UTAH'S EXTRACTIVE RESOURCE INDUSTRIES 2011

by Taylor Boden, Michael Vanden Berg, Ken Krahulec, Dave Tabet, and Mark Gwynn

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Cover photo: *Pumpjack on the Aneth oil field in San Juan County, Utah.*

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ABSTRACT

Utah energy and mineral companies produced an estimated gross value of $9.2 billion in energy and mineral commodities in 2011. On an inflation-adjusted basis, this is a $0.6 billion (7%) increase over 2010, but a $0.7 billion (7%) decrease from the 2008 record high of $9.9 billion. Nonfuel mineral production was valued at $4.6 billion, including $2.6 billion from base-metal production, $1.2 billion from industrial mineral production, and $0.7 billion from precious metal production. Total energy production in 2011 was valued at $4.6 billion, including $2.2 billion from crude oil production, $1.8 billion from natural gas production, $0.7 billion from coal production, and $0.03 billion from uranium production.

U.S. Geological Survey preliminary data ranked Utah as 4th nationally in 2011 for the value of nonfuel mineral production, accounting for approximately 6.2% of the United States total. Utah remains the only state in the nation to produce magnesium metal, beryllium concentrate, and gilsonite. Utah's only iron mine produced 1.3 million metric tons (1.4 million short tons) of run-of-mine iron ore and is expected to increase production when a concentration facility comes online.

From 2010 to 2011, Utah experienced an increase in oil and gas exploration and development activity, with the number of wells permitted increasing from 1185 to 1515, and the number of wells started (spud) increasing from 973 to 989. Utah's coal production increased 3.4% to 18.2 million metric tons (20 million short tons) in 2011 mostly due to the Castle Valley mine returning to production. However, Utah's coal production is expected to significantly decline in 2012 due to the current weak domestic coal market. Utah's uranium production was consolidated into one company in 2011, and this should facilitate increased production into the foreseeable future provided that uranium prices are stable. Mineral exploration in Utah during 2011 was primarily focused on gold, silver, copper, uranium, and potash. The number of new unpatented mining claims filed with the U.S. Bureau of Land Management in Utah has risen dramatically, from 1467 in 2010 to 5659 new claims in 2011 for a total of over 22,400. The Utah Division of Oil, Gas, and Mining approved two new large mine permit applications and eight new small mine permits, in addition to 26 Notices of Intent for mineral exploration on public lands.

INTRODUCTION

Background

Utah mineral activity summaries have been compiled annually since 1989 by the Utah Geological Survey (UGS). To maintain uniformity and continuity, the general style used in previous editions of this report will be continued. However, the title was changed from *Utah Mining 2010* to *Utah's Extractive Resource Industries 2011* to reflect the addition of crude oil, natural gas, and unconventional fuels sections. Sulfuric acid recovered at the Bingham copper smelter has also been added to the industrial minerals segment for the first time this year. The format was also modified by combining the production-value, and exploration-development activity sections together under a specific commodity group heading. Final figures were made available for 2010 production and value in the fourth quarter of 2011; subsequently some of the production and value figures published in *Utah Mining 2010* were revised when comparisons were made between 2010 and 2011 production and value. The 1996–2011 Utah mineral/mining summaries are available on the UGS website at http://geology.utah.gov/utahgeo/rockmineral/index.htm#minactivity.

Since 1993, Utah's mineral industry activity summaries have categorized mineral production and value into four broad segments consisting of base metals, precious metals, industrial minerals, and energy minerals (coal and uranium). The *Utah Mining 2010* publication marked the first combination of the separately published Annual Utah Coal Report with the Mineral Activities Summary. This year marks the first inclusion of crude oil, natural gas, and unconventional fuels production, value, exploration, and development activity summaries, resulting in one comprehensive energy and mining activity report for Utah. The U.S. Geological Survey (USGS) and the Utah Division of Oil, Gas, and Mining (DOGM) provided much of the data compiled for this report. Additional data were obtained from individual operator surveys, company websites, trade industry publications, and personal correspondence.

Historical Context

Utah's geology provides a remarkable range of energy and mineral wealth. The development of these resources for over 160 years has been and will continue to be very important,

benefitting not only Utah, but also the entire United States. Mining has played a vital role in Utah's economy and is the oldest nonagricultural industry in the state, employing thousands directly in mining, processing, and transportation, and indirectly in supporting occupations. The year 1847 marks the beginning of the recorded mining history of Utah. Soon after their arrival, Latter Day Saint pioneers began developing mineral resources, and their earliest efforts included: recovering salt from Great Salt Lake; coal mining near Coalville, Wales, and Cedar City; quarrying building stone; and manufacturing clay and lime products (Alexander, 2006).

With the arrival of the Third California Infantry under Colonel Patrick E. Connor came the discovery of significant base and precious metal deposits in the 1860s at Bingham Canyon and Stockton in the Oquirrh Mountains, and in Little Cottonwood Canyon and the Park City area in the Wasatch Range (Krahulec, 2005). After the completion of the transcontinental railroad in 1869, branch lines were developed to access mining districts and ore produced in Utah became more economic, exceeding a value of $100 million by 1917 (Stowe, 1975). Development of mining and transportation infrastructure in Utah established it as one of the largest mining and smelting centers in the western U.S. by the early 1900s. Porphyry copper mining began in Bingham Canyon in 1904, and the copper, gold, silver, and molybdenum produced from the deposit currently make it the single most valuable operation in Utah. Utah is distinguished by being the nation's only source of gilsonite since the late 1880s (Boden and Tripp, 2012), beryllium concentrate since 1969 (Alexander, 2006), and magnesium metal since 1972 (Krahulec, 2005). Demand for uranium used in nuclear weapons and power resulted in the development of Utah's uranium deposits in southeastern Utah starting in the 1950s and 1960s. In 1952, Charlie Steen made the biggest discovery of uranium ore to date on the Colorado Plateau, and developed the Mi Vida mine in the Big Indian Wash area of San Juan County. Oil and gas exploration in Utah extends back over 100 years. The first natural gas deposit locally used in Utah was accidentally discovered in 1891, from the drilling of a water well in Farmington Bay on the eastern shore of Great Salt Lake (UGS, 2006). The gas was later transported from several wells near this area by a wooden pipeline to Salt Lake City. Oil was first discovered in Utah in the early 1900s at three places, Rozel Point on the shore of Great Salt Lake in Box Elder County, Mexican Hat in San Juan County, and near the town of Virgin in Washington County (UGS, 2006). By 1960 Utah was the 10th largest oil-producing state in the nation.

By 1969, the total value of minerals produced in Utah and sold commercially had grown to $500 million (Stowe, 1975) and surpassed $1 billion in 1988 (Walker and Smith, 1989). According to data compiled by the UGS, USGS, and other sources, the nominal value of energy and minerals produced annually in Utah, including metals, nonmetals, mineral fuels, and hydrocarbon fuels, reached a record high in 2008. Worldwide recession beginning in 2008 affected nearly every aspect of Utah's economy, including mining, and is reflected in the decrease in the value of Utah's energy and mineral production in 2009. Fortunately, ongoing economic recovery in 2011 has resulted in a moderate increase in the value of Utah's energy and mineral production, regaining much of the prior losses.

The contribution of energy and mineral production to the Utah Gross Domestic Product (GDP), compared to the value of all goods and services statewide, has decreased from about 6.0% in the 1960s to about 1.5% in the early 2000s as the state has grown in other economic sectors. However, the contribution of the energy and mineral industries to Utah's GDP has grown in recent years from 1.5% in 2005 to 2.3% in 2011 (U.S. Bureau of Economic Analysis, 2012). The demand and price for energy and mineral commodities produced in Utah will likely continue to rise into the future, ensuring that energy and mineral industries will remain an important contributor to the state's economy.

Industry Overview

Gross value of all energy and mineral commodities produced in Utah during 2011 is estimated at $9.2 billion, representing a 7% increase over the 2010 inflation-adjusted value of $8.6 billion (figure 1). The decrease in values of base metals and natural gas from 2010 to 2011 were more than made up by increases in the value of oil, industrial minerals, precious metals, and coal. The 2011 total energy and mineral production value is the second highest since the inflation-adjusted record of $9.9 billion achieved in 2008. Prices for a number of energy and mineral commodities continued to rise from 2010 to 2011, with a sharp increase for some metals in 2011. However, lower copper production resulted in an overall lower value for base metals than in 2010. Despite a decrease in precious metals production, high prices in 2011 resulted in an increase in value, but due to copper's large share of metals value, the overall value of metals decreased slightly from 2010. Industrial minerals value increased substantially in 2011 by 34% over 2010, setting a record high due to higher prices and increased production for some commodities resulting, in part, from major construction projects in Utah. This 34% increase in value does not include byproduct sulfuric acid (H_2SO_4) recovered from the Bingham copper smelter off gases. Sulfuric acid value ($117 million) is included in the report's dollar values for the first time this year. This product is not easy to track in that it is not typically a publically reported value, and so it has not been included in previous reports. Two new coal mines are under development in Utah as a result of steady reserve depletion and difficult mining conditions at existing mines. Increased production from some mines helped the value of coal to increase from 2010 to 2011; however, demand for coal by electric utilities continues to suffer from the recession-related drop in demand for electricity. The combined value of oil and gas production from Utah increased from 2010 to 2011, with a significant increase in the value of oil and a slight decrease in the value of natural gas. The increase in the value of oil production is due to higher prices and increased production in 2011, but even though natu-

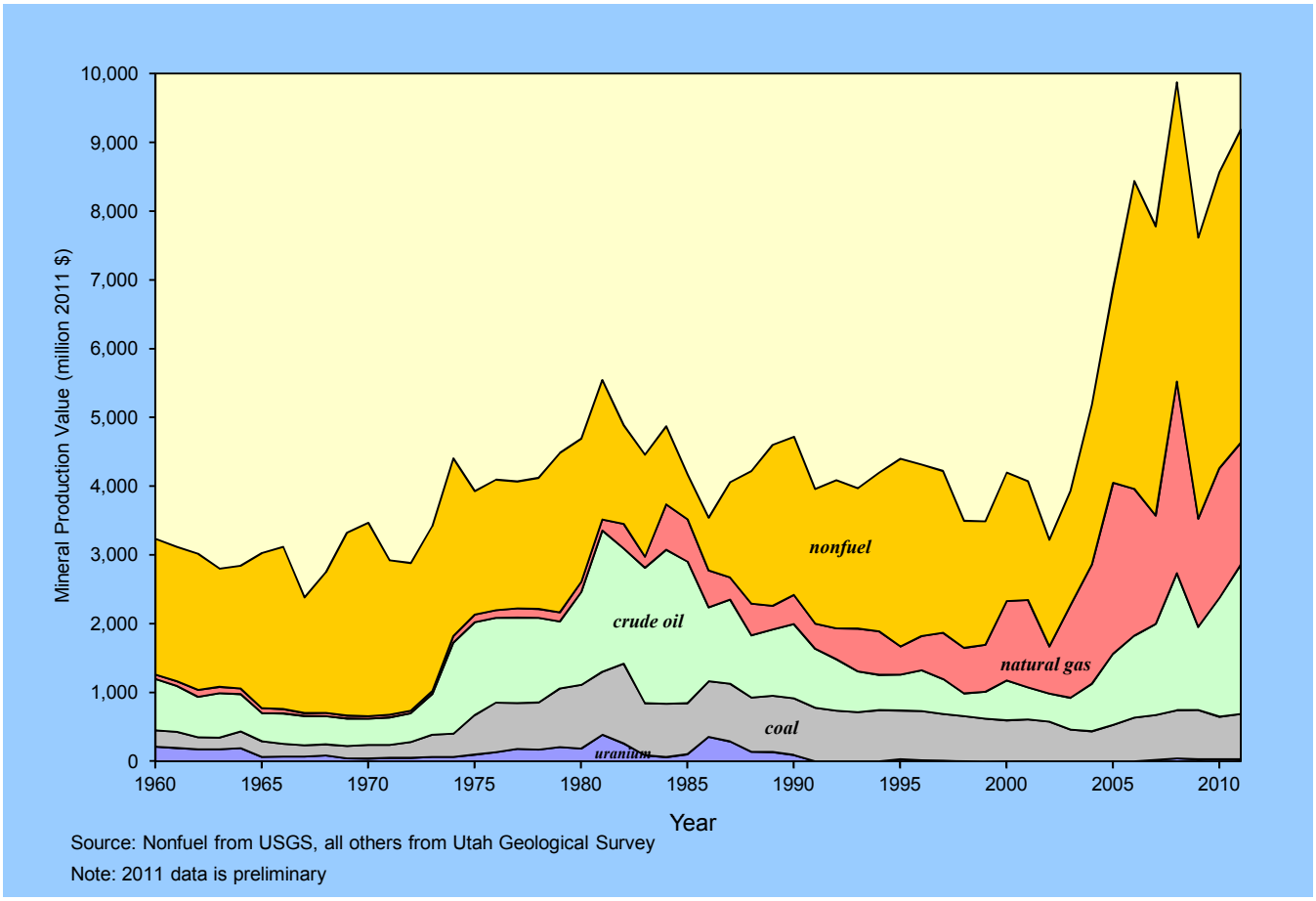


Figure 1. *Total annual value of Utah's energy and mineral production, inflation adjusted to 2011 dollars, 1960–2011.*

ral gas production increased in 2011 lower prices resulted in a lower value than in 2010. Despite lower uranium production in 2011, its value increased due to higher prices. Utah's uranium production was consolidated by Denison Mines Corp.'s acquisition of the Daneros mine in 2011, which could result in increased future production.

The total value of Utah's fuel production in 2011 is estimated to be $4.6 billion, and the total value of the nonfuel minerals production is estimated to be $4.6 billion (figures 2 and 3; table 1). The commodity segments individual contributions were approximately as follow: base metals, $2.64 billion (29% of total); oil, $2.17 billion (24% of total); gas, $1.78 billion (19% of total); industrial minerals, $1.2 billion (13% of total); precious metals, $720 million (8% of total); coal, $660 million (7% of total); and uranium, $29 million (0.3% of total) (figures 2 and 3; table 1). Compared to 2010, the 2011 values of base metals decreased $73 million (3%), oil increased $490 million (29%), gas decreased $50 million (3%), industrial minerals (now including $177 million for sulfuric acid) increased $388 million (34% not including sulfuric acid), precious metals increased $69 million (11%), coal increased $63 million (11%), and uranium increased $1.1 million (4%).

