

# THE MINERAL INDUSTRY OF ARIZONA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Arizona Department of Mines and Mineral Resources for collecting information on all nonfuel minerals.

In 1995, for the seventh time in the past 8 years, Arizona led the Nation in total nonfuel mineral production value,<sup>1</sup> according to the U.S. Geological Survey (USGS). Arizona's portion of the U.S. total (based on preliminary data) was \$4.2 billion, a 27% increase from the \$3.3 billion achieved in 1994. This followed an 18% increase in 1994 from that of 1993 (based on final 1994 data). The State accounted for more than 11% of the U.S. total nonfuel mineral production value.

Arizona continued as the top copper-producing State, accounting for 63% of total U.S. copper production. A decrease in 1993 and increases (see table 1) in 1994-95 in the State's total nonfuel mineral value were mainly the result of fluctuations in copper prices. Overall, copper represented 87% of Arizona's 1995 nonfuel mineral production value; industrial minerals, more than 8%; and the remaining 5% was divided between molybdenum, silver, and gold. Compared with 1994, the values of the following commodities increased in 1995: copper, construction sand and gravel, molybdenum, silver, lime, crushed stone, salt, masonry cement, gemstones, pumice, bentonite clays, perlite, dimension stone, industrial sand

and gravel, and common clays. The values of portland cement, gold, and gypsum showed slight decreases during the year.

Based on USGS estimates of the quantities of minerals produced in the United States during 1995, Arizona remained first in copper and molybdenum; second in silver and perlite; and fifth in the production of pumice and iron oxide pigments. While the State remained 11th of 14 gold-producing States, Arizona climbed from 7th to 6th in the production of construction sand and gravel and from 11th to a tie for 10th with New Mexico in gypsum production. The State dropped from eighth to ninth in bentonite clay production. Additionally, Arizona mines and manufacturing plants produced significant quantities of portland and masonry cements and dimension stone, although not ranking among the top 10 States.

The remainder of this report was derived from information provided by the Arizona Department of Mines and Mineral Resources (ADMMR). The copper producer price averaged a record high \$1.38 per pound for 1995, up significantly from the 1994 average of \$1.11. Byproduct molybdenum concentrate prices also surged during the year

TABLE 1  
NONFUEL RAW MINERAL PRODUCTION IN ARIZONA<sup>1 2</sup>

Mineral	1993		1994		1995 <sup>P</sup>	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>3</sup> thousand metric tons	97	\$451	98	\$452	100	\$463
Copper <sup>4</sup> metric tons	1,160,000	2,340,000	1,120,000	2,750,000	1,200,000	3,600,000
Gemstones	NA	5,630	NA	3,550	NA	3,760
Gold <sup>4</sup> kilograms	2,710	31,500	<sup>5</sup> 1,980	<sup>5</sup> 24,500	<sup>5</sup> 1,940	<sup>5</sup> 23,300
Iron oxide pigments (crude) metric tons	77	62	77	62	77	62
Sand and gravel (construction) thousand metric tons	<sup>6</sup> 35,000	<sup>6</sup> 138,000	34,800	166,000	37,000	180,000
Silver <sup>4</sup> metric tons	200	27,700	192	32,600	194	33,100
Stone (crushed) thousand metric tons	6,430	36,800	4,970	25,000	5,400	27,500
Combined value of cement, clays (bentonite), gypsum (crude), lime, molybdenum, perlite (crude), pumice and pumicite, pyrites <sup>6</sup> (1993), salt, sand and gravel (industrial), and stone [dimension (1993, 1995), dimension sandstone (1994)]	XX	196,000	XX	274,000	XX	309,000
Total	XX	2,780,000	XX	3,280,000	XX	4,180,000

<sup>1</sup>Estimated. <sup>P</sup>Preliminary. NA Not available. XX Not applicable.

<sup>2</sup>Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

<sup>3</sup>Data are rounded to three significant digits; may not add to totals shown.

<sup>4</sup>Excludes certain clays; kind and value included with "Combined value" data.

<sup>5</sup>Recoverable content of ores, etc.

<sup>6</sup>Placer canvassing discontinued beginning 1994.

