

UTAH'S EXTRACTIVE RESOURCE INDUSTRIES 2015

by Taylor Boden, Ken Krahulec, Michael Vanden Berg, and Andrew Rupke



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Cover photo: Reverse circulation drill rig on one of Pilot Gold's 2015 sediment-hosted gold-silver exploration holes in the Goldstrike district, Washington County; mineralized jasperoid breccia shown in the foreground. Photograph courtesy of Peter Shabestari, Pilot Gold, Inc.



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Gary R. Herbert, Governor

DEPARTMENT OF NATURAL RESOURCES

Michael Styler, Executive Director

UTAH GEOLOGICAL SURVEY

Richard G. Allis, Director

PUBLICATIONS

contact

Natural Resources Map & Bookstore

1594 W. North Temple

Salt Lake City, UT 84116

telephone: 801-537-3320

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website: mapstore.utah.gov

email: geostore@utah.gov

UTAH GEOLOGICAL SURVEY

contact

1594 W. North Temple, Suite 3110

Salt Lake City, UT 84116

telephone: 801-537-3300

website: geology.utah.gov

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ABSTRACT

During 2015, Utah extractive resource industries produced energy and mineral commodities with an estimated gross value of \$5.9 billion. On an inflation-adjusted basis, this is a \$4.5 billion (-43%) decrease from 2014, and \$5.3 billion (-47%) less than the 2008 record high of \$11.1 billion. Total energy production in 2015 was valued at \$3.3 billion, which includes \$1.5 billion from crude oil production, \$1.2 billion from natural gas and natural gas liquids production, and \$0.5 billion from coal production. Nonfuel mineral production was valued at \$2.6 billion, including \$1.1 billion from base metal production, \$1.3 billion from industrial mineral production, and \$0.2 billion from precious metal production. Projections for 2016 indicate that the value of energy and mineral commodities will decrease another 12% to \$5.1 billion.

U.S. Geological Survey preliminary 2015 data ranked Utah 8th nationally in the value of nonfuel mineral production, accounting for approximately 3.7% of the United States total. In 2015, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value of \$551 million and mostly produced from Kennecott Utah Copper Corporation's Bingham Canyon mine. The largest overall contributors to the value of industrial mineral production in Utah during 2015 were the brine- and evaporite-derived products of potash, salt, and magnesium chloride, which had an estimated value of \$381 million. Notably, Utah remains the only state in the nation to produce magnesium metal, beryllium concentrate, potash as potassium sulfate, and gilsonite.

From 2014 to 2015, oil and gas exploration and development activity in Utah declined; the number of permitted wells decreased 59% from 1389 to 570, and the number of wells drilled decreased 83% from 895 to 155. Utah coal production decreased 19% in 2015, and is expected to also decrease in 2016 due to shrinking domestic demand. Continuing low uranium prices in 2015 have made production from uranium mining operations in Utah uneconomic. Overall, mineral exploration and development was down in 2015, with exploration focused primarily on potash, gold, and copper. Only 975 new unpatented mining claims were filed in Utah in 2015, and 18,520 active unpatented mining claims were on file with the U.S. Bureau of Land Management at year end. The number of new claims and the total number of active claims both decreased during 2015.

INTRODUCTION

Background

Utah mineral activity summaries have been compiled annually by the Utah Geological Survey (UGS) since 1989. To maintain uniformity and continuity, the general style used in previous editions of this report will be continued. Final 2014 production and economic values became available in the fourth quarter of 2015, and for this report we used those numbers to update values published in *Utah's Extractive Resource Industries 2014* (Boden and others, 2015). Note that nonfuel mineral production values reported by the U.S. Geological Survey (USGS) may differ from those reported by the UGS, due to different data sources and compilation methods. The 1996–2015 Utah mineral/mining summaries are available on the UGS website at <http://geology.utah.gov/resources/mineral-resources/#tab-id-2>.

Since 1993, Utah mineral industry summaries have categorized mineral production and economic value into four broad segments consisting of base metals, precious metals, industrial minerals, and energy minerals (coal and uranium). In 2011, the annual Utah coal report was combined with the mineral activities summary (Gwynn and others, 2011), and in 2012 new sections on crude oil, natural gas, and unconventional fuels were added (Boden and others, 2012). The USGS, U.S. Energy Information Administration (EIA), Office of Natural Resources Revenue (ONRR), and the Utah Division of Oil, Gas and Mining (DOGM) provided some of the data assembled for this report. Additional data were obtained by the UGS from annual operator surveys, company websites, trade industry publications, and personal correspondence.

Historical Context

Utah contains a remarkable variety of energy and mineral resources. The development of these resources for over 168 years has been important to Utah and the United States. Mining plays a vital role in Utah's economy and is the oldest non-agricultural industry in the state, employing thousands directly in mining, processing, and transportation, and indirectly in supporting occupations. The recorded mining history of Utah began in 1847. Soon after their arrival, Latter-day Saint pioneers began developing mineral resources. Their early efforts

included recovering salt from Great Salt Lake, coal mining (near the communities of Coalville, Wales, and Cedar City), quarrying building stone, and production of 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, as well as in Big and Little Cottonwood Canyon and the Park City area in the Wasatch Range (Krahulec, 2006). After the completion of the transcontinental railroad in 1869, branch lines were developed to access mining districts and ore produced in Utah became more valuable, exceeding \$100 million by 1917 (Stowe, 1975). With the development of mine and transportation infrastructure, Utah became 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 even today, copper, gold, silver, and molybdenum produced from the deposit makes it the most productive mine in the U.S. Utah is also the nation's only source of gilsonite since the late 1880s (Boden and Tripp, 2012), beryllium since 1969 (Alexander, 2006), and magnesium metal since 1972 (Krahulec, 2006). Demand for uranium for use in nuclear weapons and power plants resulted in the development of uranium deposits in southeastern Utah during the 1950s and 1960s. In 1952, Charlie Steen discovered one of the biggest uranium deposits on the Colorado Plateau and developed the Mi Vida mine in the Big Indian Wash (Lisbon Valley) area of San Juan County. Oil and gas exploration in Utah extends back over 100 years. The first natural gas discovery in Utah was accidental, when gas was encountered in 1891 while drilling a water well in Farmington Bay on the eastern shore of Great Salt Lake (UGS, 2006). Gas from this area was later transported by wooden pipeline to Salt Lake City. Oil was discovered in the early 1900s at Rozel Point on the shore of Great Salt Lake in Box Elder County, and near the towns of Mexican Hat in San Juan County and Virgin in Washington County (UGS, 2006). By 1960, Utah was the 10th largest oil-producing state in the nation.

In 1969, the annual value of minerals produced in Utah had grown to \$500 million (Stowe, 1975), and it surpassed \$1 billion in 1988 (Walker and Smith, 1989). According to data compiled by the UGS, USGS, and other sources, the inflation-adjusted value of Utah energy and mineral production reached a record high in 2008 of \$11 billion. The worldwide recession beginning in late 2008 is reflected in the decreased value of Utah's energy and mineral production in 2009. Since then, the economic recovery has resulted in a relatively high value for Utah energy and mineral production through 2014.

The contribution of energy and mineral production to the Utah Gross Domestic Product (GDP), compared to the value of all goods and services statewide, decreased from 6% in the 1960s to 1.3% in the early 2000s as the state economy grew and

diversified. Over the past several years the contribution of the energy and mineral industries to the Utah GDP has ranged between 2% and 3% (U.S. Bureau of Economic Analysis, 2016). The demand and price for Utah energy and mineral commodities will likely continue to rise, and the extractive resource industries are expected to remain an important contributor to the Utah economy.