Mineral exploration and development continued at a brisk pace in 2011, similar to the fourth quarter of 2010. These exploration efforts shifted focus from copper in 2010 to gold, silver, and potash in 2011. The number of new unpatented mining claims filed in Utah has risen dramatically from 1467 in 2010 to 5659 in 2011. Juab (gold, silver), Beaver (copper), Millard (copper, gold), Iron (gold, silver), Grand (uranium, lithium), Washington (gold, silver), Tooele (copper, gold), Garfield (uranium), and San Juan (uranium) Counties each recorded over 250 new mining claims in 2011. At the end of 2011, the U.S. Bureau of Land Management (BLM) had a total of over 22,400 unpatented mining claims filed in Utah (Opie Abeyta, Utah BLM, written communication, April 2011).

The Utah School and Institutional Trust Lands Administration (SITLA), which manages about 1.8 million hectares (4.4 million acres) of state-owned lands in Utah, issued leases and/or contracts on 91 tracts in 2011. These leases were divided among the following commodities: metals (37), sand and gravel (17), bituminous sands (16), potash (10), building stone (7), oil shale (1), gemstone/fossil (1), gilsonite (1), and other (1) (William Stokes, SITLA, written communication, April 2012).

The Utah DOGM approved two new large mine permit appli-

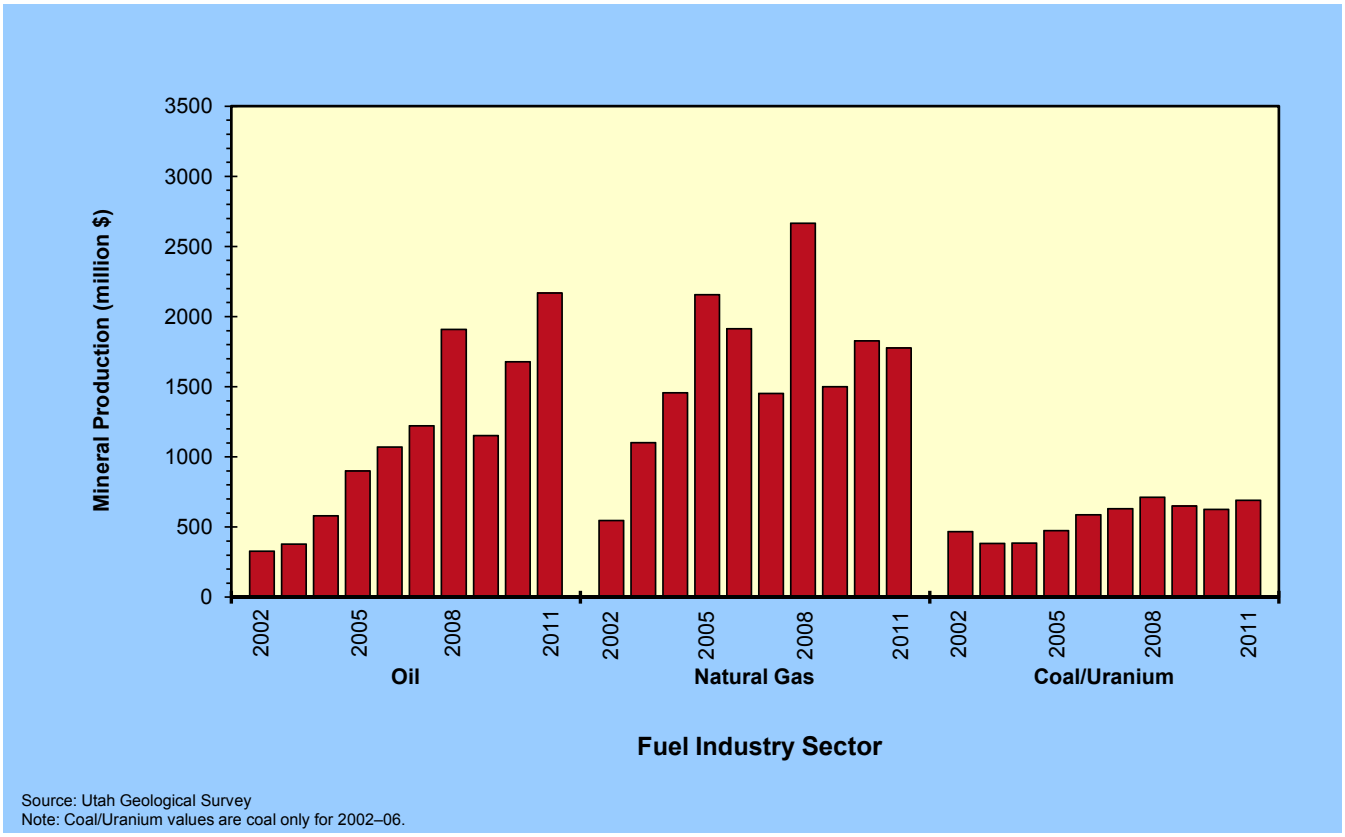


Figure 2. *Value of Utah's annual fuel production in nominal dollars, by industry sector, 2002–2011.*

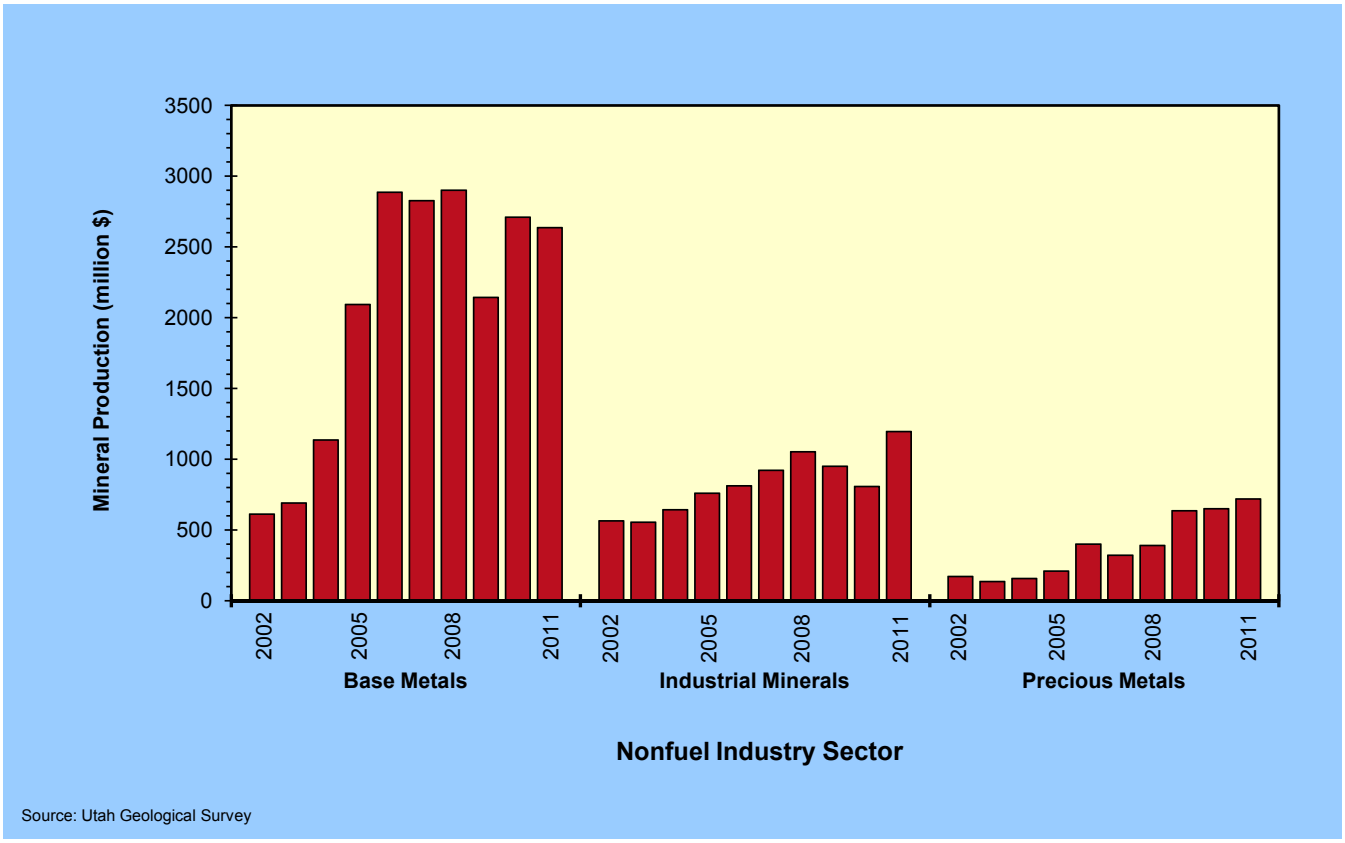


Figure 3. *Value of Utah's annual nonfuel production in nominal dollars, by industry sector, 2002–2011.*

Table 1. *Utah estimated energy and mineral production values in nominal dollars, by energy and mineral industry segment, 2002–2011. Values are in millions.*

Year	Metals	Minerals	Metals	Minerals	Oil	Gas	Total Value
2002	$612	$565	$172	$460*	$329	$547	$2685
2003	$690	$555	$136	$377*	$378	$1102	$3238
2004	$1136	$643	$158	$367*	$580	$1457	$4341
2005	$2093	$759	$209	$459*	$900	$2157	$6577
2006	$2885	$811	$400	$569*	$1070	$1912	$7647
2007	$2827	$921	$322	$621*	$1221	$1453	$7365
2008	$2900	$1053	$390	$712*	$1908	$2666	$9629
2009	$2142*	$949*	$635	$711*	$1152	$1501	$7090
2010	$2710*	$808*	$651*	$629*	$1679	$1828	$8305
2011	$2637	$1196	$720	$690	$2169	$1777	$9189

Note: Energy minerals consist of coal and uranium and 2011 industrial minerals includes sulfuric acid.
* = Revised Data.

cations and eight new small mine permit applications in 2011. The number of approved DOGM Notices of Intent to explore on public lands amounted to 26 in 2011.

National Rankings

Utah ranked 4th nationally in 2011 according to preliminary USGS data for the value of nonfuel mineral production, and accounted for approximately 6.2% of the United States total (USGS, 2012a). According to the USGS preliminary data, Utah's nonfuel mineral production value increased in 2011 to an estimated record high of $4.6 billion, moderately more than the previous record of $4.4 billion set in 2010 (figure 4). The value of Utah's nonfuel mineral production between 2002 and 2011 has generally increased despite national economic downturn in 2008, and Utah has been one of the top ten nonfuel mineral producing states over the past decade and in the top five since 2005. Utah remains the only state in the nation to produce magnesium metal, beryllium concentrates, and gilsonite. Utah ranked 14th nationally for the total amount of coal produced in 2011, according to annual production data from the U.S. Energy Information Administration (2012a). Utah ranked 11th nationally for the total amount of oil produced in 2011 (U.S. Energy Information Administration, 2012b), and 9th (2010 ranking) for the total amount of natural gas produced (U.S. Energy Information Administration, 2012c). In 2011, Utah ranked 4th nationally for the total amount of uranium produced.

Outlook for 2012

Of the nonfuel minerals producing companies surveyed for this report about 70% of them project duplicating 2011 production in 2012, some 20% plan on some production increase, and the remaining are unsure or are projecting less production. Nonfuel mineral commodities values for 2012 will again be strongly dependent on prices. Base and precious metals prices are expected to be lower in 2012 than in 2011 and production from Kennecott Utah Copper Corp. (KUC), which represents 64% of all nonfuel mineral production in Utah, will likely be flat. Consequently, base and precious metals value, which accounted for 74% of the total value of nonfuel minerals in 2011, will likely be lower for 2012. Active mining and concentrate production in 2012 from Utah's Iron County iron mine should have a positive effect on base metals value, but due to iron's small overall share of total base metal value the positive effect will be negligible. A decrease in the production of vanadium is expected in 2012, resulting in a lower value, due to Denison Mines Corp. White Mesa mill's shift to process non-vanadium-bearing ore. Industrial minerals production, which accounted for 26% of the total value of nonfuel minerals in 2011, will probably remain stable or perhaps increase slightly with an improving economy. Also, industrial minerals prices are unlikely to increase significantly; consequently, industrial minerals value will likely be flat or slightly higher. Because base and precious metals value comprises a large majority of nonfuel mineral value, a slight rise in industrial minerals value will likely not be enough to make up for the drop in metals value, and overall nonfuel mineral value will probably be slightly lower in 2012 than in 2011.

Despite higher coal prices in 2012, Utah's total projected 2012 production is expected to drop significantly, lowering its overall value. Coal production declines in 2012 are the result of decreased demand at electric utilities due to a catastrophic outage at a major plant and continued recession-related weak demand for electricity. High crude oil prices will spur new development, particularly in Duchesne County, and crude oil production should continue to increase in

the next few years. In contrast, the price for natural gas has plummeted, limiting the economic incentive for expanded development. However, Utah's overall natural gas production continues to increase slightly as associated gas is produced with new crude oil drilling. Although uranium prices are likely to remain stable, Denison Mines Corp. is expected to increase uranium production in 2012 by over 40% from 2011 production levels, which should raise the value of uranium produced in Utah in 2012 (Denison Mines, 2012).

The substantial increase in mining leases, claims, and permits from 2010 to 2011 suggests significant exploration activities in Utah can be expected to continue in 2012. Base and precious metals were the focus of a large percentage of the exploration activities in 2011, so if prices for these commodities remain relatively high, significant exploration for them can be expected in 2012.

BASE- AND PRECIOUS-METALS

Production and Values

Base and precious metals produced in Utah during 2011 had an estimated value of $3.36 billion, which accounts for 74% of the total value of all nonfuel minerals produced in Utah. Overall base and precious metal production values decreased slightly from 2010. Base metal production value in 2011 is estimated at $2.6 billion, which accounted for about 58% of the total value of all nonfuel minerals produced in Utah (figure 3; table 1). Utah's base metal production values decreased by about 3% from 2010, due to a decrease in the production of copper. Of the total base metal value, copper (67%), molybdenum (18%), and magnesium (9%) together constitute 94%, and iron, beryllium, and vanadium account for the remaining 6%.

Precious metal production value for Utah in 2011 is estimated at $720.3 million, or 16% of the total value of all nonfuel minerals produced in Utah, and is distributed between gold (86%) and silver (14%) (figure 3; table 1). Overall precious metal production values increased by about 11% from 2010 to 2011. Since both gold and silver production decreased significantly from 2010, the increased value is a direct result of higher precious metal prices in 2011.

