

# **1998 Summary of Mineral Activity in Utah**

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## **Summary**

The value of Utah's mineral production (including coal) in 1998 is estimated to be \$1.86 billion, \$401 million less than in 1997. Contributions from each of the major industry segments are: base metals, \$688 million (37 percent of total); industrial minerals, \$534 million (29 percent of total); coal, \$479 million (26 percent of total); and precious metals, \$154 million (8 percent of total).

The changes in Utah's mineral valuation by industry segment for the years 1995-1998 are shown in figure 1. Compared to 1997, the 1998 values of: (1) base metals decreased \$261 million, (2) industrial minerals increased \$1 million, (3) coal decreased \$6 million, and (4) precious metals decreased \$135 million. Prices decreased for most base metals (copper, molybdenum, and magnesium), while precious metals were split; silver prices increased slightly while gold prices decreased modestly. Coal prices decreased slightly in 1998. Industrial mineral prices increased slightly for several commodities (cement, heavy clay, gypsum, perlite, phosphate, and potash) remained flat for most commodities and were lower for other commodities (bentonite, lime, and salt).

## **Outlook**

The value of mineral production is expected to decrease in 1999 primarily due to lower base- and precious-metal prices. Operator surveys indicate that in 1999, base-metal production should remain relatively stable, precious-metal production should increase moderately, and coal production should increase modestly, establishing another year of record production. Industrial mineral commodities as a whole should show an increase in value in 1999, due mostly to increased production. Prices for copper, molybdenum, magnesium, and gold are at their respective multi-year lows and no improvement in prices is forecast for 1999. Prices for most industrial minerals should remain relatively flat while coal prices are expected to increase slightly. Base- and precious-metal exploration will remain low until the market for these minerals improves.

## **Mine Permit Summary and Status**

During 1998, the Utah Division of Oil, Gas and Mining (DOG M) received eight Large Mine permit applications (5 acres [2 hectares] and larger disturbance) and 42 new Small Mine permit applications (less than 5 acres [2 hectares] disturbance). Six of the Large Mine applications were made to change from Small to Large Mine status. These numbers represent an increase of three Large Mine and nine Small Mine permit applications compared to 1997. New Large Mine permits include five dimension stone quarries, one limestone quarry (aggregate), one gypsum quarry, and one silica quarry.

New Small Mine permits are grouped as follows: industrial minerals - 30, uranium-vanadium - 11, and precious metals - 1.

The state has 71 active Large mines (excluding sand and gravel) that are grouped by industry segment as follows: base metals - 5, precious metals - 1, coal - 13, and industrial minerals - 52. Eighty Small mines reported production in 1997. Small mines are grouped as follows: industrial minerals - 61 (including building, decorative, and dimension stone), gemstones - 7, precious- and base metals - 8, fossils - 1, and other - 3.

In December 1998, DOGM sent 476 annual report questionnaires to all Large and Small Mine permit holders. By March 1, 1999, 267 reports had been received. Fifty-eight Large mines and 80 Small mines reported production. Several reporting mines produced more than one commodity. In addition, 12 coal mines and one coal recovery plant reported production for 1998.

## **Exploration Permits**

Mineral exploration statewide has decreased substantially compared to 1997. Twenty-two Notices of Intent (NOI) to explore on public lands were filed with DOGM in 1998, compared to 34 in 1997. The number of new NOIs listed by county included: Beaver - 8, Millard - 2, Tooele - 2, Uintah - 2, Utah - 2, and one each in Box Elder, Grand, Iron, Sevier, Summit, and Wasatch Counties. Fourteen permits were issued for base- and/or precious-metals exploration, and seven permits were issued that targeted industrial minerals. One permit was issued for a water well. Most of the base and precious metal NOIs were from individuals or small companies. Two affiliated companies account for 6 of the 14 NOIs.

## **National Rankings**

The U.S. Geological Survey (USGS) ranked Utah fifth in the nation (up from seventh) in the value of nonfuel minerals produced in 1997 (latest year for which production figures are available). Utah accounted for nearly 4.5 percent of the U.S. total nonfuel mineral production value. The state ranked first in beryllium and gilsonite; second in copper, gold, magnesium metal, and potash; third in molybdenum and mercury; fourth in phosphate rock and grade-A helium; fifth in silver; sixth in salt and bentonite; and tenth in construction sand and gravel. Utah ranks 14th in coal production (down from 12th in 1997).

According to the USGS, between 1987 and 1997 the value of nonfuel mineral production in Utah increased from \$700 million to over \$1.8 billion; the high was achieved in 1995 (figure 2). Nonfuel mineral production for 1997 is estimated to be \$1.76 billion, the second-highest year of record. The Utah Geological Survey's (UGS) estimate for nonfuel mineral production for 1998 is \$1.38 billion, \$395 million less than 1997.

## **Base- and Precious-Metal Production**

Base-metal production, valued at \$688 million, was the largest contributor to the value of minerals produced in 1998. In descending order of value, those metals are: copper, magnesium metal, molybdenum, beryllium, and vanadium. Precious-metal production, valued at \$154 million, included gold (85% of total value) and silver (15% of total value). Kennecott Utah Copper Corporation's Bingham Canyon mine in Salt Lake County is the state's sole producer of copper, silver, and molybdenum, and a major producer of gold. The combined value of minerals produced from the Bingham Canyon mine is more than one-third of the total value of all minerals produced statewide.

### **Copper**

Copper is the largest contributor to the value of nonfuel minerals in the state. Significant price increases in 1994 and 1995 pushed the value of copper to historical highs and the value of base-metal production statewide to over \$1 billion for the first time in 1995. Since 1995 the price of copper has fallen significantly (\$1.38/lb [\$3.04/kg] in 1995 vs \$0.80/lb [\$1.76/kg] in 1998). Copper production from Kennecott's Bingham Canyon mine in Salt Lake County decreased modestly in 1998 to about 310,000 short tons (st), (281,000 metric tons [mt]) from 1997 production of about 330,000 st (300,000 mt) of copper metal. With the completion of their modernization and expansion program, Kennecott's copper production has stabilized at a rate slightly higher than 300,000 st (272,000 mt) annually.

### **Magnesium Metal**

Magnesium metal was the second-largest contributor to the value of base metals in 1998. Magnesium metal is produced from Great Salt Lake brines by Magnesium Corporation of America at its electrolytic plant at Rowley in Tooele County. The plant has a capacity to produce 44,000 st (40,000 mt) of magnesium metal (99.9 percent purity) annually and is one of only two active primary processing facilities in the U.S. Magnesium production was near capacity in 1998, although demand has decreased worldwide. Domestic producer prices were at their lowest level since 1994.

### **Molybdenum**

The sole molybdenum producer in Utah is Kennecott's Bingham Canyon mine, which produced about 10,000 st (9,100 mt) of molybdenum concentrate ( $\text{MoS}_2$ ) in 1998, a significant decrease from the nearly 20,000 st (18,000 mt) produced in 1997. The Bingham Canyon mine was one of 11 molybdenum producers in the U.S. in 1998. Molybdenum is recovered as a by-product from the copper milling operation.