Industry Overview

Based on UGS data, the estimated gross value of Utah energy and mineral production during 2015 was \$5.9 billion, a 43% decrease from the 2014 inflation-adjusted value. The 2015 energy and mineral production value is the lowest since the 2004 inflation-adjusted value of \$5.5 billion (figure 1). Between 2014 and 2015, crude oil and natural gas prices decreased dramatically. From 2014 to 2015, prices decreased for gold, silver, copper, and molybdenum, while the price increased for beryllium and was flat for magnesium metal. Industrial minerals prices were mixed and varied slightly from 2014, with a notable increase for potassium sulfate. From 2014 to 2015, Kennecott Utah Copper (KUC) gold, silver, copper, and molybdenum production decreased dramatically, and this together with lower prices resulted in a major decrease in the overall value of the entire metals group. Industrial minerals value decreased slightly from 2014 to 2015, due to lower potash production, but has experienced fairly steady growth since 2005. This past growth has been supported by Utah construction projects and high production and prices for potash. The combined value of Utah oil and gas production decreased significantly during 2015. The decrease in value of oil and gas resulted from dramatic decreases in prices starting in late 2014 that were followed by large decreases in production. The value of Utah coal decreased in 2015 as a result of lower coal production. Demand for Utah coal by electric utilities continues to diminish as out-of-state power plants convert from coal to natural gas or close altogether. Energy Fuels Resources suspended production of uranium and vanadium from its Utah mines in 2013, because of low uranium prices. However, in 2015 the company continued to process stockpiled uranium and vanadium ore at its White Mesa mill near Blanding in San Juan County.

The UGS's estimated value of energy resources produced in Utah during 2015 was \$3.3 billion, and nonfuel mineral resource production was \$2.6 billion. The oil industry sector contributed the largest value (\$1.5 billion; 26% of total), followed by industrial minerals (\$1.3 billion; 23% of total), natural gas including natural gas liquids (\$1.2 billion; 21% of total), base metals (\$1.1 billion; 19% of total), coal (\$508 million; 9% of total), and precious metals (\$182 million; 3% of total) (figures 2 and 3). Compared to 2014, the 2015 values for oil decreased by \$1.7 billion (-54%), industrial minerals by \$76 million (-5.5%), natural gas by \$1.2 million (-49%), base metals by \$1.1 billion (-51%), coal by \$92 million (-15%), and precious metals by \$211 million (-54%).

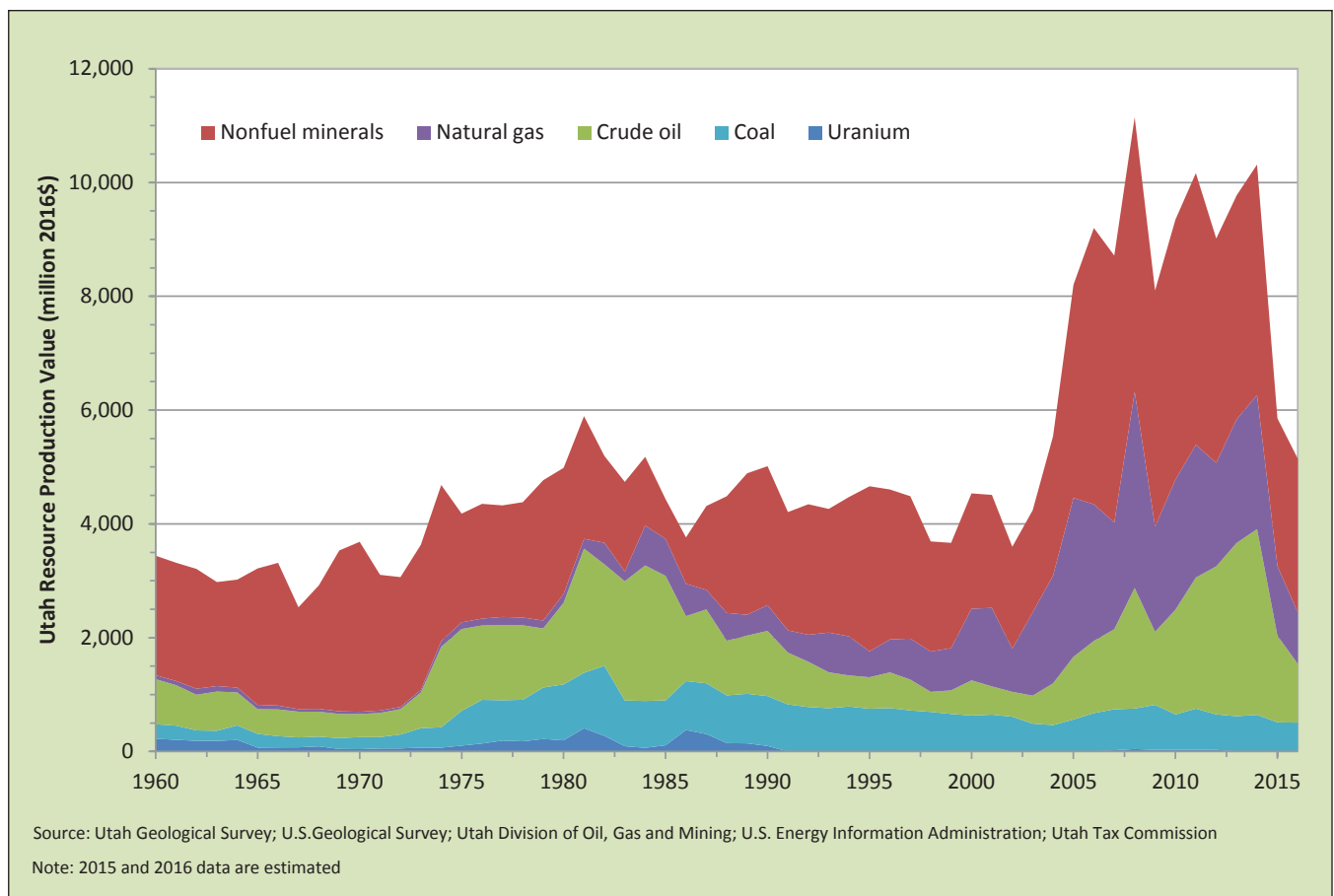


Figure 1. Annual value of Utah energy and mineral production, inflation adjusted to 2016 dollars, 1960–2016.