The vast majority of Utah's copper, gold, and silver, and all of the molybdenum, is produced from KUC's Bingham Canyon mine, located about 32 km (20 mi) southwest of Salt Lake City in Salt Lake County (figure 5). The combined value of metals produced by KUC in 2011 was approximately $2.92 billion, which was about 64% of the total value of all nonfuel minerals produced in Utah. KUC's Bingham Canyon mine was the second largest copper and molybdenum producer and the fourth largest gold and silver producer in the U.S. in 2011.

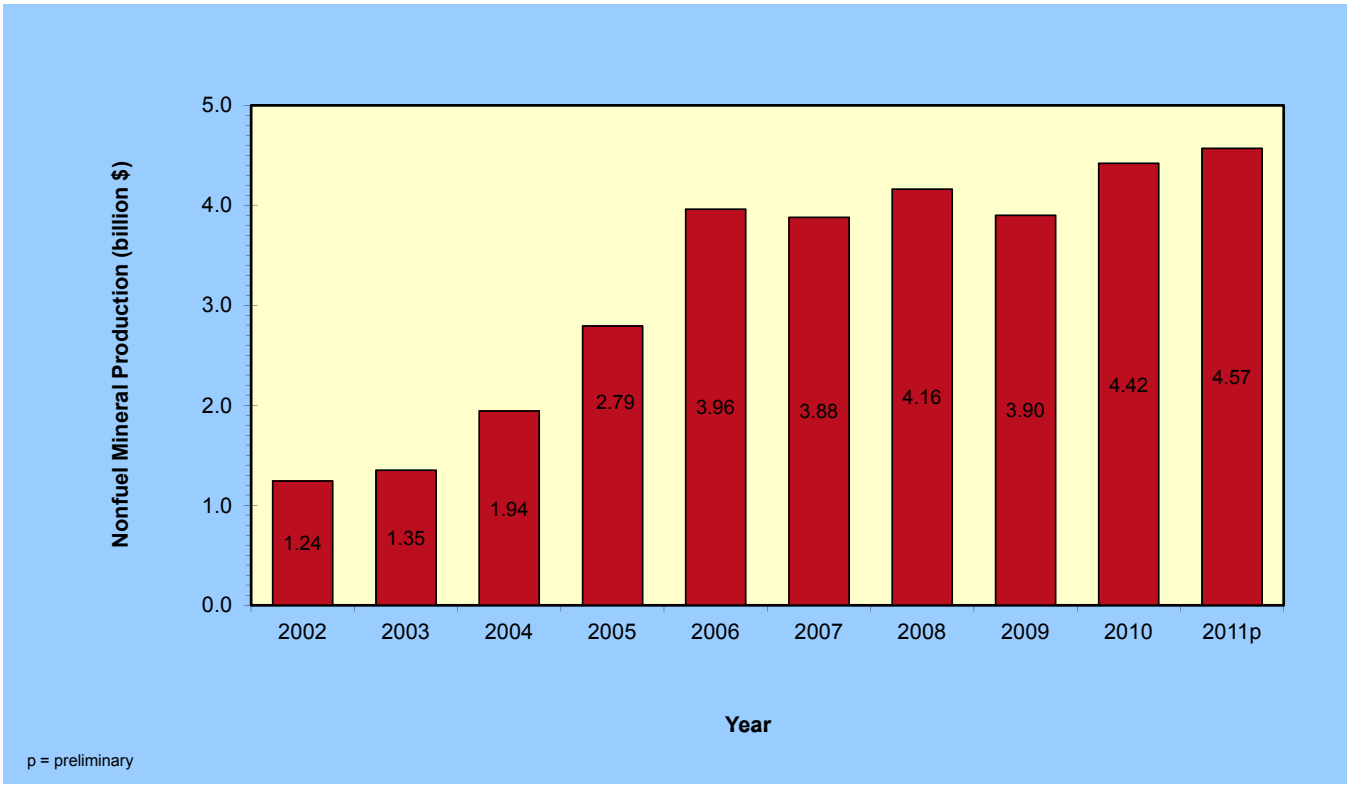


Figure 4. *Total annual value of Utah's nonfuel mineral production in nominal dollars, 2002–2011. Source: U.S. Geological Survey.*

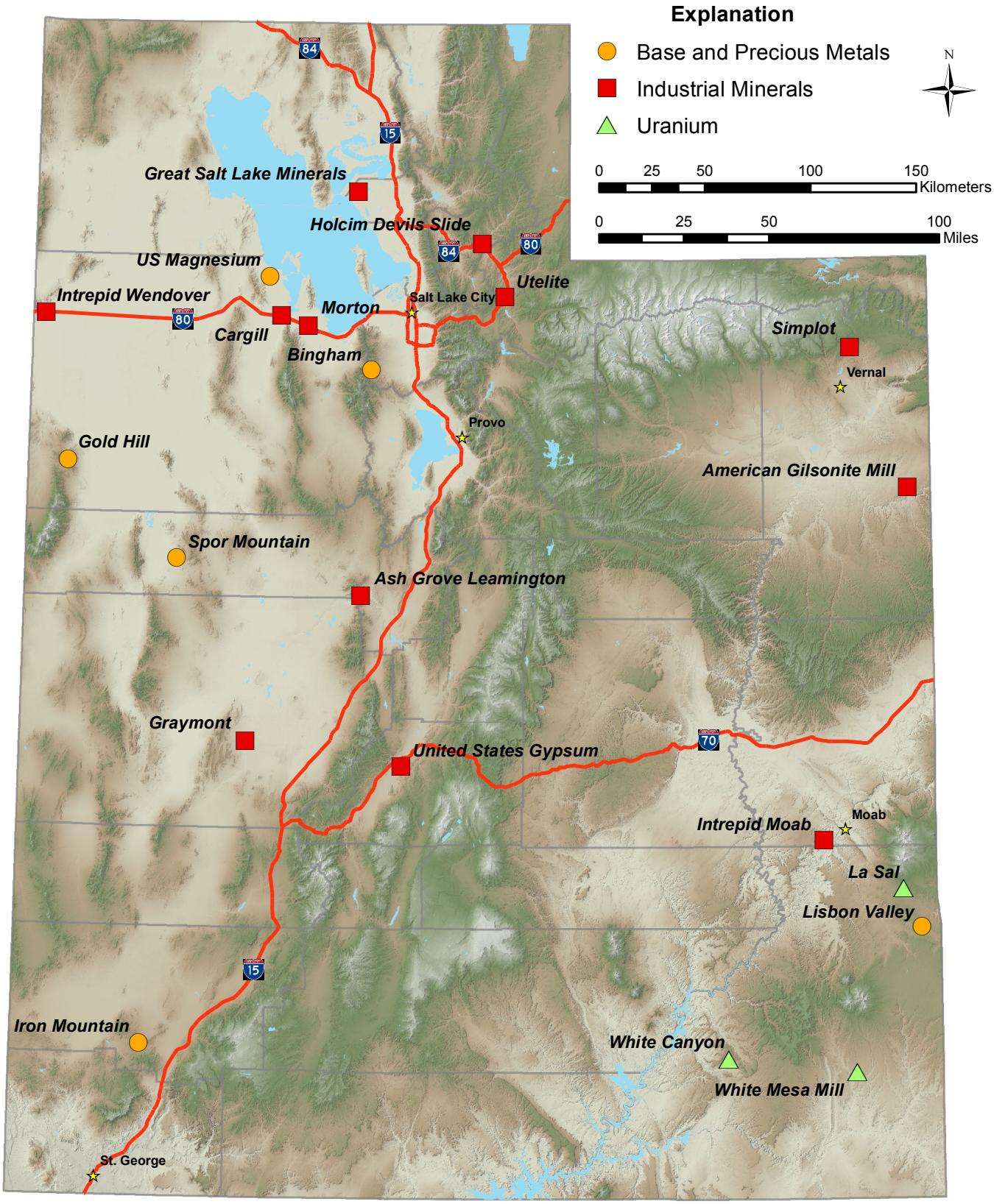


Figure 5. Base and precious metals, industrial minerals, and uranium production locations in Utah during 2011.

Copper

In 2011, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value over $1.77 billion. KUC's Bingham Canyon mine produced approximately 195,000 t (215,000 st) of Cu in 2011, a significant decrease of about 55,000 t (61,000 st) from 2010 (Rio Tinto, 2012). Copper prices have steadily increased since 2009, and KUC's production for 2011 has an estimated value of $1.72 billion, which is a decrease of about 11% from 2010.

Lisbon Valley Mining Co. operates a copper mine and processing facility about 48 km (30 mi) southeast of Moab in San Juan County (figure 5). About 5,278 t (5,818 st) of copper was produced by the company in 2011 (Lantz Indergard, Lisbon Valley Mining Co., written communication, May 2012), 25% less than in 2010, with an estimated value of $46.7 million. Copper is combined with a number of metals to create alloys for a wide variety of applications, and is used to produce a wide range of products including electrical wiring, electronic components, and pipe for plumbing, refrigerator, and heating systems.

Molybdenum

Utah's molybdenum production in 2011 came solely from KUC's Bingham Canyon mine, where it was recovered as a byproduct from the copper operation. Approximately 13,600 t (15,000 st) of molybdenum was produced in 2011, an increase of about 5% over 2010 (Rio Tinto, 2012). Molybdenum's unit price remained relatively constant from 2010 to 2011 (USGS, 2012a), with Utah's molybdenum production in 2011 valued at approximately $474.6 million. Molybdenum production value was about 4% higher than in 2010, due largely to the slight increase in production. Molybdenum ranked second as a contributor to Utah's base metal values in 2011. In 2011, molybdenum concentrate in the U.S. was produced by ten mines, as either a primary product or byproduct, and was valued at about $2.2 billion, an 8% increase from 2010. Molybdenum is primarily used in alloys with other metals by iron, steel, and other producers that account for about 81% of the molybdenum consumed (USGS, 2012a).

Magnesium

The only facility producing magnesium from a primary source in the United States is located about 96 km (60 mi) west of Salt Lake City at Rowley in Tooele County (figure 5), and is operated by U.S. Magnesium, LLC. Magnesium chloride concentrate is produced from Great Salt Lake brines through evaporation and converted to magnesium metal by an electrolytic process. USGS (2012a) reports that annual magnesium production capacity at U.S. Magnesium's plant significantly increased from 52,000 t (57,000 st) to 63,500 t (70,000 st) in 2011. The average price for magnesium metal decreased slightly from $5.36/kg ($2.43/lb) in 2010 to $5.18/kg ($2.35/lb) in 2011 (USGS, 2012a). Utah's 2011 magnesium production was valued around $329 million, assuming production at full capacity, ranking it third as a contributor to Utah's base metal values in 2011. Significant quantities of U.S. Magnesium's production are used by a nearby plant, operated by Allegheny Technologies Inc., to produce titanium sponge. Nationally, other uses of magnesium include as a constituent of aluminum-based alloys (43%), structural use in castings and wrought products (40%), and desulfurization of iron and steel (11%) (USGS, 2012a).

Iron Ore

Iron ore in Utah is solely produced by CML Metals, Inc from their Iron Mountain project, which is a redevelopment of the Comstock/Mountain Lion iron mine located about 30 km (19 mi) west of Cedar City in Iron County (figures 5 and 6). CML processed and sold approximately 1,293,000 t (1,425,000 st) of run-of-mine iron ore averaging 54% Fe, over a 10-month period ending the last day of 2011 (CML Metals, 2012). Estimated value of the iron ore is around $120 million at approximately $93/t ($84/st), ranking it fourth in contribution to Utah's base metal values in 2011. The company runs on average five unit trains per week from their Iron Mountain project to west coast ports, and their railcar fleet now consists of 539 cars. CML is reportedly near testing and completion of a 1.8 million t (2 million st) per year concentrating facility that will shift production from run-of-mine ore to ore concentrate with up to 67% Fe (CML Metals, 2012).

Figure 6. *Utah Southern dedicated railroad and train heading to CML Metals Iron Mountain iron mine.*

Beryllium

Utah remains the United States' sole producer of beryllium ore from the mineral bertrandite ($Be_4Si_2O_7(OH)_2$). Materion Natural Resources, Inc. mines bertrandite from the Spor Mountain area about 68 km (42 mi) northwest of Delta in Juab County (figure 5). Materion operates a mill 18 km (11 mi) north of Delta in Millard County, which is the nation's sole source of beryllium concentrate, where bertrandite ore, beryllium from the National Defense Stockpile, and imported beryllium are processed into beryllium hydroxide. Materion's parent company (Materion Corp.) operates a refinery and finishing plant in Ohio where the beryllium hydroxide concentrate is shipped and converted into beryllium-copper master alloy, metal, and oxide (USGS, 2012a). About 136,000 t (150,000 st) of bertrandite ore was mined in 2011. Beryllium concentrate production from Utah in 2011 is estimated to be 210 t (231 st) (USGS, 2012a), an increase of 20% over 2010, having a value of approximately $19.4 million. Beryllium prices were down but production was higher in 2011 than in 2010, which resulted in an increase of about 8% in value over 2010. Beryllium ranked fifth as a contributor to Utah's base metal values in 2011. Beryllium is used in various telecommunications and consumer electronics products, defense-related applications, industrial components, commercial aerospace applications, appliances, automotive electronics, energy applications, medical devices, and other applications.

Vanadium

Vanadium, in the form of vanadium pentoxide (V_2O_5), is a byproduct of uranium mining and milling at Denison Mines Corp.'s White Mesa mill about 10 km (6 mi) south of Blanding in San Juan County (figure 5). In 2011, Denison Mines Corp. produced approximately 585,000 kg (1,290,000 lb) of V_2O_5, with a value of approximately $8.27 million, from uranium ores of southeastern Utah (Denison Mines, 2012). The average vanadium price in 2011 was $14.13/kg ($6.41/lb) (Denison Mines, 2012), remaining steady from 2010. Vanadium production value decreased in 2011 by about 38% from 2010, and that drop is likely due to the White Mesa mill's shift to process non-vanadium-bearing ore from Denison's newly acquired Daneros mine in southeastern Utah. Vanadium ranked sixth as a contributor to Utah's base metal values in 2011. Metallurgical use by the steel industry as an alloying agent consumes about 95% of domestic vanadium production (USGS, 2012a).

