--	2,376	5,541
Egypt	--	--	--	168	--
Other Countries	101	155	130	268	310
<b>Copper Waste &amp; Scrap</b>	<b>119,776</b>	<b>132,025</b>	<b>170,789</b>	<b>153,907</b>	<b>144,749</b>
Canada	12,273	32,159	41,956	55,651	36,363
Jamaica	--	--	--	--	44
Mexico	13,533	12,672	8,639	9,789	8,264
Brazil	3,326	655	892	846	400
Chile	--	--	140	--	--
Venezuela	217	337	20	39	--
Belgium	2,154	3,100	3,991	403	103
Finland	97	--	--	--	--
France	--	--	59	436	--
Germany	4,774	10,748	14,570	6,294	572
Italy	6,769	920	280	1,080	22
Netherlands	406	1,019	3,779	793	174
Norway	--	118	245	289	107
Spain	8,877	3,725	958	168	22
Switzerland	--	17	122	--	--
United Kingdom	822	2,547	1,354	969	91
China	210	470	6,666	8,592	25,213
Hong Kong	3,656	1,579	1,242	1,003	6,045
India	545	2,222	1,203	434	652
Indonesia	--	--	456	39	313
Japan	17,141	17,780	22,411	19,622	26,149
Korea, South	10,650	21,540	35,936	35,584	32,506
Malaysia	--	--	--	--	96
Pakistan	--	--	--	--	96
Philippines	1,045	--	133	44	25

**Table 15. Copper exports of the United States, by country — continued**

[Copper content in short tons. Leaders (--), no data. (na), not available at time of publication]

	1987	1988	1989	1990	1991
Singapore	1,262	2,313	134	64	932
Taiwan	31,791	17,959	25,503	11,658	6,513
Australia	157	--	--	44	--
Other Countries	71	145	100	149	47
<b>Copper Alloy Waste &amp; Scrap (1)</b>	<b>204,335</b>	<b>220,405</b>	<b>234,284</b>	<b>203,677</b>	<b>193,207</b>
Canada	23,321	26,023	33,069	11,073	16,670
Mexico	6,308	11,127	16,322	13,180	4,068
Trinidad	776	1,053	164	795	404
Brazil	7,037	649	1,964	251	1,402
Venezuela	141	165	99	17	433
Austria	310	--	--	15	--
Belgium	8,019	9,607	6,466	6,820	3,775
Finland	--	--	--	--	2,296
France	106	770	837	644	241
Germany	8,513	23,133	44,054	15,353	2,670
Italy	7,177	2,148	5,458	12,966	1,630
Netherlands	885	1,229	3,347	4,821	250
Portugal	--	--	84	--	--
Spain	6,911	11,132	4,589	877	319
Sweden	1,763	1,780	2,319	3,605	860
Switzerland	180	59	9	3	--
United Kingdom	2,975	2,974	6,023	2,504	958
China	198	1,146	9,377	16,267	25,033
Hong Kong	576	227	1,581	3,693	7,579
India	13,079	14,533	28,169	36,232	14,694
Indonesia	--	--	--	--	747
Japan	26,522	18,988	20,558	31,667	47,175
Korea, South	28,761	48,550	32,151	28,896	46,733
Pakistan	--	--	37	57	111
Philippines	126	--	92	92	--
Singapore	255	1,254	1,339	2,557	1,937
Taiwan	60,326	43,647	15,732	9,641	12,381
Thailand	--	--	118	145	516
South Africa	--	--	98	712	2
Australia	--	--	38	347	50
New Zealand	--	--	--	78	--
Other Countries	70	211	190	595	273
<b>Master Alloys</b>	<b>1,127</b>	<b>1,034</b>	<b>631</b>	<b>762</b>	<b>747</b>
<b>Unwrought Alloys</b>	<b>9,648</b>	<b>8,695</b>	<b>6,651</b>	<b>9,459</b>	<b>9,499</b>

**Copper And Copper Alloy Exports of Brass Mill Products (2)**

<b>Strip, Sheet &amp; Plate</b>					
Copper	1,195	1,903	7,504	15,550	13,477
Copper Alloy	16,809	34,526	18,526	32,193	31,802
<b>Foil (3)</b>					
Copper & Copper Alloy	1,125	5,704	3,694	6,318	6,257
Copper	na	na	1,069	1,592	4,929
Copper Alloy	na	na	2,625	4,726	1,328

**Table 15. Copper exports of the United States, by country — continued**

[Copper content in short tons. Leaders (--), no data. (na), not available at time of publication]

	1987	1988	1989	1990	1991
<b>Wire</b>					
Copper Alloy	14,556	16,725	8,592	14,454	19,283
<b>Rod, Bar &amp; Other</b>					
Copper	8,204	5,183	34,603	27,846	24,130
Copper Alloy	16,703	24,480	50,430	54,171	44,416
<b>Tube &amp; Pipe</b>					
Copper Alloy	14,218	17,078	44,702	35,270	43,053
Copper Alloy	12,917	20,618	9,436	11,163	12,431
<b>Copper Exports Of Copper Imports Of The United States (4</b>					
Blister & Anodes	--	10	--	2	--
Refined Cathodes & Shapes	11	2,261	13,291	1,714	692
Copper Waste & Scrap	218	523	286	431	336
Copper Alloy Waste & Scrap (1	8,772	609	2,184	1,054	806

(1 Copper alloy content.

(2 Thousands of pounds.

(3 1988 data combines copper and copper alloys as well as not backed and backed.  
1989 separates copper alloys and includes only not backed.

(4 Copper content.

Source: "Non-ferrous Metal Data 1991," American Bureau of Metal Statistics Inc.



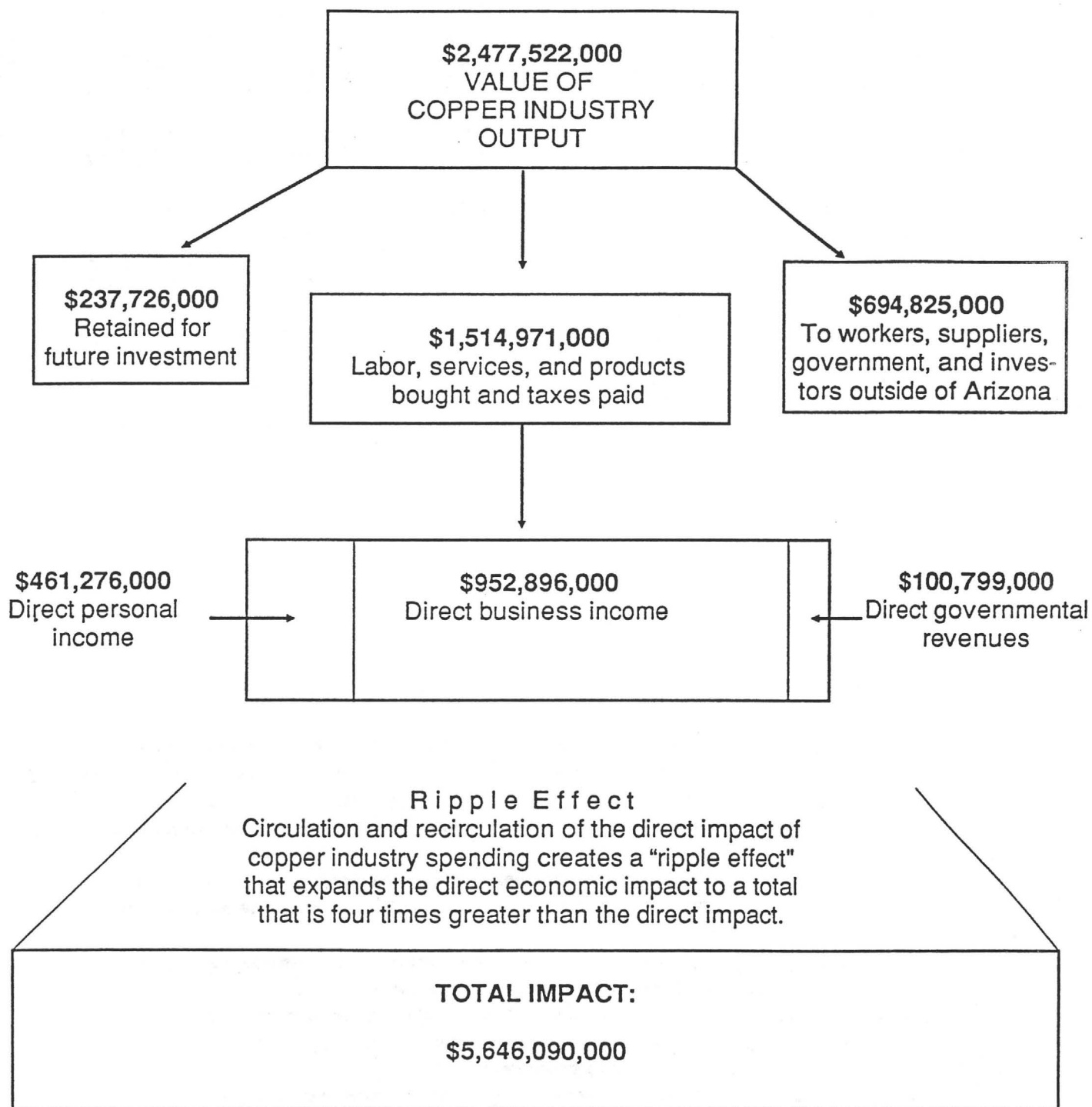
Table 16. Employment and wages in Arizona copper mining and smelting