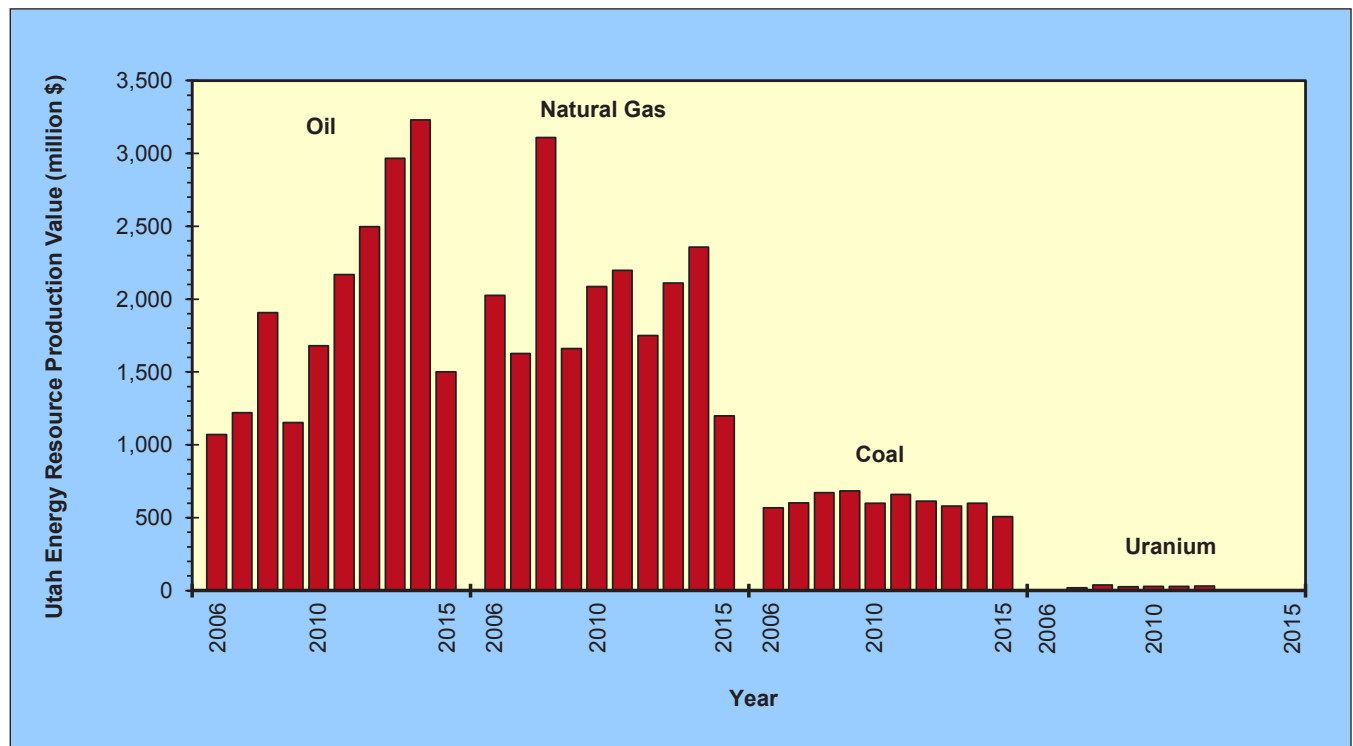


Figure 2. Annual value of Utah energy resource production in nominal dollars, by industry sector, 2006–2015. Source: Utah Geological Survey.

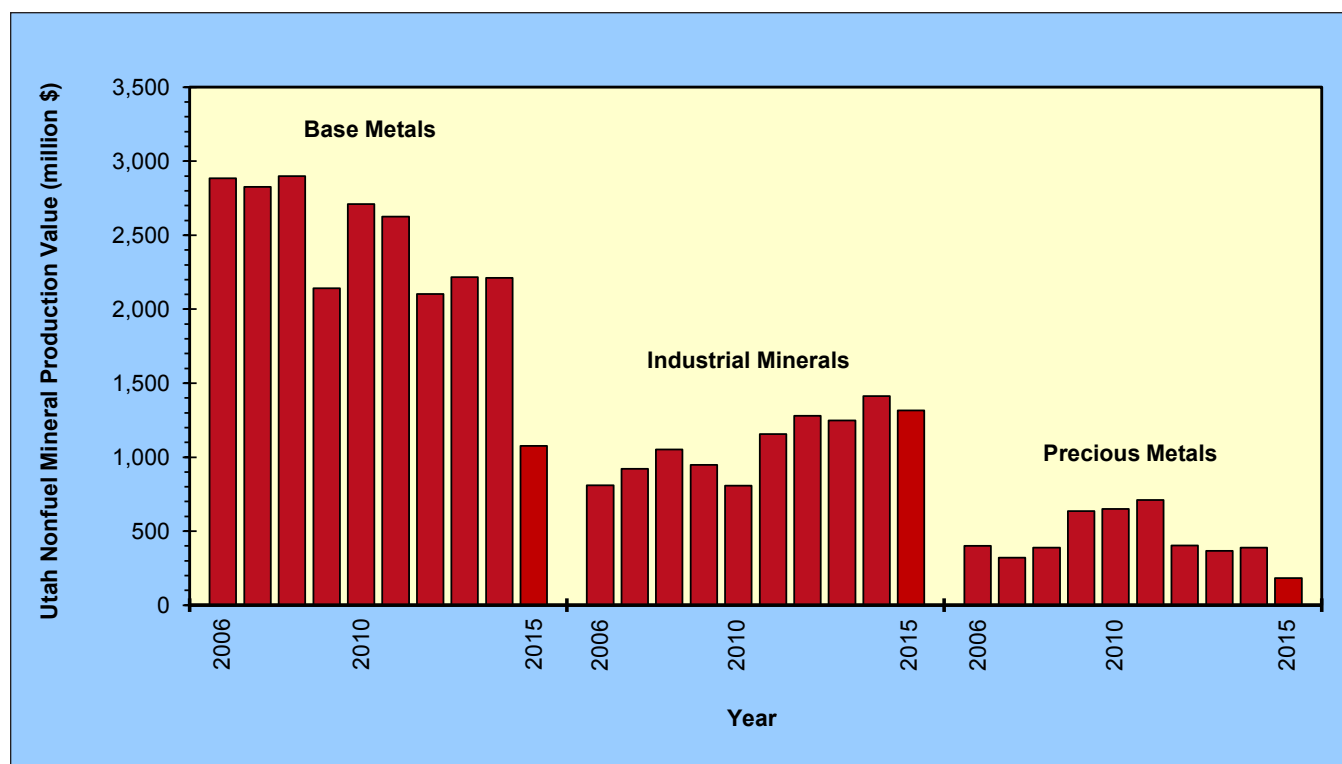


Figure 3. Annual value of Utah nonfuel mineral production in nominal dollars, by industry sector, 2006–2015. Source: Utah Geological Survey.

Commodity price indices were at a near record low in 2002 only to rise dramatically from 2003 to 2008. The 2008 financial crisis resulted in a crash in the commodity markets which bottomed in 2009 and rose to a new peak in 2011; copper reached \$4.50 per pound in February 2011 and gold hit \$1923 per ounce in September 2011. Subsequent commodity prices have declined steadily through 2015. This decline is partly the consequence of a slowing growth rate in China and has resulted in layoffs, closures, asset sales, and bankruptcies in the mining industry in Utah and around the world. These commodity price swings are well reflected in Utah's mining employment numbers (figure 4). Utah mineral exploration, development, and production have all declined along with the commodity prices over the past several years.

Slumping metal prices have resulted in a decreased number (975) of new unpatented mining claims filed in Utah in 2015, down significantly (-69%) from 2014. Tooele (gold), Washington (gold), Juab (gold-silver-copper), and San Juan (uranium) Counties were the most active, each having recorded over 150 new claims filed in 2015. At the end of 2015, the U.S. Bureau of Land Management (BLM) had a total of 18,520 active unpatented mining claims in Utah, down slightly (-6%) from 2014 (Opie Abeyta, Utah BLM, written communication, March 2016).

The Utah School and Institutional Trust Lands Administration (SITLA), which manages about 4.4 million acres of state-owned lands in Utah, had record total trust assets of over \$2.2 billion in 2015. SITLA issued new leases and/or contracts on

32 mineral tracts in 2015, down 43% from 2014. These leases were issued for the following commodities: metalliferous minerals (12), sand and gravel (12), limestone (4), building stone (3), and bituminous sand (1) (Jerry Mansfield, SITLA, written communication, March 2016).

In 2015, the Utah DOGM approved two new large mine permits, both for industrial minerals; 12 small mine permits of which nine are for industrial minerals, two are for precious metals, and one is for fossils; and 17 exploration notices of intent. Of the exploration permits, eight are for industrial minerals, seven are for precious metals, one is for uranium, and one is for oil sand (Paul Baker, DOGM, written communication, March 2016).

