



2007 Minerals Yearbook

ARIZONA [ADVANCE RELEASE]

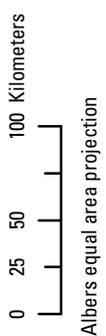
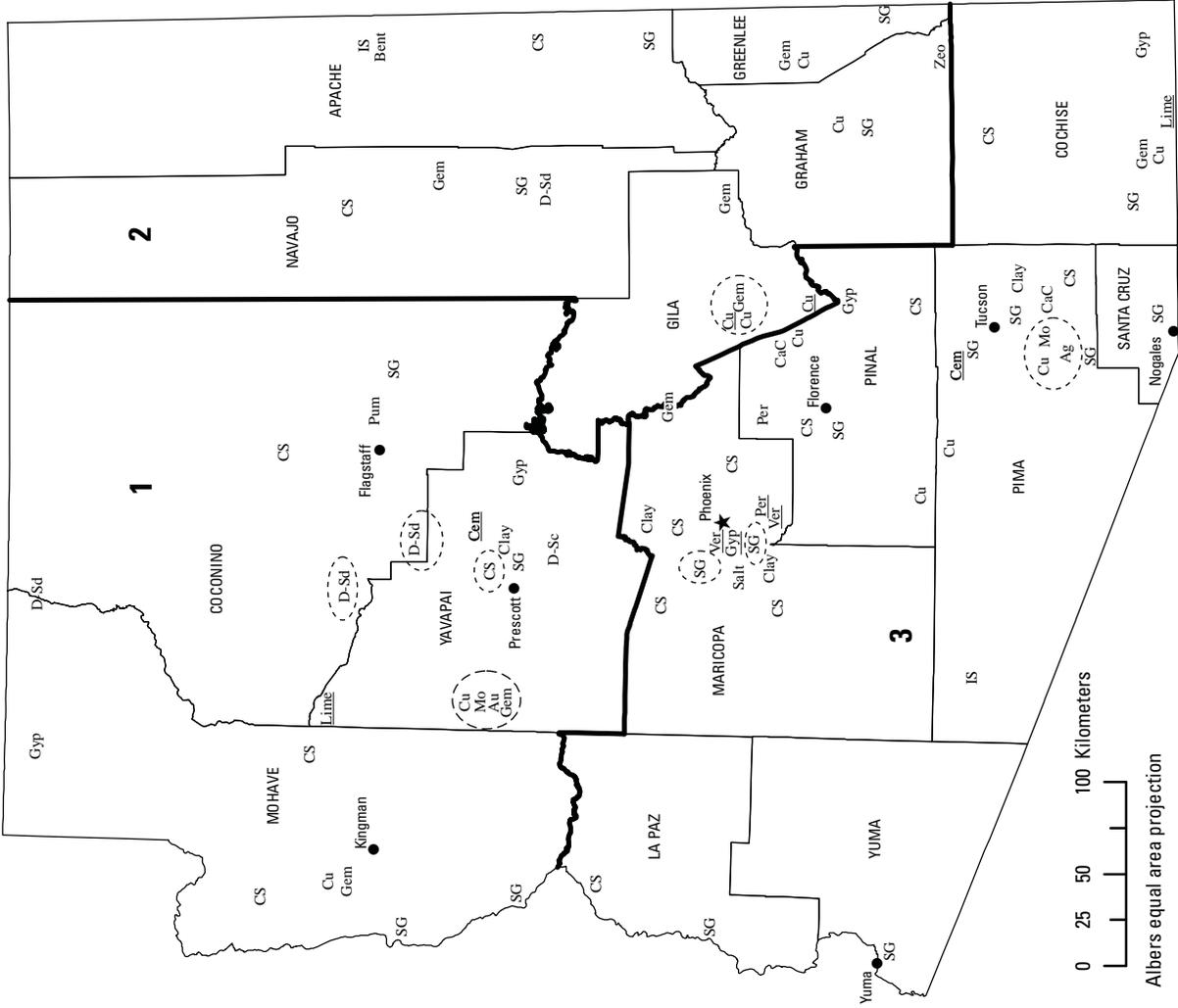
ARIZONA

LEGEND

- County boundary
- ★ Capital
- City
- 1— Crushed stone/sand and gravel district boundary

MINERAL SYMBOLS (Major producing areas)

- Ag Silver
- Au Gold
- Bent Bent
- CaC Calcium carbonate
- Cem Cement plant and quarry
- Clay Common clay
- CS Crushed stone
- Cu Copper
- Cu Copper plant
- D-Sd Dimension sandstone
- D-Sc Dimension schist/onyx
- Gem Gemstones
- Gyp Gypsum
- Gyp Gypsum plant
- IS Industrial sand
- Lime Lime plant and quarry
- Mo Molybdenum
- Per Perlite
- Per Perlite plant
- Pum Pumice and pumicite
- Salt Salt
- SG Construction sand and gravel
- Ver Vermiculite plant
- Zeo Zeolites
- Concentration of mineral operations



Source: Arizona Department of Mines and Mineral Resources/U.S. Geological Survey (2007).