<sup>7</sup>Pyrites canvassing discontinued beginning 1994.

from \$2.00 per pound in mid-1994 to \$5.50 in mid-1995 before settling to about \$3.00 at yearend. These factors combined to stimulate production of these minerals and enabled State producers to achieve high earnings from their operations. Six companies operating 16 copper properties produced a record estimated 1.2 million metric tons<sup>2</sup> (2.6 billion pounds) in 1995. This marked the fourth consecutive year of record-breaking copper mine production; in 1992, Arizona's mines produced 1.15 tons of recoverable copper, surpassing the State's alltime record copper production of 1.04 tons set in 1981. The State's high levels of copper production in recent years have been, in part, the result of ongoing company investments in mine truck and shovel fleets, mill expansions, and smelter improvements.

### **Copper**

ASARCO Incorporated drove a decline (underground roadway) from the base of the Mission Complex pit to develop a high-grade, 4.5-million-ton underground deposit. At the Santa Cruz in situ project, research partners Asarco, Freeport-McMoran Copper & Gold Inc., and the U.S. Bureau of Mines received the necessary permits and completed construction of a pilot-scale solvent-extraction electrowinning (SX-EW) copper refining plant. Injection of sulfuric acid into the deposit was begun to dissolve the copper from the ore and produce a copper-bearing leachate solution. The leachate will be pumped from recovery wells and processed through the SX-EW plant to produce copper cathode.

With the addition of a water flush crusher, mill production of copper ore at Cyprus Climax Metals Co.'s Bagdad Mine reached 76,900 tons per day. A redesign of Cyprus Miami Mining Corp.'s smelter off-gas hood allowed the company to achieve its 590,000-ton-per-year capacity at the Miami smelter operation. An \$80 million investment in a new electrolytic refinery at Miami for refinery capacity made Cyprus self-sufficient and lowered refining costs by 2 cents per pound. In April, the final environmental impact statement (EIS) was issued for the Cyprus Tohono Corp. operations, thus allowing its conversion from in situ leaching to an open pit heap-leach operation. The precipitate plant at Cyprus' Mineral Park Mine was replaced with an SX-EW unit.

In December, Broken Hill Proprietary Co. (BHP) of Australia submitted a proposal to acquire Magma Copper Co. for \$1.8 billion. The acquisition was completed the following month including the necessary inclusion of Magma debt of \$600 million for a total transaction cost of \$2.4 billion. The merger will create a new BHP copper group headed by Magma personnel. Development continued on Magma's Kalamazoo deposit, with the tunnel boring project completed in December. Production was expected to begin during 1997 and be phased in over a 2-year period as the adjacent San Manuel deposit nears depletion. The nearby, geologically related Kalamazoo

deposit will be accessed from the current shaft at San Manuel and is expected to extend the life of the San Manuel underground mine by 12 years to the year 2009.

Completion of the Southside expansion at Phelps Dodge Corp.'s Morenci Mine increased annual SX-EW capacity by 68,000 to 226,000 tons (150 to 500 million pounds). Previously, in 1994, the company reported drilling a portion of the new Garfield deposit that then added 687 million tons (760 million short tons) to the Morenci copper reserve.

In May, Azco Mining Inc. agreed to sell its Sanchez copper deposit near Safford, Graham County, to Phelps Dodge. Azco's stockholders gave final approval to the transaction in December. This added to Phelps Dodge's Safford District properties. In 1994, the company had previously announced its acquisition and subsequent drilling of the San Juan deposit, thereby identifying a leachable resource of 250 million tons. Total leachable copper resources for Phelps Dodge at Safford, including Sanchez and San Juan, now exceed 2.2 billion tons. Work on a land exchange involving the U.S. Bureau of Land Management was underway to facilitate development of the projects.

Tonto National Forest officials issued a draft EIS in January for Cambior (USA) Inc.'s Carlotta project. The company anticipates receiving a final EIS in early 1996, allowing construction of the open pit mine, heap-leach pad, and 24,000-ton-per-year copper SX-EW recovery plant.

### **Gold and Construction Sand and Gravel**

Two gold deposits were under development in 1995: Combined Metals Reduction Co.'s Klondyke/Golden Door property as a heap-leach operation in Mohave County and Gold Chord Resources Inc.'s underground Evening Star operation, in Maricopa County. In addition to gold and relatively small quantities of copper, the Evening Star deposit contains significant quantities of silica of sufficient purity to serve as a source of smelter flux for nearby copper refineries. In metal refining, a flux is a material that is used to remove undesirable materials as a molten material; e.g. silica is used in copper refining to remove iron oxide.

