Hill plant during 2004. It is a major production facility and is one of the largest producing plants of crushed stone in the state. The Texas Governor's Advisory Committee on Rock Crushers recommended tighter controls over aggregate mining activities, including bonded mine sites with reclamation language. The creation of water districts continues to introduce new restrictions to mine development. During the 2005 legislative session, SB-1354 was introduced to address protection of extraordinary streams with a pilot program designed for the Brazos River below Possum Kingdom.

Steve Cox from Zemex Industrial Minerals reported that the Zemex Sonority Pioneer plant outside of Van Horn was in full production during 2004. The company mined talc from three pits for use in blending operations to produce products for its various customer specifications. Activities include an aggressive ore characterization drilling, sampling, and associated lab analysis program. This program will start during the summer of 2005 and continue on a year-by-year basis.

### UTAH
R.L. BON and K. KRAHULEC, Utah Geological Survey

The value of Utah's mineral production, including coal, during 2004 was estimated to be $2.32 billion. This was $560 million (32 percent) higher than the revised value of $1.77 billion for 2003. All major industry segments gained in value in 2004.

Contributions from each of the segments were base metals, $1.136 billion (49 percent); industrial minerals, $643 million (28 percent); coal, $387 million (16 percent) and precious metals, $158 million (7 percent) (Fig. 1). Compared with 2003, the 2004 values of base metals increased $446 million (65 percent), industrial minerals increased $88.7 million (16 percent), coal increased $3 million (about 1 percent) and precious metals increased $21.8 million (16 percent).

Nationally, Utah ranked ninth in the value of nonfuel minerals produced in 2003 (latest year that production figures are available). The state accounted for about 3.4 percent of the total U.S. nonfuel mineral production value (Fig. 2). Utah also ranked 13th in coal production in 2003. The state should retain similar or achieve higher national rankings in 2004.

The outlook for 2005 is optimistic. The value of mineral production is projected to increase again in 2005 due to increased production of all base and precious metals, coal and most major industrial minerals. Base- and precious-metal prices increased significantly in 2003 and 2004 and should remain near or above their respective 2004 year-end prices during 2005. Industrial-mineral prices should also remain near their current levels as economic recovery continues, although a reduction in demand for several commodities is projected. Coal prices should increase as new coal contracts are negotiated at significantly higher rates.

The continued rebound in metal prices from the low point in 2002 has significantly increased activity in the metals mining sector. This activity started slowly, but in the last half of 2004, several developments were initiated that will prolong the longevity of Utah's metal mining sector. Two of the more important developments were the beginning of construction of Constellation Copper's Lisbon Valley copper mine and Kennecott Copper's announcement of a $170-million expansion at the Bingham Canyon Mine (Cu-Mo-Au-Ag). This added 147.7 Mt
(162.9 million st) of better-than-average grade Cu-Mo ore to the existing reserve.

**Outlook**

The value of mineral production in Utah is expected to increase modestly in 2005. Operator surveys indicate that base- and precious-metal, industrial-mineral and coal values will all be higher. Base- and precious-metal production is forecast to increase, as is coal. Industrial-mineral production is expected to be flat to slightly higher as many operators are operating at or near capacity.

The opening of the Lisbon Valley base-metal mine in 2005 will add incrementally to the state's base-metal values. Precious-metal production will be slightly higher in 2005 due to increased production from Kennecott's Bingham Canyon Mine. But that will be partially offset by lower gold production from the company's Barneys Canyon Mine.

Industrial-mineral values will also increase because of continued higher demand for sand and gravel, crushed stone, cement, salt and brine-related products, and lime products. Coal prices are expected to increase as new contracts replace existing contracts at significantly higher rates. The recent upturn in metal prices should increase exploration for these metals during the next few years.

**Base and precious metal production**

Base-metal production had an estimated value of $1.136 billion. It was the largest contributor to the value of minerals produced during 2004, an all-time high (Fig. 1). In descending order of value, those metals were copper, molybdenum, magnesium metal and beryllium.

The 2004 base-metal values were about $446 million (65 percent) more than 2003. Precious-metal production, valued at $158 million, included gold (85 percent) and silver (15 percent). Precious-metal values in 2004 were $21.8 million (16 percent) more than in 2003.

The Bingham Canyon Mine, located about 32 km (20 miles) southwest of Salt Lake City, is the state's sole producer of copper and molybdenum. It also the major producer of gold and silver. The combined value of minerals produced from the Bingham Canyon Mine in 2004 was nearly one-half of the total value of all minerals produced statewide.