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 2007, Arizona's nonfuel raw mineral production¹ was valued at \$7.26 billion, based upon annual U.S. Geological Survey (USGS) data. This was a \$510 million, or 7.6%, increase from the State's total nonfuel mineral value in 2006, which then had increased by \$2.4 billion, or up more than 55%, from that of 2005. In 2007, for the third consecutive year, Arizona led the Nation in total nonfuel mineral production value among the 50 States, accounting for 10.4% of the U.S. total.

Arizona continued to be the Nation's leading copper-producing State in 2007 and accounted for 63% of the total U.S. copper mine production. Copper was the State's foremost nonfuel mineral produced, accounting for nearly 73% of the total nonfuel mineral production value, followed in descending order of value by molybdenum, construction sand and gravel (with 9% of the State's total value), cement (portland and masonry) (data withheld—company proprietary data), crushed stone (about 2% of the value) (table 1), and lime (data withheld—company proprietary data). In 2007, Arizona's significant increase in value primarily resulted from the increased values of copper, molybdenum, portland cement, and crushed stone. A 3% increase in copper production, and a 4% increase in the average unit value of copper resulted in a 7%, or \$340 million, increase in the commodity's production value. The value of molybdenum production increased by more than \$110 million, its total value up nearly 20% from that of 2006. Significant increases in unit values of portland cement and crushed stone resulted in a rise of their total values by about \$30 million, and \$24 million, respectively. Smaller yet significant increases also took place in the values (descending order of change) of silver, salt, and gold (value changes withheld—company proprietary data). The value of gemstones rose by 25%, up by \$390,000 and had only a marginal effect on the overall change in the State's total value. The largest decreases in value took place in the production values of construction sand and gravel (down by \$10 million), lime, and crude gypsum (value change withheld—company proprietary data).

In 2007, Arizona remained third in the production of molybdenum, construction sand and gravel, gemstones (gemstones ranking based upon value), and crude perlite

¹The terms "nonfuel mineral production" and related "values" encompass variations in meaning, depending upon the 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 2007 USGS mineral production data published in this chapter are those available as of June 2009. All USGS Mineral Industry Surveys and USGS Minerals Yearbook chapters—mineral commodity, State, and country—can be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals>.

and sixth in that of silver and dimension stone (dimension sandstone). The State decreased in rank in the production of three nonfuel mineral commodities—to 2d from 1st in pumice and pumicite, to 5th from 4th in zeolites, and to 10th from 9th in crude gypsum. Additionally, the State continued to be a significant producer of (in descending order of value) portland cement, crushed stone, and lime.

The Arizona Department of Mines and Mineral Resources² (ADMMR) provided the following narrative information. Data presented in ADMMR reports may differ somewhat from data reported by the USGS in table 1.

Overview

A deficit in global copper production encouraged by strong demand in China, plus the additional demand for industrial minerals to supply the construction market, resulted in a record-setting year for Arizona's mining industry. Copper producer prices averaged a record \$3.28 per pound in 2007 resulting in a new high of production value of \$5.3 billion. Continued strong demand and high prices for most mineral commodities drove exploration and development activity in the State to the highest level in many years. This activity has spread beyond the usual commodities to include fluorspar and manganese, which have not been mined in Arizona for decades. The total value of mineral production reached \$7.58 billion. In 2007, Arizona accounted for more than 60% of the U.S. domestic copper production. As it has for many years, Arizona ranked first in nonfuel mineral production in the United States. Arizona also ranks in the top five States in gemstones, molybdenum, perlite, pumice, sand and gravel, silver, and zeolites. Strong and rising prices, especially toward yearend 2007, encouraged significant levels of property acquisition and exploration. Byproducts of mining porphyry copper deposits continued to be significant, accounting for all of Arizona's gold, silver, and molybdenum production. The average price for molybdenum oxide in 2007 was \$30.23 per pound, an increase of 22% from that of 2006.

Exploration and Development

Metals

Copper.—At Quadra Mining Ltd.'s Carlota Mine, work was completed on access and haul roads, and progress was made on the solvent extraction-electrowinning (SX-EW) plant. Quadra expended about \$93 million of an estimated \$218 million allocated to complete construction of the 34,000-metric-

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

ton-per-year (t/yr)-capacity copper open pit leach operation. Preproduction mining activities continued including SX-EW plant construction and leach pad liner placement. Quadra anticipated commencement of copper production in the second half of 2008. H.R. 3301, Southeastern Arizona Land Exchange and Conservation Act of 2007, which provided land exchange with Resolution Mining Co. was delayed in Congress. The exchange was viewed by the company as necessary for development of the Resolution deposit. The deposit, with its huge size and high primary grades of copper ore, could become the largest copper mine in Arizona. Resolution Copper's joint-venture partners (Rio Tinto, 55%; BHP-Billiton, 45%) were prepared to spend \$3.5 billion on development before any copper ore was extracted. Resolution spent \$250 million for planning, engineering, and buying land for the stalled trade. The delay forced suspension of underground development work, planned shaft sinking, and the layoff of recently trained underground miners.