### **Beryllium**

Utah continued to be the nation's leading producer of beryllium metal. Beryllium ore (bertrandite) is mined at Brush Wellman, Inc.'s Topaz and Hogs Back mines in Juab County and processed with imported beryl at the company's plant a few miles north of Delta in Millard County. The Hogs Back mine began producing in 1998. In 1998, more than 170,000 st (154,000 mt) of ore was mined and trucked to the company's Delta plant for processing. The product (beryllium hydroxide) is then sent to the company-owned refinery and finishing plant in Ohio where it is converted into beryllium metal, alloys, and oxide. The demand for beryllium alloys and beryllium oxide has increased modestly over the past several years as alloys are being introduced into components for the automobile and electronics industries. Beryllium production in 1998 is the highest in the past several years.

### **Vanadium**

International Uranium (USA) Corporation (IUC) mined a small amount of vanadium ore from the Rim mine in San Juan County. The ore was shipped to IUC's White Mesa mill near Blanding for processing. The mine had been on standby for several years. Vanadium production is expected to increase at the Rim mine and several new vanadium mines are planning to begin operations in 1999. Vanadium prices reached their highest level in the past five years in early 1998 before declining significantly by year's end. This spike in price led to a resurgence of new Small Mine permits but almost no increase in ore production.

### **Gold and Silver**

Gold production in 1998 is estimated to be more than 400,000 ounces (oz) (12,400 kilograms [kg]), a significant decrease from the record-high of nearly 800,000 oz (24,900 kg) produced in 1997. Gold is produced from two surface mines owned by Kennecott Corporation: one primary producer (Barneys Canyon mine) and one by-product operation (Bingham Canyon mine), both located in Salt Lake County. Several small mines in the state are known to produce minor amounts of precious metals but metal-specific production is not reported, and not included in the above totals.

In 1998, silver production statewide was estimated at about 4.0 million oz (0.12 million kg), about 800,000 oz (24,900 kg) less than 1997. Silver was produced as a by-product metal from the Bingham Canyon mine.

## **Industrial Mineral Production**

The industrial minerals segment, valued at \$543 million, was the second-largest contributor to the value of minerals produced in 1998. Major commodities produced by group or individual commodity in descending order of value included: (1) salines, including sulfate of potash, salt, potash (KCl), and magnesium chloride; (2) sand and gravel, and crushed stone; (3) Portland cement, lime, limestone, and dolomite; (4)

phosphate; (5) gilsonite; (6) gypsum; (7) common clay and bentonite; and (8) expanded shale.

### **Salt, Magnesium Chloride, Potash (Potassium Chloride), and Sulfate of Potash**

Brine-derived products including salt are the largest contributors to the value of industrial mineral production in Utah. In addition to salt, other brine-derived products include magnesium chloride and potash (potassium chloride and sulphate of potash [SOP]). The production of salt and other brine-derived products statewide is estimated to be 2.7 million st (2.4 million mt) in 1998, the same as 1997.

Salt production alone is estimated to be 1.7 million st (1.5 million mt) in 1998, with most of the production coming from three operators using brine from Great Salt Lake. These operators are, in descending order of production: (1) IMC Kalium Ogden, Inc. (formerly GSL Minerals), (2) Morton Salt Company, and (3) Cargill Salt Company (formerly Akzo Nobel Salt). In addition, three other companies produce salt and/or potash from operations not related to Great Salt Lake: (1) Reilly Chemical Company at Wendover in Tooele County (potash), (2) Moab Salt Company near Moab in Grand County (salt and potash), and (3) Redmond Minerals, Inc. near Redmond in Sanpete County (salt only).

Potash (KCl and SOP) is produced by three companies: IMC Kalium Ogden, Inc., Reilly Chemical Company, and Moab Salt Company at their above-mentioned facilities. Potash production is estimated to be more than 430,000 st (390,000 mt) in 1998, about 90,000 st (82,000 mt) less than 1997.

### **Sand and Gravel and Crushed Stone**

Sand and gravel, and crushed stone (including limestone and dolomite) are the second-highest value industrial minerals produced in 1998. These materials are produced in every county in Utah by commercial operators, and by state, federal, and county agencies. Due to the large number and diversity of producers, operators are not sent UGS production questionnaires. However, data are compiled by the USGS. The latest production data show that in 1997, 33.5 million st (30.4 million mt) of sand and gravel, and 6.9 million st (6.3 million mt) of crushed stone were produced with a combined value of \$126.2 million. Due to increased highway construction, airport runway construction, and rapid population growth, usage should remain relatively high for the next several years.

### **Portland Cement, Lime, Limestone, and Dolomite**

Portland cement and lime were respectively the third- and fourth-highest value industrial minerals produced in 1998. Two operators produce Portland cement in Utah: Holnam, Inc. and Ash Grove Cement Company. Holnam's Devil's Slide plant is east of Morgan in Morgan County, and Ash Grove's Leamington plant is east of Lynndyl in

Juab County. Both companies have recently expanded production capacity and the two plants have a combined capacity of more than 1.5 million st (1.4 million mt) of cement annually, up from 1 million st (0.9 million mt) in 1997. Both plants operated at or near capacity in 1998.

Lime demand and production remained strong in 1998. Continental Lime Company, which produces high-calcium lime, and Chemical Lime of Arizona, Inc., which produces dolomitic lime, are the two suppliers of calcined limestone (quick lime) and hydrated lime in Utah, with a combined capacity of more than 1 million st (0.9 million mt) per year. Both operations serve markets in Utah and surrounding states. Continental Lime's plant is in the Cricket Mountains, approximately 35 miles (56 km) southwest of Delta in Millard County, and is rated as one of the 10 largest lime plants in the United States. Chemical Lime of Arizona's plant is near Grantsville in Tooele County.

Nine companies quarried 2.4 million st (2.2 million mt) of limestone and dolomite in 1998 which was used mainly in the construction industry (2.1 million st [1.9 million mt]). Approximately 300,000 st (270,000 mt) were used in steel-making and for flue gas desulfurization in power plants. The three largest suppliers of crushed aggregate used in construction are: Valley Asphalt Company from two quarries in Utah County, Larsen Limestone Company from one quarry in Utah County, and Harper Construction Company from one quarry in Salt Lake County. A small amount of limestone and dolomite was also crushed to a fine powder and marketed as "rock dust" to the coal mining industry.

## **Phosphate**

Utah's only phosphate operation, SF Phosphate Ltd.'s Vernal Phosphate Operation, is 11 miles (18 km) north of Vernal in Uintah County. SF Phosphates is a partnership of Farmland Industries, Inc. (Missouri) and J. R. Simplot, Inc. (Idaho). The company mines roughly 2.5 million st (2.3 million mt) of ore annually, which is processed into about 1 million st (0.9 million mt) of concentrate and transported in slurry form to the company's Rock Springs, Wyoming fertilizer plant via a 90-mile-long (144-km-long) underground pipeline. During 1998 the mine produced more than 3 million st (2.7 million mt) of ore, the highest production level in the past seven years.