Gold

In 2011, approximately 386,000 troy ounces (oz) of gold were produced in Utah, which was 82,400 troy oz less than in 2010 (Rio Tinto, 2012). KUC mines most of this gold at its Bingham Canyon mine, where it is recovered as a byproduct from the copper operation. About 2000 troy oz of the total gold produced came from residual leaching of existing heaps at KUC's Barneys Canyon mine, which ceased active mining in 2001 after ore exhaustion, and is located 4 km (2.5 mi) north of the Bingham Canyon operation. Even though gold production decreased by 18% in 2011, a significant price increase of 30% over 2010 increased the total produced gold value over 2010 by about 7% to around $617.6 million (USGS, 2012a). Very small quantities of gold and silver may have been produced by other smaller Utah mines, but production is not reported and would not make any significant impact on the known amount of total gold and silver produced in Utah.

Silver

Kennecott Utah Copper Corp. produced most of Utah's silver in 2011 from the Bingham Canyon mine, where it is also recovered as a byproduct from the copper operation. Approximately 2,976,000 troy oz of silver were produced in 2011, which was 778,000 troy oz less than in 2010 (Rio Tinto, 2012). Even though silver production decreased, significant price increases in 2011 raised the value over 2010 by about 35% to around $102.7 million (USGS, 2012a).

Exploration and Development Activity

The escalating precious-metal prices prompted renewed exploration activity for gold and silver in Utah during 2011. Precious-metal exploration was also driven by recent important sediment-hosted gold discoveries in the Basin and Range of eastern Nevada—for example, Long Canyon, Elko County. Gold-silver exploration is being carried out by major gold-silver producers, exploration companies, and local prospectors. Base-metal exploration in 2011 was dominated by major companies doing brownfield exploration in the Bingham Canyon, Tintic, and Drum (Detroit) mining districts.

Bingham Canyon

Kennecott Utah Copper Corp. continued an aggressive development program with efforts concentrated on extending the mine life past the current 2019 plan. The Cornerstone project (south pushback), if approved, will extend the mine life to 2028, while maintaining other long-term development options. In 2011, KUC approved $238 million for a feasibility study and long-lead items to extend the life of the Bingham Canyon mine. In addition, KUC announced an underground resource on the North Rim Skarn: 20 million t (22 million st) at 3.65% copper, 1.62 ppm gold, and 20.95 ppm silver. KUC plans a $165 million prefeasibility study on this deposit.

Kennecott Utah Copper Corp. also began construction of a $340 million molybdenum autoclave process (MAP) facility, currently scheduled to begin production in early 2013. The new MAP facility will have the capacity to produce 13.6 million kg (30 million lb) of molybdenum products and an additional 4090 kg (9000 lb) of rhenium per year.

Brownfield exploration in the Oquirrh Mountains by KUC in 2011 included drilling six deep holes (totaling 8598 m [28,210

ft]) in the Bingham area east and southwest of the Bingham pit (Russ Franklin, Kennecott Exploration Company, written communication, April 2012).

Lisbon Valley Copper

The Lisbon Valley Mining Company began copper mine development in San Juan County (figure 5) in 2005, and plant construction at the sediment-hosted, open-pit, heap leach, SX-EW copper operation was completed in 2006. Following some startup problems, Lisbon Valley Mining Company LLC successfully restarted mining operations in 2009. Year-end 2011 Lisbon Valley copper reserves are estimated at over 17 million t (19 million st) averaging roughly 0.45% copper. Lisbon Valley expects to ramp up to 7.7 million kg (17 million lb) of copper in 2012 and 9.5 million kg (21 million lb) of production in 2013 (Robert Frayser, Lisbon Valley Mining Company, written communication, May 2012).

Iron Springs

The CML mine (formerly the Iron Mountain and Comstock-Mountain Lion), Iron County (figure 5), was acquired by Palladon Iron Corporation in 2005. The mine was restructured into CML Metals Corp. in early 2010. The iron ore occurs as a massive magnetite skarn/replacement deposit adjacent to Miocene laccoliths. Mining by Palladon was initiated in 2008, but ceased in 2009 due to instability in the iron ore market and logistical problems. In 2009, Palladon completed a Canadian NI 43-101 compliant resource estimate on the CML deposit showing a resource of 28.44 million t (31.35 million st) averaging 48.6% iron (SRK Consulting, 2009). Mining was restarted by CML in July 2010, and previously stockpiled and new run-of-mine ore was shipped out of the new rail load-out facility at the mine by Union Pacific Railroad to the port of Richmond, California, for overseas transport to China. In 2011, CML initiated construction of a new concentrator to produce a high-grade iron concentrate. The concentrator was completed in early 2012 and is currently (April 2012) in a testing and break-in phase. It is ultimately expected to increase annual production to roughly 1.8 million t (2 million st) of concentrate.

Tintic District

Andover Ventures Inc. purchased 78.5% of Chief Consolidated Mining Company in 2008. Chief Consolidated's main assets are properties in the East Tintic district, Utah County. Andover has released an indicated resource for the Burgin Extension deposit containing 834,500 t (920,000 st) at 0.86 ppm gold, 249 ppm silver, 9.3% lead, and 3.5% zinc, with an additional inferred resource of 1,231,000 t (1,357,000 st) at 0.45 ppm gold, 299 ppm silver, 14.4% lead, and 5.2% zinc. These resources contain an in-place value of well over a billion dollars at 2011 metal prices.

In addition, Kennecott Exploration Company (KEC), through a joint venture with Andover, acquired a porphyry copper lithocap target on Big Hill near the center of the East Tintic district, Utah County. KEC began work by running a magnetotelluric grid, six lines of induced polarization (IP), and a high-resolution aeromagnetic survey, along with geologic/alteration mapping and collection of about 200 geochemical samples. Four reverse circulation holes, totaling 1341 m (4311 ft), were precollared in 2011 to be deepened with core in 2012 (Russ Franklin, KEC, written communication, April 2012). Two drill rigs were on site in April 2012.

Quaterra Resources, Inc. acquired about 1300 hectares (3200 acres) of patented and unpatented mining claims encompassing the Southwest Tintic porphyry copper system, Juab County, in 2007. The property hosts a known historic resource of approximately 360 million t (400 million st) of 0.33% copper and 0.01% molybdenum. This property was joint ventured with Freeport-McMoRan Exploration Corporation in 2009, and Freeport began an integrated program of geological mapping, geochemical sampling, and geophysical surveying. In 2010–11, Freeport completed 7 reverse circulation and 3 deep core holes, totaling 4323 m (14,183 ft), and ranging from depths of 122 to 1265 m (400–4150 ft). Widespread quartz-sericite-pyrite, propylitic, and lesser biotite alteration zones were intersected, containing generally narrow intervals of low-grade copper mineralization. Hole STFM-3, 378 m deep (1240 ft), intersected 34 m (112 ft) of 0.20% copper starting at 52 m (171 ft) depth in the Diamond Gulch area. Hole STFM-1 intersected 15 m (49 ft) of 0.22% copper starting at 107 m (351 ft) within pyritic, advanced argillically altered volcanic rocks, and quartz-sericite and biotite alteration with isolated short intervals containing 0.1–0.3% copper deeper in the hole.

Miscellaneous Base- and Precious-Metal Developments

Clifton Mining Company and Desert Hawk Gold Corp. agreed in 2009 to jointly develop Clifton's mineral properties in the Gold Hill district, Tooele County (figure 5). They initially put the Yellow Hammer copper-gold-silver mine into production. This small open pit developed a very unusual, structurally controlled, hydrothermal alteration "pipe" in a Jurassic granodiorite stock. Primary ore-controlling structures are reportedly intersecting north-south and east-west faults. Copper pitch-malachite-scheelite-molybdenite mineralization is associated with locally very coarse grained actinolite, black tourmaline, garnet, orthoclase, titanite, apatite, and magnetite in very strongly altered granodiorite. The Desert Hawk venture mined about 12,700 t (14,000 st) in 2011 from a small Yellow Hammer open pit and processed it at the rehabilitated Cactus gravity/flotation mill 8 km (5 miles) to the north at Gold Hill. Approximately 175 t (193 st) of copper-gold concentrate and an additional minor amount (7.6 t [8.3 st]?) of 60% tungsten concentrate were produced. The total production was valued at approximately $970,000.

Desert Hawk's plans include a heap-leach operation at the Kiewit low-sulfidation, quartz-carbonate-adularia stockwork gold deposit, also in the Gold Hill district. The Kiewit deposit is known to contain a crudely estimated 1.5 million t (1.7 million st) averaging about 1 ppm gold. Permitting of the Kiewit open pit and heap leach site is in progress in 2012.

In October 2011, CS Mining, LLC acquired the Western Utah Copper Company and its land holdings in the Rocky and Beaver Lake mining districts, Beaver County. These districts host seven partially defined copper skarn and breccia pipe deposits. In 2009, Copper King completed construction of a flotation mill and started open-pit mining the Hidden Treasure copper skarn. The mill began production at about 1100 t per day (1200 st/d) in May 2009 and produced a very limited amount of copper concentrate. A separate magnetite concentrate was also produced and sold to a coal wash plant in the fall of 2009. The mill experienced less than 20% copper recovery due to the mixed oxide-sulfide nature of the skarn ore and operations were halted near the end of 2009. The operation filed Chapter 11 bankruptcy proceedings in late 2009, which were ultimately resolved by the acquisition by CS Mining. CS Mining is currently constructing a tailing impoundment adjacent to the mill.

Cadillac Mining Corp. acquired 1540 ha (3800 acres) covering the historic mining area of the Goldstrike sedimentary-rock-hosted gold-silver mining district, Washington County. Production in the 1980s and 1990s totaled approximately 210,000 troy oz of gold and 198,000 troy oz silver. The company compiled and digitized the historic exploration/mining data on the district in 2011 and drilled three holes from a single pad on the Hamburg Extension target late in the year. Two of these three reverse circulation holes (GS11-02 and 03), aggregating 567 m (1860 ft), intersected 1.08 ppm gold over 73.1 m (240 ft) and 1.25 ppm gold over 82.3 m (270 ft).

High Desert Gold Corp. controls a 2430 ha (6000 acre) block of ground in the Gold Springs mining district on the Utah-Nevada border, Iron County. In 2010, High Desert drilled 11 reverse-circulation holes totaling 1823 m (5980 ft) on a swarm of low-sulfidation, volcanic-hosted, gold-silver veins. These drill intersections were used to help delineate a NI 43-101 inferred resource of approximately 3 million t (3.3 million st) at 0.99 ppm gold and 17.3 ppm silver (Katsura and Armitage, 2012). High Desert is planning a follow-up reverse-circulation drill program totaling 1830 m (6000 ft) to begin in early 2012.

Renaissance Gold Inc. signed Newmont Mining Corporation to an earn-in agreement on their Wildcat sedimentary-rock-hosted gold property in the Drum Mountains (Detroit district), Juab County. The property consists of 176 ha (434 acres) of unpatented mining claims. The property was explored by Gold Fields Mining Corp. in the early 1990s. Gold Fields drilling cut intervals of up to 22.9 m (75 ft) of 1.27 ppm gold (hole DM-27). Newmont completed four reverse circulation holes in 2011 and plans a second round of drilling for 2012 (Rendy Keaten, Newmont Mining Corporation, written communication, April 2012). Both AngloGold Ashanti USA Exploration (186 claims) and Freeport-McMoRan Exploration Corporation (175 claims) have large land blocks in the Drum Mountains.

Newmont Mining Corporation also drilled five holes at the Cina mine in north-central Iron County for gold in 2011. The Cina mine is a high-level, epithermal mercury-sulfur system. Newmont has two additional sedimentary-rock-hosted gold claim blocks in extreme western Box Elder County: the northern Pilot Range and the Goose Creek Mountains.

Invenio Resources Corp. acquired the Kings Canyon sedimentary-rock-hosted gold-silver property in southwestern Millard County and controls approximately 930 ha (2300 acres). The property was explored in the early 1990s, primarily by Crown Resources. The property contains several known gold zones, the largest defined resource being about 6.2 million t (6.8 million st) averaging roughly 1 ppm gold.

Grand Central Silver Mines, Inc. continued work on two Utah properties. Grand Central owns a 46-ha (114-acre) tract on the southwestern fringe of the Bingham district, Salt Lake County, where they have completed 13 reverse-circulation holes totaling 4980 m (16,340 ft) and one deep vertical core hole to 830.6 m (2725 ft). Intersections include 12.2 m (40 ft) 159 ppb gold, 25 ppm silver, and 0.23% zinc in hole 13.

Grand Central also controls a large 1934-ha (4779-acre) Cave mine property position in the southern Mineral Mountains of Beaver County. The Cave mine targets include copper-gold skarns and high-grade, precious metal-rich, polymetallic carbonate replacement deposits, like the old Cave mine itself. Initial work included surface and underground geological mapping and geochemical sampling along with a 150-line-km (93-line-mi) ground magnetometer survey and some induced polarization surveying.

Metamining of Utah drilled several shallow, close-spaced holes for iron at the Iron Blossom mine near Schoenburger Spring in the northern Drum Mountains, Juab County. The ore is a goethitic gossan hosted in Cambrian limestone that averages about 57% iron. The holes reportedly intersected 60 to 80 m (200–260 ft) of gossan. Analytical results are still pending (Ken Lowder, Metamining of Utah, oral communication, April 2012).

IBC Advanced Alloys Corp. acquired 371 claims adjacent to Materion's (Brush-Wellman's) Spor Mountain beryllium mine, the largest beryllium producer in the world. IBC completed a 7495 line km (4657 line mi) airborne magnetic and radiometric survey in 2010, which defined several potential targets. In 2011, IBC began drill testing these targets, com-

pleting an east-west fence of 35 reverse circulation holes totaling 5500 m (18,040 ft) south of Materion's property.

In other rare and strategic metal developments in Utah: Avalon Rare Metals staked 690 unpatented lode claims (5298 ha; 13,902 acres) on a Spor Mountain rare earth-beryllium prospect, Juab County; Redhill Resources Corp. acquired the Honeycomb Hills high-silica rhyolite rare earth-beryllium-lithium project 517 ha (1,280 acres), Juab County; and EMC Metals acquired the Little Green Monster scandium property in Utah County.

INDUSTRIAL MINERALS

Production and Values

Industrial-minerals production in 2011 had a record-breaking value of an estimated $1.2 billion (including sulfuric acid) and was second at 26% in contribution to the total value of nonfuel minerals produced in Utah (figure 3; table 1). Industrial minerals value in 2011 experienced a major increase of about $388 million (including sulfuric acid) (34%, excluding sulfuric acid) over 2010, rebounding tremendously from the drop between 2008 and 2010 that resulted from the economic downturn that severely impacted the construction industry. This major increase in value resulted from the new inclusion of sulfuric acid value, some higher prices, and some increased production as a result of major construction projects in Utah during 2011.