National Rankings

Preliminary USGS data show Utah ranked 8th nationally in 2015 for the value of nonfuel mineral production, accounting for about 3.7% of the United States total (USGS, 2016a). Utah remained among the top 10 nonfuel mineral-producing states during the past decade. The USGS data also show that Utah nonfuel mineral production value decreased in 2015 from 2014 to an estimated \$2.9 billion. Between 2006 and 2015, the value of Utah nonfuel mineral production has fluctuated between \$2.6 and \$4.5 billion (figure 5), with a notable decrease in 2009 associated with the recession, and in 2012 and 2015 from significant decreases in base and precious metals production by KUC. Utah remains the only U.S. state to produce magnesium

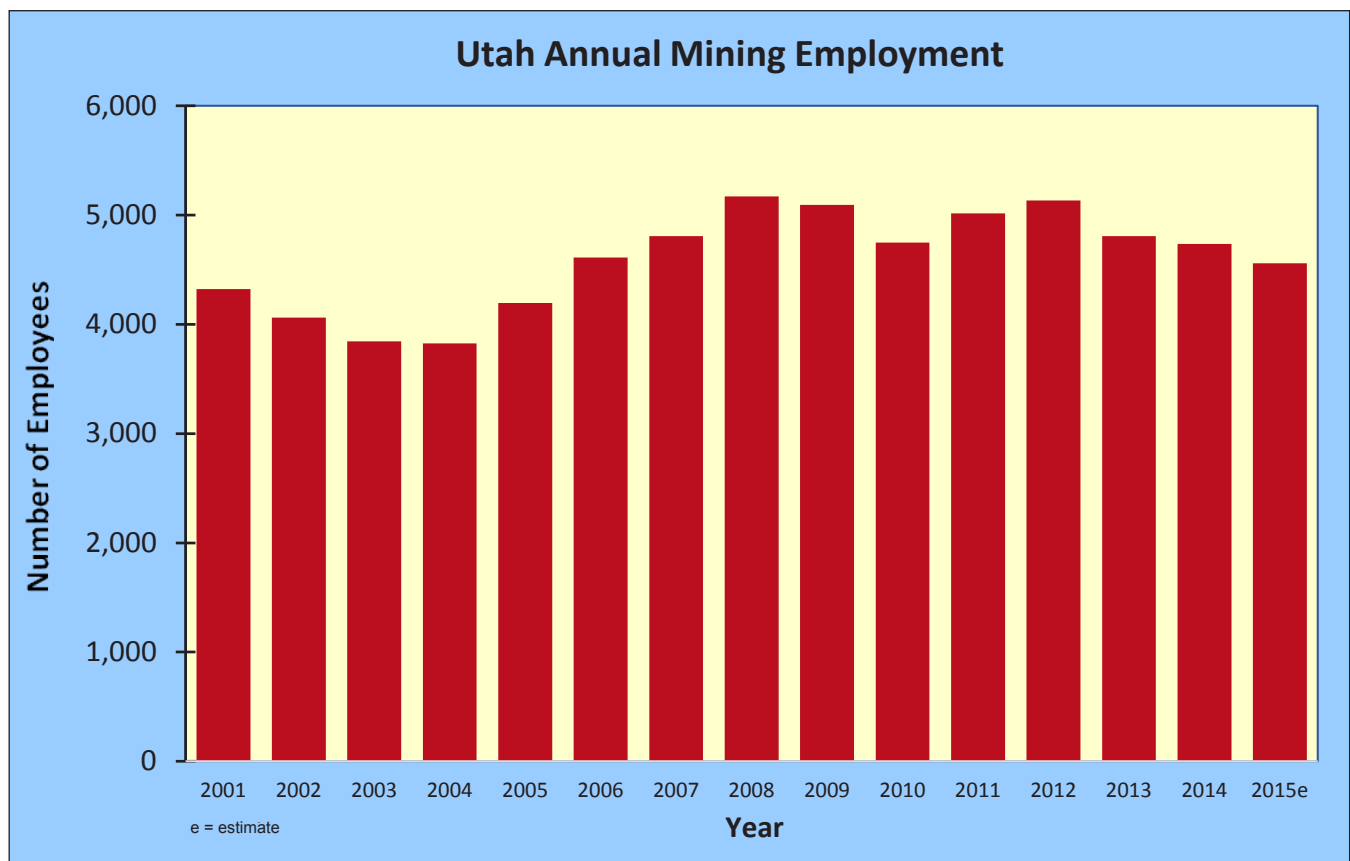


Figure 4. Average annual mining employment in Utah, including metal, industrial minerals, and coal mines and plants. Source: Utah Department of Workforce Services.

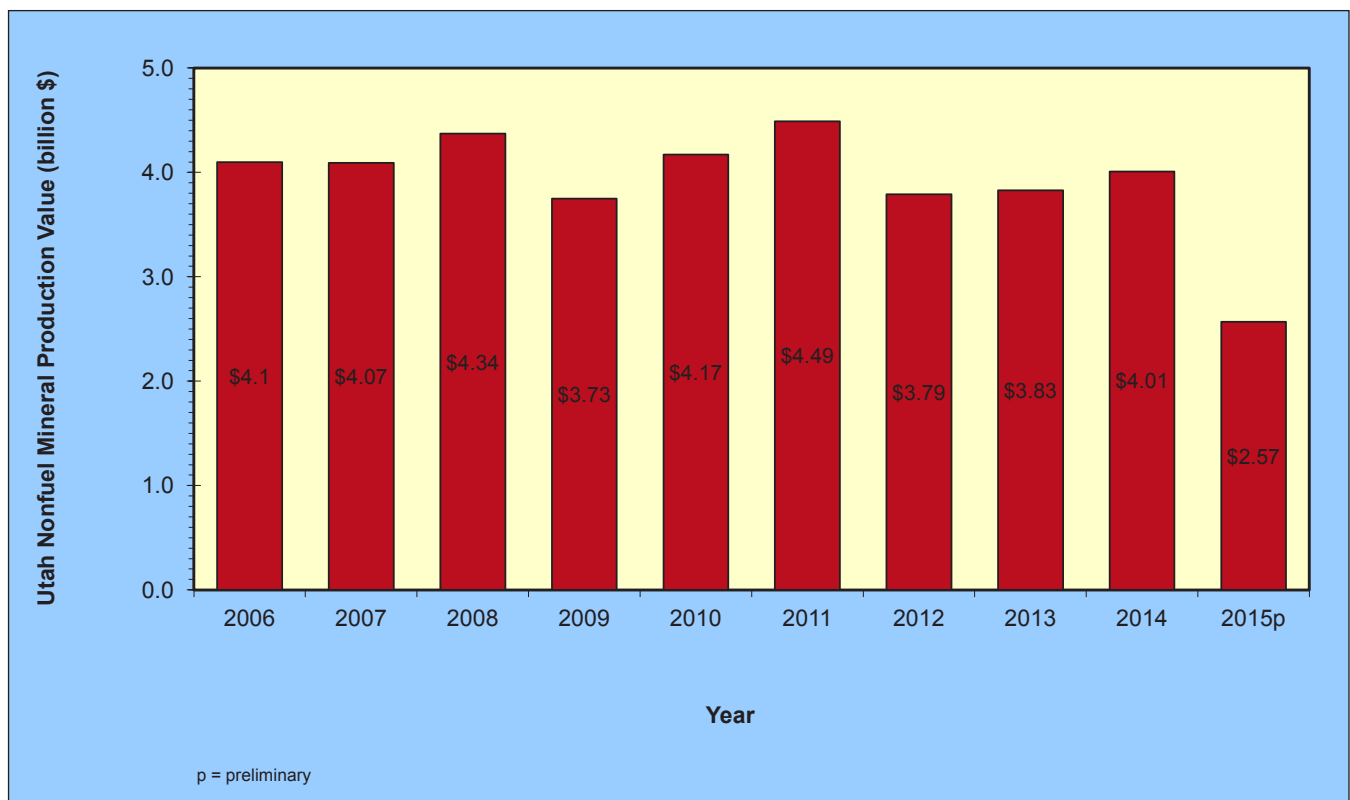


Figure 5. Annual value of Utah nonfuel mineral production in nominal dollars, 2006–2015. Source: Utah Geological Survey.

metal, beryllium concentrate, potash as potassium sulfate, and gilsonite. In the 2015 Fraser Institute annual survey of mining companies, Utah was ranked as the 9th most favorable state/nation (92nd percentile) out of the 109 international jurisdictions included in the survey in terms of overall investment attractiveness with regard to mining (Jackson and Green, 2016). The investment attractiveness index is a combination of a region's geologic favorability and government policies toward exploration and development. Compared to other states Utah ranked 14th for 2015 coal production (U.S. EIA, 2016a), 11th for 2015 oil production (U.S. EIA, 2016b), and 11th (2014 ranking) for natural gas production (U.S. EIA, 2016c).

