

THE MINERAL INDUSTRY OF ARIZONA

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

In 2000, the estimated value¹ of nonfuel mineral production for Arizona was \$2.55 billion, based upon preliminary U.S. Geological Survey (USGS) data. This was about a 2.8% increase from the \$2.48 billion of 1999,² and followed a 9.5% decrease from 1998 to 1999. Arizona accounted for more than 6% of the U.S. total nonfuel mineral production and, for the third consecutive year, was third in the Nation (first from 1994-97) in total nonfuel mineral production value.

Arizona continued in 2000 as the top copper-producing State, accounting for nearly two-thirds of total U.S. copper mine production and value. Copper was the State's leading nonfuel mineral, representing about 72% of Arizona's 2000 total nonfuel mineral production value. In 2000, copper mine production was down by almost 11%, but, owing to higher average copper prices, the value of production was up 4%. The increase in copper's value, about \$70 million, and a \$14 million rise in construction sand and gravel accounted for most of the increases in the State's nonfuel mineral commodity values. Smaller yet significant increases also occurred in crushed stone and gypsum. Except for decreases of about \$8 million in silver and smaller yet significant drops in salt, gold, and lime, all other changes were on the order of \$1 million or less—relatively inconsequential to the State's overall change in value. (Listings of mineral commodities are in descending order of value, magnitude of change in value, or quantity produced.)

In 1999, the \$300 million decrease in the value of copper was the most significant change affecting the State's mineral economy, followed by drops in the values of molybdenum and lime, down a combined \$33 million; gold, down about \$10.3 million; and silver, down \$3.8 million. Smaller yet significant decreases occurred in gypsum and bentonite. These were offset somewhat by increases of \$67 million in construction sand and gravel, \$9.3 million in crushed stone, and about \$3 million in dimension sandstone (table 1).

¹The terms "nonfuel mineral production" and related "values" encompass variations in meaning, depending upon 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 2000 USGS mineral production data published in this chapter are preliminary estimates as of July 2001 and are expected to change. For some mineral commodities, such as 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. A telephone listing for the specialists may be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals/contacts/comdir.html>, by using MINES FaxBack at (703) 648-4999 from a fax machine with a touch-tone handset (request Document #1000 for a telephone listing of all mineral commodity specialists), or by calling USGS information at (703) 648-4000 for the specialist's name and number. All Mineral Industry Surveys—mineral commodity, State, and country—also may be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals>; facsimile copies may be obtained from MINES FaxBack.

²Values, percentage calculations, and rankings for 1999 may vary from the Minerals Yearbook, Area Reports: Domestic 1999, Volume II, owing to the revision of preliminary 1999 to final 1999 data. Data for 2000 are preliminary and are expected to change; related rankings may also be subject to change.

Based upon USGS estimates of the quantities produced in the 50 States during 2000, Arizona remained the leading State in molybdenum output; third in gemstones; fourth in construction sand and gravel, silver, and zeolites; fifth in pumice and pumicite; fifth of five mica-producing States; sixth in iron oxide pigments; seventh in bentonite; and eighth in crude gypsum. While the State rose to 8th from 10th in dimension stone, it decreased to 3d from 2d in crude perlite. Additionally, Arizona was a significant producer of portland and masonry cement and lime.

The Arizona Department of Mines and Mineral Resources³ provided the following narrative information. Data may disagree somewhat from data reported by the USGS in table 1. In 2000, Arizona's copper production continued to decline as it had done in 1999 to 950,000 metric tons (t). While the domestic producer cathode price increased to \$0.88 per pound (\$1.94 per kilogram), production was negatively impacted from dramatically increased costs of diesel, natural gas, and electricity. Shortages of electricity caused interruptions that forced production cutbacks. Adding to producers difficulties were large amounts of rain that fell during the fourth quarter.

Grupo Mexico S.A. de C.V. announced in mid-2000 that its wholly owned ASARCO Incorporated subsidiary would be moving its corporate headquarters to Phoenix. About 100 former corporate New York and Tucson copper employees will work in Phoenix while more than 110 employees will remain in Tucson. In December 2000, Grupo Mexico announced formation of a U.S.-based mining subsidiary called Americas Mineral Group (AMG) to be based in Phoenix that will include Asarco, Southern Peru Copper Corp. (54.2% interest), and Grupo Industrial Minera Mexico S.A. de C.V. AMG's formation is anticipated to further coordinate mining, purchasing, and sales activities for the three companies and allow for a future U.S. stock listing that could allow Grupo to raise capital more efficiently.