The largest overall contributors to the value of industrial-minerals production in Utah during 2011 were the brine-derived products salt, magnesium chloride, and potash, having a combined value of $390.2 million. This value represented 36% (this percentage along with others in this paragraph do not include the value of sulfuric acid) of total industrial mineral value in 2011, and was a 24% increase over 2010. The sand and gravel, crushed stone (including limestone and dolomite), and dimension stone commodity group was the second-largest contributor to the value of industrial-minerals production at $262.6 million. The value of this commodity group accounts for 24% of total industrial mineral value in 2011, and increased 36% over 2010. The third-largest overall contribution to the value of industrial-minerals production came from Portland cement and lime products, having a combined value of almost $200 million that accounts for 18% of total industrial mineral value in 2011, an increase of 25% in value over 2010. These three commodity groups contributed 78% of the total value of industrial minerals produced in Utah during 2011. The remaining 22% of Utah's total industrial mineral value came from, in decreasing order of value, phosphate, gilsonite, clays, expanded shale, and gypsum.

Salt, Magnesium Chloride, and Potash

The brine-derived commodities salt, magnesium chloride, and potash (in the form of potassium sulfate) produced from Great Salt Lake were important contributors to the value of Utah's industrial-mineral production in 2011. Potash in the form of potassium chloride, along with lesser amounts of magnesium chloride and salt, was produced by operations in other parts of the state. Small amounts of concentrated magnesium brine for use in nutritional supplements were produced by Mineral Resources International, Inc (NorthShore Limited Partnership).

Utah's salt production in 2011 was approximately 2.60 million t (2.87 million st), a slight increase of about 1% from 2010. This salt production was valued at approximately $143.5 million, an increase of 16% over 2010 that was due to higher prices in 2011. Some 80% of this salt was produced from Great Salt Lake brine by three operators who were, in descending order of production, (1) Great Salt Lake Minerals Corp., (2) Cargill Salt Co., and (3) Morton International (figure 5). The remaining 20% came from another three operators who were, in descending order of production, (1) Redmond Minerals, Inc near Redmond in Sanpete County, (2) Intrepid Potash-Wendover, LLC near Wendover in Tooele County, and (3) Intrepid Potash-Moab, LLC near Moab in Grand County.

Magnesium chloride production in Utah was over 544,000 t (600,000 st) in 2011, a slight increase from 2010. Production and value of magnesium chloride changed little from 2010 to 2011. Great Salt Lake Minerals Corp. on the east side of Great Salt Lake and Intrepid Potash-Wendover, LLC produced the magnesium chloride.

Potash production in Utah was over 363,000 t (400,000 st) in 2011 and was a major contributor to the value of the brine-derived commodities group. Great Salt Lake Minerals Corp. produces the potassium sulfate variety, where as Intrepid Potash-Wendover, LLC (figure 5) and Intrepid Potash-Moab, LLC (figures 5 and 7) produce the potassium chloride variety. The 2011 value of potassium chloride significantly increased compared to the value in 2010, due to large increases in production and price; potassium sulfate also had a moderate increase in value for the same reasons.

Sand and Gravel, Crushed Stone, and Dimension Stone

Sand and gravel, crushed stone, and dimension stone are produced by commercial operators as well as various county, state, and federal agencies. Due to the large number of producers in this commodity group it is not practical for the UGS to send annual production questionnaires to all of the operators. However, the UGS does compile data from selected operators to track these commodities. In Utah during 2011, approximately 32.6 million t (35.9 million st) of sand and gravel were produced, valued at $193 million (USGS, 2012b). About 8.97

million t (9.89 million st) of crushed stone with a value of $69 million (USGS, 2012b), and approximately 8133 t (8965 st) of dimension stone with a value of about $469,000 were produced in 2011. Production for the commodity group increased in 2011 by approximately 32% over 2010, and by about $69.3 million in value. The value increase resulted from greater production of sand and gravel and crushed stone, and a slight unit price increase for these commodities. Increased production of these two commodities likely resulted from major road, light-rail, and building construction projects in Utah during 2011.

Portland Cement, Lime, and Limestone

Portland cement in Utah during 2011 was produced by two companies, Holcim, Inc. and Ash Grove Cement Co., and amounted to over 907,000 t (1 million st) having a value over $100 million. Holcim, Inc. operates the Devils Slide quarry and plant located east of Morgan in Morgan County, and Ash Grove Cement Co. operates the Leamington quarry and plant east of Leamington in Juab County (figure 5). Along with limestone, Holcim and Ash Grove Cement also mine small amounts of shale, clay, and sandstone that are used in cement manufacturing. Portland cement production in 2011 increased about 12% over 2010, resulting in a moderate value increase for 2011 as well. However, production still remained below the combined potential capacity of the companies' plants of 1.4 million t (1.5 million st) of cement annually.

Lime in 2011 was produced solely by Graymont Western U.S., Inc. In the past Lhoist North America has produced dolomitic lime, but their quarry and plant in Tooele County have been idle since 2008. Lime production increased approximately 17% from 2010 to 2011. Graymont Western U.S., Inc. produces high-calcium quicklime and dolomitic quicklime from their quarry and plant in the Cricket Mountains about 56 km (35 mi) southwest of Delta in Millard County (figure 5). The annual production capacity when both plants are in operation is over 0.9 million t (1.0 million st).

Limestone production for 2011 amounted to approximately 3.4 million t (3.8 million st), which is an increase of about 18% over 2010. The three operators responsible for most of this production were, in decreasing order of production, (1) Graymont Western U.S., Inc., (2) Holcim, Inc., (3) and Ash Grove Cement Co. Cotter Corp. in San Juan County and Diamond Mountain Resources in Uintah County produced lesser amounts of limestone for flue-gas desulfurization in coal-fired power plants. Limestone is primarily used in the manufacture of cement and lime products, with lesser amounts used in various aspects of the construction industry, for flue-gas desulfurization in coal-fired power plants, and as a safety product for the coal mining industry as "rock dust."

Sulfuric Acid

KUC's Bingham Canyon porphyry copper-molybdenum-gold-silver mine generates approximately 770,000 t (850,000 st) of sulfuric acid (H_2SO_4) each year as a byproduct of the copper-gold-silver smelting process. Although sulfuric acid has been recovered at the Bingham copper smelter since 1917, this is the first year its dollar value is included in the UGS production survey, now ranking it 4th in contribution to the value of Utah industrial minerals. In 2011, sulfuric acid prices averaged about $152/t ($138/st) suggesting a very approximate total value of about $117 million. Sulfuric acid is used in the production of fertilizer and by some gold, copper, uranium, and beryllium producers, as well as in chemical manufacturing, power plants, steel companies, farming, and water treatment.

Figure 7. *Potash (potassium chloride) evaporation ponds, operated by Intrepid Potash-Moab, LLC, near the Colorado River (foreground).*

Phosphate

Simplot Phosphates, LLC continues to be the only active phosphate producer in Utah. The company's phosphate operation is located 19 km (12 mi) north of Vernal in Uintah County (figure 5). In 2011, the mine produced about 3.7 million t (4.1 million st) of ore, approximately 12% more than in 2010. The ore yields about 1.3 million t (1.4 million st) of phosphate concentrate (P_2O_5) after processing. The concentrate is then transported in slurry form through a 155 km (96 mi) underground pipeline to the company's fertilizer plant near Rock Springs, Wyoming. Over 95% of the phosphate rock mined in the U.S. was used to manufacture phosphoric acids to make ammonium phosphate fertilizers and animal feed supplements (USGS, 2012a).

Gilsonite

Gilsonite is a shiny, black, solid hydrocarbon that forms a swarm of laterally and vertically extensive veins in the Uinta Basin. It has been mined since the late 1880s. In 2011, American Gilsonite Co. (figure 5) and Ziegler Chemical and Mineral Co. both mined and processed gilsonite at their operations in southeastern Uintah County. Gilsonite production has increased over the past few years and was approximately 20% higher in 2011 than in 2010, with American Gilsonite Co. responsible for most of that production. Utah is the only place in the world that contains large economic deposits of gilsonite, and it has been shipped worldwide for use in a large number of diverse products ranging from asphalt paving mixes and coating to inks and paints (Boden and Tripp, 2012).

Common Clay, Bentonite, and High-Alumina Clay

Production of common clay, bentonite, and high-alumina clay in Utah during 2011 amounted to approximately 248,000 t (274,000 st), slightly more than was produced in 2010. These commodities are produced by many small and large mines, often on an intermittent base. In descending order of production, the largest producers of common clay were Interstate Brick Co., Holcim, Inc., and Interpace Holdings, LLC., which together produced around one third of the total production. The manufacturing of bricks was the primary use for common clay. Bentonite was produced by two companies, Western Clay Co. and Redmond Minerals, Inc., which together produced about two thirds of the total production. Uses for bentonite include well drilling and foundry operations, various civil engineering applications, and as litter-box filler. High-alumina clay production in 2011 was either minimal or non-existent. The manufacturing of Portland cement is the primary use for high-alumina clays in Utah.

Expanded Shale

Expanded shale in Utah is solely produced by Utelite, Inc. at their quarry and plant near Wanship in Summit County (figure 5). The company produced almost 180,000 t (200,000 st) in 2011, a significant increase of about twice that produced in 2010. Expanded shale is a lightweight aggregate, sometimes referred to as "bloated shale," mainly used by the construction industry. It is produced by heating high-purity shale from the Cretaceous Frontier Formation to about 1100° C (2000° F), causing it to expand and vitrify. The resulting aggregate is durable, inert, uniform in size, and lightweight, having a density about one half that of conventional aggregates. Their material is used as aggregate in roof tile, concrete block, structural concrete, and in other ways in horticulture, highway construction, and loose fill. Some of Utelite's production is used locally along the Wasatch Front, but much is shipped out of state.

Gypsum

Four operators reported combined Utah gypsum production of about 199,000 t (219,000 st) in 2011, an increase of approximately 19% over 2010. This production had an estimated value of roughly $2.6 million, an increase of about 6% over 2010. In descending order of production, the four producers were (1) Sunroc Corp., (2) United States Gypsum Co., (3) Diamond K Gypsum, Inc., and (4) Nephi Gypsum. Two wall board plants are located in Utah, both near the town of Sigurd in Sevier County. The plant operated by Georgia Pacific has seen limited, intermittent operation over the past twelve years, but is now expected to remain idle for the foreseeable future due to economic considerations. The plant operated by United States Gypsum Co. was active in 2011 (figure 5). Utah gypsum is primarily used in the manufacturing of wallboard, with lesser amounts of raw gypsum used by regional cement companies as an additive to retard the setting time of cement, and it is also used in agriculture industry as a soil conditioner. Despite having vast gypsum resources, Utah's gypsum production is low relative to the years before the economic downturn in 2008.

Exploration and Development Activity

In 2011, Utah also had an increase in industrial minerals exploration activity, principally for potash. Potash exploration has focused on such diverse sources as deep bedded evaporites in the Paradox Basin, shallow brines at the Sevier Lake and Great Salt Lake Desert, and alunitized [$KAl_3(SO_4)_2(OH)_6$] volcanic rocks. These potash projects are briefly summarized in table 2. In addition, Mesa Uranium Corporation announced that it has acquired approximately 2400 ha (6000 acres) of property at their Green Energy lithium-brine project, also in the Paradox Basin.

URANIUM

Production and Values

Denison Mines Corp. was responsible for most uranium produced in Utah during 2011, having acquired White Canyon Uranium Ltd. during the year, including its producing Dane-

Table 2. *Potash exploration projects in Utah, 2011.*

Property	Deposit Type	County	Company*	Progress
Blawn Wash	Alunite alteration	Beaver	Potash Ridge Corporation	Acquired historic resource of 694 million tons of 33% alunite, completed 28 confirmation holes
Bounty Potash	Great Salt Lake Desert, shallow brine	Box Elder	Mesa Exploration Company	Acquired 66,048 acres, historic resource of 5.14 million tons KCl
Crescent Junction	Paradox Basin, deep evaporites	Grand	Pinnacle Potash International	Acquired 13 state leases, completed 1 hole
Green River	Paradox Basin, deep evaporites	Grand	American Potash LLC (Magna Resources Ltd.)	Applied for 63,242 acres, has a drilling program planned for 2012
Paradox Basin	Paradox Basin, deep evaporites	Grand	Universal Potash Corporation	Applied for 29,000 acres
Salt Wash	Paradox Basin, deep brines and evaporites	Grand	Mesa Exploration Company	Applied for 35,510 acres
Whipsaw	Paradox Basin, deep brines and evaporites	Grand	Mesa Exploration Company	Applied for 17,988 acres
White Cloud	Paradox Basin, deep brines and evaporites	Grand	Mesa Exploration Company	Applied for 21,184 acres
Sevier Lake	Sevier (Dry) Lake, shallow brine	Millard	Peak Minerals Inc. (EPM Mining Ventures Inc.)	Acquired 96,000 acres, completed 426 (mostly) shallow holes, historic resource 5.2 million tons
Hatch Point	Paradox Basin, deep evaporites	San Juan	K2O Utah LLC (Potash Minerals Limited)	Holdings include 90,190 acres of federal land under application and state leases on Hatch Point, completed 3 deep holes on SITLA tracts
Lisbon Valley	Paradox Basin, deep evaporites	San Juan	Potash Green Utah LLC (North American Potash Developments Inc.)	Acquired 9 state leases totaling 6421 acres in Lisbon Valley, completed 1 deep hole
Monument	Paradox Basin, deep evaporites	San Juan	Paradox Basin Resources Corp.	Holdings include 97,595 acres of federal land under application, state leases, and private land

*Parent company or controlling partner in parentheses.

ros mine. Denison Mines Corp. produced approximately 230,000 kg (508,000 lb) of uranium oxide (U_3O_8) with a value of about $29.5 million, at an average price of $127.95/kg ($58.04/lb) (Denison Mines, 2012), mainly from three mines (Beaver, Pandora, and Daneros) in southeastern Utah. The uranium, and byproduct vanadium, ore was shipped to Denison's White Mesa mill (figure 5), located about 10 km (6 mi) south of Blanding in San Juan County, and processed into U_3O_8 and V_2O_5. Uranium spot prices had stabilized at about $115/kg ($52/lb) by the end of 2011, off by 30% of 2011's peak price of about $161/kg ($73/lb), with the year-end spot price 10% higher than the 2010 average spot price (Denison Mines, 2012). An approximate 4% increase in value of uranium produced in Utah in 2011, even though production was approximately 17% less than in 2010, was due to the higher price for uranium in 2011.