## **Gilsonite**

Gilsonite production for 1998 is estimated to be 65,000 st (59,000 mt), about the same as 1997. Gilsonite is an unusual solid hydrocarbon that has been mined in Utah for more than 100 years. The three operations that produce gilsonite are all near the town of Bonanza in eastern Uintah County. In descending order of production they are: (1) American Gilsonite Company's Bonanza mine, (2) Zeigler Chemical and Minerals Company's Zeigler and Tom Taylor mines, and (3) Lexco, Inc.'s Cottonwood mine. Gilsonite is used in over 150 products ranging from printing inks to explosives and is

marketed worldwide. Gilsonite production has been relatively stable for the past several years.

## **Gypsum**

More than 400,000 st (363,000 mt) of gypsum were produced by six companies in 1998, slightly more than in 1997. In descending order of production the companies are: (1) Georgia Pacific Corporation, (2) U.S. Gypsum Company, (3) Thomas J. Peck and Sons, (4) H.E. Davis and Sons, (5) D.K. Gypsum Industries, and (6) Western Clay Company. Both U.S. Gypsum and Georgia Pacific operate wall board plants near Sigurd in Sevier County. The majority of gypsum produced in Utah is used for making wall board, but several operators supply raw gypsum to regional cement companies where it is used as an additive to retard the setting time of cement and to the agriculture industry for use as a soil conditioner.

## **Common Clay and Bentonite**

More than 225,000 st (204,00 mt) of common clay and more than 70,000 st (64,000 mt) of bentonite were produced by five companies in 1998, a moderate increase in common clay production and a significant increase in bentonite production compared to 1997. In descending order of production the companies are: (1) Interstate Brick Company (common clay), (2) Redmond Minerals, Inc. (bentonite), (3) Paradise Management Company (common clay), (4) Western Clay Company (bentonite), and (5) Interpace Industries, Inc. (common clay). More than 75 percent of all clay is used in the manufacture of brick. Bentonite is used as a sealant in many civil engineering applications, as a pet waste absorbent (litter box filler), as an additive in oil and gas drilling fluids, and as a binder in foundry molds.

## **Expanded Shale**

One company, Utelite, Inc., mined about 180,000 st (163,000 mt) of shale to manufacture 'expanded shale' for use as a lightweight aggregate for the construction industry. The mine is located near the town of Wanship in Summit County. Production of 'expanded shale' products has increased moderately over the past several years. Two other companies (Holnam and Ash Grove Cement) mine modest amounts of shale for use in the manufacture of cement.

# **Energy Minerals Production**

## **Coal**

Utah's coal producers, which operate 12 underground mines and one coal recovery plant, produced 26.6 million st (24.1 million mt) of coal valued at \$479 million in 1998,

about 200,000 st (181,000 mt) more than 1997. Production in 1998 was the second-highest amount of coal produced in Utah history (figures 3 and 4). The mines are located in Carbon (7), Emery (4), and Sevier (1) Counties in east-central Utah. The coal recovery facility is located near the town of Wellington in Carbon County. The five largest mines, in descending order of production, are: (1) SUFCO, operated by Canyon Fuel Company, LLC (Sevier County), (2) Deer Creek, Operated by Energy West Mining Company (Utah Power, Inc.) (Emery County), (3) Skyline #1 and #3, operated by Canyon Fuel Company, LLC (Carbon and Emery Counties), (4) Crandall Canyon, operated by Genwal Coal Company (Emery County), and (5) Trail Mountain, operated by Energy West Mining Company (Emery County). Slightly more than 50 percent of Utah's coal was consumed by electric utilities within the state. Coal is used for industrial and other purposes within the state, shipped to electric utilities and industrial users in other states, and exported to Pacific Rim countries for both power generation and industrial use.

Two new mines began producing coal in 1998: Dugout Canyon mine operated by Canyon Fuel Company, LLC and Horizon mine operated by White Oak Mining and Construction Company. Both mines are located in Carbon County. Two additional mines (also in Carbon County) are in the permitting process. Coal production is expected to reach a record high in 1999.

## **Uranium**

IUC mined a small amount of uranium-vanadium ore from its re-opened Rim mine in the East Canyon (Dry Valley) area in San Juan County. Approximately 7,000 st (6,350 mt) of ore averaging 0.08 percent  $U_3O_8$  and more than 2.0 percent  $V_2O_5$  was mined between May and December 1998 and shipped to IUC's White Mesa mill for processing. The Rim mine is currently on standby and will resume operations when the vanadium market improves. Several other independent mines shipped ore to the White Mesa mill. Approximately 1,000 st (900 mt) of stockpiled ore was shipped from the Neighbor mine in the East Canyon area and about 2,000 st (1,800 mt) of mined ore was shipped from the Snake and Spring Creek mines in the Cottonwood Canyon area, also in San Juan County. In addition, NBS Mining Company produced about 300 st (270 mt) of ore from their Cougar No. 1 mine in the Yellowcat area of the Thompson district in Grand County. Nearly all of the ore was from Morrison Formation-hosted deposits, which have a high vanadium content.

IUC has four other permitted uranium mines in Utah that are on standby. The company may open several of these mines when market conditions improve. Hanson Exploration Company acquired six small uranium-vanadium mines, mostly in the East Canyon area, and plans to begin permitting these properties. In addition, a number of other uranium-vanadium mines, mostly operated by local miners, are ready to resume production as the markets for uranium, and more importantly, vanadium improve.

IUC has been stockpiling uranium-vanadium ore at the White Mesa mill and plans to process the stockpile beginning in April 1999. The stockpile contains about 80,000

st (72,600 mt) of ore from the company's Sunday (Colorado) and Rim mines, and ore purchased from independent miners. About 4,000 st (3,600 mt) per month is produced from the company mines and IUC purchases 1,000 to 2,000 st (900 to 1,800 mt) per month from outside sources.

The White Mesa mill processed "alternate feed" for almost all of 1998. The 2,000 st- (1,800-mt) per-day mill operated for about 10 months with a two-month hiatus in early summer when it was shut down to allow modification of the tantalum and niobium circuit to improve recovery. During 1998, the mill produced about 45,000 lbs (20,400 kg) of  $U_3O_8$  and an undisclosed amount of tantalum and niobium from alternate feed. Alternate feeds acquired included 16,000 st (14,500 mt) of uranium-tantalum-niobium-bearing industrial by-products from Cabot Corporation in Pennsylvania, 40,000 st (36,300 mt) of uranium tailings and partially processed uranium ore from the U.S. Army Corp of Engineers in New York, and a small tonnage of high-grade uranium conversion residue from Cameco Corporation in Canada.