Copper is the largest contributor to the value of nonfuel minerals in Utah. Substantial price increases in 2003 and 2004 raised the value of copper to near an all-time high, and the value of base-metal production statewide to more than $1 billion for only the second time. From 1995 through 2002, the price of copper fell significantly 76 cents/lb in 2002 from $1.38/lb in 1995. Copper prices rebounded in 2003 and 2004, closing in 2004 at more than $1.50/lb and averaging $1.36/lb.

Copper production from the Bingham Canyon Mine decreased slightly in 2004 to about 264 kt (291,000 st) from 2003 production of approximately 282 kt (311,000 st) of copper metal. Kennecott also reported that the Bingham Canyon Mine produced more than 10 percent of the annual refined copper requirements in the United States.

Bingham Canyon is also Utah's only molybdenum producer. During 2004, it produced about 6.8 kt (7,500 st) of byproduct molybdenum, about 12 percent less than in 2003.

Magnesium metal was the third-largest contributor to the value of base metals in 2004. Magnesium metal is produced from Great Salt Lake brines by US Magnesium (formerly Magnesium Corporation of America, Magcor) at its electrolytic plant at Rowley in Tooele County (Fig. 3). The plant’s annual capacity is 43 kt (47,000 st) of magnesium metal (99.8 percent purity). It is the only active primary magnesium processing facility in the United States. Magnesium production was about the same as in 2003. In September, US Magnesium announced that it would increase plant capacity to 51 kt/a (57,000 stpy) by adding a third line of electrolytic cells. The line will begin production in June 2005 and will be at full capacity in 2006. Magnesium metal prices reached a 12-year low in 2003, but have improved during the past year.

Utah is the nation's sole producer of beryllium concentrates. Beryllium ore (bertrandite) is mined at Brush Resource's Topaz and Hogs Back mines in Juab County. It is processed, along with imported beryl, at the company's plant a few miles north of Delta in Millard County. The product (beryllium hydroxide) is then sent to the company-owned refinery and finishing plant in Ohio. There it is converted into beryllium metal, alloys and oxide. In 2004, about 14.5 kt (16,000 st) of ore was mined and trucked to the processing plant. The mine produced less ore than in previous years due to increased processing of stockpiled ore. The use of beryllium in electronic and electrical components, and aerospace and defense applications accounted for an estimated 80 percent of total consumption. Sales of alloy products increased during the first half of 2004.
Gold production in Utah during 2004 was estimated to be about 9.95 t (320,000 oz). This was a 6-percent increase from the 9.3 t (300,000 oz) produced in 2003. Gold is produced from two surface mines owned by Kennecott, a primary producer (Barneys Canyon) and a byproduct operation (Bingham Canyon).

Several other small mines in the state are known to produce minor amounts of gold and silver. But metals-specific production is not reported, and not included in the above totals. The Barneys Canyon Mine exhausted its economic ore reserves in late 2001 and ceased mining. However, the operation will continue to produce gold from its heap-leach pads at a much reduced rate into 2006, when those pads will be depleted. The Bingham Canyon Mine produced slightly more gold in 2004 than in 2003.

Silver is also a byproduct metal from the Bingham Canyon Mine. Silver production was estimated to be about 111 t (3.58 million oz) in 2004, about the same as in 2003.

Industrial minerals production

Industrial-minerals production had an estimated value of $643 million. It was the second-largest contributor to the value of minerals produced in 2004 (Fig. 1), an record high. The value of industrial minerals has grown substantially during the past five years, increasing from $500 million in 2000 to $643 million 2004, a 29-percent increase.

Those commodities or commodity groups that have realized most of those gains included sand and gravel and crushed stone; portland cement and lime; and salines, including salt, magnesium chloride, potash (potassium chloride) and sulfate of potash (SOP). These commodities account for about 90 percent of the total value of the industrial minerals segment. Other important commodities produced in Utah, in descending order of value, included phosphate, gilsonite, expanded shale, common clay, bentonite and gypsum.

Sand and gravel, and crushed stone (including limestone and dolomite) were the highest contributors to the value of industrial minerals produced in Utah during.

Due to the large number of operations (about 122 active sand and gravel pits and 20 stone quarries), the Utah Geological Survey (UGS) did not send production questionnaires to this group. However, production data are compiled by the U.S. Geological Survey (USGS). Based on third quarter USGS 2004 production data, the UGS estimated that 2004 production would be 33.2 Mt (36.5 million st) of sand and gravel with a value of $154 million, and 9.5 Mt (10.5 million st) of crushed stone valued at $47 million. Crushed stone production includes raw material for lime and cement plants. This was a 27-percent increase in sand and gravel production and a 24-percent increase in the production of crushed stone, compared with 2003.