Exploration and Development Activity

Historically, Utah is the third largest uranium producing state, with the majority of its production from the Colorado Plateau. The spot price of U_3O_8 has been especially volatile over the last decade, with spikes to $300/kg ($136/lb) in June 2007, and lows of under $100/kg ($45/lb) in 2009–2010. The spot price rebounded to $161/kg ($73/lb) in early 2011, only to fall again following the Fukushima nuclear power plant disaster in March 2011. Uranium exploration and development in Utah has waxed and waned with these spot price fluxuations. Long-term contract U_3O_8 prices, in contrast, have remained relatively constant at approximately $139/kg ($63/lb). In the last few years of low spot prices, the uranium industry in Utah underwent a period of consolidation when both Denison Mines and Energy Fuels acquired promising properties from distressed exploration groups. The following paragraphs report the major uranium developments in Utah in 2011, and table 3 summarizes miscellaneous uranium activities.

Table 3. *Uranium projects in Utah, 2011.*

Property	District	County	Company	Progress
San Rafael	San Rafael River	Emery	Energy Fuels, Inc.	Indicated resource: 758,050 tons @ 0.23% U_3O_8
Frank M	Henry Mountain	Garfield	Uranium One, Inc.	Resource: 1.5 M tons @ 0.12% U_3O_8
North Wash	Henry Mountain	Garfield	Vane Minerals Plc.	29 holes drilled, including 9.5 ft @ 0.36% U_3O_8
Tony M/Bullfrog	Henry Mountain	Garfield	Denison Mines Corp.	Permitted resource: 1.527 M tons @ 0.24% U_3O_8
Whirlwind	Beaver Mesa	Grand	Energy Fuels, Inc.	Permitted resource: 656,000 lb U_3O_8
Thompson Project	Thompson	Grand	Denison Mines Corp.	Acquired 6672 acres
Dunn Mine	Dry Valley	San Juan	Midasco Capital Corp.	Resource: 143,400 tons @ 0.12% U_3O_8
Rim-Columbus	Dry Valley	San Juan	Denison Mines Corp.	Permitted resource: 660,000 lb U_3O_8
Marcy-Look	Elk Ridge	San Juan	Denison Mines Corp.	Acquired 907 acres
Blue Jay	Fry Canyon	San Juan	Denison Mines Corp.	Acquired 289 acres
Energy Queen (Hecla Shaft)	La Sal	San Juan	Energy Fuels, Inc.	Permitted resource: 1.2 M lb U_3O_8
North La Sal	La Sal	San Juan	Vane Minerals Plc.	Acquired 80 acres
Pandora/Snowball/ Beaver	La Sal	San Juan	Denison Mines Corp.	In production: 1.2 M lb U_3O_8 reserve
La Sal #2	Lisbon Valley	San Juan	Laramide Resources Ltd.	Resource: 440,000 tons @ 0.31% U_3O_8
Lisbon mine area	Lisbon Valley	San Juan	Mesa Exploration Corp.	22 holes (~60,000 ft), including 3.5 ft @ 0.28% U_3O_8
North Alice Extension	Lisbon Valley	San Juan	Vane Minerals Plc.	Resource: 43,000 tons @ 0.14% U_3O_8
Velvet	Lisbon Valley	San Juan	Uranium One, Inc.	Permitted resource: 580,000 lb U_3O_8
Sage Plain (Calliham-Sage)	Ucolo	San Juan	Energy Fuels, Inc.-Aldershot Resources	Resource: 642,971 tons @ 0.22% U_3O_8 and 1.39% V_2O_5
Daneros (Lark Royal)	White Canyon	San Juan	Denison Mines Corp.	In production: 1.2 M lb U_3O_8 resource
Geitus	White Canyon	San Juan	Denison Mines Corp.	Resource: 40,000 ton @ 0.3% U_3O_8
Happy Jack	White Canyon	San Juan	Vane Minerals Plc.	22 holes completed, including 1.5 ft @ 0.39% U_3O_8

Denison Mines Corporation

Denison Mines Corp. owns five permitted uranium mines in Utah as well as the 1800 t-per-day (2000 st/d), dual-circuit (uranium-vanadium) White Mesa mill near Blanding. The mill processes both uranium ore and an alternate feed waste material. The mill began operating on stockpiled ore from Denison owned mines in 2008, and began accepting ore from other companies for toll milling in 2009. The mill has the capacity to produce about 1.36 million kg (3 million lb) of U_3O_8 and 2 million kg (4.5 million lb) of V_2O_5 annually. Uranium recoveries from ore average over 90%. Energy Fuels, Inc. and Denison Mines Corp. announced on April 16, 2012 that they had signed a letter agreement for Energy Fuels to acquire the U.S. assets of Denison Mines in exchange for Energy Fuels shares. This should accelerate development of Energy Fuels' Energy Queen and Whirlwind U properties.

In late 2006, Denison's Pandora mine, in the eastern La Sal mining district (figure 5), San Juan County, became the first Utah uranium producer since 1991. The Pandora mine currently ships about 150 t per day (165 st/d) of ore a distance of 110 km (70 mi) south to the White Mesa mill. Reserves at the Pandora mine are estimated to be 263,000 t (290,000 st) at 0.22% U_3O_8 and 1.1% V_2O_5. In 2009, Denison reopened the Beaver mine, which is located 3 km (2 mi) west of the Pandora mine, also in the La Sal district. The Beaver mine produces about 150 t per day (165 st/d) from a resource estimated at 680,000 t (750,000 st) at 0.20% U_3O_8 and 1.25% V_2O_5. The La Sal district uranium ores are hosted in the Upper Jurassic Salt Wash Member of the Morrison Formation. In 2011, Denison drilled 68 holes totaling 15,833 m (51,945 ft) in the La Sal district to increase its existing resources.

The Daneros mine in the White Canyon mining district (figure 5), San Juan County, was permitted in May 2009. Development began in July, and production started in December 2009. Denison acquired the mine in June 2011. The Daneros ore body has an estimated resource of 363,000 t (400,000 st) at 0.22% U_3O_8 and about 1% copper, hosted in the basal Shinarump Conglomerate Member of the Upper Triassic Chinle Formation. The mine is accessed by twin declines, developed by room and pillar methods, and is ramping up production to 120 t per day (130 st/d). Ore is shipped 100 km (62 mi) to the White Mesa mill. In 2011, the Daneros produced 31,200 t (34,400 st) averaging about 0.22% U_3O_8.

Denison's Henry Mountains Complex (Tony M mine and Bullfrog properties) in the Shootaring Canyon district, Garfield County, and the Rim mine in the Dry Valley (East Canyon) district of San Juan County, are both on standby awaiting higher uranium prices. Both the Shootaring and Dry Valley district ore bodies are hosted in the Upper Jurassic Salt Wash Member of the Morrison Formation.

Energy Fuels, Inc.

Energy Fuels, Inc. is exploring, acquiring, and rehabilitating historical uranium producing properties. In 2007, Energy Fuels acquired the Energy Queen mine, in the La Sal district (figure 5), San Juan County, and began rehabilitation. The mine has an estimated resource of 87,302 t (96,250 st) of ore averaging 0.32% U_3O_8 and 1.24% V_2O_5, with access via an existing 229-m-deep (750-ft) lined shaft (Peters, 2011b). The Whirlwind mine on Beaver Mesa straddles the Utah-Colorado border about 45 km (28 mi) northeast of Moab in Grand County. The property began limited production in 2009, but has been on standby since then. The Whirlwind mine's measured resource is 134,057 t (147,798 st) of ore averaging 0.27% U_3O_8 and 0.88% V_2O_5 (Peters, 2011a). Both the Energy Queen and Whirlwind uranium ores are hosted in the Upper Jurassic Salt Wash Member of the Morrison Formation. As of mid 2012, Energy Fuels also continues the permitting process for building a new dual circuit uranium-vanadium mill near Naturita, CO.

In 2011, Energy Fuels acquired the Deep Gold and Down Yonder uranium resources in the San Rafael River mining district, Emery County, through a merger with Titan Uranium Inc. The San Rafael project has an estimated resource of about 1.58 million kg (3.49 million lb) U_3O_8 (Gatten, 2011).

Also in 2011, Colorado Plateau Partners LLC, a 50:50 joint venture between subsidiaries of Energy Fuels and Aldershot Resources Ltd., calculated a measured and indicated resource of 583,194 t (642,971 st) at 0.22% U_3O_8 and 1.39% V_2O_5 on their Sage Plain project (Peters, 2011c). This San Juan County project encompasses the historic Calliham and Sage mines.

Uranium One, Inc.

Uranium One, Inc. acquired the uranium assets of the U.S. Energy Corp. in 2006 and Energy Metals in 2007. These assets included the Velvet mine with a resource of about 64,260 t (70,850 st) averaging 0.41% U_3O_8 and 0.57% V_2O_5 in the Lisbon Valley district (Beahm and Hutson, 2007). The Velvet has the highest grade uranium resource known in Utah and is hosted in a Lower Permian Cutler Group sandstone. Other assets include the large, albeit low-grade, Frank M underground uranium resource and nearby inactive 680 t per day (750 st/d) Shootaring Canyon (Ticaboo) uranium mill, both in the Henry Mountains, Garfield County.

COAL

Production and Values

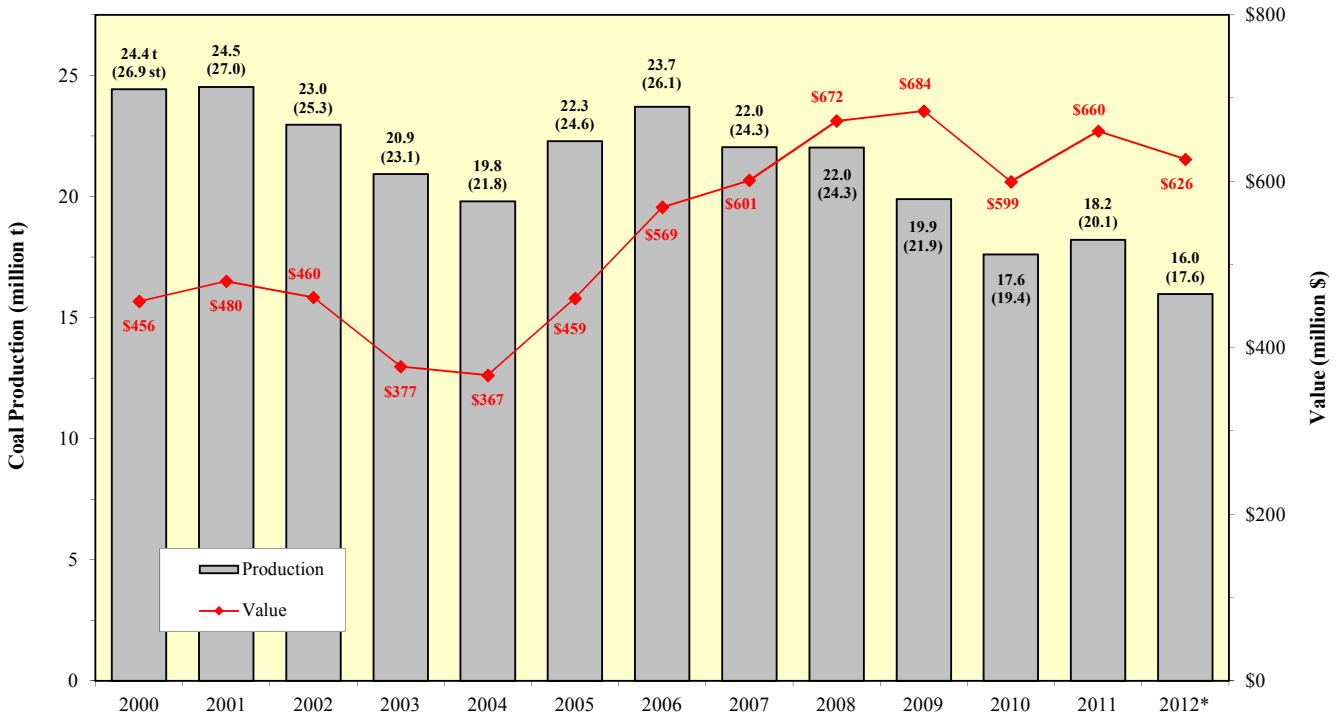
Seven Utah coal operators produced 18.2 million t (20.1 million st) of coal valued at $660 million from nine underground mines in 2011 (figures 8 and 9). This production was 605,000

t (667,000 st) (3.4%) more than in 2010. The majority of this increase was attributed to the Castle Valley mine (formally Bear Canyon) returning to production after being acquired by Rhino Resources (table 4). Despite this small production increase, demand for coal, especially at electric utilities, continues to suffer from the recession-related drop in demand for electricity and a catastrophic generator failure at a power plant near Delta, Utah. Canyon Fuel expects their 2012 coal production to drop by about 2.7 million t (3.0 million st), reducing Utah's total projected 2012 production to just 16.0 million t (17.6 million st) (table 4). Other Utah mines are expected to hold production steady or even increase slightly in 2012, including an almost doubling of production at the Castle Valley mine.

In 2011, the majority of Utah coal, 12.3 million t (13.6 million st) was produced from the Wasatch Plateau coalfield, with 5.6 million t (6.1 million st) coming from mines in the Book Cliffs coalfield, and 366,000 t (403,000 st) from the Coal Hollow mine in the Alton coalfield. The majority of Utah coal, 48.0% (8.7 million t, 9.6 million st) was produced from federal land, while 46.6% (8.5 million t, 9.3 million st) was from state-owned land. The remainder was produced from private (3.9%, 719,000 t, 793,000 st) and county (1.5%, 281,000 t, 310,000 st) lands. In July 2011, the Deer Creek mine's state-owned Mill Fork coal tract reverted back to federal ownership after a certain coal production threshold was reached. This reversion will dramatically increase the amount of coal produced on federal land in 2012.

Existing Utah mines are faced with steady reserve depletion and difficult mining conditions. As a result, operators are increasingly looking to new areas to replenish their reserve base. For the first time in several years, two new coal mines are in various stages of development. Utah American Energy commenced development of the Lila Canyon mine in the southern portion of the Book Cliffs coalfield in Emery County. Miners entered the coal bed in June 2010, producing 65,300 t (72,000 st) during the remainder of the year, and 142,000 t (157,000 st) in 2011 while developing the mine for longwall production—full production, about 4.1 million t (4.5 million st) per year, at Lila Canyon is still several years away. In addition, Alton Coal Development acquired the necessary permits to produce coal from an open-pit mine on private land in southern Utah's Alton coalfield, with production totaling 366,000 t (403,000 st) in 2011. Simultaneous with mine development on private land, the BLM continues to prepare an Environmental Impact Statement, which is needed before Alton Coal Development can lease surrounding federal coal. Production from these two new operations could offset declining production from existing mines, but future increases in production will depend on coal demand.