Population growth and freeway construction projects in the metropolitan Phoenix area have contributed to Arizona's ranking sixth nationally in construction sand and gravel production. Salt River Sand and Rock, Maricopa County, was reported by ADMMR to be the second largest operation in the Nation.

ADMMR compiled its *Directory of Active Mines in Arizona 1996*. The directory provides a detailed listing of companies, mines, and personnel, as well as a summary of Arizona's mining industry.

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<sup>2</sup>The terminologies "nonfuel mineral production" and related "values" encompass variations in meaning, depending on the minerals or mineral products. Production may be measured by mine shipments, mineral commodity sales, or marketable production (including consumption by producers) as is applicable to the individual mineral commodity.

All 1995 USGS data are estimated as of Dec. 1995. Estimates for some commodities, e.g., construction sand and gravel, crushed stone, and portland cement, are periodically updated. To obtain the most recent information please contact the appropriate USGS mineral commodity specialist. Call MINES FaxBack at

(703) 648-4999 from your fax machine and request Document No. 1000 for a telephone listing of all mineral commodity specialists or call USGS information at (703) 648-4000 for the specialist's name and number.

<sup>2</sup>All tons are metric tons unless otherwise specified.

TABLE 2  
**ARIZONA: CRUSHED STONE<sup>1</sup> SOLD OR USED BY PRODUCERS IN 1994, BY USE<sup>2</sup>**

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
<b>Coarse aggregate (+1 1/2 inch):</b>			
Riprap and jetty stone	152	\$1,170	\$7.70
Other coarse aggregate	6	38	6.33
<b>Coarse aggregate, graded:</b>			
Bituminous aggregate, coarse	6	51	8.50
Railroad ballast	76	663	8.72
<b>Coarse and fine aggregates:</b>			
Graded road base or subbase	78	271	3.47
Unpaved road surfacing	25	142	5.68
Terrazzo and exposed aggregate	71	733	10.30
Crusher run or fill or waste	1	8	8.00
Other coarse and fine aggregates <sup>3</sup>	130	803	6.18
<b>Agricultural: Poultry grit and mineral food</b>			
	W	W	11.60
<b>Chemical and metallurgical:</b>			
Cement manufacture	W	W	3.67
Flux stone	W	W	11.60
<b>Special:</b>			
Other fillers or extenders	W	W	11.60
Other specified uses not listed	2,470	9,990	4.04
<b>Unspecified:<sup>4</sup></b>			
Actual	32	158	4.94
Estimated	1,920	11,000	5.73
<b>Total</b>	<b>4,970</b>	<b>25,000</b>	<b>5.03</b>

W Withheld to avoid disclosing company proprietary data; included with "Other specified uses not listed."

<sup>1</sup>Includes granite, limestone, marble, miscellaneous stone, sandstone and quartzite, traprock, and volcanic cinder and scoria.

<sup>2</sup>Data are rounded to three significant digits; may not add to totals shown.

<sup>3</sup>Includes concrete aggregate, coarse, filter stone, and screening (undesignated).

<sup>4</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3  
**ARIZONA: CRUSHED STONE SOLD OR USED, BY KIND<sup>1</sup>**

Kind	1993				1994			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	'10	'3,970	'\$22,200	'\$5.58	8	2,710	\$10,500	\$3.88
Granite	12	1,760	9,860	5.59	12	1,330	7,870	5.94
Marble	2	W	W	5.74	4	593	3,730	6.28
Trap rock	2	W	W	5.09	4	W	W	5.61
Volcanic cinder and scoria	3	112	'206	'1.83	3	45	94	2.09
Sandstone and quartzite	1	55	782	14.20	2	125	1,550	12.40
Miscellaneous stone	3	251	2,110	8.41	2	W	W	8.47
<b>Total</b>	<b>XX</b>	<b>'6,240</b>	<b>'35,600</b>	<b>'5.71</b>	<b>XX</b>	<b>4,970</b>	<b>25,000</b>	<b>5.03</b>

<sup>1</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Total." XX Not applicable.

<sup>2</sup>Data are rounded to three significant digits.