Year	Employees (1 (average number)	Total wages	Annual wage (average)	Weekly wage (average)	Copper ore mined (tons)
1948	11,493	41,318,524	3,595	69.13	39,072,204
1949	11,001	40,612,224	3,692	71.00	37,365,611
1950	10,181	41,994,321	4,125	79.33	41,757,273
1951	10,754	47,825,698	4,447	85.52	42,784,388
1952	11,365	54,950,235	4,835	93.14	44,472,522
1953	12,068	62,742,982	5,199	99.98	45,187,838
1954	12,502	65,518,853	5,241	100.79	43,072,894
1955	12,399	71,293,263	5,750	110.58	52,189,728
1956	14,008	83,568,996	5,966	114.73	60,468,580
1957	14,652	85,125,320	5,809	111.71	59,571,834
1958	14,100	74,726,972	5,300	101.93	56,255,809
1959	11,568	72,095,130	6,232	119.85	53,121,545
1960	13,764	90,312,848	6,562	126.19	66,032,439
1961	14,275	97,271,286	6,814	131.04	71,918,991
1962	14,408	101,920,108	7,074	136.04	78,868,147
1963	14,303	104,291,588	7,292	140.23	80,615,132
1964	14,720	113,792,031	7,730	148.65	86,132,039
1965	15,239	122,163,124	8,016	154.16	92,859,535
1966	17,018	137,187,611	8,061	155.02	101,558,298
1967	13,426	108,427,206	8,076	155.31	74,289,203
1968	15,734	136,089,579	8,649	166.33	101,293,963
1969	19,459	173,183,018	8,900	171.15	127,848,828
1970	21,479	201,665,064	9,389	180.56	150,241,000
1971	21,231	211,978,597	9,984	192.00	149,294,000
1972	23,233	254,717,341	10,964	210.85	165,914,825
1973	25,494	291,294,328	11,426	218.89	181,311,945
1974	27,894	340,832,096	12,219	234.98	178,913,296
1975	25,950	363,349,178	14,002	269.27	168,750,152
1976	25,631	405,289,034	15,812	304.08	194,136,559
1977	23,373	398,539,789	16,835	323.75	168,641,401
1978	21,092	397,790,419	18,860	362.69	178,204,491
1979	23,239	494,963,476	21,299	409.60	203,997,408
1980	21,602	510,168,454	23,617	454.17	169,650,401
1981	26,031	687,434,789	26,408	507.85	216,787,430
1982	17,182	487,415,292	28,368	545.53	135,768,647
1983	13,864	395,266,852	28,510	548.29	135,301,652
1984	12,556	387,028,537	30,824	592.77	145,278,431
1985	11,155	349,311,047	31,314	602.19	174,218,218
1986	10,848	326,915,975	30,136	579.54	167,808,000
1987	10,340	299,297,407	28,946	556.65	166,113,000
1988	10,588	348,502,604	33,008	634.78	175,261,000
1989	11,111	383,199,684	34,488	663.23	196,684,000
1990	11,352	411,433,093	36,243	696.99	213,168,000
1991	12,369	462,827,195	37,418	719.58	258,646,597

1) Reported as "Covered Employment" that by law includes all employees of employers of three or more persons. Prior to 1966 only a portion of the workers in smelting, refining, and rod fabrication were included in this table.

Source: Table 17, this publication; "Minerals Yearbook - Area Reports: Domestic," U.S. Bureau of Mines; Research and Statistics Unit, Arizona Department of Economic Security.

**Figure 6. Direct and indirect impact of the copper industry on the Arizona economy - 1991**



Source: Leaming, G.F., 1992, "The copper industry's impact on the Arizona economy

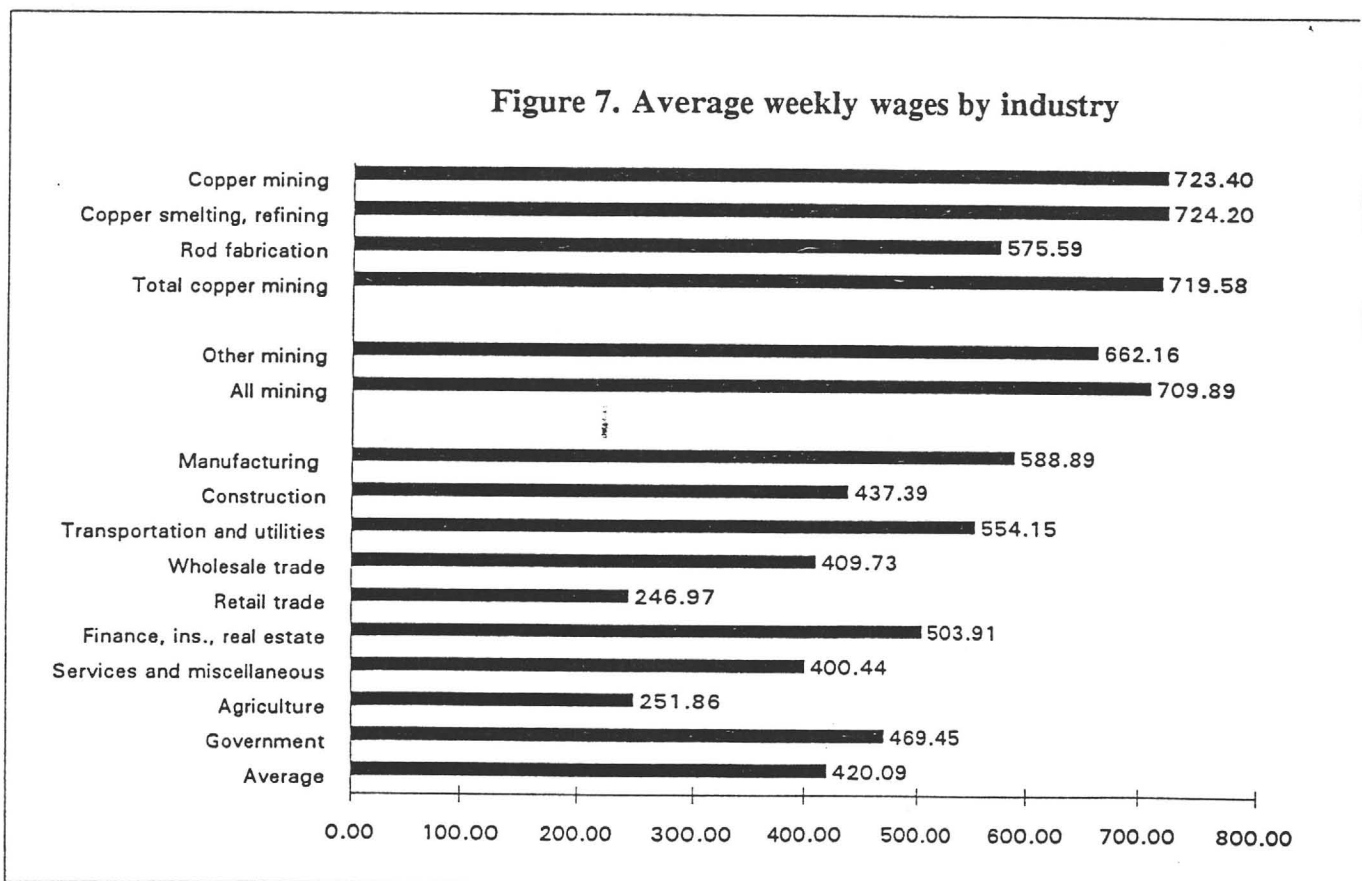
**Table 17. Arizona employment and wages in 1991, by industry**