Outlook for 2016

Of the nonfuel mineral-producing companies surveyed for this report, 31% plan to increase production, 23% anticipate less production, and 46% project duplicating 2015 production in 2016. The massive April 2013 landslide of approximately 145 million short tons (st) of waste rock from the northeast highwall into the bottom of KUC's Bingham Canyon open pit copper-gold-molybdenum mine will continue to have significant negative consequences on Utah's nonfuel mineral production in 2016 and 2017. Bingham's production is expected to be about the same in 2016 as 2015, while KUC works to stabilize the east side of the pit. Utah's uranium and iron mines remain closed due to the low commodity prices. On average, commodity prices have fallen each year from 2011 to 2015, and have continued to fall in 2016 albeit more slowly. The overall production of metals is expected to remain steady or slightly increase in 2016. Production of both potash

types (potassium chloride and higher-value potassium sulfate) is expected to decrease, while production of other industrial mineral commodities will probably remain stable or perhaps increase slightly with an improving housing and construction market. Nonfuel mineral exploration activities in Utah during 2016 are expected to increase from 2015. Most nonfuel exploration activities planned in 2016 are focused on lithium, potash, gold, and copper.

Utah coal production is expected to decrease in 2016 to 14.1 million st, while prices should remain steady (figure 6; table 1). Continued coal production declines are mostly demand related. Depressed crude oil prices are expected to dampen exploration and development throughout Utah until demand and prices increase. Natural gas prices have been slowly recovering from a low in April 2012, and this slow price recovery is limiting the economic incentive for expanded gas development. We estimate that the total mineral value of produced resources in 2016 will drop another 12% to about \$5.1 billion, mostly due to continued declines in crude oil and natural gas production.

BASE AND PRECIOUS METALS

Production and Values

Base and precious metals produced in Utah during 2015 had an estimated value of \$1.3 billion, which accounts for 49% of the annual value of nonfuel minerals produced in Utah. Overall, base and precious metal production values decreased 51%

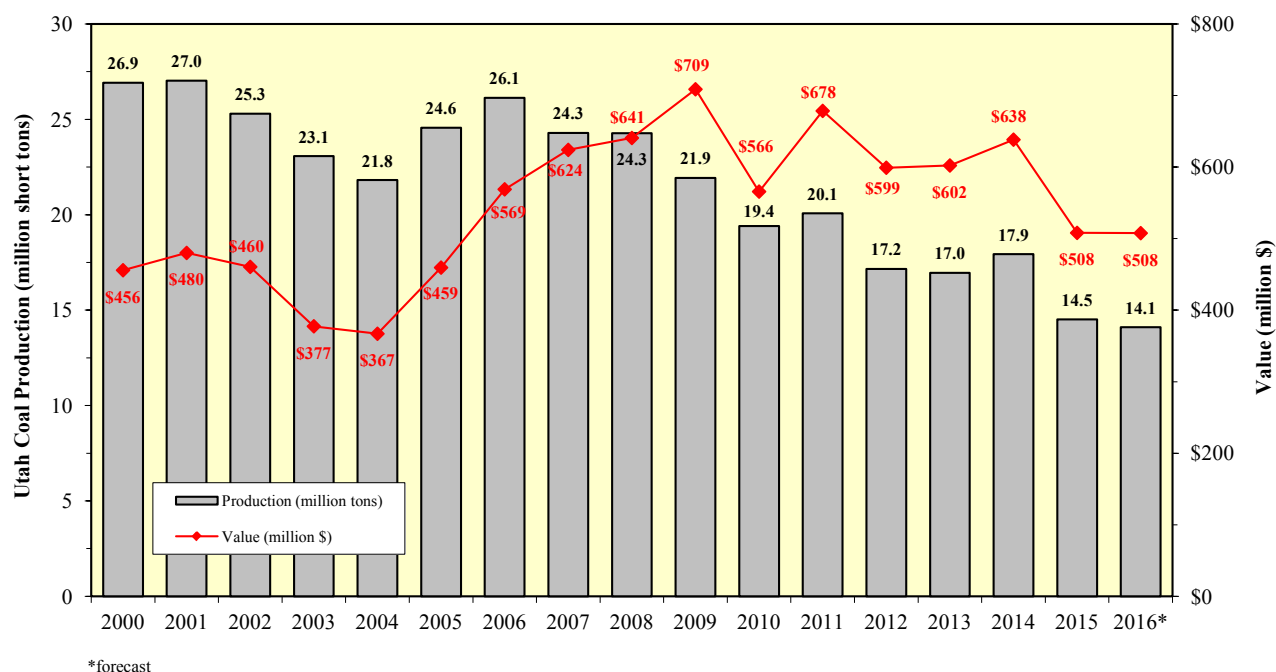


Figure 6. Utah annual coal production and value in nominal dollars, 2000–2016.

Table 1. Coal production in Utah by coal mine, 2009–2016.

Company	Mine	County	Coalfield	2009	2010	2011	2012	2013	2014	2015	2016 *
				thousand short tons							
Canyon Fuel Company, LLC – Bowie Resources Partners, LLC ¹	Dugout Canyon Skyline #3 SUFCO	Carbon	Book Cliffs	3,291	2,307	2,395	1,588	561	676	763	700
		Carbon	Wasatch Plateau	2,910	3,050	2,950	1,954	3,135	4,170	4,409	4,200
		Sevier	Wasatch Plateau	6,748	6,398	6,498	5,651	5,959	6,539	6,095	6,000
Bronco Utah Operations, LLC ²	Emery	Emery	Emery	1,238	999	--	--	4	--	--	200
Castle Valley Mining, LLC – Rhino Resource Partners, LP ³	Castle Valley #3	Emery	Wasatch Plateau	--	--	--	--	--	--	218	1,000 ^
	Castle Valley #4	Emery	Wasatch Plateau	651	--	592	1,004	875	1,061	757	
Energy West Mining Co. – PacifiCorp	Deer Creek	Emery	Wasatch Plateau	3,833	2,954	3,143	3,295	2,785	2,083	15	--
Hidden Splendor Resources, Inc. – America West Resources, Inc.	Horizon	Carbon	Wasatch Plateau	194	270	370	210	--	--	--	--
West Ridge Resources, Inc. – UtahAmerican Energy, Inc. – Murray Energy Corp.	West Ridge	Carbon	Book Cliffs	3,063	3,355	3,566	2,579	2,629	2,514	1,580	--
UtahAmerican Energy, Inc. – Murray Energy Corp.	Lila Canyon	Emery	Book Cliffs	--	72	157	304	257	335	350	1,500
Alton Coal Development, LLC	Coal Hollow Burton #1	Kane	Alton	--	--	403	570	747	555	316	500 ^
		Kane	Alton	--	--	--	--	--	--	11	
Total				21,928	19,405	20,074	17,155	16,953	17,933	14,513	14,100

Source: UGS coal company questionnaires

*Forecast

^Includes both mines

¹Owned by Arch Coal until summer 2013²Owned by CONSOL Energy until 2015³Owned by C.W. Mining (Co-op) until summer 2010, mines formerly called Bear Canyon

from 2014. The estimated base metal production value in 2015 was \$1.1 billion, which accounted for 42% of the annual value of Utah nonfuel mineral production (figure 3). Utah's base metal production value in 2015 decreased 53% from 2014, and had both large decreases in copper and molybdenum production and prices from 2014. The base metals, in decreasing order of 2015 total value, are copper (49%), magnesium (32%), molybdenum (10%), and beryllium (8%).