In July, Augusta Resource Corporation filed a plan of operations for the Rosemont project with the U.S. Forest Service. The planned project could produce 104,000 t/yr of copper for at least 20 years and provide employment for 500 workers and more than 1,000 indirect jobs. The main Rosemont porphyry skarn occurrence containing 500 million metric tons per year (Mt/yr) with a grade of 0.75% copper equivalent. The company acquired rights to use Central Arizona Project water for the project and stored 6,000 hectares (ha) of water, a 3-year supply for operation of the mine. Ascendant Copper Corp. signed an agreement to acquire St. Geneviève Resources Ltd., which holds two past-producing properties, Emerald Isle and Zonia. Exploration drilling took place on many projects with large footages drilled despite widespread complaints about difficulty in obtaining drill rigs and contractors. All this activity overwhelmed the assay labs and many projects did not report results. Aurelio Resources Corp. continued assembling property and gathering historic data and drill core for its Hill Copper Zinc project in the Turquoise District. Three mineralized areas were identified. These include the MAN area where historic drilling identified inferred resource of 58 million metric tons (Mt) with a grade of 0.56% of copper equivalent; the Courtland area to the north was drilled during 2006 and 2007; and the South Courtland area where 29 holes drilled in 2007 identified an area of zinc mineralization not previously recognized. A 15,000-meter (m), two-phase core drilling program was planned to acquire data for a feasibility study scheduled for 2009.

Redhawk Resources Inc. explored the Keel and American Eagle deposits in the Copper Creek District. Phase I drilling was completed in late 2007. Significant copper grades were encountered in a number of the core holes of its 5,000-m drill program. The program was designed to expand and upgrade resources in the Mammoth Breccia and test other breccia bodies where historical drilling intercepted potential ore-grade material. Phase 2 began at yearend and included a 21,000-m drilling program to confirm and expand the American Eagle deposit. The drilling program's goals were to connect the Keel zone with the American Eagle, and drill some of the breccia targets near the proposed exploration decline. Phase 2 also included metallurgical testing, continued environmental work, hydrologic

studies, and groundwater monitoring. All work would lead to an updated resource study expected to be completed before yearend 2008. At the Copper Creek District, Bell Resources Corp. completed its phase 2 drill program comprised of 12 drill holes at Sombrero Butte, a breccia pipe deposit with a suspected underlying porphyry copper system. Assay results were expected in early 2008. Bell planned to begin phase 3 drilling in the near future.

At Bell's Kabba project in Mohave County, the phase I drill program followed up geophysical studies that targeted a suspected down-faulted copper-molybdenum porphyry system. Four diamond holes, totaling 3,630 m, were completed in November. The holes showed indications of proximity to a mineralized system including interceptions of thick alteration, and in-hole K-4, porphyritic dikes and anomalously mineralized veins. A new site, 1.2 kilometers (km) east of the porphyry dike swarm encountered in drill hole K-4, was selected to be drill tested. In April, Bell announced that it had entered into an alliance with Bronco Creek Exploration Inc. to explore four projects: Mesa West, Red Hills, Silver Bell West, and Superior West. A drilling program began at Mesa West to test a magnetic anomaly below gravel cover. Based on previous exploration, Red Hills contains 450 Mt of oxide mineralization at 0.1% copper. Structural reinterpretation and geophysics suggested rotation of the deposit. Plans call for deeper portions of the system to be drill tested. Work at Silver Bell West is focusing on mapping and geochemical sampling to identify porphyry/skarn targets hosted in Paleozoic rocks below Mesozoic volcanics. At Superior West there were two target types—the down-dropped extension of the high-grade magma vein system and the suspected deep-seated porphyry copper source for the vein mineralization. Drilling was scheduled to start in the first quarter of 2008 (Zinn, 2007).

Big Bar Gold Corp. completed four drill holes in late 2007 on the Troy Ranch prospect east of the Ray Mine where it has earned a 51% interest in a joint venture with Freeport-McMoRan Copper & Gold Inc. (FCX). Numerous intercepts of copper and molybdenum mineralization were encountered along with long potassic-altered intervals coincident with an audiomagnetotelluric (AMT) geophysical target. Big Bar was active at the Yuma King property where step-out drilling resulted in the discovery of a porphyry copper system with significant molybdenum values in a Jurassic thrust fault complex. Favorable geology continued to the northeast and southeast of Yuma King but was not tested. Lebon Gold Mines Ltd. controlled a second area of mineralization west of Sheep Mountain. A three-hole drill program totaling 618 m found significant thicknesses of copper oxide mineralization in 2007. The holes, however, failed to reach to the redox boundary where historic reports of higher grades, up to 0.8% copper, of chalcocite ore had been reported. The company was debating to do further work on its own or opting for a joint-venture partner. Black Pearl Minerals Consolidated Inc. completed a phase I drilling program on the Four Metals breccia pipe in 2007. The seven-hole drilling program totaled 996 m. The company confirmed historic grades while adding width and depth to the south and east sides of the deposit. Permitting was underway for additional drilling.