Portland cement and lime were the second-highest contributors to the value of industrial minerals produced in 2004. Their combined value was $180 million, about $13 million (8 percent) more than in 2003. Two operators produce portland cement in Utah: Holcim (formerly Holnam, and Ash Grove Cement.

Holcim's Devils Slide Mine and plant are east of Morgan. Ash Grove's Leamington mine and plant are east of Lyndyl. The companies have a combined capacity of more than 1.4 Mt/a (1.5 million stpy) of cement. Both plants operated at or above capacity during 2004. Total production was nearly 1.5 Mt (1.7 million st). In addition to limestone, Holcim and Ash Grove Cement mine modest amounts of shale and sandstone that are used in the manufacture of cement.

Lime production was about 12 percent higher in 2004, with an estimated production of about 660 kt (730,000 st). There are two suppliers of lime in Utah, with a combined capacity of more than 910 kt/a (1 million stpy). Graymont Western U.S. (formerly Continental Lime) produces dolomitic quick lime and high-calcium quick lime. Chemical Lime of Arizona produces...

FIGURE 4
380 kt (420,000 st) of gypsum during 2004, nearly 32 kt (35,000 st) more than in 2003. In descending order of production, the three largest producers were U.S. Gypsum, H.E. Davis and Sons and Nephi Gypsum.

U.S. Gypsum operates the only active wallboard plant in Utah. The plant is located near Sigurd. The Georgia Pacific plant, also near Sigurd, closed in 2002 and the company’s mines in Utah operate only intermittently. Georgia Pacific shifted wallboard manufacturing to the company’s Las Vegas, NV facility.

Most gypsum produced in Utah is used for making wallboard. However, several operators supply raw gypsum to regional cement companies for use as an additive to retard the setting time of cement. The agricultural industry also used gypsum as a soil conditioner.

Energy minerals production

Coal. Utah’s coal operators produced 19.7 Mt (21.7 million st) of coal during 2004. It was valued at $387 million and came from 13 underground mines (Figs. 1 and 4). This production was about 1.3 Mt (1.4 million st), or 6.5 percent, less than in 2003. All of the mines and facilities are located in east-central Utah.

Utah’s synfuel plant, DTE Utah Synfuels, is the only synfuel facility west of the Mississippi River. The synfuel plant is located at the Castle Valley railroad spur near Wellington. The plant operated on a limited basis in 2004 but is scheduled to operate on a full-time basis for at least the next two years. It uses low-Btu, high-ash coal purchased from several local coal operators.

The largest coal producer was the Sufco Mine, operated by Canyon Fuel. It produced a near-record high of 6.87 Mt (7.57 million st) of raw coal. In addition, the following three mines each produced more than 1.8 Mt (2 million st) of coal — Deer Creek, operated by Energy West Mining (Pacificorp); Dugout, operated by Canyon Fuel and West Ridge, operated by West Ridge Resources. The Horizon Mine, owned by Hidden Splendor Resources, produced a small amount of coal before being idled in late January 2002. The mine was re-opened in 2003 and produced without disruption in 2004. Consolidation Coal’s Emery Mine, which was idled in late 2003, restarted in the fall of 2004.

Utah American Energy’s Lila Canyon Mine is in the final stages of permitting. It could begin producing within a year or so, depending on successful marketing. The Skyline No. 3 Mine, owned by Canyon Fuel, closed in May 2004 because of significantly increased water handling costs and related operational expenses. The mine was scheduled to re-open in the first quarter of 2005.

More than half of Utah’s coal was consumed in-state by three electric utilities in 2004. Coal was also used for industrial purposes in the state and shipped to electric utilities and industrial users in other states. The export market to Pacific Rim countries had accounted for up to 5 Mt (5.5 million st) of production in 1996. This dwindled to less than 450 kt (500,000 st) in 2002 and to none in 2003 and 2004. This was mainly due to foreign competition. No overseas coal exports are anticipated for the next several years.

Uranium. Escalating uranium prices rejuvenated exploration in the historic mining areas of the Colorado Plateau. In Utah, this work has primarily focused on areas of previously delineated but unmined resources, particularly in Emery, Garfield, Grand and San Juan counties. These areas have seen renewed claim staking and leasing of state-owned land.

Uranium prices have increased significantly since
July 2003, rising from $15.50/lb at the end of 2003 to $20.70/lb at the end of 2004. But no uranium ore was mined in Utah in 2004.

U.S. Energy's Shootaring Canyon Mill remained idle throughout the year. Meanwhile, International Uranium's White Mesa mill processed an alternate feed. Eleven uranium/vanadium mines are listed as inactive statewide.