The uranium tailings and partially processed ore were initially milled in the late 1940s to early 1950s using less sophisticated metallurgy. The Cabot Corporation milling campaign ended in August 1998. The Corp of Engineers milling campaign started in October 1998 and should be completed by March 1999, followed by the Cameco residue.

U.S. Energy Corporation, through its wholly owned subsidiary Plateau Resources Ltd., continued to rehabilitate its Shootaring Canyon mill near the town of Ticaboo in eastern Garfield County. During 1998, the company upgraded the leach and pulp storage tanks, checked and refurbished all rubber-lined tanks, and ordered a new mill operations computer system. Installation of a five-part liner system for the tailings pond should begin in 1999.

The Shootaring Canyon mill is a 750- to 1,000-st- (680- to 900-mt) per-day, acid-leach, solvent extraction uranium mill and was the last uranium mill constructed in the U.S. All federal and state operating permits have been obtained. The start-up date for milling will depend on uranium market conditions. The initial mill feed will be stockpiled ore from the Tony M mine with later feed consisting of ore mined from the Tony M mine and ore for toll milling from other operations.

The Tony M stockpile contains 220,000 st (200,000 mt) of 0.138 percent  $U_3O_8$ , a sufficient amount for the first year's milling campaign. The Tony M mine has indicated mineable reserves of 5 million pounds (2.3 million kg) of uranium ( $U_3O_8$ ). Two other zones of uranium mineralization are known in the area but additional drilling would be required to finalize a detailed mine plan. These areas could contain as much as 20 million pounds (9.1 million kg) of uranium.

### **Base- and Precious-Metals Exploration Activity**

Most of the exploration activity was concentrated in and around several well-known areas and mining districts: (1) Oquirrh Mountains area (including West Mountain and Mercur districts); (2) East and Main Tintic districts in the Tintic area; (3) San Francisco,

Rocky Range, and Beaver Lake districts and the Blue Mountain-Blawn Mountain area in the Milford area; (4) Clifton-Gold Hill district in west-central Utah; (5) Washington-Indian Peak and Silver Reef districts in southwestern Utah; (6) Kaiparowits Plateau area in south-central Utah; and (7) Lisbon Valley in southeastern Utah (figure 5).

Most drilling was to define reserves at known mines and/or was follow-up drilling to further test areas that had previously been drilled, mostly between 1994 and 1997. There was only a minor amount of true 'grass roots' exploration or drilling in the state; even sampling and geophysical surveys were mostly confined to old districts or areas of known mineralization.

### **Oquirrh Mountains Area**

Exploration activity in the Oquirrh Mountains in 1998 was the lowest it has been in many years. Kennecott Utah Copper Company disbanded its near-mine exploration group in early 1998 and the company has done no exploration or drilling outside the immediate mine area. No activity was reported in either the Stockton or Ophir districts and only minor work was done in the Mercur area.

Barrick Resources (USA), Inc. conducted some surface exploration in the Mercur district of the southern Oquirrh Mountains in 1998, and plan a modest drilling program in 1999 to test several targets in and around their Mercur property. The last ore was mined at Mercur in March 1997, and the last tailings were reprocessed in 1998. The tailings pond is currently being dewatered and when dry will be reclaimed. By the end of 1998 all other mine areas and facilities had been reclaimed.

### **Tintic Area**

Chief Consolidated Mining Company (Chief Consolidated) continued to explore several properties in the East and Main Tintic districts through its various joint ventures and subsidiaries (Tintic Utah Metals, LLC and Chief Gold Mines).

Tintic Utah Metals, owned by Chief Consolidated (75 percent) and Korea Zinc Company (25 percent), continued exploration on the Burgin-Apex property and adjacent Eureka Standard property (held by Chief Gold Mines). In the Apex mine, Tintic Utah Metals tested the "Silver Fissure," a zone of high-grade fissure veins, on and above the 1300 level of the mine. The "Silver Fissure" is a high-angle, west-dipping, siliceous, silver-copper-lead fissure vein in the Tintic Quartzite. An ore zone 350 ft (110 m) long, 2 to 4 ft (0.6 - 1.2 m) wide, and averaging about 30 ounces per st (oz/st) (1,029 grams per metric ton [g/mt]) silver has been delineated. Ore reserves have not yet been announced.

To the southwest, in the Eureka Standard mine, the Eureka Standard fault zone was tested above the 1300 level. Nineteen underground holes were drilled totaling 3,400 ft (1,040 m). Fifteen holes were mineralized and five contained ore-grade material. The target was high-grade, siliceous, gold-silver-bearing fissure veins. The

tested zones are above the water table and could be mined with minimum development. Mining could begin as early as mid-1999.

Tintic Utah Metals continued work on dewatering plans for the Burgin mine. The joint venture submitted a dewatering permit application to the Utah Division of Water Quality and entered into an agreement with U.S. Filter Corporation to determine the feasibility of a water treatment plant to treat and recycle produced mine water. The projected dewatering rate for the Burgin mine is estimated to be about 12,000 gallons per minute (760 liters per second).

No drilling was done in the Burgin mine in 1998, but new reserve numbers were released based on previous drilling. The proven and probable reserves are 1,075,000 st (975,000 mt) of ore with an average grade of 16.5 oz/st (566 g/mt) silver, 21 percent lead, and 6.7 percent zinc. Potential reserves are 407,000 st (369,000 mt) of ore with an average grade of 15.4 oz/st (531 g/mt) silver, 16 percent lead, and 5.2 percent zinc. Additional ore will likely be delineated by in-fill drilling. At least three undrilled areas exist between the known ore areas. Ore probably extends into these areas beyond the limits of the drill-tested reserves.

The Burgin mill is currently being rehabilitated and regulatory permitting is underway. The mill will initially process ore from the Apex, Eureka Standard, and Trixie mines. Future mill feed could come from numerous other mines controlled by Chief Consolidated including the Burgin, Plutus, and Iron Blossom.

Chief Gold Mines has rehabilitated the Trixie shaft to the 1200 level and rehabilitated stations and drifts on the 750, 1050, and 1200 levels. Drift rehabilitation is continuing on the 750 and 1200 levels in preparation for the 1999 underground drilling program. The target is steeply dipping gold-copper fissures and breccia ore in quartzite. If successful, mine production could begin in mid- to late 1999.

In the Main Tintic district, Chief Consolidated continued a modest exploration program in the Plutus and Iron Blossom mine areas. The 1600 level of the Plutus mine was rehabilitated to the America Star area (south) and three underground holes were drilled to test the projected ore zone between the 1400 and 1800 levels. Chief is also evaluating the feasibility of developing the Iron Blossom mine. Proven reserves are 70,000 st (63,000 mt) of gold-silver-copper jasperoid ore, but only a portion of the ore is mineable. The company is also doing gravity and flotation testing on dump and tailing samples to evaluate the feasibility of re-treating several large mine dumps, particularly the Chief and Gemini dumps.