In addition to FCX, four other groups were exploring in the Safford District. Franconia Minerals Corp. announced the core-drilling program at Red Knoll in Graham County and confirmed that the property has widespread potential host rocks for porphyry copper mineralization at reasonable depth. Three holes were completed in 2007. Hole RK-4 intersected Laramide meta-volcanics displaying intense phyllic alteration, 1% to 3% pyrite and anomalous copper values at a depth of 300 m to 750 m. Followup geophysics and further drilling was planned for hole RK-4. High Desert Gold Corp. reported in November that two 600-m drill holes were completed at the Markham Wash property optioned by Teck Cominco Ltd. Assay results were pending. Nord Resources Corp. completed ground induced polarization (IP) and resistivity geophysical surveys in early 2007 on Coyote Springs. A drill program was planned to test anomalous IP values. Entrée Gold Inc. began to test an IP anomaly on its Sol Dos property and planned a 2,000-m drill program. Entrée Gold also entered into an agreement with Empirical Discovery LLC to explore for additional porphyry copper targets in southeastern Arizona.

Lone Tree Exploration LLC assembled historic exploration data at Sheep Mountain that is a partially delineated copper molybdenum deposit. There were 56 core and rotary holes drilled, totaling 23,000 m, at the Sheep Mountain property. A 2007 preliminary feasibility study on the supergene portion of the deposit concluded that a 7,300 to 9,100 metric-ton-per-day (t/d) operation could generate a 28% return at \$1.50 per pound for copper and \$12 per pound for molybdenum. American Copper Corp. announced it would drill in early 2008 at its Squaw Creek project located 110 km north of Phoenix. The initial core-drilling program targeted high-grade copper/molybdenum veins and stock works that were last mined in the 1940s. The company planned to drill approximately 1,500 m in 10 to 15 holes (Eadie, 2008).

Gold.—Fueled by rising gold prices, interest in Arizona gold deposits was widespread, and numerous companies conducted exploration drilling and other work programs. American Bonanza Gold Corp. controlled the Copperstone deposit in La Paz County, with 10,000 kilograms (kg) (335,000 troy ounces) of measured and indicated underground resources. A two-phase drilling program was completed consisting of 44 holes totaling 13,000 m. Two new gold zones were discovered. Patriot Gold Corp. controlled the Margarita Mine area in Santa Cruz County, which covered approximately 360 ha of patented and unpatented mining claims. American Goldrush Corp.'s drilling program was permitted to test for high-grade faults that feed the near surface cap of disseminated mineralization. Drilling was planned to begin in early 2008. Northern Freegold Resources Ltd. acquired the Burro Creek gold/silver property in Mohave County. The 810-ha property covered a low-sulfidation epithermal vein system that has been traced for more than 1.7 km with widths up to 45 m. A previous drilling program identified more than 2.5 Mt of 0.03 grade gold mineralization in the central portion of the property. Kent Exploration Inc. holds an option on the Rosebud property in Mohave County. Following a limited underground sampling program, a 1,500-m diamond drill program began in September. In August, Ventura Gold Corp. began a core-drilling program at its 100% held Gold Gulch property near the

Morenci Mine in Greenlee County. A 3,000-m program of six to eight holes was planned. A private group held the Verdstone property in Yuma County where a drift to collect a bulk sample for metallurgical testing was planned. Kinross Gold Corp. sold the previously drilled Yarnell resource in Yavapai County containing approximately 9,000 kg (300,000 troy ounces) of gold to CaNev Resources Corp.

Silver.—Wildcat Silver Corp. controlled 80% of the Hardshell deposit in Santa Cruz County, along with Arizona Minerals. In February 2007, a preliminary assessment reported an inferred resource of 1.7 million kg (53.5 million troy ounces) of silver along with 540,000 metric tons (t) of manganese. Wildcat Silver Corp. began a 2,300-m drill program in July to obtain material for metallurgical testing and to explore untested deep extensions and mineralization of the Hardshell deposit. Southern Silver Corp. and Tombstone Exploration Corp. both assembled large land positions in the historic Tombstone silver district in Cochise County to explore for silver and base metals. Southern Silver began a drill program late in the year to followup on a series of mineralized east-northeast trending fracture zones identified in a portion of the property by mapping. The company plans to followup with geophysical surveys.