Industry	Employees (average number)	Total wages	Annual wage (average)	Weekly wage (average)
Copper mining	10,847	408,030,213	37,616.87	723.40
Copper smelting and refining	1,196	45,039,525	37,658.47	724.20
Copper rod fabrication	326	9,757,457	29,930.85	575.59
<b>Total copper mining and processing</b>	<b>12,369</b>	<b>462,827,195</b>	<b>37,418.32</b>	<b>719.58</b>
Other mining, quarrying and processing	2,512	86,500,159	34,432.49	662.16
<b>All mining quarrying and processing</b>	<b>14,881</b>	<b>549,327,354</b>	<b>36,914.27</b>	<b>709.89</b>
Manufacturing except copper processing	174,672	5,348,847,954	30,622.24	588.89
Construction	77,710	1,767,465,426	22,744.42	437.39
Transportation and utilities	73,270	2,111,357,591	28,815.96	554.15
Wholesale trade	74,419	1,585,571,441	21,305.96	409.73
Retail trade	298,468	3,833,110,590	12,842.60	246.97
Finance, insurance, and real estate	92,341	2,419,661,954	26,203.43	503.91
Services and miscellaneous	391,439	8,150,851,589	20,822.80	400.44
Agriculture, forestry, and fishing	35,223	461,302,802	13,096.70	251.86
Federal, state, and local government	270,660	6,607,189,651	24,411.42	469.45
<b>Total and averages</b>	<b>1,503,084</b>	<b>32,834,686,352</b>	<b>21,844.88</b>	<b>420.09</b>

(1 Includes all employees covered by Arizona employment security laws.

Source: Research Administration, Arizona Department of Economic Security.

**Figure 7. Average weekly wages by industry**



**Table 18. Employment, earnings, and hours in copper mining  
in the United States and Arizona**

[These statistics do not reflect workers in copper smelting, refining, and rod fabrication]

Year	All employees		Production workers							
	Average number (thousands)		Average number (thousands)		Weekly earnings (4 (average)		Weekly hours (average)		Hourly earnings (5 (average)	
	AZ (1)	U.S. (2)	AZ (3)	U.S. (2)	AZ	U.S.	AZ	U.S.	AZ	U.S.
1970	18.8	37.0	14.9	29.5	173.01	175.67	43.8	44.7	3.95	3.93
1971	18.9	34.7	14.9	26.8	178.50	178.46	42.4	42.9	4.21	4.16
1972	20.5	38.9	16.1	30.7	194.69	192.19	41.6	41.6	4.68	4.62
1973	21.5	42.3	17.6	33.7	206.75	206.42	41.6	42.3	4.97	4.88
1974	24.0	42.8	19.1	33.8	222.16	226.46	39.6	41.1	5.61	5.51
1975	22.5	37.1	17.9	28.4	247.43	247.14	38.6	39.2	6.41	6.33
1976	21.7	35.5	17.2	27.0	286.31	280.70	40.1	40.1	7.14	7.00
1977	19.3	35.1	15.3	26.9	302.99	288.73	39.4	38.6	7.69	7.48
1978	17.2	35.2	13.7	26.9	344.76	338.40	40.8	40.0	8.45	8.46
1979	19.3	31.9	15.3	24.6	404.81	405.03	42.3	42.5	9.57	9.53
1980	17.7	29.4	14.0	22.6	446.19	435.01	41.7	41.0	10.70	10.61
1981	21.9	36.2	17.4	27.9	497.28	492.54	41.2	41.6	12.07	11.84
1982	15.2	25.3	12.1	18.5	495.60	484.91	38.3	38.7	12.94	12.53
1983	11.3	18.9	9.0	13.5	519.25	522.69	39.1	39.9	13.28	13.10
1984	10.5	16.3	8.2	11.4	553.83	562.74	41.3	41.5	13.41	13.56
1985	9.4	13.1	7.5	9.4	573.80	574.76	41.4	42.2	13.86	13.62
1986	8.7	11.4	6.9	8.8	582.38	507.99	40.4	41.3	14.42	12.30
1987	8.6	13.5	6.9	10.7	556.65	492.20	40.1	43.1	13.88	11.42
1988	8.8	14.4	7.0	11.2	517.74	510.12	41.3	43.9	12.53	11.62
1989	9.5	14.1	7.5	11.2	561.26	540.44	43.4	45.8	12.94	11.80
1990	10.0	15.1	7.9	12.3	599.84	569.09	43.7	45.6	13.72	12.48
1991	11.1	15.8	8.6	13.0	648.68	610.55	43.8	45.7	14.81	13.36

(1) These figures are estimates made by the Arizona Department of Economic Security in cooperation with the U.S. Bureau of Labor Statistics, and they include all full-time and part-time wage and salary workers who are employed in copper mining in any part of the pay period that included the 12th of each month of the year.

(2) Estimates made by the U.S. Bureau of Labor Statistics in cooperation with the 50 states, and based upon monthly samplings similar to those in (1) above, adjusted periodically to census benchmark.

(3) Estimates of production (non-supervisory) workers based upon samplings as in (2) above. Since 1975 figures have been calculated by the Arizona Department of Mines and Mineral Resources dividing the annual number of "All Employees in Arizona" by a factor of 1.26. This factor was derived by comparing the annual number of "All Employees-Arizona" with "Production Workers - Arizona" from 1970 to 1974.

(4) Weekly earnings figures are the product of hourly earnings and weekly hours for that year.

(5) Gross payroll aggregates, exclusive of irregular bonuses and other pay not earned in a sample pay period, are divided by gross man-hour aggregates of production and related workers for the period in order to determine hourly earnings.

(6) Weekly earnings times 52 weeks.

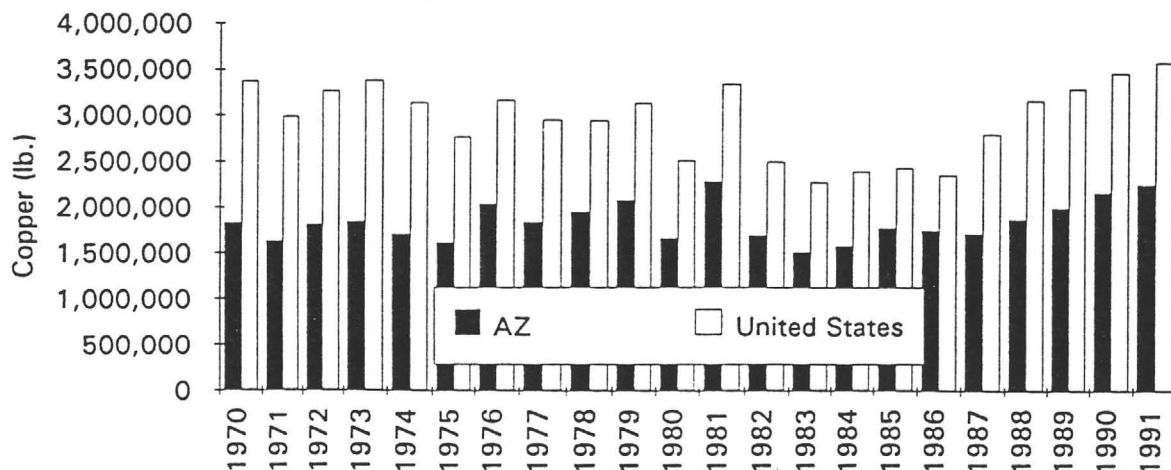
(7) Product of the number of production workers, weekly hours, and 52 weeks.