### **Milford Area**

The Milford area was the most active exploration area in the state in 1998. At least eight companies explored mostly in the San Francisco, Beaver Lake, and Rocky Range districts, and Blue Mountain-Blawn Mountain area. Most exploration was for porphyry-breccia pipe gold-copper, disseminated sediment-hosted, or jasperoid gold deposits. Other exploration was for oxidized zinc. West Hills Excavating Company and its sister

company, Breccia Development Ltd., were the most active, drilling over 60 reverse circulation (RC) holes in the area.

### **San Francisco District**

Several companies continued exploring on properties held by Horn Silver Mines in the San Francisco (Frisco) district west of Milford in Beaver County.

Kennecott Minerals Company drilled six holes totaling 6,000 ft (1,830 m) on a breccia pipe gold-copper target southeast of the Cactus mine in the southern San Francisco Mountains. Kennecott is currently evaluating the results to decide about additional follow-up work. No assay results have been released.

Breccia Development drilled 23 angled RC holes in several fan patterns at the Horn Silver mine to refine grade-thickness estimates for the oxidized zinc zone on the footwall (west) side of the Horn Silver fault. The zinc mineralization occurs as a sheath on the footwall of the Horn Silver vein and as irregular replacements in limestone. Individual drill holes were 250 to 400 ft (76-120 m) long and tested the zinc zone to a depth of about 400 ft (120 m). Assay results have not been released.

Farther to the northeast, Sepa Resources, Inc. completed one deep core hole in 1998. The hole intersected altered and pyritized volcanic rock but no ore-grade mineralization. The company plans to complete one or more additional core holes in 1999. The target is porphyry copper mineralization beneath altered volcanic rocks.

### **Rocky Range-Beaver Lake Districts**

During 1998, Nevada Star Resources Company drilled 44 holes on their Milford copper properties to confirm previous exploration results. Five core holes totaling 905 ft (276 m) and 39 RC holes totaling 6,974 ft (2,126 m) were drilled. Most of the drilling was on the Cortex properties in the Rocky Range district, but some drilling was on the Grand Central properties in the Beaver Lake district to the northwest. Drilling results confirmed previous exploration and identified several additional zones of lower grade copper mineralization. The drill-indicated resource for the combined properties (Cortex and Grand Central) is 6.4 million st (5.8 million mt) of 0.74 percent copper containing a mineable resource of 2.5 million st (2.3 million mt) of 1.2 percent copper. A bankable feasibility study completed by Western States Engineering indicated copper could be produced at a cash cost of \$0.57/lb (\$1.26/kg) for a 5,000 st (4,500 mt) per year copper metal operation. Nevada Star is currently evaluating the results in light of currently depressed copper prices.

### **Blue Mountain-Blawn Mountain Area**

Breccia Development explored a number of prospects in the Blue Mountain area southwest of Milford with mixed success. The company drilled a single 1,400 ft (427 m) hole on its Three Dog prospect to test for porphyry copper mineralization. The

prospect is near the northeast corner of Blue Mountain close to the Moonshine Well range front fault. The hole targeted a small magnetic anomaly; the test was inconclusive as the hole never hit bedrock. Additional drilling to the west and south is planned for 1999 to test magnetic and molybdenum-copper geochemical anomalies. Six holes totaling 2,000 ft (610 m) were drilled on the Moonshine property southeast of Blue Mountain with negative results. The target was disseminated gold beneath alluvial cover.

To the west, the company tested several covered areas for precious metal mineralization. Two holes, 300 ft (91 m) and 700 ft (210 m) deep, respectively, were drilled in the Miller Meadow area along Jockey Road. The holes intersected ore-grade mineralization associated with jasperoids in limestone. Additional drilling is planned for 1999.

Twenty-five holes totaling 7,500 ft (2,300 m) were drilled in the AB area west of the Miller Meadow prospect. Drill holes 250 to 350 ft (76-110 m) deep tested for precious-metal mineralization in altered volcanics and underlying silicified limestone. Results were moderately successful with some intercepts as high as 0.02 oz/st (0.69 g/mt) gold. Mineralization occurs both in the volcanics and in the limestone. Only six of the 25 holes have been assayed to date. Additional drilling is planned for 1999 to delineate the resource which may extend farther in several directions. Breccia Development is seeking a partner to explore this and other properties in the area.

Evaluation and pre-production studies continued on the Ruby Violet red beryl deposit eight miles (13 km) northwest of Blue Mountain. In late 1998, Neary Resources through its affiliate Gemstone Mining, Inc. (GMI) exercised its option to acquire the Ruby Violet red beryl gemstone mine and associated claims. The first \$2.5 million payment was made on the \$10 million purchase price with the remaining three payments due over the next 2.5 years. The property had been drilled and bulk sampled by Kennecott Exploration Company between 1993 and 1997 before transferring its option to GMI. GMI did additional drilling and bulk sampling in late 1997, and in 1998 processed a bulk sample of approximately 2,700 st (2,450 mt). This bulk sample yielded 11,430 finished stones for a total of approximately 1,030 finished carats (206 g) and 375 mineral specimens weighing about 108 oz (3,350 g). No additional drilling or sampling was done at the mine in 1998. Probable reserves are 159,000 st (144,000 mt) of ore with a grade of 0.79 oz/st (27.02 g/mt) raw beryl within a probable resource of 1.6 million st (1.5 million mt). Additional potential exists beyond the probable resource area.

GMI completed a positive feasibility study including a strategic marketing study and arranged financing for property purchase, construction, mine equipment capital, and operating costs. A mine plan has been prepared based on a total reserve of 500,000 st (454,000 mt) with an initial production rate of 25,000 st (22,700 mt) per year increasing to 50,000 st (45,400 mt) per year. GMI began limited open-pit mining on the property in late 1998 and plans to increase production to approximately 100 st (90 mt) per day as soon as the current mine permit is upgraded. The ore will be processed at the

company's plant in Minersville and the raw beryl product sent to Red Emerald Ltd. who has been contracted by GMI to cut and market the finished red beryl gemstones.

## **Other Areas**

Breccia Development drilled three holes on the Dead Horse property at the south end of the Shautie Hills. The target was porphyry copper and/or associated base metals in and beneath argillitized dacitic volcanic rocks. Results were permissive for a porphyry system with thick intercepts of argillitized and moderately to strongly pyritized volcanics containing up to 5 percent pyrite. The property is also being evaluated for production of a dust-free road surfacing material. The economics of developing a modest size operation are being investigated.

## **West-Central Utah**

Clifton Mining Company continued to explore their properties in the Clifton-Gold Hill district of western Tooele County and began a limited amount of mining and milling. Work concentrated on the "Clifton shears" geological structures throughout most of the year and during the last quarter on several copper-gold prospects south of the town of Gold Hill.