The total amount of Utah coal distributed to market in 2011 was just 17.0 million t (18.7 million st), much less than total coal produced for the year, meaning significant amounts of coal were stockpiled. The vast majority of Utah's coal, 86%, goes to the electric utility market. As a result of the slowed U.S. economy, demand for electricity decreased, resulting in a 29% drop in the demand for Utah coal at electric generating



*forecast

Figure 8. *Utah's annual coal production and value in nominal dollars, 2000–2012.*

facilities between 2008 and 2011, from 19.5 million t (21.5 million st) in 2008 to 14.0 million t (15.4 million st) in 2011. The economic recession also slowed demand for Utah coal in the industrial sector, with deliveries remaining steady at 2.3 million t (2.5 million st) for the past three years, the lowest level since 1987. Coal deliveries in 2012 are expected to remain relatively low, in the 15 million t (17 million st) range, due to lingering recession-related demand declines and an unexpected outage at the Intermountain Power Plant (Utah's largest consumer of coal). Utah coal producers currently rely on out-of-state demand and foreign export markets for consumption of roughly one-third of Utah's annual coal sales.

For detailed statistics on Utah's coal industry (including information previously published in the Annual Utah Coal Report), please refer to the abundant data tables located on the UGS's Utah Energy and Mineral Statistics website: http://geology.utah.gov/emp/energydata.

Exploration and Development Activity

UtahAmerican Energy, Inc. – Murray Energy Corporation

Lila Canyon mine: The new Lila Canyon mine is located south of Horse Canyon in the Book Cliffs coalfield in Emery County. In spring of 2010, the company finished construction on 366-m- (1200 ft) long rock slopes and began development work in the Sunnyside coal bed, producing 65,000 t (72,000 st) of coal in 2010. Development work continued in 2011, with total coal production reaching 142,000 t (157,000 st), and for 2012 coal production is expected to total about 272,000 t (300,000 st). By the time the mine is at full capacity, the timing of which depends on a recovering coal market, it could employ up to 200 people and produce up to 4.1 million t (4.5 million st) of coal per year. Coal will be mined from federal leases where the merged upper and lower Sunnyside

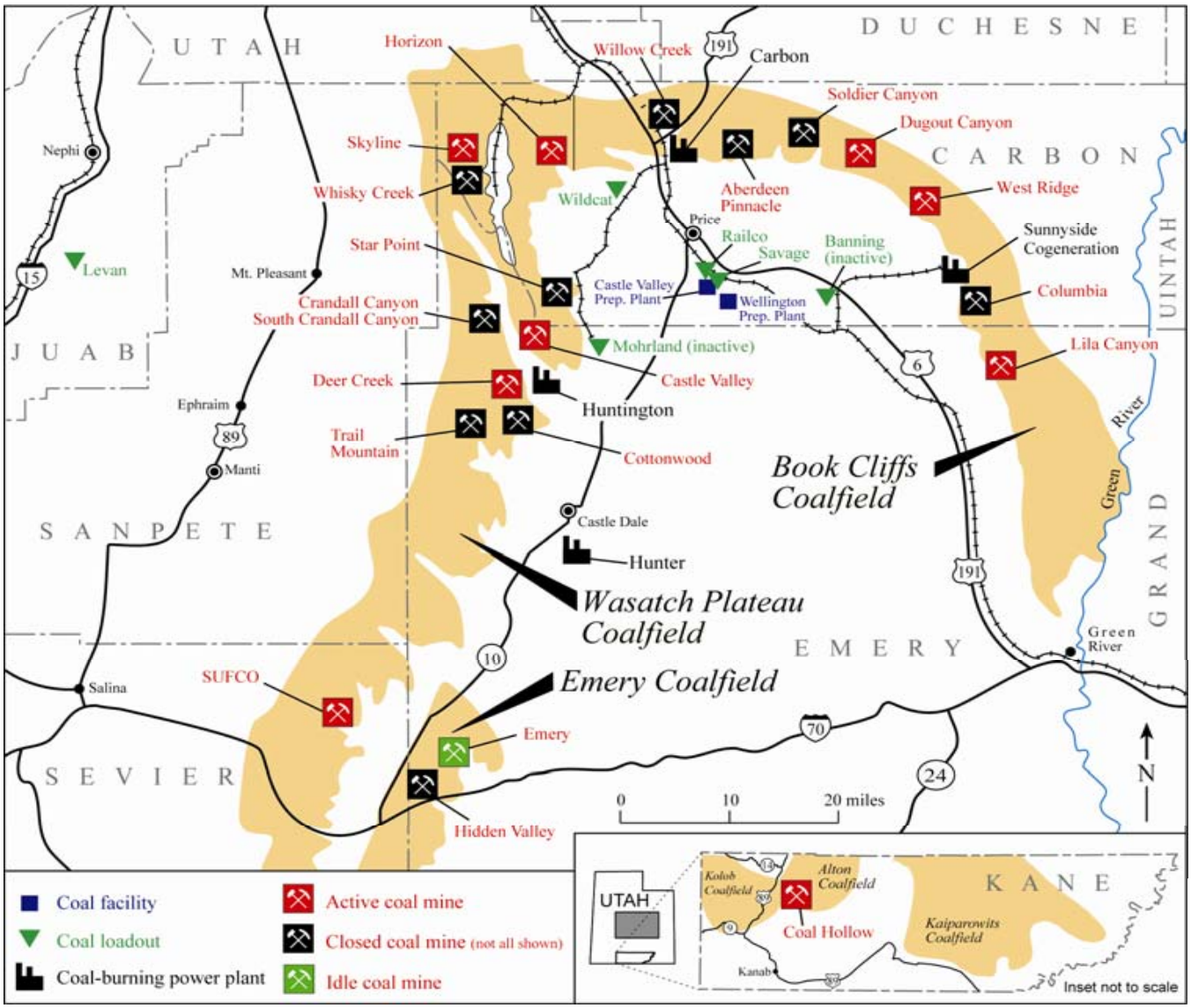


Figure 9. *Location and status (at time of printing) of Utah's coal mines and associated facilities.*

Table 4. Coal production and recoverable reserves in Utah by coal mine, 2010–2012.

Company	Mine	County	Coalfield	2010		2011		2012*	
				million t	million st	million t	million st	million t	million st
UtahAmerican Energy, Inc. - Murray Energy Corp.	Lila Canyon	Emery	Book Cliffs	66	72	142	157	272	300
Canyon Fuel, LLC - Arch Coal, Inc.	Dugout Canyon	Carbon	Book Cliffs	2093	2307	2173	2395	1361	1500
	Skyline #3[2]	Carbon	Wasatch Plateau	2767	3050	2676	2950	1814	2000
	SUFCO	Sevier	Wasatch Plateau	5804	6398	5895	6498	4808	5300
CONSOL Energy	Emery	Emery	Emery	907	999	--	--	--	--
Castle Valley Mining[1] - Rhino Resources	Castle Valley #4	Emery	Wasatch Plateau	--	--	537	592	907	1000
Energy West Mining Co.	Deer Creek	Emery	Wasatch Plateau	2680	2954	2851	3143	2994	3300
Hidden Splendor Resources, Inc. - America West Resources, Inc.	Horizon	Carbon	Wasatch Plateau	245	270	336	370	454	500
WEST RIDGE Resources, Inc. - UtahAmerican Energy, Inc. - Murray Energy	West Ridge	Carbon	Book Cliffs	3043	3355	3235	3566	2994	3300
Alton Coal Development	Coal Hollow	Kane	Alton	--	--	365	403	363	400
Total				17,605	19,406	18,210	20,073	15,966	17,600

Source: UGS coal company questionnaires

[1]Formerly owned by C.W. Mining (until summer 2010) - mines formerly called Bear Canyon
*Forecast

bed is about 4.0 m (13 ft) thick. Between 24 and 36 million t (26 and 40 million st) of recoverable coal are under lease, with recovery largely dependent on the cutting height of the equipment that will be used. Approximately 45 million t (50 million st) of additional unleased federal coal is available to the south of current leases.

West Ridge Resources, Inc. – West Ridge mine: The West Ridge mine began operation in 1999 in the Book Cliffs coalfield with production from the lower Sunnyside bed. The West Ridge mine produced 3.2 million t (3.6 million st) of coal in 2011, up from 3.0 million t (3.4 million st) in 2010. Production in 2012 is expected to decrease slightly to 3.0 million t (3.3 million st). UtahAmerican estimates that the West Ridge mine has 8.8 million t (9.7 million st) of recoverable coal under lease.

Canyon Fuel Company – Arch Coal

Dugout Canyon mine: The Dugout Canyon mine, located in the Book Cliffs coalfield, produced 2.2 million t (2.4 million st) of coal from the Gilson bed in 2011, up slightly from the 2.1 million t (2.3 million st) produced in 2010. Dugout's production is expected to decrease to 1.4 million t (1.5 million st) in 2012 due to a demand-related stoppage of their longwall mining equipment. Longwall production is expected to resume in fall 2012, with only one additional panel in the Gilson coal bed before equipment will be moved back into the Rock Canyon bed. Canyon Fuel estimates that the Dugout mine has 13.6 million t (15.0 million st) of recoverable coal remaining under lease.

Skyline mine: Canyon Fuel Company's Skyline mine, located in the Wasatch Plateau coalfield, is currently mining in the Lower O'Connor 'A' bed on their North lease (Winter Quarters lease) in Carbon County. Production from this bed decreased slightly in 2011 to 2.7 million t (3.0 million st), and 2012 production is expected to drop to 1.8 million t (2.0 million st) as operators move the longwall equipment to the north side of the Winters Quarters graben. Canyon Fuel estimates that 13.8 million t (15.2 million st) of coal can be recovered from current leases.

SUFCO mine: SUFCO is Utah's largest coal producer and the sixth-largest producing underground coal mine in the United States (figure 10). It is also the only active coal mine in Sevier County. SUFCO produced 5.9 million t (6.5 million st) of coal in 2011 from the upper Hiawatha bed, 17.8% less than record high production of 7.2 million t (7.9 million st) achieved during 2006. Production at SUFCO is expected to decrease to 4.8 million t (5.3 million st) in 2012 due to reduced demand caused by the 6-month outage at the Intermountain Power Plant. Canyon Fuel estimates that roughly 42.4 million t (46.8 million st) of reserves remain under lease in the upper and lower Hiawatha beds.

Greens Hollow tract: Canyon Fuel has nominated the federal Greens Hollow tract for leasing, located northwest of the already acquired Quitchupah lease. A draft EIS was issued in the spring of 2009 and the BLM is continuing to address issues raised during the comment period. The Greens Hollow tract is thought to contain approximately 66 million t (73 million st) of reserves within the lower Hiawatha bed.

Cottonwood tract: On December 31, 2007, SITLA held a sale of the Cottonwood Competitive Coal Leasing Unit. The tract was awarded to Ark Land Company, which is a subsidiary of Arch Coal, Inc., also the owner of the Canyon Fuel Company. Two coal leases were issued, one for 3320 ha (8204 acres) covering lands within the 1998 land exchange Cottonwood Coal Tract and the other for 243 ha (600 acres) within an adjacent SITLA section. In mid-2011, the Cottonwood lease was transferred to Fossil Rock Fuels, a subsidiary of PacifiCorp and Rocky Mountain Power, as part of a settlement of litigation between the two companies. The Cotton-

Figure 10. *SUFCO mine in northeastern Sevier County.*

wood tracts are adjacent to PacifiCorp's existing, but inactive, Train Mountain federal lease. Total recoverable coal in the Hiawatha bed for the combined leases is estimated to equal 44 million t (49 million st).

CONSOL Energy

Emery mine: CONSOL Energy's Emery mine, its only mine in the western United States, produced about 0.9 million t (1 million st) annually from the Ferron Sandstone I bed from its opening in 2005 through 2010. However, CONSOL indefinitely idled the mine in December 2010, citing lack of coal demand. CONSOL estimates recoverable reserves under lease to total 8 million t (9 million st), but significant unleased reserves can be found adjacent to the mine. In addition, the company owns coal near the undeveloped Hidden Valley mine farther south in the Emery coalfield.

Rhino Energy

Castle Valley mines: Rhino Energy purchased the Bear Canyon mines, formerly owned by C.W. Mining (Co-Op), in 2010, and during bankruptcy proceedings renamed the mines Castle Valley. No coal was produced from the property in 2010, but Rhino produced 537,000 t (592,000 st) in 2011 using continuous miner machines in the Tank bed. Full-scale production with two continuous miners should reach about 907,000 t (1.0 million st) in 2012. Roughly 45.9 million t (50.6 million st) of recoverable reserves are still available in the Tank, Blind Canyon, and Hiawatha beds in the surrounding area.

Energy West Mining Company (PacifiCorp)

Deer Creek mine: Production at the Deer Creek mine increased to 2.9 million t (3.1 million st) in 2011 and is expected to increase again in 2012 to 3.0 million t (3.3 million st). From the inception of mining on the Mill Fork lease to July 2011, this tract was temporarily state-owned; however, its reversion back to a federal ownership will greatly decrease Utah's production of state-owned coal. Production in the Blind Canyon bed at Mill Fork was completed in mid-2010, and shifted back to the Hiawatha bed. Roughly 15 million tons of coal remain in the Hiawatha in this area, after which, mining will once again return to the Blind Canyon bed. As of the end of 2011, the Deer Creek mine had roughly 21.4 million t (23.6 million st) of coal remaining. Energy West, under the new subsidiary name Fossil Rock, will begin a three year exploration program in 2012 on the newly acquired Cottonwood lease.

America West Resources, Inc.

Hidden Splendor Resources, Inc. – Horizon mine: The Horizon mine, located approximately 18 km (11 miles) west of Helper in the Wasatch Plateau coalfield, is owned and operated by Hidden Splendor Resources, a fully owned subsidiary of America West Resources. Since Hidden Splendor's acquisition of the mine in 2003, annual production with one continuous miner has averaged 236,000 t (260,000 st); however, 2011's production increased to 336,000 t (370,000 st) with the introduction of a second continuous miner. Plans call for a third continuous miner to be added in 2012 with production increasing to about 454,000 t (500,000 st). America West estimates that 14.7 million t (16.2 million st) of coal remain under lease.