Source: Table 1 this publication, American Bureau of Metal Statistics Unit, Arizona Department of Economic Security, Mineral Yearbook - Metals, Minerals," U.S. Bureau of Mines. "Employment and Earnings", U.S. Dept. of Labor, Bureau of Labor Statistics, March issues, U.S. Dept. of Interior.

**Table 18. Employment, earnings, and hours in copper mining  
in the United States and Arizona — continued**

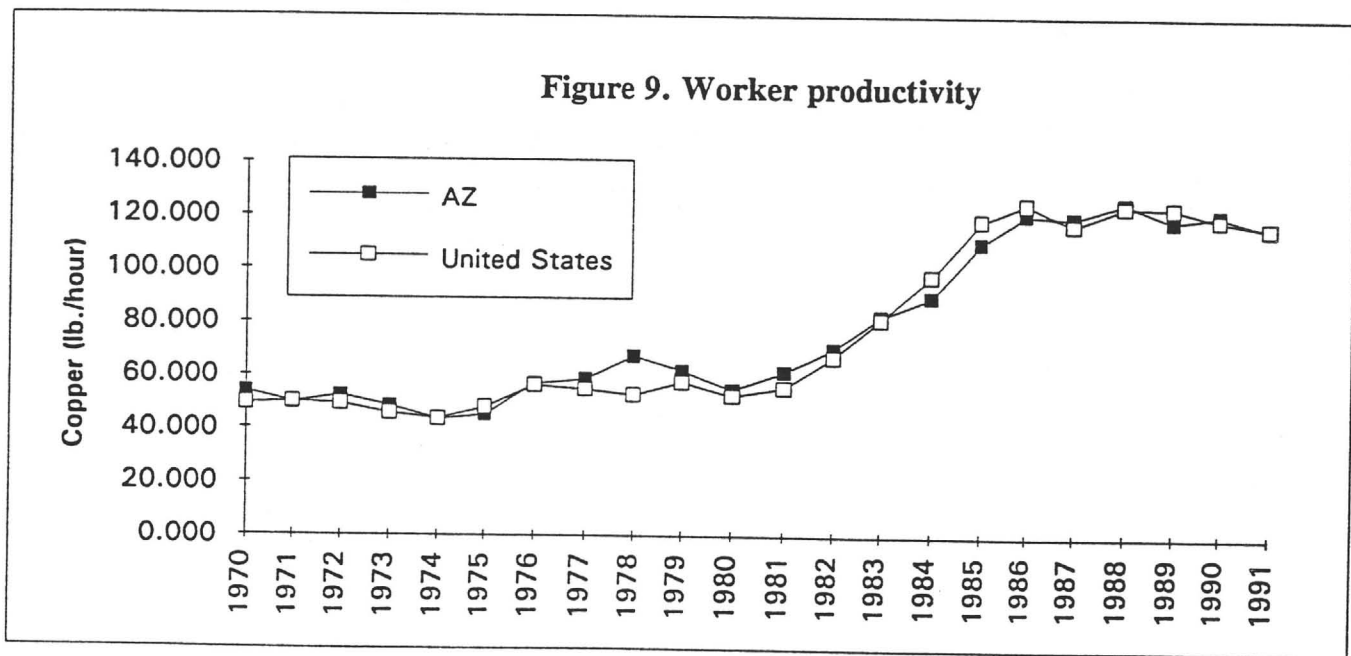
Year	Production workers							
	Annual earnings (6		Aggregate hours (7		Copper ore mined		Copper produced	
	AZ	U.S.	AZ	U.S.	AZ	U.S.	AZ	U.S.
			(thousands)		(thousand short tons)		(recoverable content, thousand pounds)	
1970	8,997	9,135	33,936	68,570	150,241	257,729	1,826,734	3,368,957
1971	9,282	9,280	32,852	59,785	149,294	242,656	1,633,568	2,986,599
1972	10,124	9,994	34,827	66,410	165,815	266,831	1,816,118	3,264,113
1973	10,751	10,734	38,072	74,127	173,605	289,998	1,847,635	3,386,357
1974	11,552	11,776	39,331	72,237	178,821	293,443	1,710,744	3,145,148
1975	12,866	12,903	35,929	57,891	168,656	263,003	1,619,535	2,772,111
1976	14,888	14,596	35,865	56,300	194,046	283,736	2,043,168	3,166,889
1977	15,755	15,014	31,347	53,994	168,601	259,974	1,843,949	2,964,539
1978	17,928	17,597	29,066	55,952	178,201	263,722	1,965,072	2,955,210
1979	21,050	21,061	33,654	54,366	203,977	291,078	2,085,556	3,140,110
1980	23,202	22,621	30,358	48,183	169,650	241,090	1,669,495	2,527,920
1981	25,859	25,612	37,278	60,353	216,787	306,089	2,294,437	3,354,548
1982	25,771	25,215	24,098	37,229	146,125	200,589	1,697,500	2,507,070
1983	27,001	27,180	18,299	28,010	152,902	196,203	1,514,538	2,288,612
1984	28,799	29,002	17,610	24,601	145,278	189,499	1,583,505	2,405,866
1985	29,838	29,888	16,146	20,627	174,218	239,399	1,778,334	2,443,675
1986	30,284	26,415	14,496	18,899	167,808	186,105	1,752,525	2,361,127
1987	28,946	25,595	14,388	23,981	166,113	219,545	1,724,068	2,810,182
1988	26,932	26,526	15,033	25,567	175,261	246,380	1,885,112	3,168,229
1989	29,186	28,103	16,926	26,674	196,684	261,534	2,009,782	3,303,002
1990	31,177	29,593	17,952	29,166	213,168	275,024	2,174,574	3,477,904
1991	33,731	31,749	19,587	30,893	258,647	305,221	2,265,072	3,595,930

**Figure 8. Copper production in the U.S. and Arizona**



**Table 18. Employment, earnings, and hours in copper mining  
in the United States and Arizona — continued**

Year	Worker productivity			
	Ore mined/hour (tons)		Copper produced/hour (pounds)	
	AZ	U.S.	AZ	U.S.
1970	4.427	3.759	53.829	49.132
1971	4.544	4.059	49.725	49.996
1972	4.761	4.017	52.161	49.151
1973	4.872	3.912	48.530	45.683
1974	4.547	4.062	43.496	43.539
1975	4.694	4.543	45.076	47.885
1976	5.410	5.040	56.968	56.250
1977	5.379	4.815	58.824	54.905
1978	6.131	4.713	67.607	52.817
1979	6.061	5.369	61.971	57.759
1980	5.588	5.004	54.994	52.465
1981	5.815	5.072	61.549	55.582
1982	6.064	5.388	70.442	67.342
1983	8.356	7.005	82.766	81.707
1984	8.250	7.703	89.921	97.795
1985	10.790	11.606	110.141	118.470
1986	11.576	9.847	120.897	124.934
1987	11.545	9.155	119.827	117.189
1988	11.658	9.637	125.398	123.918
1989	11.620	9.805	118.739	123.828
1990	11.874	9.430	121.133	119.245
1991	13.205	9.880	115.642	116.400