In October, Asarco announced changes to Mission's open pit mine plan that would increase the stripping of overburden from higher grade ore areas. As a result, daily ore production will decline by 34% from 56,000 metric tons per day (t/d) to 37,000 t/d while total material moved will increase by 25%. The changes will extend mine expected life to 22 years, increase ore grades and mill recovery, and reduce mine and concentrator plant costs. Copper in concentrate production, however, will decline by 22,000 metric tons per year (t/yr) (ASARCO Incorporated, 2000).

Asarco reported that it continued to search for options to reduce production costs. These include negotiations with unions and vendors as well as finding ways to mitigate the impact of higher energy costs and lower mineral royalties (ASARCO Incorporated, 2000).

³Nyal J. Niemuth, Mining Engineer, authored the text of State minerals information provided by the Arizona Department of Mines and Mineral Resources.

In December, Phelps Dodge Corp. announced plans to sell its manufacturing business PD Wire & Cable Group and its Columbian Chemicals Co, a carbon black manufacturer, and focus on mining. Together, the two units make up Phelps Dodge Industries, which accounts for one-third of Phelps Dodge's 16,000 employees and one-third of its \$3.4 billion in sales through the third quarter. The proceeds of the sale will be used to reduce debt and to provide the financial flexibility necessary to pursue longer term strategic objectives (Phelps Dodge Corp., 2000).

In March 2001, Phelps Dodge completed its mine-for-leach facilities at Morenci and was expecting to be at full capacity by the fourth quarter of 2001. In 1999, \$220 million was invested to convert Morenci (Phelps Dodge 85% and Sumitomo 15%) to all-leach production. The conversion entailed expansion of the mine's crushing and conveying systems, installation of mobile stackers to construct leach piles, expansion of solvent extraction facilities, and construction of a new electrowinning tank house. The new mine-for-leach facilities were expected to increase Morenci's annual electrowon cathode production capacity to 372,000 t/yr (Phelps Dodge Corp., 2001).

Heavy rains at the Morenci Mine in the fourth quarter of 2000 caused a temporary suspension of mining, diluted leach solutions, and impacted milling operations, causing the loss of 9,100 t of copper production.

A major drill program moved forward to delineate mineralization for the first phase of mining at the Garfield deposit located in the Morenci district. Garfield contains a 900-million-metric-ton (Mt) leach resource grading 0.27% copper. Exploration programs were also initiated by Phelps Dodge at its newly acquired Miami and Sierrita properties.

At midyear, stripping at the Miami Mine was suspended temporarily allowing reallocation of mining equipment to other operations, and 65 staff positions were eliminated (20 were temporary or contract). Leach production in 2000 will not be affected but will drop in 2001 by 16,000 t and by 39,000 t in 2002. Costs were expected to drop in both 2000 and 2001.

After dispelling closure rumors in the spring of 2000 by announcing plans to invest \$13 million to improve the mine and mill at Sierrita, in January 2001, Phelps Dodge announced it might be forced to lay off 70 workers. High-energy prices and energy disruptions along with low molybdenum prices were the reported cause.

Permitting continued for the Dos Pobres and San Juan deposits located near Safford. Open pit leach reserves total 570 Mt with a grade of 0.32% copper.

According to BHP Copper Inc., the San Manuel and Pinto Valley mines and associated smelter, refinery, and wire-rod mill remained closed and are unlikely to reopen soon, except for residual leach operations. BHP has been trying to sell the properties, but, despite numerous parties expressing interest, there have been no serious offers reported. Thus, the outlook remains poor for the nearly 3,000 laid-off miners.

In the fall, American Bonanza Gold Mining Corp., formerly know as Asia Minerals Corp., began an underground development project at the Copperstone Gold Project in La Paz County to provide drill sites and possible extraction of a 45,000-t bulk sample. The project, a joint venture with the contractor Centennial Development Corp., included a 600 meter (m) decline from the lower level of the open pit. Closely spaced underground drilling will be performed to further delineate the

underground 750,000-t resource previously estimated to contain 19 grams per metric ton of gold (Asia Minerals Corp., 2000).