TABLE 4  
**ARIZONA:<sup>1</sup> CRUSHED STONE SOLD OR USED BY PRODUCERS IN 1994, BY USE AND DISTRICT<sup>2</sup>**

(Thousand metric tons and thousand dollars)

Use	District 2		District 3	
	Quantity	Value	Quantity	Value
<b>Construction aggregates:</b>				
Coarse aggregate (+1 1/2 inch) <sup>3</sup>	9	53	150	1,160
Coarse aggregate, graded <sup>4</sup>	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )
Fine aggregate (-3/8 inch) <sup>6</sup>	—	—	( <sup>5</sup> )	( <sup>5</sup> )
Coarse and fine aggregate <sup>7</sup>	101	400	123	1,160
<b>Agricultural<sup>8</sup></b>				
Chemical and metallurgical <sup>9</sup>	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )
Special <sup>10</sup>	—	—	( <sup>5</sup> )	( <sup>5</sup> )
Other miscellaneous uses <sup>11</sup>	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )
<b>Unspecified:<sup>12</sup></b>				
Actual	—	—	32	158
Estimated	149	802	1,770	10,200
<b>Total</b>	<b>1,210</b>	<b>3,220</b>	<b>3,760</b>	<b>21,800</b>

<sup>1</sup>Production reported in District 1 was included with "District 2" to avoid disclosing company proprietary data.

<sup>2</sup>Data are rounded to three significant digits; may not add to totals shown.

<sup>3</sup>Includes filter stone, riprap and jetty stone, and other coarse aggregate.

<sup>4</sup>Includes concrete aggregate (coarse), bituminous aggregate (coarse), and railroad ballast.

<sup>5</sup>Withheld to avoid disclosing company proprietary data; included with "Total."

<sup>6</sup>Includes screening (undesignated).

<sup>7</sup>Includes graded road base or subbase, terrazzo and exposed aggregate, unpaved road surfacing, crusher run (select material or fill), and other coarse and fine aggregate.

<sup>8</sup>Includes poultry grit and mineral food.

<sup>9</sup>Includes cement manufacture, and flux stone.

<sup>10</sup>Includes other fillers or extenders.

<sup>11</sup>Includes other specified uses not listed.

<sup>12</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 5  
**ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1994, BY MAJOR USE CATEGORY<sup>1</sup>**

Use	Quantity (thousand metric tons)	Value (thousands)	Value per ton
Concrete aggregate (including concrete sand)	13,100	\$65,900	\$5.03
Plaster and gunite sands	157	1,140	7.25
Concrete products (blocks, bricks, pipe, decorative, etc.)	235	1,300	5.52
Asphaltic concrete aggregates and other bituminous mixtures	4,410	31,500	7.15
Road base and coverings <sup>2</sup>	6,070	25,300	4.17
Fill	1,270	4,580	3.62
Snow and ice control	W	W	2.69
Railroad ballast	133	1,120	8.38
Filtration	W	W	15.70
Other	444	2,770	6.23
<b>Unspecified:<sup>3</sup></b>			
Actual	6,190	19,000	3.07
Estimated	2,770	13,500	4.88
<b>Total or average</b>	<b>34,800</b>	<b>166,000</b>	<b>4.78</b>

W Withheld to avoid disclosing company proprietary data; included with "Other."

<sup>1</sup>Data are rounded to three significant digits; may not add to totals shown.

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 6  
**ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1994, BY USE AND DISTRICT<sup>1</sup>**

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products <sup>2</sup>	1,170	7,310	318	1,750	12,000	59,300
Asphaltic/bituminous mixtures	678	4,630	375	2,900	<sup>3</sup> 3,350	<sup>3</sup> 24,000
Road base and coverings <sup>4</sup>	1,970	8,070	357	1,860	<sup>3</sup> 3,740	<sup>3</sup> 15,400
Fill	420	1,350	103	476	742	2,750
Snow and ice control	W	W	W	W	—	—
Railroad ballast	—	—	W	W	W	W
Other miscellaneous uses	W	W	—	—	W	W
Unspecified: <sup>5</sup>						
Actual	—	—	130	216	6,060	18,800
Estimated	303	1,430	753	3,810	1,720	8,280
Total	4,560	22,900	2,160	11,500	<sup>3</sup> 28,100	<sup>3</sup> 132,000

W Withheld to avoid disclosing company proprietary data; included with "Total."

<sup>1</sup>Data are rounded to three significant digits; may not add to totals shown.

<sup>2</sup>Includes plaster and gunite sands.

<sup>3</sup>Includes unspecified within all districts.

<sup>4</sup>Includes road and other stabilization (cement and lime).

<sup>5</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.