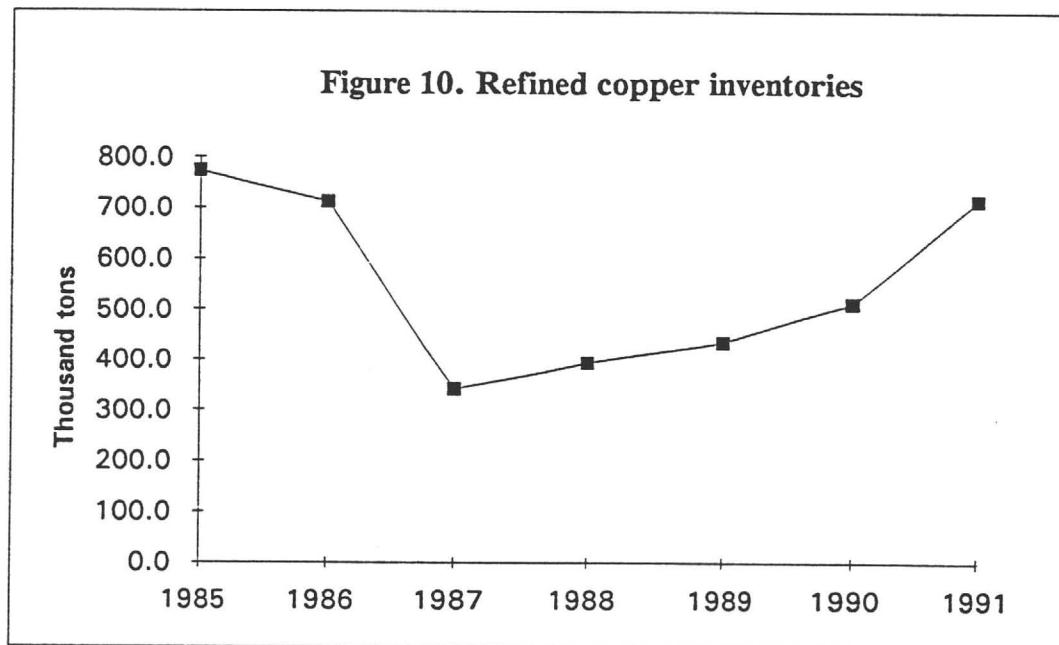


**Table 19. Refined copper inventories**

[Figures are end of year in thousand short tons]

Location	1985	1986	1987	1988	1989	1990	1991
U.S. refineries	150.4	145.1	63.1	42.9	56.4	52.1	41.6
Comex warehouses	120.3	93.3	18.3	13.4	16.3	20.2	33.7
Total U.S.	270.7	238.4	81.4	56.3	72.7	72.3	75.3
Refineries elsewhere	293.7	280.6	202.6	265.0	243.3	239.4	274.1
LME warehouses	209.1	193.1	58.3	72.5	119.0	200.1	366.3
Total elsewhere	502.8	473.7	260.9	337.5	362.3	439.5	640.4
Aggregate Inventories	773.5	712.1	342.3	393.8	435.0	511.8	715.7

Source: "Non-ferrous Metal Data 1991," American Bureau of Metal Statistics Inc.

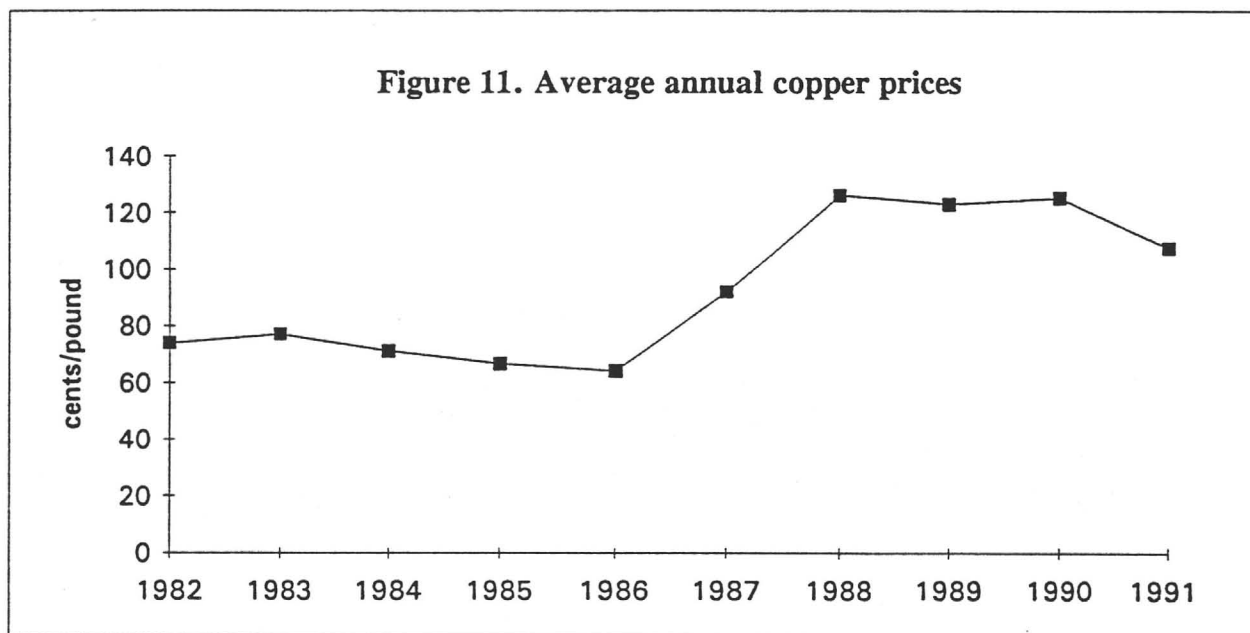


**Table 20. Average monthly price of cathode copper**

[All prices are Metals Week U.S. producer delivered cents/lb.]

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
January	78.634	80.219	68.792	64.487	69.881	64.986	132.496	152.770	108.644	114.614
February	78.779	84.024	70.748	66.446	68.253	65.525	105.025	140.211	111.260	115.012
March	75.862	82.072	75.311	65.547	70.144	68.071	109.720	148.492	128.414	113.953
April	76.273	83.493	77.388	70.318	68.801	67.129	103.641	143.486	126.936	113.127
May	77.948	85.634	72.229	69.864	67.082	70.985	104.373	127.146	124.574	105.574
June	71.488	81.836	69.849	67.094	67.471	74.346	114.275	115.901	117.346	103.877
July	71.053	82.947	64.402	66.773	63.815	80.419	104.848	113.487	126.115	104.344
August	70.999	80.542	64.535	66.284	62.374	82.183	101.451	127.430	134.960	105.969
September	71.065	77.587	63.408	65.716	64.844	85.607	116.120	138.439	134.215	111.109
October	72.413	73.392	62.039	66.680	63.464	88.253	138.048	131.659	130.182	111.336
November	72.968	69.581	65.650	66.294	62.855	108.528	152.320	118.109	119.762	110.034
December	74.230	70.805	63.538	68.025	63.630	133.339	161.270	109.216	115.611	102.972
Annual average.	74.309	79.344	68.157	66.961	66.051	82.448	120.299	130.529	123.168	109.327

Source: Metals Week.



**Table 21. Estimated copper production costs for the United States**

[Cents per pound of copper. Data may not add to totals shown due to rounding. (na), not available]

Product costs	1983	1984	1985	1986	1987	1988	1989	1990	1991
Mine operating cost	22	20	23	23	19	18	17	17	na
Mill-float operating cost (2	24	23	20	21	28	28	27	27	na
Mill-leach operating cost	7	7	(3	(3	(3	(3	(3	(3	na
Smelt/refine/transportation	26	24	23	19	14	17	18	18	na
Taxes (4	3	2	2	2	2	1	1	1	na
<b>Total cost</b>	<b>82</b>	<b>76</b>	<b>68</b>	<b>65</b>	<b>63</b>	<b>64</b>	<b>63</b>	<b>63</b>	<b>na</b>
Byproduct credits	-13	-11	-9	-9	-10	-10	-9	-10	na
<b>Cash cost (5</b>	<b>69</b>	<b>65</b>	<b>59</b>	<b>56</b>	<b>53</b>	<b>54</b>	<b>54</b>	<b>53</b>	<b>na</b>
Recovery of capital	na	na	na	11	5	7	6	6	na
<b>Total</b>	<b>na</b>	<b>na</b>	<b>na</b>	<b>67</b>	<b>58</b>	<b>61</b>	<b>60</b>	<b>60</b>	<b>na</b>

(1 Includes 18 mines, most of which were producing from 1983 to 1990.