Minerals Fuels and Related Materials

Uranium.—Uranium spot prices softened to \$70 per pound at yearend but remained 10 times the price of 5 years ago. That strength, along with the likelihood that plants under construction in Asia would create strong future demand, supported continued high levels of exploration activity in Arizona, particularly for high-grade (more than 0.5% U₃O₈) collapse breccia pipes. Uranium mining activities in the Colorado Plateau are summarized as follows: In February, Denison Mines Inc. acquired five deposits on the Arizona Strip from Pathfinder Mines Corp. (a subsidiary of Areva NC Inc.) for \$5.5 million cash plus a 1% yellow cake royalty and a commitment to sell Areva 3,000 t of U₃O₈ per the sale and price agreement. Included mines were the EZ1, EZ2, DB, and WHAT breccia pipes and the Moonshine Springs deposit hosted in the Chinle Formation. The deposits contain an estimated 3,200 t of uranium. Denison reported that Redpath Mining was engaged as a mining contractor to resume development work on the Arizona 1 Mine that contains an inferred resource 450 t U₃O₈. Rehabilitation and deepening of the shaft continued for most of the year and work shifted to mine development. The mine is substantially permitted, and production was expected to begin during mid-2008. In July, Denison announced an ore buying program to provide supplemental feed for its White Mesa mill at Blanding, UT (Denison Mines Corp., 2007). Dumont Nickel Inc. acquired 132 unpatented mining claims midyear and in the fall, and fieldwork identified five possible breccia pipe targets. In June, Energy Fuels began drilling the Weap pipe and formed a joint venture with Mesa Uranium Corp., acquiring 13 Arizona State land sections in Mohave and Coconino Counties. These holdings were in addition to the 25 pipe targets in the High Plains joint venture formed in 2006. Five of those targets are confirmed breccia pipes based on historical data from prior drilling. Eagle Hill Exploration Corp. reported in December

that it was negotiating two separate agreements to acquire the Rimshot and Lombardo properties totaling 469 claims, plus five Arizona State section leases that include 157 breccia pipe targets (Kitchen, 2007).

Liberty Star Uranium and Metals Corp. conducted extensive geochemical sampling across hundreds of breccia pipe targets and detailed sampling and mapping on 110 pipes. During the year, the company drilled with joint-venture partner XState Resources on the Elle pipe area. Drilling was underway on the Neola pipe, with three other high-priority targets scheduled to be drilled in 2008. Mesa Uranium acquired the Moonshine Springs project a mile from Denison's Moonshine Springs deposit. Later it drilled two holes that confirmed previous Exxon intercepts of 2 m grading 0.40% U_3O_8 . Monster Uranium Corp. acquired an option on three uranium properties including the Rose breccia pipe from Uranium One Inc. Historic drill data on the Rose pipe shows an intercept of 3.3 m of 1.0% U_3O_8 . Vane Minerals Group drilled a number of pipes beginning in January, finding mineralization in the Big Red, Miller, Miller SW, and Red Dike pipes. Work on Vane's land package increased the number of identified breccia targets to 39.

In early 2007, Quaterra Resources Inc. contracted Geotech Ltd. to conduct the first extensive test of an airborne time-domain electromagnetic system on the Arizona Strip to identify mineralized collapse structures. The VTEM (helicopter-borne time-domain electromagnetic) system has identified anomalies related to collapse structures in a majority of the known breccia pipes as well as 200 additional anomalies with similar geophysical signatures. Takara Resources Inc. and DIR Exploration Inc.'s Kaibab joint-venture project holds seven drill-ready breccia pipe targets discovered because of previous geophysical and geochemical surveys. In 2007, the group increased its land position by staking to acquire 221 breccia pipe targets. Tournigan's sampling program identified 22 of 65 pipe targets as being geochemically anomalous. Twelve of those were prioritized for a drill program that began in May. In central Arizona, uranium mining activities included Rodinia Minerals Inc.'s Workman Creek and Red Bluff properties in the Sierra Ancha Mountains. Recent estimates from previous drilling indicate resources of more than 4,100 t of U_3O_8 . Rodinia drilled its Mormon Lake property to confirm stratigraphy and mineralization outlined in previous exploration data. Golden Patriot Inc.'s multihole drilling project on the past-producing heap-leach Lucky Boy Mine has returned positive results showing U_3O_8 grades from 0.12% to 0.13%. Universal Uranium Ltd. began a 41-hole drill program to confirm historical data on its Artillery Peak uranium property that contains mineralization and stratigraphy similar to the Anderson Mine that produced uranium. Previous work in the 1970s identified a resource of 770 t U_3O_8 in the northern portion of the property. Concentric Energy Corp. controls the nearby Anderson Mine and continued to evaluate mining and milling options for the huge, but low-grade deposit. Uranium Energy Corp. acquired Dry Mountain southeast of Safford, Coyote Ranch property east of Springerville, and New River, also known as Los Cuatros property north of Phoenix, and was evaluating historic data.

Commodity Review

Industrial Minerals

Cement, Concrete, and Gypsum.—In early 2007, Cemex S.A.B de C.V. acquired a bid for Rinker Materials Corp. and proceeded with the acquisition, subjected to requirements of the U.S. Department of Justice. In November, Cemex complied with conditions that required the disposal of two quarries and five ready-mix concrete operations in the Flagstaff and Tucson markets. Cemex announced plans to sell these to CRH plc, an Ireland-based building materials group. Cemex also began permitting to construct a 1.9 Mt/yr cement plant near Seligman. The company planned to invest \$400 million in the Seligman Crossing Plant that would begin operation by 2012. The state-of-the-art facility would increase supply to meet the growing needs of the southwestern United States.