### Exploration and development activity

Exploration in Utah began to turn around in the last half of 2004, lagging somewhat behind increasing metal prices and continued to improve into early 2005. More than 2,900 claims were staked in Utah during 2004. Land acquisition for mineral exploration was particularly active in Iron (iron and gold), San Juan (uranium and copper and), Beaver (copper and gold), Washington (gold), Tooele (gold and copper) and Emery (uranium) counties. The main exploration/development areas are discussed here and shown in Fig. 5.

#### Lisbon Valley

The Lisbon Valley mining district in southeastern Utah was one of the most active exploration areas in the state during 2004. Companies acquired land in the district for uranium and copper. Many pursued copper exploration and development.

Constellation Copper’s Lisbon Valley project is the most advanced in the district. Constellation is building an openpit, heap-leach, solvent extraction/electrowinning (SX/EW) operation. Copper production should begin in September 2005, with full production by the end of the year.

The three planned openpits are each 30 to 46 m (100 to 150 ft) deep with roughly a 0.1-percent copper cut-off grade. The Utah portion of the Lisbon Valley copper project has a seven-year mine life based on a reserve of 33.3 Mt (36.7 million st) averaging 0.51 percent copper. Total cost, including overhead, is 75 cents/lb. The projected cash costs are 50 cents/lb of copper. Copper production should begin in September 2005, with full production by the end of the year.

Initially, the Lisbon Valley Mine will produce about 16.3 kt/d (18,000 stpd) of ore with a 2.25:1 stripping ratio. At full capacity, the mining rate will be 54.5 kt/d (60,000 stpd) of ore. The used processing plant was purchased and moved from the Hall porphyry, molybdenum-copper mine near Tonopah, NV. In 2004, all of the facilities were relocated to a lay-down yard at Lisbon Valley.

The general flow path from the mine is to the primary and secondary crusher, then to agglomerating with sulfuric acid to jump-start the leaching, and then to stackers to create the heap-leach pad. The pregnant liqour from the leach pad will then be pumped to the SX/EW facility for processing.

#### Bingham district

Drilling at the Bingham Canyon Mine in 2004 focused on work to extend the mine life beyond about 2013. The thrust of this program was geotechnical drilling, infill resource-definition drilling in the pit, and mine dewatering. The geotechnical program was implemented by:

- Geological mapping and modeling for better geo-

- Oriented core drilling for geotechnical planning efforts.
- Core drilling to collect strength data for pit slope stability analyses.
- Inclinometer drilling and construction for pit slope monitoring.
- Piezometer, water well, and horizontal drain drilling to monitor dewatering performance and assist with pit slope depressurization.

The economic and engineering study for a $170-million pit expansion to the northeast was approved in February 2005. In addition to the pit expansion, Kennecott will purchase new equipment and build facilities. It will also relocate some facilities, and expand operations at the Copper concentrator. The new pit design added 147.7 Mt (162.9 million st) of better-than-average grade Cu-Mo ore. This will extend mine life until 2017 and does not preclude future underground mining. Other mine options currently being considered are additional openpit expansion, underground block caving, underground skarn mining, or any combination of the above. The targeting of deep porphyry and skarn mineralization is planned for 2005.

#### Tintic district

Atlas Mining is reopening the old Dragon halloysite mine in the southern portion of the Tintic mining district. Halloysite is an unusual, bright-white, microtubular, high-value clay used in specific ceramic, paint, and other potential applications based on its distinctive structure. The Dragon deposit is a selective hydrothermal replacement of portions of the Cambrian Ajax Limestone adjacent to a small monzonite porphyry plug.

Atlas has driven a 91-m- (300-ft-) long, 15° decline into the halloysite deposit. The company has drifted about 18 m (60 ft) using a small road header, installed a chain crusher (100 percent to -45 µm (-325 mesh), built an air classifier and began test mining in late 2004. Atlas anticipates a mining rate of 910 t to 1.8 kt/m (1,000-2,000 st/month), based on market demand.

#### Milford area

In late 2003, Palladon Ventures optioned a 65-percent interest in Western Utah Copper's (WUC) Milford area properties in the Rocky, Beaver Lake, San Francisco and Blue Mountain areas in Beaver County. Palladon initiated an exploration program of drilling and geophysical surveys in 2004. In total, the company drilled 73 holes totaling more than 11,000 m (33,045 ft) on its 24-hm² (60,000-acre) property. Drilling at the Maria openpit (three holes), Hidden Treasure mine (three holes) and Sunrise ore body (seven holes) confirmed previous mining grades.