During 1998, Clifton continued surface and underground sampling of existing workings and performed some additional drifting on the "Clifton shears." Based on the 1998 work, proven and probable reserves for the "Clifton shears" increased nearly 10 percent to 534,000 st (484,000 mt) of ore with an average grade of 8.3 oz/st (285 g/mt) silver, 0.038 oz/st (1.3 g/mt) gold, and 5.6 percent lead. The increase was from additional reserves in the Yellow Cougar, 130-foot Shaft, Lower George, and George Washington vein shear zones. Clifton did some limited mining on three of the shear zones and produced about 3,000 st (2,700 mt) of ore.

The company also did some sampling, drifting, and limited test mining on the "smelter tunnel" deposit in the southwestern part of the "Clifton shears." The "smelter tunnel" is a bedded replacement deposit in limestone developed adjacent to one of the shear zones. No reserves have been calculated for the deposit, but it could contain up to 70,000 st (63,500 mt) of ore of which about 40,000 st (36,300 mt) could be mined by open-pit methods.

In the Gold Hill area, Clifton Mining is evaluating several recently acquired gold and gold-copper properties. Surface and underground sampling have been done in the Cane Springs mine area with a number of samples assaying from 0.04 to nearly 1.0 oz/st (1.4 to nearly 34.3 g/mt) gold. The Cane Springs mine is a gold-copper skarn deposit in garnet-wollastonite marble. Clifton plans to dewater the mine and sample the lower workings to confirm the historic assay results. They will then drill as many as four holes to test the downdip continuation of the ore shoot. The deposit was mined previously to the 149-foot (45-m) level and ore could continue to a depth of 600 ft (180 m) or more. Historical mine ore grades were 0.5 to 1.0 oz/st (17.1 to 34.3 g/mt) gold.

Clifton also did some underground sampling in the Frankie mine 1.5 miles (2.4 km) farther south. Samples averaged 0.053 oz/st (1.82 g/mt) gold and 6.63 percent copper. No additional work is planned for the Frankie mine.

Essentially no exploration work was done in the Kings Canyon area of western Millard County. Crown Resources, Inc. retained its Kings Canyon gold properties but did no exploration work. Several other companies allowed their claims to lapse and many of these have already been restaked by other individuals or companies. Most property owners, however, are retaining their core properties.

Phoenix Gold Resources, Ltd. made several test shipments totaling about 400 st (360 mt) of ore from its Coyote Knolls property north of Delta in the Desert Mountain area to Clifton Mining's mill at Gold Hill but did no other work on the property. Exploration drilling is planned for 1999 to extend the strike length of the mineralization if funding becomes available.

Phelps Dodge Corporation conducted surface sampling on their Maple Peak property located at the south end of the West Tintic Mountains. The sampling confirmed the potential for sediment-hosted gold with a number of jasperoid samples assaying greater than 0.03 oz/st (1.03 g/mt) gold. The host rock is the Mississippian Great Blue Limestone. Phelps Dodge is currently seeking joint-venture partners to continue to explore the property.

Kennecott Minerals did reconnaissance ionization potential (RIP) surveys over the northern Keg Mountains and Desert Mountain to evaluate their porphyry copper potential. No follow-up work is planned.

### **Southwestern Utah**

West Hills Excavating drilled three properties in the Indian Peak Range in western Beaver County to explore for jasperoid-hosted gold. West Hills also drilled six holes on the Elephant Back prospect south of Sawtooth Peak in silicified Ordovician limestone; results were discouraging. Twenty-two holes totaling about 10,000 ft (3,000 m) were drilled on the Indian Peak prospect on the west side of the Indian Peak Range in silicified Cambrian to Ordovician limestone. Drilling encountered significant thicknesses of silicification but no assay results have been released. The property had been previously leased to Royal Gold who drilled seven holes in 1997, before returning the property to West Hills. The 1997 drilling intercepted rock assaying as much as 0.05 oz/st (1.71 g/mt) gold. Additional work is planned for 1999. Farther south, West Hills drilled three holes on the Blue Jay property in addition to the eight holes drilled in 1997; results were moderately encouraging with some intercepts assaying as much as 0.04 oz/st (1.37 g/mt) gold.

Phelps Dodge did extensive surface sampling in the Stateline district and confirmed widespread gold mineralization in a quartz adularia system in altered volcanic rocks. Phelps Dodge believes the property has both high-grade vein and bulk precious-metal potential and is currently seeking joint-venture partners to continue work in the district.

No drilling was done in the Goldstrike district in 1998. Bull Valley, LLC controls the central part of the district and they have been seeking joint-venture partners. Bull Valley believes the property has potential for deep ore along and adjacent to east-west- and northwest-trending feeder faults. The company plans to drill a few deep holes to test this concept during 1999 if they are unsuccessful in finding a partner.

Silver Standard Resources drilled 12 holes totaling about 7,000 ft (2,100 m) in the northern part of the Silver Reef district to extend the strike length of mineralization discovered in 1997. The target was disseminated silver-copper mineralization in the western downdip continuation of the White Reef sandstone at depths of 400 to 700 ft (120-200 m). The holes intersected anomalous to ore-grade mineralization with grades of 2 to more than 8 oz/st (69 to more than 274 g/mt) silver, and associated copper (as much as 1.0 percent) over thicknesses of 5 to 40 ft (1.5-12.2 m). The company is currently evaluating the results and intends to seek a joint-venture partner to further explore the property and the surrounding area.

### **South-Central Utah**

3-R Minerals began mining and pilot testing of Holocene titanium- and zirconium-bearing alluvium on their lease in Alvey Wash in the Kaiparowits Plateau area south of Escalante in Garfield County. Work consisted of shallow test mining of surface sands at several sites in Alvey Wash and concentration of the contained titanium- and zirconium-bearing heavy minerals by spiral classifiers. Plant capacity is about 2 st (1.8 mt) per hour, but 3-R Minerals plans to increase capacity by staged expansions with ultimate capacity of 50 st (45 mt) per hour.

At full capacity the operation could produce 2 to 3 st (1.8-2.7 mt) per hour of heavy mineral concentrate consisting of about 75 percent zircon and 25 percent ilmenite. The feed is fluvial point bar sands and gravels containing zircon and titanium minerals eroded from Cretaceous fossil placer deposits, and from sandstone containing widely disseminated grains of zircon, ilmenite, and rutile. Heavy mineral content for the alluvium is variable; 1-2 percent zircon is common with some samples containing as much as 10 percent zircon.

In addition, 3-R Minerals continues to evaluate the heavy mineral potential of the Cretaceous sandstone on their existing leases. Stratigraphic sampling and analysis using X-ray fluorescence (XRF) outlined a number of additional zircon-rich horizons. These zircon-rich horizons are not easily identified; they are generally not magnetic or radioactive, contain only minor opaque iron minerals, and do not necessarily occur at the top of regressive marine sandstone. 3-R Minerals has recognized several stacked zircon-rich horizons stratigraphically below the cemented iron-titanium-zircon-bearing horizons. Nearly all of the earlier exploration work was confined to these cemented horizons.