In November, Atna Resources Ltd. announced the purchase of four patented mining claims composing the Lone Pine VMS deposit near Mayer in Yavapai County and began a sampling and mapping program there. A 457-m diamond drill program is planned for early 2001 to test the downdip extension of mineralization beneath the underground workings of the former copper, zinc, silver, and gold producer.

Superior Marble LLC (previously Mineral Development Inc.) acquired a site and began development of a new marble crushing and preparation plant to replace its Queen Creek facility. It is adjacent to Omya Arizona Inc.'s \$30 million calcium carbonate plant that opened in 2000. Both operations receive marble feed from the same quarry east of Superior.

Phoenix Cement Co. announced plans for a \$105 million modernization of its Clarkdale cement plant. The upgrades will include a new high-efficiency vertical roller mill, a low nitrogen oxide (NOx) kiln system for clinker manufacture, and an increased capacity of 3,600 t/d.

Vulcan Materials Co. continued its investment in Arizona following last years' acquisition of Calmat Co. It opened two new plants near Sun City, a hot asphalt plant and an aggregate processing facility costing \$7.5 million.

The U.S. Bureau of Land Management (BLM) approved but has not yet completed a land exchange with Asarco that would allow expansion of Ray's tailings impoundments and that would allow future development of the Copper Butte, Buckeye, and Chilito deposits, and the Ray and Hayden Limestone deposits. Asarco would trade 3,000 hectares (ha) in Pinal and Mohave Counties for 4,400 ha in Pinal and Gila Counties. Lands the BLM would acquire are coastal habitat and areas within or adjacent to wilderness areas. The exchange has not been completed because BLM is trying to resolve a protest.

Cambior Inc. received a Storm Water Drainage Discharge Permit from the U.S. Environmental Protection Agency (EPA) for the Carlota project. Cambior agreed to clean up the Gibson Mine's copper discharge thus improving water quality of Pinto Creek. Hereafter Cambior only has to file a notice of intent to build with EPA (approval takes about 48 hours) and it can begin construction. There are, however, no immediate plans to begin construction because of the company's continuing financial difficulties. Throughout the year, Cambior continued property sales and financial restructuring efforts. Despite Cambior's announced intention to sell its nongold assets by the end of 2001 as part of its debt repayment effort, no transaction involving Carlota has been reported.

In October, Congress approved the Department of the Interior's proposal to pay Tufflite Inc. \$1 million to close the White Vulcan pumice mine north of Flagstaff and to relinquish its property. The company has 6 months to cease mining and then must begin a 5-year reclamation project. It has a 10-year period to ship about 382,000 cubic meters of stockpiled materials. The pumice is used primarily in making lightweight concrete and stone-washed denim cloth. The mine was originally developed to supply pozzolan for the construction of Glen Canyon Dam.

In a period of little more than a year, towards the end of 2000, five new national monuments were created in Arizona, totaling about 800,000 ha. Three of the monuments were created in areas of known mineral resources—the Agua Fria, Grand

Canyon-Parashant, and Ironwood—by Presidential Order without the oversight of Congress or public hearings. One reason given for their National Monument status protection was to prohibit possible mine development of future valuable mineral resources. Mountain States Legal Foundation (MSLF) filed suit in Federal Court on August 28, 2000, challenging whether the President had the Constitutional authority to create the new monuments (Mountain States Legal Foundation, *Mountain States Legal Foundation, et al. v. Bush*, accessed August 22, 2001, via URL http://www.mountainstateslegal.org/legal_cases.cfm?legalcaseid=63). The lawsuit was later amended to include another monument (Niemuth, 2001, p. 63, 64).