The Palladon/WUC joint venture completed the first of a two-phase program of detailed induced polarization (IP) and ground magnetic surveying. Phase one covered areas hosting known mineral resources to help define the geophysical expression of mineralization and look for potential extensions of the currently defined resources. Phase two of the program began in early February 2005 and covered potential copper porphyry areas.

#### Iron Springs-Pinto district

Palladon-WUC joint venture (65 percent and 35 percent, respectively) en...
tered into an agreement with Iron Ore Mines to purchase for $10 million its iron properties in the Iron Springs-Pinto mining district in southwestern Utah. Iron Ore Mines' property contains two iron deposits, the Comstock/Mountain Lion and the Rex.

The Iron Ore Mines property contains about 2,000 hm² (4,940 acres) of patented mining claims and other fee lands and an additional 400 hm² (990 acres) of unpatented mining claims. The measured reserve remaining in the Comstock/Mountain Lion pits is 25 Mt (27.6 million st) of ore averaging 47.1 percent iron with a 0.3:1 stripping ratio. The Rex deposit has never been mined. It contains a measured reserve of 81 Mt (89 million st) of ore averaging 39 percent iron. It could be amenable to open pit mining. Several low-grade stockpiles are located near the Comstock/Mountain Lion deposit. They are estimated to contain 12.5 Mt (13.8 million st) of ore averaging 42 percent iron. Palladon and WUC are proposing to re-open the mine and build an on-site smelter with a capital cost of $1.1 billion.

Deer Trail Mine. Unico continued exploration to delineate Zn-Ag-Cu-Pb-Au resources in the Upper Deer Trail Mine and the PTH Tunnel workings in the Marysvale district. Initial work consisted of surface, rock-chip sampling and underground confirmation sampling of old mine assays.

A preliminary round of 28 reverse-circulation holes testing the Upper Deer Trail mine served to focus further work to the north and above the existing workings. Phase two drilling will test known mineralized horizons in the PTH Tunnel area for new mineralization at depth. In addition to exploration work, improvements and additions were made to the mine's surface infrastructure.

Gold Hill-Clifton district. Dumont Nickel has been exploring in the old Gold Hill (Clifton) mining district in western Tooele County for the past two years. Dumont is focusing on bulk-minable gold and gold-copper targets. The company has assembled an 87-km² (33-sq mile) property position. To date, Dumont's work has defined five project areas — Kiewit (gold), Cane Springs (gold), IBA (copper-silver-gold), Clifton Shears (gold-silver-lead-zinc) and jasperoid silica-breccia (gold). Work in 2003 and 2004 included drilling 16 core holes totaling 2,260 m (7,413 ft), collecting 5,200 soil samples over a 54-km² (20-sq mile) area and taking 2,500 rock samples over a 24-km² (9-sq mile) area. Additional definition drilling was planned for 2005.

**VIRGINIA**

D.B. SPEARS, Virginia Department of Mines, Minerals and Energy

Continued economic recovery contributed to increased production in most of Virginia's mineral sectors during 2004. National rankings were not yet available for 2004, but in 2003 Virginia was ranked ninth in the nation for coal production, eighth for crushed stone and 10th for lime. Virginia was the only state to produce kyanite and mullite was about 90.7 kt (100,000 st).

Virginia Vermiculite, in Louisa County, is the nation's second largest producer of vermiculite. The soft ore is excavated with earthmoving equipment and processed on site. Production for 2004 was expected to be about 32 kt (35,000 st). A new processing plant is currently under construction. It will replace the existing milling, washing, drying and screening facility during the second half of 2005.

During 2004, Virginia was one of three states producing titanium and zircon sands. Iluka Resources' Old Hickory Mine, in Dinwiddie County, produced ilmenite and zircon concentrates from Tertiary-age beach sands. Production has increased steadily since a major expansion took place in 2002. Reported production of heavy mineral concentrates was 469 kt (517,000 st), a 44-percent increase from 2003.

U.S. Silica produces feldspar from an anorthosite pluton near Montpelier in Hanover County. The company's product is marketed as Virginia Aplite, plagioclase feldspar used primarily in the glass industry. Production was down slightly during 2004, to 192 kt (212,000 st).

Two operators produced fuller's earth for cat-box litter and industrial absorbents. Bennett Mineral, of King and Queen County, and Nestle Purina Petcare, of King William County, extracted montmorillonite clay from the Tertiary-age Calvert Formation. Combined production during 2004 was up slightly to about 270 kt (300,000 st).

Production of iron oxide pigments remained steady during 2004, at about 450 t (500 st). Hoover Color produced pigments from one pit in residuum over the Shady