HeidelbergCement completed its acquisition of Hanson plc in August 2007 following the approval of the United States and European regulatory authorities. The purchases gave HeidelbergCement more than a dozen aggregate operations in the Maricopa and Yavapai Counties. National Gypsum Properties LLC's construction of a wallboard plant at Eloy, midway between Phoenix and Tucson, was delayed as a result of the slowdown in the construction market. When completed, the plant could have a production capability of 93,000,000 square meters per year (m^2/yr) of wallboard.

Diatomite and Zeolites.—The TSX Venture Exchange approved the Zeox Corp. acquisition of GSA Resources Inc.'s zeolite assets. TSX has acquired the White Cliffs diatomite plant and mine located near San Manuel from Atlas Minerals Inc. The plant was refitted to process diatomite and zeolites. Alpha Calcit Fullstoff Gesellschaft mbH & Co. KG's Arizona operations conducted percussion drilling on its Dragoon marble property and has proceeded to permit the development of a new quarry.

Metals

Copper.—In March 2007, FCX completed its acquisition of Phelps Dodge Corp. The \$26 billion merger created the world's largest publicly traded copper company. FCX moved its headquarters from New Orleans to the former Phelps Dodge Corp.'s offices in Phoenix. At Morenci, by far Arizona's largest mine, FCX and Sumitomo Corporation of America completed a \$241 million investment to build the first commercial-scale copper concentrate pressure leach operation. Two leach vessels were installed and operations started during the second half of the year. Morenci resumed copper sulfide concentration in 2006 to supply feed to the new plants and production increased to 49,000 t/d capacity. Copper cathodes were produced from the new leach plant. Production at Morenci was 370,000 t in 2007, nearly one-half of Arizona's total. The mine fleet was comprised of 115 236-ton capacity trucks. An additional \$100 million was expected to be invested in 2008 to expand the mining fleet and add east-west capacity, increasing production capacity by 45,000 t/yr. FCX also operated the Bagdad and Sierrita Mines,

the State's third and fourth largest copper mines respectively. Both mines recovered large amounts of byproduct molybdenum. In 2007, Bagdad produced 92,000 t of copper and about 4,500 t of molybdenum. In December, plans were announced that the sulfide copper concentrate pressure leach demonstration plant would be converted into a molybdenum concentrate leaching plant by 2010. The conversion was expected to increase FCX's molybdenum processing capacity by approximately 9,000 t/yr. The changes would allow the plant to convert 3.6 t per hour of molybdenum sulfide concentrate into molybdenum trioxide, and a solution extraction system would produce a rhenium byproduct. Sierrita had Arizona's largest copper mill with a capacity of 102,000 t/d. The Sierrita Mine also produced 68,000 t of copper and an estimated 9,000 t of molybdenum. The facilities at Sierrita include two molybdenum roasters, a rhenium processing facility, and a copper sulfate plant. Incremental expansions were announced for both mines. At the Bagdad Mine, a \$110 million 19,000-t/d mill expansion was expected to increase copper production by 25,000 t/yr starting in 2009. At the Sierrita Mine, a \$160 million 14,000-t/d mill expansion was expected to increase annual copper production by 11,000 t starting in 2010. At FCX's Safford project in Graham County, expenditures of \$675 million were planned to construct a giant leach pad, associated with the SX-EW plant, and to develop the Dos Pobres pit associated with the crushing plant. The crushing facility had a design rate of 103,000 t/d of ore and mining capacity was 290,000 t/d of ore and waste. While construction continued, and despite worker and housing shortages, the first cathode production was reached ahead of schedule in December 2007. This marked the first major new copper mine to start in Arizona since the San Manuel open pit heap-leach operation began in 1985. The Safford Mine was the first in Arizona to introduce autonomous blast-hole drilling and employed the ARDVARC™ automated drill control system. Production was expected to increase and reach design capacity during the next 6 months. An 18-year life was expected for the Dos Pobres and nearby San Juan deposits combined, which together have 490 Mt of copper reserves that contain 0.37% of oxide copper. Freeport expected to spend \$70 million on exploration, primarily at Lone Star in the Safford District and in Morenci in 2008. At the Miami Mine, residual leach production was 9,000 t. The restart of mining at Miami was delayed until 2010 because of planned expansions by Freeport McMoRan elsewhere in Arizona. Capital investment at Miami was expected to be approximately \$100 million, primarily for mining equipment. During the project's 5-year life, it was expected to produce 45,000 t/yr of copper.