Precious metal production value for Utah in 2015 is estimated at \$182 million, or 7% of the value of nonfuel minerals produced in Utah, and is distributed between gold (85%) and silver (15%) (figure 3). Precious metal production value decreased by 54% from 2014 to 2015, due primarily to significantly lower gold production.

Most Utah copper, gold, and silver, and all of the molybdenum, is produced from the KUC Bingham Canyon mine, located about 20 miles southwest of Salt Lake City in Salt Lake County (figure 7). The combined value of metals produced by KUC in 2015 is estimated at \$797 million, a 62% decrease from 2014, and accounts for 31% of the value of nonfuel minerals produced in Utah. The Bingham Canyon mine was the fourth-largest copper and molybdenum producer in the U.S. in 2015.

Copper

In 2015, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value of \$551 million, a 63% decrease in value from 2014. The KUC Bingham Canyon mine produced most of this copper; their 2015 production amounted to 101,000 st, and is 124,000 st less than their production in 2014 (Rio Tinto, 2016). The average copper price decreased about 21% from 2014 to \$2.50/lb. KUC production for 2015 at the average copper price has an estimated value of \$507 million, a decrease of about 65% from 2014.

Lisbon Valley Mining Company operates a copper mine and solvent extraction—electrowinning (SX-EW) processing facility about 30 miles southeast of Moab in San Juan County (figure 7). About 5000 st of copper was produced by the company in 2015, which is about 15% less than in 2014. The 2015 production has an estimated value of \$26 million at the 2015 average copper price. CS Mining, LLC produced about 638,000 st of ore in 2015 primarily from its Sunrise and Bawana Extension copper mines in Beaver County. In 2015, CS Mining ran its ore through a conventional flotation mill to create a saleable copper concentrate. However, CS Mining completed a new SX-EW plant in early 2016 and this will likely to be the primary metallurgical source of its future production.

Copper is an internationally traded commodity and its price is determined by the world metal exchanges. Copper is com-

bined 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, refrigeration, and heating systems.

Magnesium

US Magnesium, LLC is the only facility producing magnesium from a primary source in the United States and is located about 60 miles west of Salt Lake City at Rowley in Tooele County (figure 7). Magnesium chloride concentrate is produced from Great Salt Lake brines through evaporation and ultimately converted to magnesium metal by an electrolytic process. The annual magnesium production capacity at the US Magnesium plant reportedly expanded from 70,000 st in 2014 to over 73,000 st in 2015. The price for magnesium metal remained flat from 2014, averaging \$2.15/lb in 2015 (USGS, 2016a). Assuming plant operation at full capacity, Utah 2015 magnesium production has an estimated value of \$315 million. Magnesium ranked second as a contributor to Utah base metal values in 2015. Significant quantities of US Magnesium's production are used by a nearby plant, operated by Allegheny Technologies Inc., to produce titanium sponge. Lithium, which is concentrated along with magnesium in the US Magnesium solar evaporation ponds system, has been considered as a possible future byproduct from the operation (Tripp, 2009). Nationally, other markets for magnesium include use as a constituent of aluminum-based alloys, structural use in castings and wrought products, desulfurization of iron and steel, and other minor uses (USGS, 2016a).

Molybdenum

Utah molybdenum production in 2015 came solely from the KUC Bingham Canyon mine and was recovered as a coproduct from the copper operation. Approximately 8400 st of molybdenum were produced in 2015, a 34% decrease from 2014 (Rio Tinto, 2016). During 2015, the average price of molybdenum decreased by 42% to \$6.83/lb. At the 2015 average price, Utah molybdenum production has an estimated value of \$114 million, a 62% decrease from 2014 that reflects the large decrease in both production and prices. This valuation makes molybdenum the third-most valuable base metal produced in Utah during 2015.

Molybdenum is primarily used in alloys with other metals by iron, steel, and superalloy producers that account for about 74% of the molybdenum consumed (USGS, 2016a). Molybdenum prices have fallen nearly 80% since the record highs of 2005–08. This has resulted in mine closures or reduction of U.S. molybdenum operations at Sierrita, Arizona; Thompson Creek, Idaho; Questa, New Mexico; Mineral Park, Arizona; and Ashdown, Nevada. Furthermore, Freeport-McMoRan announced that it plans to close its Henderson porphyry molybdenum mine, Colorado, the largest producer in the U.S., in about four years.

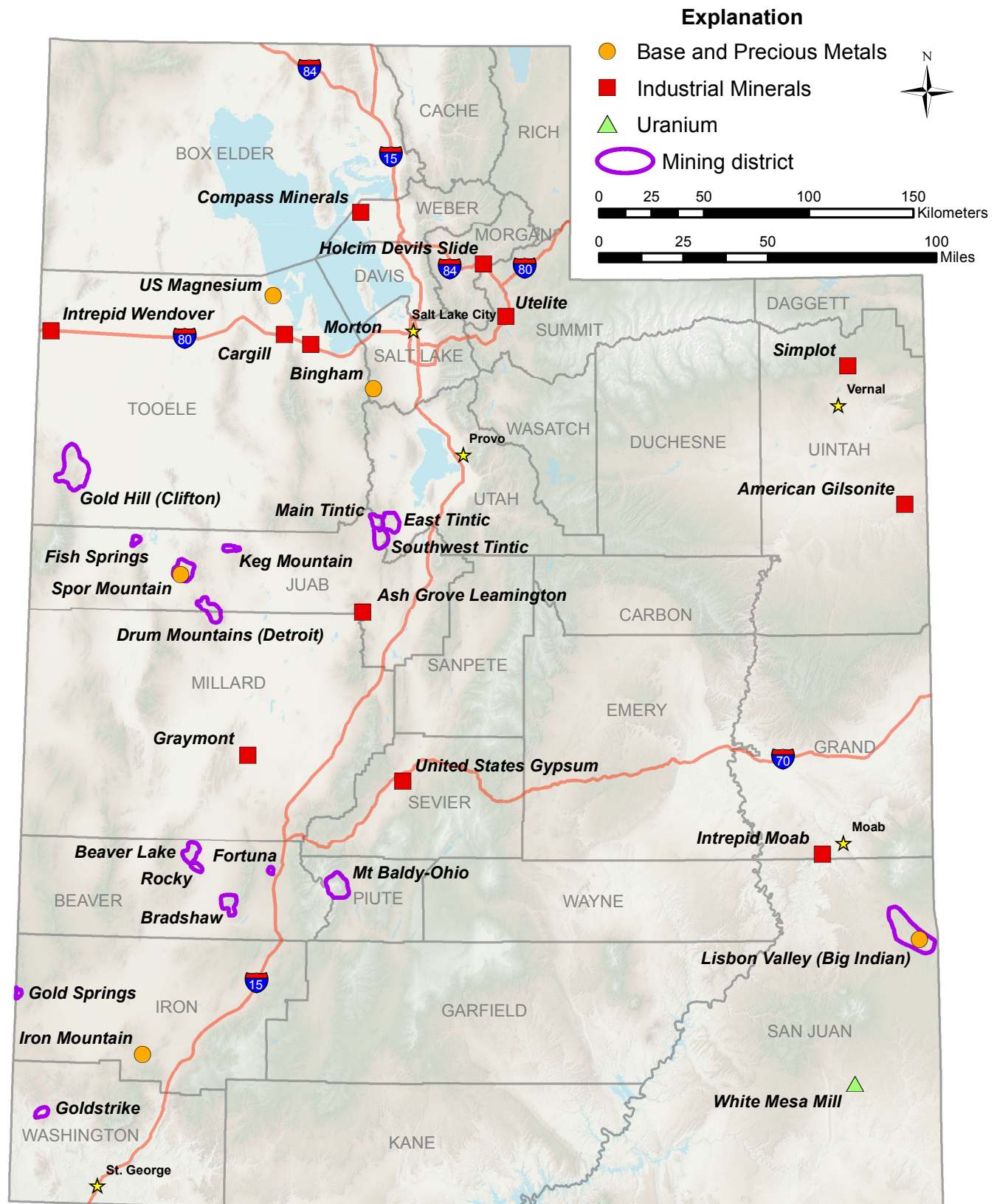


Figure 7. Base and precious metals, selected industrial minerals, and uranium production and development activity locations in Utah during 2015.

