

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 1996, for the eighth time in the past 9 years, Arizona led the Nation in total nonfuel mineral production value,¹ according to the U.S. Geological Survey (USGS). Arizona's mineral production was valued at (based on preliminary data) \$3.5 billion, a 16% decrease from the \$4.2 billion of 1995. This followed a 28% increase from 1994 to 1995 (based on final 1995 data). The State accounted for more than 9% of the U.S. total nonfuel mineral production value.

Arizona continued as the top copper-producing State, accounting for 65% of total U.S. copper mine production and value. Copper was the State's leading nonfuel mineral, representing 83% of Arizona's 1996 total nonfuel mineral value. The State's 1996 decrease in total nonfuel mineral production value (as well as its significant increase in 1995) mainly resulted from declines (and significant increases in 1995) in average copper and molybdenum prices, but especially those of copper. Copper production increased by more than 5% in 1996, but its value decreased by about 18%, owing to a drop in average prices. In 1995, production had increased 4%; but conversely, the red metal's value then increased nearly 30%.

Compared with 1995, the values of the following commodities increased in 1996: construction sand and gravel, portland cement, lime, silver, crushed stone, gold, masonry cement, crude gypsum, gemstones, industrial sand and gravel, dimension stone, and iron oxide pigments. In addition to copper, the values of molybdenum, salt, bentonite clay, perlite, and pumice and pumicite decreased for the year.

Based on USGS estimates of the quantities produced in the United States during 1996, Arizona remained second in silver and perlite, and fifth in portland cement and zeolites. While the State climbed from second back to first in molybdenum and from ninth to eighth in lime, it was third in gemstones and dropped from fifth to sixth in the production of pumice and pumicite. Additionally, Arizona was a significant producer of portland and masonry cement and dimension stone.

The following narrative information was provided by the Arizona Department of Mines and Mineral Resources² (ADMMR). The Arizona Legislature selected the Mine Inspectors Office to administer the 1994 Mine Land Reclamation Act. The act became effective January 1,

1997, for new metal exploration and mine projects.

Existing operations were given until April 1, 1997 to submit reclamation plans. The Prescott Forest tightened regulations governing mining and prospecting activities to protect Mexican spotted owls and other endangered species.

Copper

ASARCO Incorporated's Silver Bell Mine continued to produce copper by dump-leach precipitation, while construction of a new \$70-million solvent extraction-electrowinning (SW-EX) plant was underway. The project was being developed with Mitsui and Co. Ltd. as a 25% partner. Production was anticipated to start in mid-to-late 1997, with a capacity of 16,000 metric tons³ of refined cathode copper annually. Oxide ore for the project will come from a new area of the property known as Silver Bell North that contains nearly 180 million tons of reserves. Asarco, facing a bottleneck at the Hayden smelter, cut back on concentrate production at the Ray Mine's Hayden mill beginning in October. At its Mission Mine, production increased 16% owing to improved ore grades from its new underground mine.

Magma Copper Co. was acquired by Broken Hill Proprietary Co. (BHP) of Australia effective January 1996. The merger made BHP Copper the second largest copper producer in the world with 9% of mine production. San Manuel and Pinto Valley are the company's two active mining divisions in Arizona. The Magma Mine at Superior closed in June 1996. It produced 17,000 tons of copper in 1995. BHP has begun engineering and permitting for an in situ leaching and an SX-EW plant for the Poston Butte deposit at Florence.

Development of the Lower Kalamazoo ore body at San Manuel continued during 1996 and was nearly complete at yearend. Its estimated ore reserves of 950,000 tons contained copper will add 12 years to the San Manuel underground mine operations. Production was planned to be phased in parallel with the depletion of the San Manuel ore body during the period from 1997 through 1999. San Manuel became the sole producing underground copper mine in the State with the closure of the Oracle Ridge and Superior mines.

Construction of the Carlota Mine of Carlota Copper

Co., a subsidiary of Cambior USA Inc., continued to be delayed. The long-awaited Environmental Impact Statement from Tonto National Forest, expected to be received by January 1996, was still not completed as of December 1996.

The ADMMR stated that the Cyprus Sierrita Corp. operated one of the most efficient mines in the world, with an average copper grade of only 0.27%, the lowest of all milling operations in the State. Sierrita contained proven and probable reserves to last 20 years at its present mining rate of almost 45 million tons of ore per year.

The Cyprus Tohono Corp. operated a SX-EW plant fed by a newly developed test open pit mining and heap-leach operation. According to the company's 10K report, in 1996, Tohono produced 17,700 tons, an increase of over 2,700 tons from that of 1995. A 540-million ton resource could become reserves if copper recovery and acid consumption remain within profitable levels. At yearend, mining from the test pit was temporarily suspended while Cyprus investigated large-scale alternatives. Leaching from existing leach pads continued.