(2 Includes copper recovered by leaching in 1985 et.seq.

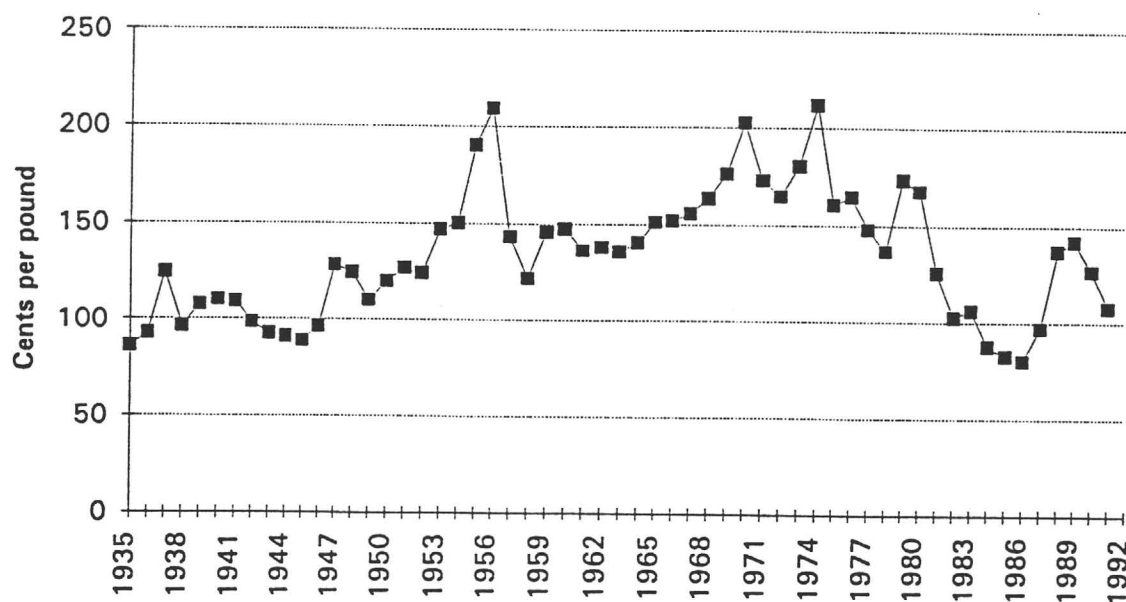
(3 Mill-leach costs after 1984 included in mill-float operating costs.

(4 Property, severance taxes, and royalties, if applicable.

(5 Includes all cash cost of production and credit for byproducts but excludes depreciation and profit. Costs are in actual dollars for each year shown.

Source: "Minerals Yearbook, Metals & Minerals," U.S. Bureau of Mines.

**Figure 12. Copper price in constant 1991 dollars**



Source: "Non-ferrous Metal Data 1991," American Bureau of Metal Statistics.

**Table 22. Copper reserve base in 1991**

[Reserve base is that part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices, including those for grade, quality, thickness, and depth. The reserve base is the in-place demonstrated (measured plus indicated) resource from which reserves are estimated. It may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics. The reserve base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently subeconomic (subeconomic resources). Definition from "Mineral Facts and Problems" 1985 edition, U.S. Bureau of Mines, Bulletin 675, page 3]

Deposit Location	Company	Mineral type	Million tons	% Cu	Source/comments
Antler T17N R16W S. 4	Standard Metals Corp.	Sulfide	5.0	1.95	Annual report & form 10-K, 1987. With 4.13% Zn, 0.94% Pb, and 1.05 Ag oz/ton. An additional 2.5 million tons reported in 1979 annual report.
Atlas T11S R8E S. 32	Asarco Inc.	Sulfide	5.0	0.64	"Report on the BS&K Project" by Buchella, F.
		Acid Soluble	5.0	0.4	Sulfide cutoff 0.40%. Acid Soluble cutoff 0.20%.
		Sulfide	19.0	0.7	Asarco property adjacent to Atlas.
		Acid Soluble	12.0	0.4	Asarco property adjacent to Atlas.
Bagdad T14N R9W S. 4	Cyprus Copper Co.	Sulfide	741.4	0.40	Cyprus Minerals form 10K, 1991. With 0.022% Mo. Sulfide includes acid soluble.
Buckeye East T3S R12E S. 26	Asarco Inc.	Acid Soluble	20.0	0.65	"Arizona Wilderness 1988", Arizona Mining Association, Report A-23. 40 million possible.
Carlota T1N R13E S. 36	Cambior USA Inc.	Acid Soluble	92.0	0.44	Reported by Cambior. Includes Cactus and Eder deposits.
Casa Grande T6S R5E S. 18	Asarco & Freeport McMoran JV.	Mixed	352.0	1.00	Getty Oil Co. annual report, 1980. With 0.01% Mo. Cutoff at 0.5% Cu.
Casa Grande (Lakeshore) T10S R4E S. 25	Cyprus Copper Co.	Sulfide	41.0	0.71	Porphyry - Noranda annual report, 1984.
		Sulfide	9.0	1.35	Tactite - Noranda annual report, 1984.
		Acid Soluble	15.5	0.76	Cyprus Minerals form 10-K, 1991.
Chilito T4S R15E S. 22	Asarco Inc.	Mixed	75.0	0.51	Chilito Mines Report. With 0.01% Mo, and 0.04 oz/ton Ag.
Christmas T4S R16E S. 30	Cyprus Copper Co.	Sulfide	7.0	0.63	Inspiration Resources form 10-K, 1983. Open pit.
		Sulfide	20.0	1.82	Underground.
Cochise T23S R24E S. 9	Phelps Dodge Corp.	Acid Soluble	210.0	0.40	Phelps Dodge form 10K 1991.
Copper Basin T13N R3W S. 20	Phelps Dodge Corp.	Sulfide	70.0	0.5	Phelps Dodge form 10K 1991. With 0.021% Mo.
Copper Butte T3S R13E S. 30	Asarco Inc.	Acid Soluble	22.0	1.1	"Arizona Wilderness 1988", Arizona Mining Association, Report A-23.
Copper Creek T8S R18E S. 11	Magma Copper Co.	Sulfide	80.0	0.55	Unpublished estimate.