The Arizona Preserve Initiative and the Growing Smarter Legislation, passed in 1996, was designed to preserve open spaces and was originally conceived as a Statewide approach that could be beneficial for environmentally sensitive trust lands in both urban and rural areas. It was designed to encourage the preservation of select parcels of State Trust Land in and around urban areas for open space to benefit future generations. The Arizona State Land Department (ASLD) manages State Trust Land on behalf of the 14 beneficiaries of the trust (Arlan Colton, [2001], Presentation 10—Arizona Preservative Initiative, accessed September 24, 2001, at <http://ag.arizona.edu/OALS/urbanization/preserve.html>). As a result, the ASLD was working to develop and implement a Statewide mineral

assessment study. The study is called the Mineral Assessment Asset Management Geographic Information System (MAAMGIS). The objective of MAAMGIS was to create a system to facilitate and improve land-use decisions. Two mineral commodities—copper and aggregate—were chosen for the initial assessment within the three-county area of Maricopa, Pinal, and Pima. Although its primary function is to assess and analyze mineral resource potential on State Trust Land, MAAMGIS has the ability to forecast local and regional market growth. This forecasting ability is pivotal to model aggregate demand for an area, and, in turn, does two things: (1) allows the ASLD to capitalize on the multiple land-use and (2) facilitates the realization of mineral potential on State Trust Land.

References Cited

- ASARCO Incorporated, 2000, Asarco Mission Mine plan: New York, ASARCO Incorporated news release, October 30, 1 p.
 Asia Minerals Corp., 2000, Copperstone Development activity and corporate developments: Vancouver, Asia Minerals Corp. news release, September 18, 2 p.
 Niemuth, N.J., 2001, Arizona Annual Review 2000: Mining Engineering, v. 53, no. 5, May, p. 61-64.
 Phelps Dodge Corp., 2000, Phelps Dodge to sharpen focus on mining: Phoenix, Phelps Dodge Corp. news release, December 8, 2 p.
 ———2001, New Phelps Dodge Morenci mine-for-leach facilities in production: Phoenix, Phelps Dodge Corp. news release, May 14, 2 p.

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

(Thousand metric tons and thousand dollars unless otherwise specified)

Mineral	1998		1999		2000 p/	
	Quantity	Value	Quantity	Value	Quantity	Value
Copper 3/	1,190	2,060,000	1,050	1,760,000	935	1,830,000
Gemstones	NA	2,120	NA	1,950	NA	1,700
Gold 3/ kilograms	1,840	17,400	786	7,080	W	W
Molybdenum concentrates metric tons	16,600	W	16,000	W	W	W
Sand and gravel:						
Construction	47,900	229,000	54,500	296,000	55,200	310,000
Industrial	307	3,290	268	3,720	W	W
Silver 3/ metric tons	211	34,700	183	30,900	137	23,000
Stone, crushed	8,080	44,800	9,010	54,100	9,200	56,600
Zeolites metric tons	(4/)	NA	(4/)	NA	(4/)	NA
Combined values of cement, clays (bentonite, common), gypsum, (crude), iron oxide pigments (crude), lime, mica (1999-2000), perlite (crude), pumice and pumicite, salt, stone (dimension sandstone), and values indicated by symbol W	XX	344,000	XX	319,000	XX	324,000
Total	XX	2,740,000	XX	2,480,000	XX	2,550,000

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

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

2/ Data are rounded to no more than three significant digits; may not add to totals shown.

3/ Recoverable content of ores, etc.

4/ Withheld to avoid disclosing company proprietary data.

TABLE 2
ARIZONA: CRUSHED STONE SOLD OR USED, BY KIND 1/

Kind	1998				1999			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	8 r/	4,310 r/	\$23,900	\$5.55	9	4,420	\$24,300	\$5.50
Granite	15 r/	2,310 r/	11,800 r/	5.12 r/	19	1,980	14,500	7.30
Marble	1 r/	W	W	5.00 r/	2	W	W	11.53
Sandstone and quartzite	4 r/	W	W	11.01 r/	3	W	W	14.26
Traprock	1	W	W	5.49	2	W	W	7.07
Volcanic cinder and scoria	7	333	1,610 r/	4.83	7	232	917	3.95
Miscellaneous stone	12 r/	812	4,470	5.51	9	1,900	10,300	5.46
Total or average	XX	8,080	44,800	5.54	XX	9,010	54,100	6.00