Beryllium

Utah remains the United States' sole producer of beryllium ore. Materion Natural Resources, Inc., mines the mineral bertrandite $[\text{Be}_4\text{Si}_2\text{O}_7(\text{OH})_2]$ from the Spor Mountain area about 42 miles northwest of Delta in Juab County (figure 7). Materion operates a mill 11 miles north of Delta in Millard County, which is the nation's sole source of beryllium concentrate. Bertrandite ore and imported beryl are processed at the mill into beryllium hydroxide. Materion's parent company (Materion Corporation) operates a refinery and finishing plant in Ohio where the beryllium hydroxide concentrate is shipped and converted to beryllium-copper master alloy, beryllium metal, and oxide (USGS, 2016a). About 81,800 st of bertrandite ore was mined in 2015 from the Topaz mine at Spor Mountain. The average beryllium price for 2015 (\$231/lb) was 7% higher than in 2014 (USGS, 2016a). Contained beryllium metal from the concentrate production was about 412,400 lbs, having an estimated value of \$95.3 million at the 2015 average beryllium price. Beryllium ranked fourth as a contributor to Utah 2015 base metal values. Beryllium is a specialty metal 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 uses. A statistical misunderstanding on the UGS's mineral production questionnaire sent out annually to operators resulted in the UGS underreporting the Spor Mountain beryllium production from 2011 to 2014. The correct beryllium metal production in pounds for those years is: 2011 – 475,000; 2012 – 455,000; 2013 – 450,060; and 2014 – 546,189.

Iron Ore

Iron ore in Utah has been produced by CML Metals, Inc., from their Iron Mountain project; the project is a redevelopment of the Comstock-Mountain Lion iron mine, located about 19 miles west of Cedar City in Iron County (figure 7). In October 2014, CML Metals, Inc., suspended operations at Iron Mountain as a result of low iron ore prices. The operations have not been restarted.

Gold

In 2015, approximately 133,600 troy ounces (oz) of gold were produced in Utah, about a 49% decrease from 2014. Nearly all of this gold was from the KUC Bingham Canyon mine, where it is recovered as a coproduct from the copper ore (Rio Tinto, 2016). Desert Hawk Gold Corp. also produced a few thousand troy oz of gold from their Kiewit gold-silver mine in the Gold Hill district in western Tooele County. The average gold price in 2015 was \$1163.33/troy oz, an 8% decrease from the 2014 average price. Utah gold production during 2015, at the 2015 average price, has a value of \$155 million that is 53% less than the 2014 valuation. Small quantities of gold and silver may have been produced by other small Utah mines, but this production is inconsistently reported and would not make a

significant impact on the total amount or value of gold and silver produced in Utah.

Gold is an internationally traded precious metal used primarily for jewelry, coinage, bullion for monetary purposes, and to a lesser extent a variety of industrial and electronic applications.

Silver

Most of the silver produced in Utah during 2015 came from the KUC Bingham Canyon mine and was recovered as a by-product from the copper ore. Total silver production from KUC in 2015 was about 1,458,000 troy oz (Rio Tinto, 2016), a 50% decrease from 2014. The CS copper mine near Milford contributed about 243,000 troy oz of silver. Nominal silver production also came from the Kiewit gold mine near Gold Hill. The average silver price in 2015 was \$15.72/troy oz, a 19% decrease from the 2014 average price. Utah silver production from all reporting sources during 2015, at the 2015 average price, has a value of \$27 million that is 56% less than the 2014 valuation.

Silver is part precious metal and part industrial mineral. Like gold, it is used for jewelry and coinage, but it is also heavily used for electronics, photography, and a wide variety of other industrial applications.

Exploration and Development Activity

The information in this section is largely compiled from mining company websites, press releases, a UGS annual industry survey of mine and quarry operators, and personal communications with government and operations staff. Exploration and development information was also obtained from the DOGM website (<http://linux3.ogm.utah.gov/WebStuff/wwwroot/minerals/mineralsfilesbypermitinfo.php>). The location of selected exploration areas in 2015 is shown in figure 7.

Metal prices had a fourth consecutive down year in 2015 with molybdenum (-42% year/year), copper (-21% yr/yr), silver (-19% yr/yr), gold (-8% yr/yr), and iron ore (-10% yr/yr) prices all down significantly. Falling iron ore prices caused CML Metals, Inc., to close their Iron Mountain mine in late 2014 and low prices have continued to keep all of Utah's uranium operations suspended. Overall metallic mineral exploration activity was down in 2015. The significant known Utah base and precious metal properties are shown in figure 7 and summarized in table 2.

Bingham Canyon

Bingham is the most productive mining district in the U.S. Bingham's 2015 production ranks it as the fourth largest copper, fourth largest molybdenum, sixth largest silver, and fourteenth largest gold producer in the U.S.

Table 2. Miscellaneous metal exploration projects in Utah, 2015.

Property	Commodity	District	County	Company	Progress
Blair Project	Silver-Gold	Antelope Range	Iron	Silver Peak Exploration - Tuvera Exploration, Inc.	State section acquired and unpatented claims staked
Bingham	Copper-Gold-Molybdenum	Bingham	Salt Lake	Kennecott Utah Copper Co.	Ongoing deep, near mine exploration drilling
Cave Mine	Polymetallic	Bradshaw	Beaver	Grand Central Silver Mines, Inc.	Two holes totaling over 1300 feet completed
Drum Mountain	Polymetallic	Drum Mountains	Juab - Millard	Freeport-McMoRan Exploration Corp.	Drilled two deep (>2000 ft) core holes completed
Wildcat	Gold-Silver	Drum Mountains	Juab	TroyMet Exploration - Renaissance Gold, Inc.	Acquired by TroyMet and exploration underway
West Desert (Crypto)	Polymetallic	Fish Springs	Juab	InZinc Mining Ltd.	NI 43-101* and PEA** completed (Nilsson, 2010)
Dutch Mountain	Gold-Silver	Gold Hill	Tooele	Newmont USA Ltd.	Staked over 1500 unpatented claims and began drilling
Kiewit Deposit	Gold-Silver	Gold Hill	Tooele	Desert Hawk Gold Corp.	Small open pit — heap leach in production
Jumbo	Gold-Silver	Gold Springs	Iron	TriMetals Mining, Inc.	14 new holes and NI 43-101* PEA** completed
Goldstrike	Gold-Silver	Goldstrike	Washington	Pilot Gold, Inc.	Pilot Gold drilled 18 holes and major plans for 2016
Bromide Basin	Gold-Copper	Henry Mountain	Garfield	Bromide Mining LLC	Large block of claims
Iron Mountain	Iron	Iron Springs	Iron	CML Metals Corp.	Iron ore mine closed in late 2014 due to low prices
Kings Canyon	Gold	Kings Canyon	Millard	Pine Cliff Energy Ltd.	NI 43-101* completed
Thompson Knoll	Polymetallic	Kings Canyon	Millard	Inland Explorations Ltd.	NI 43-101* completed
Lisbon Valley Copper	Copper	Lisbon Valley	San Juan	Lisbon Valley Mining Company, LLC	Operating copper mine with ongoing exploration
East Canyon	Polymetallic	Lucin	Box Elder	Tuvera Exploration, Inc.	NI 43-101* completed
North Lucin	Gold-Silver	Lucin	Box Elder	Newmont USA Ltd.	Large block of 300 claims and drilling continued
Sunshine	Gold	Mercur	Tooele	Priority Minerals Ltd.	Acquired land position and drilled several holes
Deer Trail	Polymetallic	Mount Baldy	Piute	Western Pacific Resources Corp.	NI 43-101* and underground drilling completed
Hidden Treasure	Polymetallic	Ophir	Tooele	Kennecott Utah Copper Co.	Ongoing deep exploration drilling
Milford Copper	Copper-Silver	Rocky Range	Beaver	CS Mining, LLC	Open pit copper mines and agitation leach SX-EW
Speedway	Gold	Silver Island	Tooele	Emu NL - Genesis Gold Corp.	One core hole completed and property dropped
TUG	Gold-Silver	Tecoma	Box Elder	West Kirkland Mining, Inc.	NI 43-101* and PEA** completed
Big Hill	Copper	East Tintic	Utah-Juab	Kennecott Exploration Company	Five deep holes completed and property dropped
Burgin	Lead-Silver	East Tintic	Utah	Chief Consolidated Mining Company	NI 43-101* Completed (Tietz and others, 2011)
SWT Porphyry	Copper	Southwest Tintic	Juab	Freeport-McMoRan Exploration Corp.	Freeport purchased the property from Quaterra
Little Bingham	Copper	West Tintic	Juab	Cerberus Venture, LLC	Property retained
Straight Fork	Gold	White Rock	Box Elder	Newmont USA Ltd.	Property dropped