The status of the Calf Canyon-Dave Canyon claims of 3-R Minerals is not yet decided. The U.S. Bureau of Land Management (BLM) rejected 3-R Minerals' application for a drilling permit because the claims were located after the Wilderness

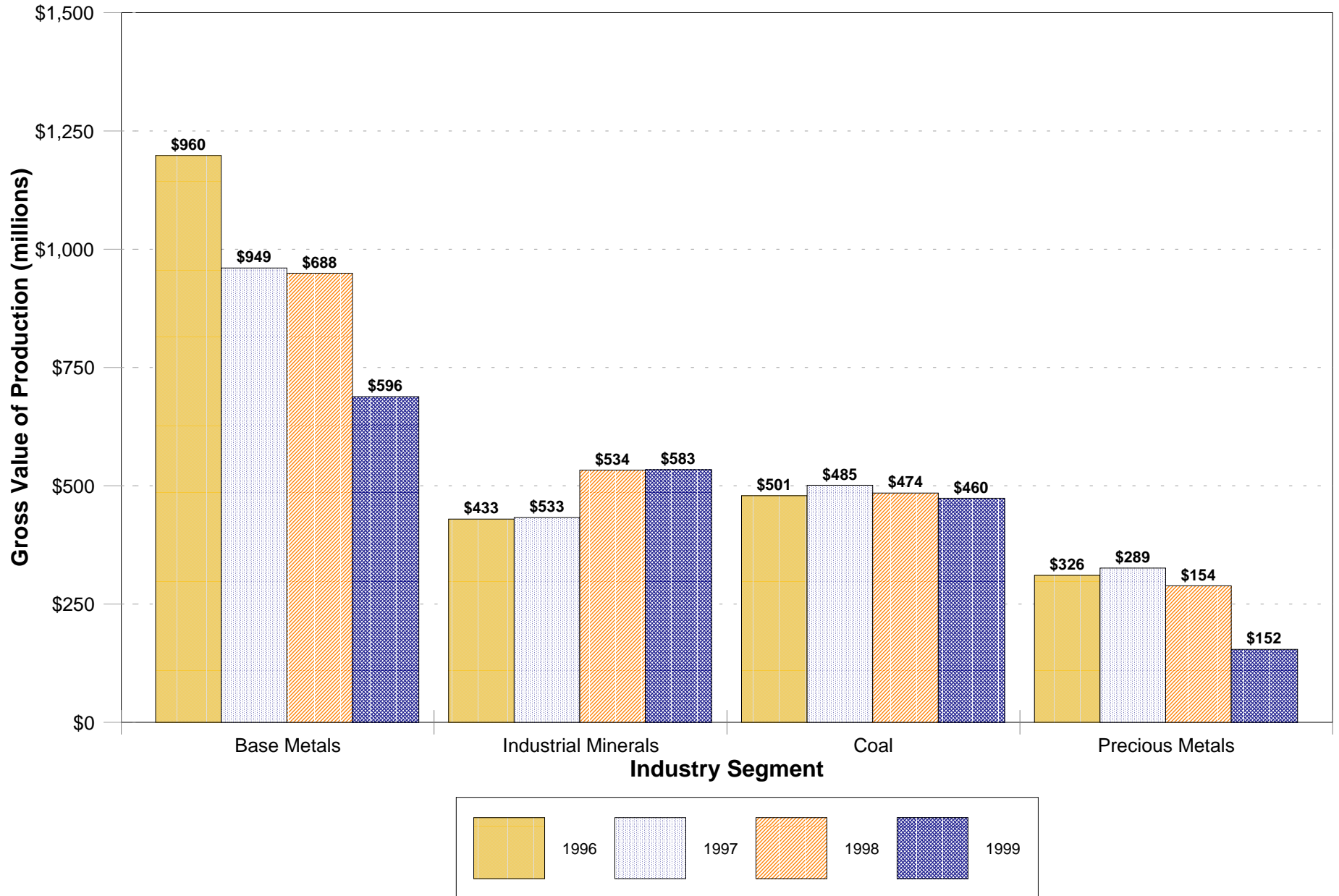
Study Area was established and the BLM contends that any activity must follow rules governing wilderness. 3-R Minerals appealed the decision to the Interior Board of Land Appeals (IBLA) which has reviewed the appeal but has not yet announced a decision. The development of these claims and the other existing leases is uncertain because they are all within the boundaries of the Grand Staircase-Escalante National Monument.

### **Southeastern Utah**

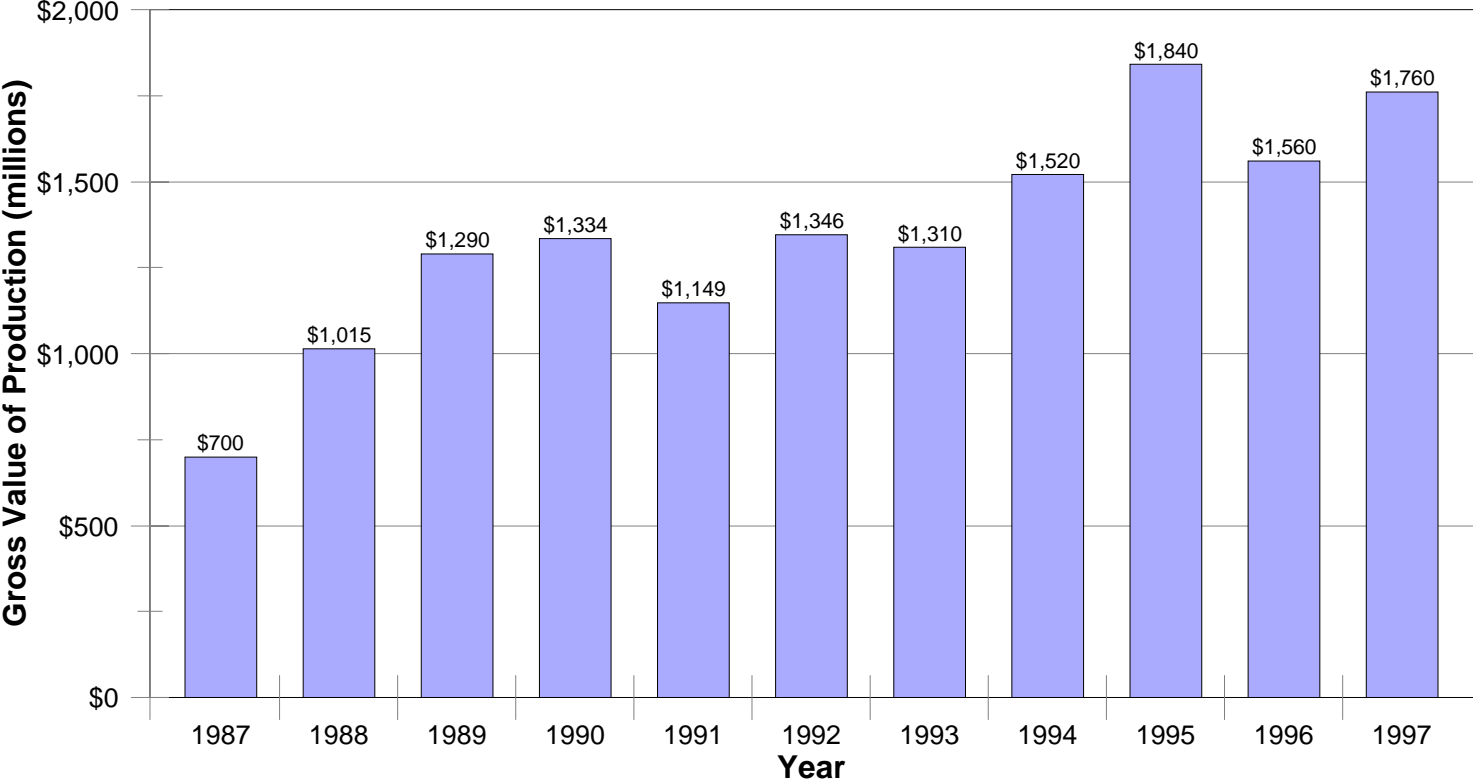
In September 1998, IBLA rendered a decision allowing Summo Minerals Corporation to develop its Lisbon Valley copper mine in northern San Juan County. The BLM initially approved the project in February 1997, with issuance of the Final Environmental Impact Statement (FEIS) and Record of Decision, but this decision was appealed to IBLA by several environmental groups. The IBLA issued a stay on mining until several questions regarding the potential of ground-water contamination could be addressed. In early 1998, Summo Minerals completed a study that confirmed and supported the conclusions reached in the FEIS. As part of the study, eight additional ground-water wells were drilled in addition to the existing 12 wells and ground-water samples were collected and analyzed. The results confirmed that the water is Class III, suitable for industrial and agricultural applications only, and that the proposed mining would *actually improve* the quality of the ground-water. The BLM submitted its final brief incorporating these results in March 1998 and the final IBLA decision was rendered on September 24, 1998. This decision was again appealed by several environmental groups who filed a Petition for Reconsideration with the IBLA in November 1998. The BLM plans to submit its response to the IBLA in February 1999, with a final decision expected in mid-1999.