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

1/ Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

TABLE 3
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS
IN 1999, BY USE 1/ 2/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Construction:			
Coarse aggregate (+1 1/2 inch):			
Riprap and jetty stone	247	\$1,200	\$4.91
Filter stone	40	321	8.03
Total or average	287	1,530	5.34
Coarse aggregate, graded:			
Concrete aggregate, coarse	31	242	7.81
Bituminous aggregate, coarse	486	4,000	8.35
Bituminous surface-treatment aggregate	1	12	12.00
Railroad ballast	72	573	7.96
Total or average	590	4,880	8.28
Fine aggregate (-3/8), screening, undesignated	32	293	9.16
Coarse and fine aggregates:			
Graded road base or subbase	211	1,010	4.79
Unpaved road surfacing	73	252	3.45
Terrazzo and exposed aggregate	592	6,160	10.41
Total or average	876	7,420	8.47
Other construction materials	171	1,290	7.53
Chemical and metallurgical:			
Cement manufacture	W	W	5.51
Lime manufacture	W	W	5.51
Total or average	3,250	17,900	5.51
Other miscellaneous uses, acid neutralization	(3/)	(3/)	6.00
Unspecified: 4/			
Reported	3,050	17,000	5.58
Estimated	760	3,800	4.94
Total or average	3,810	20,800	5.46
Grand total or average	9,010	54,100	6.00

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

1/ Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

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

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

4/ Reported and estimated production without a breakdown by end use.

TABLE 4
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 1999,
BY USE AND DISTRICT 1/ 2/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3		Unspecified districts	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Construction:								
Coarse aggregate (+1 1/2 inch) 3/	W	W	38	301	W	W	--	--
Coarse aggregate, graded 4/	14	129	W	W	W	W	--	--
Fine aggregate (-3/8 inch) 5/	1	10	20	133	11	150	--	--
Coarse and fine aggregate 6/	369	2,810	W	W	W	W	--	--
Other construction materials	3	35	168	1,250	--	--	--	--
Chemical and metallurgical 7/	W	W	--	--	W	W	--	--
Other miscellaneous uses 8/	W	W	--	--	--	--	--	--
Unspecified: 9/								
Reported	1,170	6,450	12	63	146	1,120	1,720	9,390
Estimated	150	740	--	--	610	3,000	--	--
Total	2,620	15,200	538	4,820	4,140	24,700	1,720	9,390

W Withheld to avoid disclosing company proprietary data; included in "Total." -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

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

3/ Includes filter stone and riprap and jetty stone.

4/ Includes bituminous aggregate (coarse), bituminous surface-treatment aggregate, concrete aggregate (coarse), and railroad ballast.

5/ Includes screening (undesignated).

6/ Includes graded road base or subbase, terrazzo and exposed aggregate, and unpaved road surfacing.

7/ Includes cement manufacture and lime manufacture.

8/ Includes acid neutralization.

9/ Reported and estimated production without a breakdown by end use.

TABLE 5
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1999,
BY MAJOR USE CATEGORY 1/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Concrete aggregate (including concrete sand)	7,150	\$47,300	\$6.62
Plaster and gunite sands	1,330	5,000	3.75
Concrete products (blocks, bricks, pipe, decorative, etc.)	855	5,120	5.99
Asphaltic concrete aggregates and other bituminous mixtures	2,920	15,900	5.44
Road base and coverings 2/	9,640	43,600	4.52
Fill	847	4,190	4.95
Railroad ballast	78	522	6.69
Other miscellaneous uses	357	1,800	5.04
Unspecified: 3/			
Reported	26,500	148,000	5.58
Estimated	4,800	24,000	5.00
Total or average	54,500	296,000	5.42

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

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

3/ Reported and estimated production without a breakdown by end use.

TABLE 6
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1999,
BY USE AND DISTRICT 1/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3		Unspecified districts	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products	820	7,700	246	1,240	6,940	43,500	--	--
Plaster and gunite sands	38	513	23	236	1,270	4,250	--	--
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	2,140	12,900	646	1,430
Road base materials 2/	391	2,590	465	2,510	8,580	37,000	200	1,520
Fill	46	281	3	9	798	3,900	--	--
Other miscellaneous uses 3/	W	W	W	W	203	1,060	--	--
Unspecified: 4/								
Reported	2,380	13,800	411	2,010	23,200	131,000	514	850
Estimated	1,800	9,900	430	2,400	2,600	12,000	--	--
Total	5,690	36,500	1,710	9,500	45,800	246,000	1,360	3,800

W Withheld to avoid disclosing company proprietary data; included in "Total." -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

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

3/ Includes railroad ballast.

4/ Reported and estimated production without a breakdown by end use.