Alton Coal Development, LLC

Coal Hollow mine: In 2011, Alton Coal Development, LLC began production at a new coal mine in the Alton coalfield in southern Utah's Kane County. Surface-mine production on the company's private property totaled 365,000 t (403,000 st) for 2011. Production is expected to be about the same in 2012. Full production at the Coal Hollow mine could total 1.8 million t (2.0 million st) per year, but depends on the acquisition of surrounding federal lands. The BLM is currently preparing a draft EIS for the proposed federal leasing action. Alton's private lease is estimated to contain about 4.5 million t (5.0 million st) of recoverable coal, while reserves on the combined private and federal mining areas are estimated between 36 and 41 million t (40 and 45 million st). The Coal Hollow mine produces subbituminous Dakota Formation coal from the Smirl bed, which ranges from 10,023 kJ to 10,550 kJ (9500 to 10,000 btu/lb), and averages about 1% sulfur and 9% ash.

CRUDE OIL AND NATURAL GAS

Production and Values

Most of the statistical data presented here on oil and gas were found on the DOGM web site at: http://oilgas.ogm.utah.gov/index.htm. At an estimated value of $3.9 billion, oil and gas production was the largest contributor to the total value of fuel commodities produced in Utah during 2011, with 4.2 million m^3 (26.3 million barrels [bbls]) of oil and 13.1 billion m^3 (461.9 billion ft^3) of gas produced from Utah's oil and gas fields (figure 11). Oil and gas constituted 85% of Utah's total fuel production value in 2011. Oil and gas values increased about $439 million (13%) in 2011 compared to 2010, but while the volume and value of oil was up, the value of gas was down due to a lower average annual price. Utah's oil prices have more than doubled between 2004 and 2011, while production has risen by 78%; during that same period gas prices have decreased by 27%, while gas production has risen by 57%. Thus, gas and oil are following different market trends with oil production following price upward, but gas production increasing in spite of falling prices. In 2012, gas prices may fall so low that gas production volumes are finally affected. Utah's 2011 oil and gas production came from 10,283 producing wells, 3814 oil wells and 6469 gas wells, an increase from the 9583 producing wells in 2010 (3508 oil and 6075 gas).

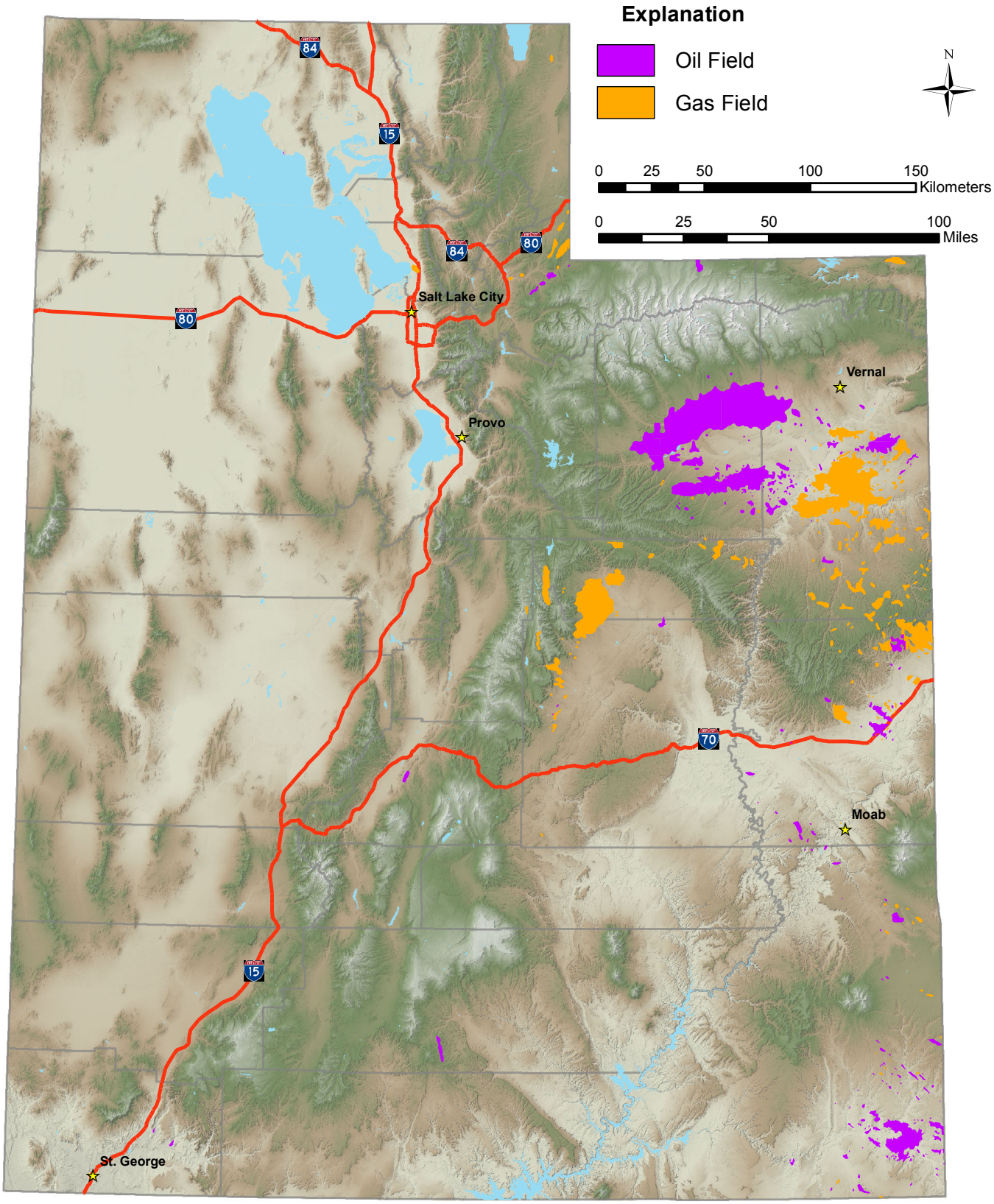


Figure 11. *Oil and gas fields in Utah.*

Oil contributions were the largest to the total value of fuel production in Utah in 2011, with a value of $2.2 billion, about $490 million (29%) more than in 2010. Duchesne, Uintah, San Juan, and Sevier Counties, in decreasing order of production, were the four largest oil producing counties in Utah in 2011, and when combined, contributed for about 98% of the total state production volume. The five largest producing oil fields in 2011, Monument Butte (Duchesne and Uintah), Greater Aneth (San Juan), Altamont (Duchesne), Covenant (Sevier), and Bluebell (Duchesne and Uintah), accounted for about 62% of Utah's total oil production.

Gas contributed the second largest share of the overall value of fuel commodities produced in Utah during 2011, with an estimated value of $1.8 billion, a $50 million (3%) decrease from 2010. Uintah, Carbon, Duchesne, and Emery Counties, in decreasing order of production, were the four largest gas producing counties in Utah in 2011, and when combined, contributed about 95% of the total state gas production volume. The five largest producing gas fields in 2011, Natural Buttes (Uintah), Drunkards Wash (Carbon), Helper (Carbon), Nine Mile Canyon (Carbon), and Peters Point (Carbon), accounted for 71% of the total gas production, but Natural Buttes alone accounted for about 54% of the Utah's 2011 gas production.

Exploration and Development Activity

Utah experienced an increase in oil and gas exploration and development activity in 2011, and, in comparison with 2010, the number of wells permitted rose 28% from 1185 to 1515, and the number of wells started (spud) increased 2% from 973 to 989. The county with the most oil and gas exploration and development activity was Uintah County with 802 new well permits and 524 well spuds; the second most active was Duchesne County with 539 new well permits and 352 well spuds; and the third most active was Carbon County with 138 new well permits and 94 new well spuds. These top three counties accounted for 98% of the new well permits and well spuds in Utah in 2011. The 846 new oil and gas wells completed during 2011 were a drop in number from the 907 completed in 2010. The new oil and gas wells completed in 2011 consist of 650 new wells within established field boundaries, 139 wells drilled outside of an existing field boundary with the intent of extending the field boundary, and 57 wildcat wells drilled in an unproven area. Not all 846 new wells drilled in 2011 were productive and 22 (3%) were plugged and abandoned; 400 (47%) were oil wells, 415 (49%) were gas wells, and 8 (1%) were service wells (injection or disposal wells). The ratio of new oil wells to new gas wells drilled has increased in the past few years in response to the high oil prices and low gas prices, and this trend will continue until gas prices recover to a more attractive level.

UNCONVENTIONAL FUELS—OIL SHALE AND TAR SAND

Exploration and Development Activity

Oil Shale

The upper Green River Formation in Utah's Uinta Basin hosts one of the largest deposits of oil shale in the world. Estimated in-place resources total 207 billion m^3 (1.3 trillion bbls) of oil (USGS Oil Shale Assessment Team, 2011) with approximately 12 billion m^3 (77 billion bbls) as a potential economic resource (Vanden Berg 2008). The richest oil shale horizon in Utah is the Mahogany zone, where in individual beds oil in the rock can reach up to 334 l/t (80 gal/st). The Mahogany zone is 21 to 31 m (70 to 100 ft) thick and is accessible via extensive outcrop along the eastern and southern flanks of the basin.

Operators

The outcrop accessibility, low dip, and shallow cover of Utah's richest oil shale deposits make surface/underground mining and surface retort the preferred technology for recovering the oil from the shale. Currently, two companies are pursuing oil shale development: Enefit American Oil and Red Leaf Resources.

Enefit American oil is an Estonian company that acquired 100% of OSEC (Oil Shale Exploration Company), including all their private land (the Skyline property), state leases, and a U.S. BLM Research, Development, and Demonstration oil shale lease. Enefit's plan is to develop an 8000 m^3/day (50,000 bbls/day) oil shale operation, consisting of a surface/underground mine (which would process ~27 million t [~30 million st] of shale per year), a surface retort and circulating fluidized bed combustion unit, and a shale oil upgrader. The project will commence in two stages, with plans for 4000 m^3/day (25,000 bbls/day) by 2020 and 8000 m^3/day (50,000 bbls/day) by 2024. Current work has focused on drilling several wells and recovering core to prove up the resource and collect "fresh" mining-horizon samples for testing the company's retort technology.

Red Leaf Resources is a Utah company with several state oil shale leases on the southeastern side of the Uinta Basin. Red Leaf has developed a modified in-situ retort technology referred to as the Ecoshale technology. Basically, the process involves surface mining a pit, lining the pit with an impermeable clay layer, placing the oil shale back in the "capsule" with a series of pipes, covering the capsule with clay and top soil, and retorting the shale in the capsule via hot air circulating through the pipes. Reclamation can commence while the capsule is still retorting the shale. This process has already been tested on the pilot scale level and the company is currently seeking a large mine permit to test the process

at a larger scale. Commercial plans are to produce 1500 m^3/day (9500 bbls/day) of oil from several capsules running simultaneously.

Oil Sand

North America has the greatest oil sand resources in the world, the majority of which are in Canada. Utah's oil sand resource, though small in comparison to that of Canada, is the largest in the United States. Utah's oil sand deposits contain 2.2 to 2.4 billion m^3 (14 to 15 billion bbls) of measured in-place oil, with an additional estimated resource of 3.7 to 4.4 billion m^3 (23 to 28 billion bbls). Twenty-four individual deposits exist in the Uinta Basin, mainly around its periphery, and an additional 50 deposits are scattered throughout the southeastern part of the state. Utah's major oil sand deposits individually have areal extents ranging from 52 to over 647 km^2 (20 to over 250 mi^2), as many as 13 pay zones, gross thickness ranging from 3 to more than 305 m (10 to more than 1000 ft), and overburden thickness ranging from zero to over 152 m (500 ft).

With the current high price of crude oil as an incentive, new drilling, bitumen extraction, and upgrading techniques developed in Canada may provide the necessary knowledge for successful and sustainable development of oil sand in Utah in the near future. However, factors such as site accessibility, adequate infrastructure, water availability, environmental concerns, and permitting, and the problems associated with the heterogeneity of reservoir sands, must be resolved before economically viable oil sand development can become a reality in Utah.

Operators

U.S. Oil Sands is the most active company seeking to develop Utah's oil sand resources. The company has several state leases within the PR Springs oil sand deposit in the southern Uinta Basin. The company plans to surface mine the oil sand and extract the bitumen using a solvent-based technology. In the summer of 2011, the company drilled over 180 wells on their leases to prove up the resource. Currently the company is working to secure the necessary mining permits to develop their technology at the commercial scale.

One of Utah's most promising oil sand deposits is located along Asphalt Ridge near Vernal, Utah. Several companies in the past have tried to develop oil sand operations in the area, but in 2011 no commercial activity took place.

NEW MINERALS INFORMATION

The following recent publications provide new information on the energy and mineral resources of Utah. These and other publications are available through the Utah Department of Natural Resources Map and Bookstore (http://mapstore.utah.gov). Additional geographic information system (GIS) data on Utah is available for free download at http://agrc.its.state.ut.us/ and http://geology.utah.gov/databases/index.htm.

Boden and Tripp (2012) report on the latest mapping of gilsonite veins and provide an up-to-date compilation of new and existing data on Utah's gilsonite resource of the Uinta Basin in Duchesne and Uintah Counties. Krahulec (2011) reports on sedimentary-rock-hosted gold and silver deposits of the northeastern Basin and Range, Utah. Massoth and Tripp (2011) provide a well database of salt cycles of the Paradox Basin, Utah. Rupke, Tripp, and Boden (2011) report on limestone, dolomite, and building stone resources of Sanpete County, Utah. The U.S. Geological Survey Oil Shale Assessment Team (2011) gives a comprehensive assessment of in-place oil in oil shales in the Eocene Green River Formation of Wyoming, Colorado, and Utah.

The UGS maintains a comprehensive repository for Utah energy and mineral data at http://geology.utah.gov/emp/energy-data. The website contains over 130 tables and 50 figures (in both Excel and PDF formats) in nine chapters that are continuously updated as new data become available.

RECLAMATION AND THE ENVIRONMENT

The U.S. Department of Energy (DOE) and the State of Utah agreed to move the 10.8 million t (11.9 million st) of Atlas uranium mill tailings located along the Colorado River near Moab. The tailings are being moved 48 km (30 mi) north to a site near Crescent Junction. The DOE is transporting the tailings by rail to a 100-ha (250-acre) disposal cell developed in the Cretaceous Mancos Shale. The project began shipping tailings in April 2009 and had moved nearly 4.5 million t (5 million st) by the end of 2011. DOE intends to finish the cleanup by 2019.

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