Although Summo is legally free to proceed with the project, construction and development have been postponed indefinitely. During the nearly two-year delay, the financing arrangements expired and Summo is attempting to arrange replacement financing for the \$45 million project. Should financing be obtained, Summo would probably proceed with construction and development of the mine, with mining scheduled to begin 10 to 12 months later. Current announced reserves are 46.5 million st (42.2 million mt) of ore at an average grade of 0.424 percent copper in three designated mine areas. There is additional resource potential between and below the designated mine areas which could double the current reserves.

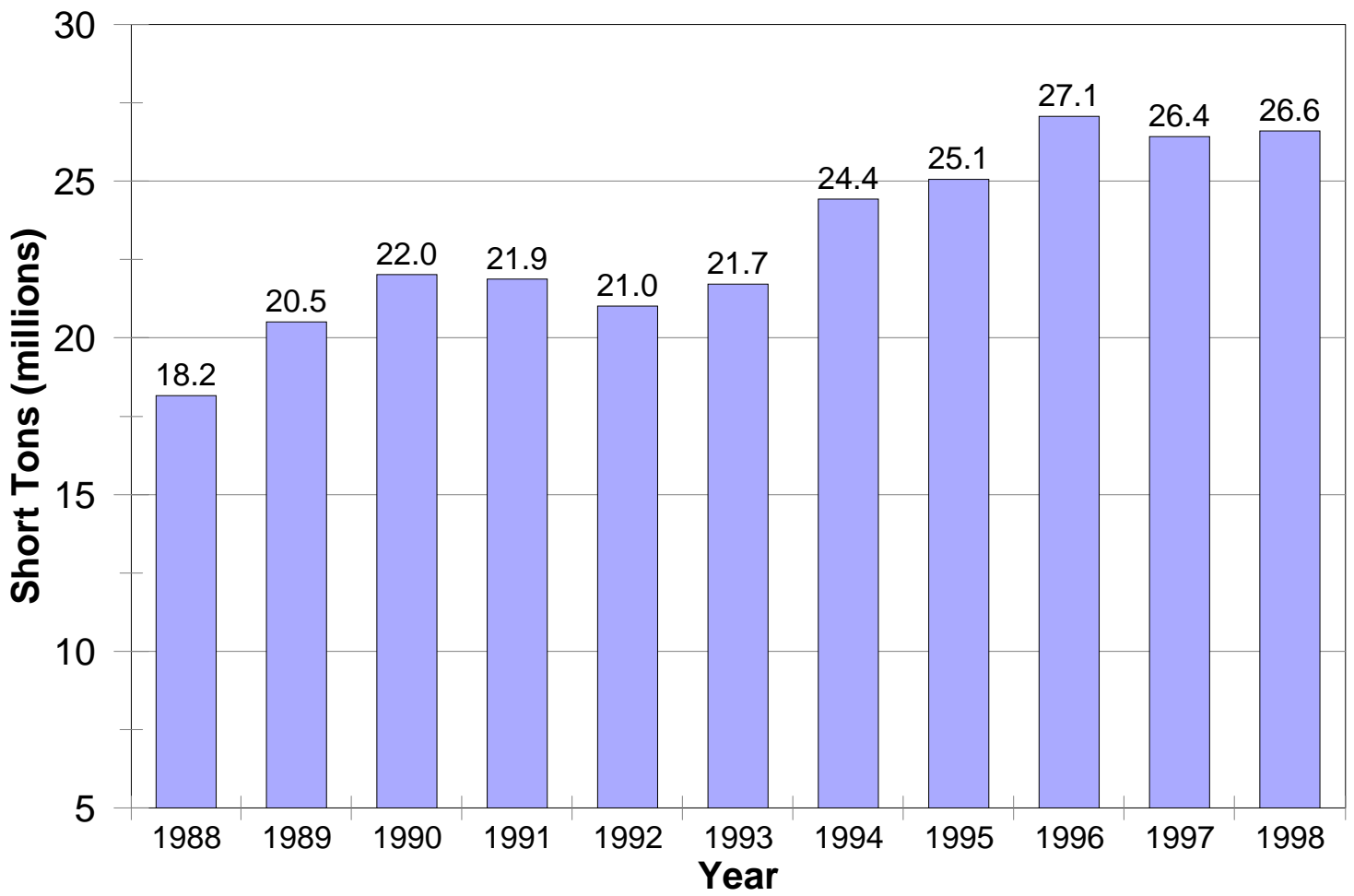
**Figure 1:Utah mineral & coal valuation  
gross value estimates, 1995-1998**



**Figure 2: Utah nonfuel minerals valuation 1987 through 1997**



**Figure 3: Utah coal production  
1988 through 1998**



**Figure 4: Utah coal valuation  
1988 through 1998**