Oracle Ridge Mining Partners, the operators of the underground Oracle Ridge Mine, suspended operations at the mine in early 1996. Santa Catalina Mining Corp., a 70% owner of the mine, reportedly has expressed the wish to sell its interest in the mine since that time. In 1995, Oracle Ridge produced concentrates containing 3,390 tons of copper from the mine.

Phelps Dodge Corp., headquartered in Phoenix, was the Nation's largest copper producer and the world's largest producer of SX-EW cathode copper. Its Morenci Mine was the largest copper producer in North America and the fourth largest copper mine in the world. According to the company's 10K report, in 1996, Morenci produced a record 462,000 tons of copper, or almost one-third of Arizona's total. More than one-half of Morenci's production was recovered by a leaching and SX-EW process. Morenci's milling and leaching reserves totaled more than 1.4 billion tons.

In 1994-95, a large resource of leachable material containing 900 million tons grading 0.27% copper was outlined north of Metcalf at the Garfield deposit. Phelps Dodge anticipated that continued drilling will result in a doubling of this resource.

Phelps Dodge Corp. and the Bureau of Land Management continued work on land exchanges for future Morenci and Safford operations. In October 1996, the final Environmental Impact Statement for the Morenci exchange was issued. In late 1995, the Sanchez deposit was acquired from AZCO Mining Inc. This increased the company's open pit, leachable copper resources in the Safford District to nearly 2.2 billion tons. Dos Pobres, in

the Sanchez District, also contained 270 million tons of sulfide reserves.

The New Cornelia Mine at Ajo remained inactive, but study of the geology of the copper resource continued. New Cornelia was last reported to contain 145 million tons grading 0.56%.

Gold, Zinc, and Construction Materials

In December 1995, Addington Resources Inc. sold Addwest Minerals Inc. to a group of private investors. The company continued to operate the Gold Road Mine and mill at Oatman. The Gold Road Mine recently became the sole producing primary gold mine in Arizona.

Bema Gold Corp., owner of the Yarnell Mining Co., continued permitting efforts for its Yarnell deposit that contained 6.6 million tons with 1.3 grams per ton gold. The final Environmental Impact Statement is expected by September 1997 for the open pit heap-leach operation.

Nevada Pacific Mining Co. acquired permits for an open pit heap-leach gold operation at the Cyclopic Mine in Mohave County but had not yet announced reserve figures or a construction date.

Phelps Dodge Corp. and Cominco Ltd. announced a joint-venture agreement for the United Verde massive sulfide deposit at Jerome. Although historically a large copper producer, the property contains one of the largest zinc resources in the United States, with a 19-million-ton resource grading 6.6% zinc plus copper and precious metals. Recently, work has focused on rehabilitating the Hopewell Tunnel and performing a geologic review.

The Georgia Marble Co. opened a new marble quarry named Davidson at their Andrada operations south of Tucson. The sand and gravel industry had another big year fueled by rapid population growth and continuing strong economic activity in Arizona.

¹The terms "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 1996 USGS mineral production data published in this chapter are estimates as of February 1997. For some commodities (for example, construction sand and gravel, crushed stone, and portland cement), estimates are updated periodically. To obtain the most current information, please contact the appropriate USGS mineral commodity specialist. Call MINES FaxBack at (703) 648-4999 from a fax machine with a touch-tone handset, and request Document # 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. This telephone listing may also be retrieved over the Internet at <http://minerals.er.usgs.gov/minerals/contacts/comdir.html>

²Nyal J. Niemuth, Mining Engineer, authored the text of State minerals information provided by the Arizona Department of Mines and Mineral Resources.

³All tons are metric tons unless otherwise specified.

TABLE 1
NONFUEL RAW MINERAL PRODUCTION IN ARIZONA 1/ 2/

(Thousand metric tons and thousand dollars unless otherwise specified)

Mineral	1994		1995		1996 p/	
	Quantity	Value	Quantity	Value	Quantity	Value
Clays	98 3/	452 3/	119	449 3/	120	454 3/
Copper 4/	1,120	2,750,000	1,170	3,560,000	1,230	2,930,000
Gemstones	NA	3,550	NA	3,230	NA	4,010
Gold 4/ kilograms	2,050	25,300	1,920	23,900	2,100	26,300
Iron oxide pigments (crude) metric tons	77	62	68	90	W	W
Sand and gravel:						
Construction	34,800	166,000	40,100	201,000	41,900	220,000
Industrial	W	W	334	2,910	332	3,310
Silver 4/ metric tons	198	33,700	220	36,400	240	40,900
Stone (crushed)	4,970	25,000	5,520	32,600	5,600	33,600
Combined value of cement, clays (bentonite), gypsum (crude), lime, molybdenum, perlite (crude), pumice and pumicite, salt, stone (dimension sandstone), and value indicated by symbol W	XX	274,000	XX	331,000	XX	274,000
Total	XX	3,280,000	XX	4,190,000	XX	3,530,000

p/ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

1/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

3/ Excludes certain clays; kind and value included with "Combined value" data.