Table 22. Copper reserve base in 1991 — continued

Deposit Location	Company	Mineral type	Million tons	% Cu	Source/comments
Copper Queen T23S R24E S. 9	Phelps Dodge Corp.	Mixed	1.0	5.50	Phelps Dodge prospectus, May 8, 1975. Underground, contains significant gold resource.
Dos Pobres T5S R26E S. 27	Phelps Dodge Corp.	Sulfide UG Mixed OP	230.0 150.0	0.9 0.5	Phelps Dodge form 10-K, 1991, page 9, 12. Open pit reserves are recoverable by leaching.
Dragoon T16S R22E S. 25	Sullivan, James	Acid Soluble	25.0	0.50	Unpublished estimate.
Dynamite T17S R13E S. 30	Smith, Addison	Mixed	100.0	0.53	Unpublished estimate.
Emerald Isle T23N R18W S. 22	Arimetco International Inc.	Acid Soluble	2.0	0.72	Arimetco International, Inc. prospectus May 16, 1990.
Esperanza T18S R12E S. 16	Cyprus Copper Co.	Sulfide	48.0	0.27	Pennzoil form 10-K, 1981. With 0.034% Mo.
Four Metals T23S R16E S. 20	Duerr & Prochnav	Sulfide	14.0	0.7	Personal communication.
Gibson T1S R14E S. 21	Lodestar Minerals Inc.	Acid Soluble	11.0	0.7	Fletcher, J.B. et al report August, 1984. 43 million tons at 0.40% Cu.
Helvetia T18S R15E S. 36	Asarco Inc.	Sulfide Acid Soluble	337.0 22.0	0.54 0.55	Summary report by Dresher. Sulfide - 0.088 oz/ton Ag, 0.0005 oz/ton Au.
I-10 T15S R23E S. 31	Sullivan, James	Mixed	100.0	0.52	Unpublished estimate; with 0.02% Mo.
Iron Door T13S R25E S. 17	Unknown	Sulfide	63.0	0.4	Spike-E Hills Report. Cutoff at 0.20% Cu.
Johnson T15S R22E S. 26	Arimetco International Inc.	Sulfide Acid Soluble	9.0 26.0	0.60 0.3	Arimetco prospectus May, 1990.
Kalamazoo T9S R16E S. 9	Magma Copper Co.	Sulfide Sulfide	17.0 143.0	0.72 0.71	Magma Copper form 10-k, 1991. Second sulfide is resource below 2950 level of lower orebody.
Kay Copper T8N, R2E, S. 4	Rayrock Mines Inc.	Sulfide	6.0	2.20	Northern Mines Handbook 1990-1. With 3% Zn, 1.6 oz/ton Ag and 0.08 oz/ton Au.
Korn Kob T12S R17E S. 14	Keystone Minerals Inc.	Acid Soluble	18.0	0.40	Reported by Keystone Minerals from 1990 drilling by A. F. Budge.
Lone Star T6S R27E S. 5	Phelps Dodge Corp.	Mixed	1600.0	0.38	Phelps Dodge form 10-K, 1991.
Lonesome Pine T1S R14E S. 14	Corn, Russ	Mixed	20.0	0.4	Partially tested chalcocite/oxide zone.

Table 22. Copper reserve base in 1991 — continued

Deposit Location	Company	Mineral type	Million tons	% Cu	Source/comments
Mame T19S R25E S. 20	Hope Mining & Milling Co.	Acid Soluble	1.0	1.10	Unpublished estimate.
Miami T1N R14E S. 25	Cyprus Copper Co.	Acid Soluble	213.0	0.45	Cyprus Minerals form 10K, 1991. Acquired from Inspiration July, 1988.
Miami East T1N R15E S. 19	Magma Copper Co.	Sulfide Sulfide	6.0 50.0	3.14 1.95	Newmont Mining annual report, 1985. USBM Minerals Yearbook 1973, Area Reports.
Miami Tailings T1N R15E S. 30	Magma Copper Co.	Acid Soluble	29.0	0.3	Magma form 10-K, 1991. 54% recovery expected.
Mineral Butte T4S R7E S. 1	U.S. Government	Mixed	15.0	0.4	Withdrawn from mineral entry.
Mineral Park T23N R17W S. 19	Cyprus Copper Co.	Acid Soluble	11.0	0.27	Cyprus Minerals form 10-k, 1991.
Mission T16S R12E S. 31	Asarco Inc.	Sulfide	584.0	0.67	Asarco annual report, 1991. With 0.16 oz/ton Ag.
Morenci T4S R29E S. 16	Phelps Dodge (85%) and Sumitomo (15%)	Sulfide Acid Soluble Sulfide Mixed	665.0 922.4 150.0 180.0	0.79 0.3 0.72 0.71	Phelps Dodge form 10K, 1991. Milling reserves. Leaching reserves. Western Copper. Coronado deposit.
New Cornelia T12S R6W S. 27	Phelps Dodge Corp.	Sulfide	160.0	0.56	Phelps Dodge form 10-K, 1991.
Oracle Ridge T11S R16E S. 16	Oracle Ridge Mining Partners	Mixed	4.0	2.23	E&MJ June 1989. With 0.67 oz/ton Ag. Additional 4.4 million tons possible.
Peach Elgin T18S R15E S. 15	Asarco Inc.	Sulfide Acid Soluble	14.0 10.0	0.8 0.8	West, Barbara J. report, January 1980.
Pinto Valley T1N R14E S. 2	Magma Copper Co.	Sulfide Sulfide Sulfide Sulfide	177.0 495.0 146.0 49.0	0.37 0.14 0.42 0.20	Magma form 10-K, 1991. Milling reserve. Dump leach reserve. Milling resource. Dump leach resource.
Poston Butte T4S R9E S. 33	Magma Copper Co.	Sulfide Acid Soluble	500.0 300.0	0.39 0.4	Magma "Copper Sense", August, 1992.
Ray T3S R13E S. 10	Asarco Inc.	Sulfide	1100.0	0.63	Asarco 1992 2nd quarter investor meeting.
Red Mountain T22S R16E S. 20	Kerr McGee Corp.	Sulfide	100.0	0.71	Tucson Daily Citizen, Sept. 23, 1970.
Sacaton East T5S R5E S. 26	Asarco Inc.	Sulfide	15.0	1.3	Asarco form 10K, 1979. Underground.



**Table 22. Copper reserve base in 1991 — continued**

Deposit Location	Company	Mineral type	Million tons	% Cu	Source/comments
San Juan T5S R26E S. 35	Phelps Dodge Corp.	Acid Soluble	16.0	0.5	Producers Minerals Corp. Report June, 1975. At 0.35% Cu cutoff.
San Manuel OP T8S R16E S. 35	Magma Copper Co.	Acid Soluble Acid Soluble Sulfide	31.0 4.0 0.7	0.5 0.2 0.90	Magma Copper form 10-k 1991. Open pit marginal.
San Manuel UG T8S R16E S. 34	Magma Copper Co.	Sulfide Sulfide Acid Soluble	74.0 142.0 205.0	0.7 0.6 0.4	Magma Copper form 10K, 1991. Additional mineralization in shaft pillar. In-situ. 50% recovery anticipated.
Sanchez T6S R27E S. 25	AZCO Mining Inc.	Acid Soluble Acid Soluble	168.0 23.0	0.3 0.2	AZCO report, 1992. Reseve and low grade suitable for leaching.
Santa Cruz T6S R4E S. 13	Asarco & Freeport McMoran	Acid Soluble	800.0	0.4	U.S. Bureau of Mines data, 1985.
Sheep Mtn. T8N R1W S. 15	Orcana Resources Ltd.	Sulfide	39.0	1.27	"Preliminary economic evaluation ..." by Watts Griffis and McOuat, 1992. Supergene only.
Sierrita T18S R12E S. 7	Cyprus Copper Co.	Sulfide	526.6	0.30	With 0.033% Mo. Cyprus Minerals form 10-K, 1991. Reserve includes Twin Buttes deposit.
Silver Bell T12S R8E S. 11	Asarco Inc.	Sulfide	101.0	0.5	Asarco annual report, 1991. With 0.01 oz/ton Ag.
Squaw Peak T13N R5E S. 29	Squaw Peak Copper Co.	Sulfide	20.0	0.4	Roe, Robert R., 1976 report.
Superior T1S R12E S. 35	Magma Copper Co.	Sulfide Sulfide	1.4 2.6	6.54 5.70	Magma Copper form 10-k 1991. Current reserve. Additional tonnage not presently economic.
Stray Elephant T4N R20W S. 31	Heinrichs GEO Exploraton Co.	Acid Soluble	4.0	0.4	ASCO 1989 report by James Loughry. Potential of 13 million tons at 0.50%.
Strong & Harris T15S R22E S. 13	AZCO Mining Inc.	Mixed	60.0	0.60	Unpublished estimate with 0.70 Zn.
Turquoise T19S R25E S. 17	Santa Fe Pacific Mining Inc.	Acid Soluble Mixed	15.0 1.0	0.50 3.10	Santa Fe property synopsis 1992. With 0.05 oz/ton Au.
Twin Buttes T18S R13E S. 5	Cyprus Copper Co.	Sulfide Acid Soluble			Reserves included with and being depleted with Sierrita's. As last separately reported in Cyprus Minerals form 10-K, 1989 reserves were 39 million tons @ 1.00%, 11 million tons @0.73%.
Two Peaks T19S R19E S. 20	Dugan Production	Sulfide	32.0	0.3	U.S. Geological Survey Professional Paper 1300, page 128.
United Verde T16N R2E S. 22	Phelps Dodge Corp.	Sulfide	21.0	0.5	U.S. Geological Survey Bulletin 1857D.