Asarco LLC continued operations at its Arizona properties under the protection of the Federal U.S. Bankruptcy Court. Asarco owned three copper mines in Arizona, Ray, Mission, and Silver Bell, and a copper smelting operation at Hayden. The company filed for bankruptcy protection in 2005 under the weight of massive debt, environmental cleanup costs, and asbestos liability claims. Asarco's three mines produced nearly 180,000 t of copper in 2007. At yearend, Asarco had accumulated more than \$950 million in cash. The Ray Mine produced 104,000 t of copper in 2007. A new \$46 million in-pit crusher and conveying system was to be installed with

completion scheduled by the end of the first quarter 2009. The mine received five new Liebherr T282B 363-t trucks last year, the largest operating in Arizona. Asarco planned to purchase 20 of these trucks during a 5-year period. Total cost of the trucks would be \$81 million, not including tires, which cost about \$35,000 each. At the Mission Mine, copper production increased by 28% to 55,000 t and the byproduct molybdenum concentration circuit was operated for the entire year. An SX-EW expansion was studied for the Silver Bell Mine, where production exceeded 21,000 t. The Number 2 dump leach project was approved at year's end, and production was expected to increase by 5%. BHP Billiton Ltd. resumed mining at Pinto Valley in October 2007 following an investment of \$140 million to rehabilitate the 68,000-t/d sulfide concentrator. A \$300 million contract was issued to the Washington Group to finish mining the slice-6 pushback that contains 77 Mt of mill sulfide ore at 0.41% copper and molybdenum and 34 Mt of 0.21% copper leach oxide material. Additional resources could be mined from pushback slices 7 and 8 depending on copper prices. Pinto Valley Division produced 12,500 t of copper in 2007 from new sulfide concentration and ongoing oxide leaching operations. Mercator Minerals Ltd.'s Mineral Park Mine produced 5,000 t of copper from SX-EW leach operations in 2007. Construction was underway on a flotation mill that would produce copper-silver and molybdenum concentrates to greatly increase production. Mercator expected that concentrate recovery would start by June 2008 at 23,000 t/d operation. Full production capacity of 45,000 t/d was expected by spring 2009. An annual production of 25,000 t of copper, 4,500 t of molybdenum, and 19,000 kg (600,000 troy ounces) of silver was anticipated. Mill and leach reserves of 390 Mt were expected to provide for a 21-year mine life. Nord Resources Corp. began residual leaching of existing heaps at Johnson Camp in November 2007 and announced the first copper cathodes had been produced in January 2008. Nord anticipated that copper production from newly mined ore would be delayed an additional 14 to 20 weeks from its forecast construction schedule, subject to the timing of the receipt of an air quality permit for a new crushing circuit.

More information on mining is available from Directory 51, Active Mines in Arizona 2007, at www.mines.az.gov (Niemuth and others, 2007). Additional details on the geology and distribution of metallic commodities in Arizona are presented in the Arizona Department of Mines and Mineral Resource's OFR08-26 Arizona's Metallic Resources—Trends and Opportunities (Niemuth, 2008).

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TABLE 1
 NONFUEL RAW MINERAL PRODUCTION IN ARIZONA^{1,2}

(Thousand metric tons and thousand dollars)

Mineral	2005		2006		2007	
	Quantity	Value	Quantity	Value	Quantity	Value
Clays, bentonite	33	1,670	34	1,710	30	1,520
Copper ³	690	2,640,000	712	4,950,000	731	5,290,000
Gemstones	NA	1,370	NA	1,560	NA	1,950
Sand and gravel, construction	84,900	516,000	94,000	662,000	85,800	652,000
Stone, crushed	12,100 ⁴	72,400 ⁴	14,700 ^r	121,000 ^r	15,700	145,000
Combined values of cement, clays (common), gold, gypsum (crude), lime, molybdenum concentrates, perlite (crude), pumice and pumicite, salt, sand and gravel (industrial), silver, stone [crushed traprock (2005), dimension sandstone], zeolites	XX	1,120,000	XX	1,020,000	XX	1,170,000
Total	XX	4,350,000	XX	6,750,000 ^r	XX	7,260,000

^rRevised. NA Not available. XX Not applicable.

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

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

³Recoverable content of ores, etc.

⁴Excludes certain stones; kind and value included with "Combined values" data.

TABLE 2
 ARIZONA: CRUSHED STONE SOLD OR USED, BY TYPE¹

Type	2006			2007		
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Number of quarries	Quantity (thousand metric tons)	Value (thousands)
Limestone ²	8 ^r	6,250 ^r	\$46,700 ^r	8	6,520	\$69,700
Marble	2 ^r	453 ^r	4,800 ^r	2	358	3,300
Granite	25 ^r	3,850 ^r	35,500 ^r	25	5,030	48,500
Traprock	4	436	3,420	4	271	2,470
Sandstone and quartzite	4	421	3,190	4	535	4,940
Volcanic cinder and scoria	8 ^r	118 ^r	1,070 ^r	5	81	684
Miscellaneous stone	21 ^r	3,140 ^r	26,300 ^r	16	2,880	14,900
Total	XX	14,700 ^r	121,000 ^r	XX	15,700	145,000

^rRevised. XX Not applicable.