4/ Recoverable content of ores, etc.

TABLE 2
ARIZONA: CRUSHED STONE 1/ SOLD OR USED BY PRODUCERS
IN 1995, BY USE 2/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Coarse aggregate (+1 1/2 inch):			
Riprap and jetty stone	59	\$150	\$2.54
Coarse and fine aggregates:			
Graded road base or subbase	35	136	3.89
Unpaved road surfacing	59	219	3.71
Terrazzo and exposed aggregate	W	W	11.10
Crusher run or fill or waste	W	W	5.87
Other construction materials	224	1,980	8.82
Chemical and metallurgical:			
Cement manufacture	(3/)	(3/)	6.61
Flux stone	(3/)	(3/)	12.70
Special: Other fillers or extenders	(3/)	(3/)	7.72
Unspecified: 4/			
Actual	711	4,910	6.90
Estimated	3,420	18,000	5.28
Total	5,520	32,600	5.91

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

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

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

3/ Withheld to avoid disclosing company proprietary data; included in "Total."

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

TABLE 3
ARIZONA: CRUSHED STONE SOLD OR USED, BY KIND 1/

Kind	1994				1995			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	7 r/	2,690 r/	\$10,400 r/	\$3.86 r/	4	2,550	\$14,000	\$5.48
Granite	13 r/	1,350 r/	8,000 r/	5.94	10	1,760	9,880	5.61
Marble	4	593	3,730	6.28	3	W	W	6.09
Sandstone and quartzite	2	125	1,550	12.40	2	158	2,310	14.60
Traprock	4	W	W	5.61	--	--	--	--
Volcanic cinder and scoria	3	45	94	2.09	4	135	416	3.08
Miscellaneous stone	2	W	W	8.47	3	W	W	7.26
Total	XX	4,970	25,000	5.03	XX	5,520	32,600	5.91

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.

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

TABLE 4
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 1995, BY USE AND DISTRICT 1/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Construction aggregates:						
Coarse aggregate (+1 1/2 inch) 2/	--	--	--	--	59	150
Coarse and fine aggregate 3/	129	394	--	--	189	1,940
Chemical and metallurgical 4/	(5/)	(5/)	--	--	(5/)	(5/)
Special 6/	--	--	--	--	(5/)	(5/)
Unspecified: 7/						
Actual	--	--	--	--	705	4,880
Estimated	(5/)	(5/)	6	22	(5/)	(5/)
Total	1,420	8,390	6	22	4,090	24,200

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

2/ Includes riprap and jetty stone.

3/ Includes graded road base or subbase, terrazzo and exposed aggregate, unpaved road surfacing, crusher run (select material or fill), and other construction materials.

4/ Includes cement manufacture and flux stone.

5/ Withheld to avoid disclosing company proprietary data; included in "Total."

6/ Includes other fillers or extenders.

7/ Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 5
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED
IN 1995, BY MAJOR USE CATEGORY 1/

Use	Quantity (thousand metric tons)	Value (thousands)	Value per ton
Concrete aggregate (including concrete sand)	12,100	\$67,800	\$5.62
Plaster and gunite sands	110	866	7.87
Concrete products (blocks, bricks, pipe, decorative, etc.)	487	2,470	5.07
Asphaltic concrete aggregates and other bituminous mixtures	3,740	23,900	6.39
Road base and coverings 2/	6,030	23,500	3.90
Fill	680	2,610	3.83
Railroad ballast	218	1,880	8.61
Filtration	104	537	5.16
Other	157	878	5.59
Unspecified: 3/			
Actual	9,980	45,500	4.56
Estimated	6,520	30,600	4.70
Total or average	40,100	201,000	5.00

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

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

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

TABLE 6
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1995,
BY USE AND DISTRICT 1/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products 2/	494 3/	3,430 3/	171	987	12,000	66,800
Asphaltic concrete aggregates and road base materials 4/	1,910 3/	8,060 3/	530	3,360	8,000	38,600
Railroad ballast	--	--	--	--	218	1,880
Other miscellaneous uses 5/	3	15	--	--	258	1,400
Unspecified: 6/						
Actual	226	887	--	--	9,750	44,600
Estimated	1,470	7,180	1,080	4,480	3,970	19,000
Total	4,100 3/	19,600 3/	1,780	8,830	34,200	172,000

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

2/ Includes plaster and gunite sands.

3/ Includes unspecified within all districts.

4/ Includes fill, road, and other stabilization (cement and lime).

5/ Includes filtration.

6/ Includes production reported without a breakdown by end use and estimates for nonrespondents.