**Table 22. Copper reserve base in 1991 — continued**

Deposit Location	Company	Mineral type	Million tons	% Cu	Source/comments
Van Dyke T1N R15E S. 30	Arimetco International Inc.	Acid Soluble	100.0	0.53	Arimetco annual report, 1990.
Vekol hills T10S R3E S. 4	Tohono O'odham Tribe	Sulfide	105.0	0.56	Vekol Hills Project EIS, U.S. Interior Dept. 1988. With 0.014% Mo, 16 million tons acid soluble.
Ventura T23S R15E S. 1	Cyprus Copper Co.	Sulfide	6.0	0.26	Iso Mines Ltd. annual report, 1965. With 0.28% MoS <sub>2</sub> , 6 million additional tons possible.
White Mesa T38N R9E S. 29	Navajo Tribe & private party.	Acid Soluble	2.0	0.75	Mayo, E.B., 1955 report. Additional tonnage likely.
Zonia T11N R4W S. 12	Arimetco International Inc.	Acid Soluble	35.0	0.31	Lundin, Richard J. et.al. Feb. 1985 report.
<b>Total copper reserve base in Arizona</b>					
		Sulfide	7,146.7	0.56	contains 39.863 million tons of copper
		Acid Soluble	3,369.9	0.40	contains 13.463 million tons of copper
		Mixed	2,658.0	0.52	contains 13.709 million tons of copper
<b>Total</b>			<b>13,174.6</b>	<b>0.51</b>	<b>contains 67.035 million tons of copper</b>

**Company index to copper reserve base**

Company	Deposit	Company	Deposit
Arimetco International	Emerald Isle	Keystone Minerals	Korn Kob
Arimetco International	Johnson	Lodestar Minerals	Gibson
Arimetco International	Van Dyke	Magma Copper	Copper Creek
Arimetco International	Zonia	Magma Copper	Kalamazoo
Asarco & Freeport	Casa Grande	Magma Copper	Miami East
Asarco & Freeport	Santa Cruz	Magma Copper	Miami Tailings
Asarco Inc.	Atlas	Magma Copper	Pinto Valley
Asarco Inc.	Buckeye East	Magma Copper	Poston Butte
Asarco Inc.	Chilito	Magma Copper	San Manuel OP
Asarco Inc.	Copper Butte	Magma Copper	San Manuel UG
Asarco Inc.	Helvetia	Magma Copper	Superior
Asarco Inc.	Mission	Navajo Tribe	White Mesa
Asarco Inc.	Peach Elgin	Oracle Ridge	Oracle Ridge
Asarco Inc.	Ray	Orcana Resources	Sheep Mtn.
Asarco Inc.	Sacaton East	Phelps Dodge	Copper Basin
Asarco Inc.	Silver Bell	Phelps Dodge	Copper Queen
AZCO Mining Inc.	Sanchez	Phelps Dodge	Dos Pobres
AZCO Mining Inc.	Strong & Harris	Phelps Dodge	Lone Star
Cambior USA Inc.	Carlota	Phelps Dodge	New Cornelia
Corn, Russ	Lonesome Pine	Phelps Dodge	San Juan
Cyprus Copper	Bagdad	Phelps Dodge	United Verde
Cyprus Copper	Casa Grande	Phelps Dodge	Cochise
Cyprus Copper	Christmas	Phelps Dodge	Morenci
Cyprus Copper	Esperanza	Rayrock Mines	Kay Copper
Cyprus Copper	Miami	Santa Fe Pacific	Turquoise
Cyprus Copper	Mineral Park	Smith, Addison	Dynamite
Cyprus Copper	Sierrita	Squaw Peak	Squaw Peak
Cyprus Copper	Twin Buttes	Standard Metals	Antler
Cyprus Copper	Ventura	Sullivan, James	Dragoon
Duerr & Prochnav	Four Metals	Sullivan, James	I-10
Dugan Production	Two Peaks	Tohono O'odham	Vekol hills
Heinrichs GEO	Stray Elephant	U.S. Government	Mineral Butte
Hope Mining	Mame	Unknown	Iron Door
Kerr McGee Corp.	Red Mountain		

Table 23. Historic Arizona and U.S. copper mine production

[Copper reported in tons]

Period	Arizona production	Arizona cumulative	U.S. production	U.S. cumulative	Az. % of U.S. Production	
					Period	Cummulative
1874-1971(1)	24,889,171	24,889,171	60,365,183	60,365,183	41.2	41.2
1972	847,929	25,737,100	1,664,840	62,030,023	50.9	41.5
1973	867,506	26,604,606	1,717,940	63,747,963	50.5	41.7
1974	804,904	27,409,510	1,597,002	65,344,965	50.4	41.9
1975	751,489	28,160,999	1,413,366	66,758,331	53.2	42.2
1976	956,215	29,117,214	1,605,586	68,363,917	60.0	42.6
1977	852,620	29,969,834	1,503,964	69,867,887	56.7	42.9
1978	908,835	30,878,669	1,496,482	71,364,363	60.7	43.3
1979	957,251	31,835,920	1,591,200	72,955,563	60.2	43.6
1980	760,926	32,596,846	1,301,900	74,257,463	58.4	43.9
1981	1,071,949	33,668,795	1,695,500	75,952,963	63.2	44.3
1982	848,750	34,517,545	1,264,322	77,217,285	67.1	44.7
1983	747,604	35,265,149	1,144,306	78,361,591	65.3	45.0
1984	822,815	36,087,964	1,215,400	79,576,991	67.7	45.3
1985	878,044	36,966,008	1,218,900	80,795,891	72.0	45.8
1986	878,926	37,844,934	1,180,564	81,976,455	74.4	46.2
1987	862,034	38,706,968	1,384,394	83,360,849	62.3	46.4
1988	942,556	39,649,524	1,584,115	84,944,964	59.5	46.7
1989	1,004,891	40,654,415	1,651,501	86,596,465	60.8	46.9
1990	1,087,287	41,741,702	1,738,952	88,335,417	62.5	47.3
1991	1,132,536	42,874,238	1,797,965	90,133,382	63.0	47.6

1) For cumulative breakdown 1874-1911 and annual production 1912-1971, see Phillips, K., 1973, "The Copper Industry," Arizona Department of Mines and Mineral Resources.

Source: "Minerals Yearbook - Area Reports: Domestic," U.S. Bureau of Mines; Table 1, this publication.

## THE ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

The objective of the Department is to promote the development of Arizona's mineral resources. This is accomplished through technical research, field investigations, compilation of information into a mineral occurrence data base and disseminating information through publications, personal contacts and seminars.

The Department's mining engineers and geologists assist mining and exploration companies, prospectors and others interested in Arizona's minerals with mineral processing, mineral land acquisition, exploration, mine development, financing, government regulations and marketing.

The Department is a service agency and does not regulate, tax, or require any type of registration. The agency provides assistance that is tailored to meet the differing needs of the public. The following is a partial list of services which the Department offers:

- Maintain a site specific data base of unpublished reports and maps which includes 5,000 mine files and indexes of 10,000 computerized Arizona
- Maintain an information bank and library of mineral and mining information including a mine map library (hard copy and microfilm), government publications, periodicals, and unpublished master and doctorate theses.
- Gather and disseminate information on commodities and markets.
- Suggest target areas for possible exploration activity.
- Suggest prospects and individual properties for study and acquisition.
- Assist individuals and companies in their dealings with State regulatory agencies to facilitate their mining and exploration activity.
- Produce publications in the form of mineral reports, annual directories, technical reports, annual mineral industry surveys and information circulars. These include Laws and Regulations Governing Mineral Rights in Arizona, Directory of Active Mines in Arizona, Manual for Determination of Status and Ownership of Arizona Mineral and Water Rights, and others. A current listing of the Department publications is available upon request.