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

²Includes limestone-dolomite reported with no distinction between the two.

TABLE 3
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 2007, BY USE¹

(Thousand metric tons and thousand dollars)

Use	Quantity	Value
Construction:		
Coarse aggregate (+1½ inch):		
Riprap and jetty stone	199	2,800
Filter stone	W	W
Coarse aggregate, graded:		
Concrete aggregate, coarse	W	W
Bituminous aggregate, coarse	W	W
Railroad ballast	W	W
Other graded coarse aggregate	298	3,670
Fine aggregate (¾ inch):		
Stone sand, concrete	W	W
Stone sand, bituminous mix or seal	W	W
Screening, undesignated	W	W
Other fine aggregate	88	1,080
Coarse and fine aggregates:		
Graded road base or subbase	648	4,070
Terrazzo and exposed aggregate	W	W
Other coarse and fine aggregates	171	1,730
Other construction materials	52	515
Chemical and metallurgical:		
Cement manufacture	W	W
Lime manufacture	W	W
Other miscellaneous uses and specified uses not listed	17	130
Unspecified: ²		
Reported	1,620	3,190
Estimated	8,300	77,000
Total	15,700	145,000

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

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

²Reported and estimated production without a breakdown by end use.

TABLE 4
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 2007, BY USE AND DISTRICT¹

(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 (+1½ inch) ²	W	W	--	--	W	W	--	--
Coarse aggregate, graded ³	W	W	--	--	1,590	16,100	--	--
Fine aggregate (¾ inch) ⁴	W	W	--	--	W	W	--	--
Coarse and fine aggregates ⁵	W	W	--	--	903	7,950	--	--
Other construction materials	52	515	--	--	--	--	--	--
Chemical and metallurgical ⁶	W	W	--	--	W	W	--	--
Other miscellaneous uses	17	130	--	--	--	--	--	--
Unspecified: ⁷								
Reported	42	326	65	504	--	--	1,510	2,360
Estimated	2,100	19,000	410	3,800	5,800	54,000	--	--
Total	4,360	49,300	479	4,330	9,320	88,600	1,510	2,360

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

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

²Includes riprap and jetty stone and filter stone.

³Includes concrete aggregate (coarse), bituminous aggregate (coarse), railroad ballast, and other graded coarse aggregate.

⁴Includes stone sand (concrete), stone sand (bituminous mix or seal), screening (undesignated), and other fine aggregate.

⁵Includes graded road base or subbase, terrazzo and exposed aggregate, and other coarse and fine aggregates.

⁶Includes cement and lime manufacture.

⁷Reported and estimated production without a breakdown by end use.

TABLE 5
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 2007,
BY MAJOR USE CATEGORY¹

Use	Quantity	Value	Unit
	(thousand metric tons)	(thousands)	value
Concrete aggregate (including concrete sand)	9,580	\$86,600	\$9.04
Plaster and gunitite sands	3,350	19,400	5.80
Concrete products (blocks, bricks, pipe, decorative, etc.)	1,600	6,070	3.78
Asphaltic concrete aggregates and other bituminous mixtures	4,950	49,000	9.90
Road base and coverings ²	9,450	66,100	6.99
Fill	1,640	9,650	5.88
Other miscellaneous uses ³	797	6,300	7.90
Unspecified: ⁴			
Reported	27,100	200,000	7.38
Estimated	27,400	209,000	7.64
Total or average	85,800	652,000	7.60

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

²Includes road and other stabilization (cement)

³Includes filtration, railroad ballast, and snow and ice control.

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

TABLE 6
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 2007, BY USE AND DISTRICT¹
(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	843	12,000	622	5,040	13,100	95,000
Asphaltic concrete aggregates and other bituminous mixt	196	2,110	276	2,560	2,140	22,400
Road base and coverings ³	899	5,820	589	4,530	7,900	55,300
Fill	274	1,470	502	1,990	865	6,190
Other miscellaneous uses ⁴	435	2,900	26	291	336	3,110
Unspecified: ⁵						
Reported	4,030	30,000	424	3,060	22,200	166,000
Estimated	2,850	21,900	1,750	13,900	22,800	174,000
Total	9,530	76,200	4,190	31,400	69,300	521,000
	Unspecified district					
	Quantity	Value				
Concrete aggregate and concrete products ²	--	--				
Asphaltic concrete aggregates and other bituminous mixt	2,340	21,900				
Road base and coverings ³	58	377				
Fill	--	--				
Other miscellaneous uses ⁴	--	--				
Unspecified: ⁵						
Reported	361	715				
Estimated	(6)	(6)				
Total	2,760	23,000				

-- Zero.

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

²Includes plaster and gunitite sands.

³Includes road and other stabilization (cement)

⁴Includes filtration, railroad ballast, and snow and ice control.

⁵Reported and estimated production without a breakdown by end use.

⁶Less than ½ unit.