*An NI 43-101 is a Canadian National Instrument technical report prepared to a codified set of rules for the public reporting of mineral exploration and development data on properties operated by companies listed on Canadian stock exchanges.

**A PEA is a preliminary economic assessment.

The massive Manefay pit-wall failures at the Bingham Canyon open pit mine (figure 7) on April 10, 2013, brought about 145 million st of waste into the bottom of the pit. Two landslides occurred from the northeast corner of the open pit on April 10, the first at 9:30 p.m. and the second followed a little over an hour and a half later at 11:05 p.m. (Pankow and others, 2014). Remarkably, the Manefay slides resulted in no injuries or deaths, but the face of the mine was significantly changed and hundreds of millions of dollars of damage was done to the operation. Nearly all of the slide debris has been removed from the pit. However, KUC has still not completely recovered from these slides and does not expect to do so until 2017.

In response to the slide, Kennecott purchased 2 new shovels, 20 haul trucks, 30 dozers, 9 excavators, and 3 drills and quickly restarted production. However in 2015, a reappraisal of the overall stability of the east side of the open pit mandated a massive stripping program (East Wall Remediation) to reduce the risk of future landslides. This required virtually all of the mine's mobile equipment to be used in the waste stripping operation resulting in very little new ore production and the highest stripping ratio (>5:1 waste:ore) in the century of Bingham's open pit mining operations. Consequently, the majority of the material processed through the Copperton concentrator in 2015 was from a large, low-grade stockpile of previously mined material. Copper production from this low-grade material reduced the mine's output in 2015 by about 50% from the mine's already impaired 2014 production. As a consequence, Bingham's 2015 production was the lowest since the mine was closed completely in 1986 due to low metal prices. This shortfall in copper production was compounded by 2015 having the lowest copper price in about six years. Despite these considerable difficulties Bingham remained just profitable in 2015. Lower copper production from the pit in recent years leaves the KUC smelter at Magna with excess capacity, which has allowed for increased toll smelting of compatible outside copper concentrates. The continued decline in copper prices has also resulted in a series of deepening layoffs of Kennecott personnel.

Bingham is currently developing ore on the south side of the open pit, termed the south wall pushback (SPB). The SPB will open up roughly 700 million st of ore and move the wall of the pit about 1000 ft farther south and the pit bottom 300 ft deeper. This new reserve will extend the mine life through 2028. Complete Bingham Canyon mine historical production statistics for 1904 to 2015 are tabulated in the appendix.

Kennecott Exploration Company continued its near-mine exploration drilling program in the Oquirrh Mountains in 2015. Two deep core holes were completed south the Bingham Canyon mine at South Butterfield totaling 7513 ft. Three holes were also completed at Hidden Treasure in the western Oquirrh Mountains, about 11 miles southwest of Bingham, totaling 14,150 ft. Additional exploration drilling is planned for 2016 (Russ Franklin, Kennecott Exploration Company, written communication, March 2016).

Lisbon Valley Copper

The Lisbon Valley Mining Company operates a sediment-hosted, open-pit, heap leach, solvent-extraction and electro-winning (SX-EW) copper operation situated in the Lisbon Valley mining district of San Juan County (figure 7). The company began mine development in 2005 and plant construction was completed in 2006. Following some startup difficulties, Lisbon Valley Mining Company, LLC has been operating successfully since 2009. Total mine production in 2005–2015 (inclusive) is estimated at 127 million pounds of copper. The 2015 copper cathode production is estimated to be down slightly from 2014.

Rocky and Beaver Lake Districts

CS Mining, LLC (St. Cloud Capital LLC) controls a group of small, Oligocene (~30 Ma) copper deposits in the Rocky and Beaver Lake mining districts of Beaver County (figure 7). These properties include several prograde, anhydrous copper skarns. In 2009, a flotation mill was built and open pit mining started on the Hidden Treasure copper-silver skarn. The mill began production in 2009, but experienced poor copper recovery due to the mixed oxide-sulfide nature of the skarn ore and operations were halted. The mine and mill were successfully restarted in 2012. The copper-silver concentrates are trucked to the KUC smelter at Magna, Utah. The operation continued to have low, but steadily improving, copper recovery from the flotation plant through 2015. The mining operation moved to the Sunrise mine in 2013, Bawana Extension in 2014, and to Copper Ranch in 2015. The estimated total metal contained in concentrate from 2008 to 2015 (inclusive) is very approximately 20 million pounds of copper, 800,000 ounces of silver, and a nominal amount of gold.

CS Mining began construction of an agitation leach SX-EW plant in 2015 to more effectively process copper oxide ore and reprocesses the older flotation mill tailings to recover additional metal. This new plant opened in early 2016 and could yield an increased total copper recovery, albeit without the previous byproduct precious metal credits.

Spor Mountain

The Spor Mountain mining district lies on the west flank of the Thomas Range in west-central Juab County (figure 7), and is the world's premier beryllium producer. The beryllium occurs in epithermal, carbonate-replacement deposits in Miocene tuffaceous sediments along northeast-trending, half-graben faults. Over 3.5 million st of ore with an average grade of greater than 0.2% beryllium has been mined from 10 small- to medium-sized pits in the district since production began in the late 1960s. The total district production is over 15 million pounds of beryllium. Materion Corporation has proven and probable reserves of about nine million st at 0.25% beryllium, which at current production rates would support more than 50 years of continued beryllium production. Materion increased their ore production by approximately 40% beginning in 2013.

Gold Hill District

In 2009, Clifton Mining Company agreed to jointly develop their Gold Hill district properties with Desert Hawk Gold Corp. Clifton's mineral properties lie in the northern Deep Creek Mountains of western Tooele County (figure 7). In April 2014, Desert Hawk received permits and started construction of a small open-pit, heap leach operation at the Kiewit Miocene (~8 Ma) intrusive-hosted, low-sulfidation, quartz-carbonate-adularia stockwork gold deposit. Construction was completed and production began in September 2014. Desert Hawk commenced gold recovery in late 2014 and the mine continued operations through 2015. The Kiewit deposit initially contained an estimated 2 million st averaging about 0.93 parts per million (ppm) gold.

Newmont Mining Corporation holds a large block of land including about 1500 unpatented claims surrounding and to the northwest of the old patented mining claims in the district. In 2015, Newmont drilled several exploration holes on a sediment-hosted gold target in the Trail Gulch area on Dutch Mountain, north of Gold Hill.

Goldstrike District

Cadillac Mining Corporation assembled a 3800-acre land package encompassing the historical mining area of the Goldstrike sediment-hosted gold-silver mining district of Washington County (figure 7). Production from Goldstrike in the late 1980s and early 1990s totaled approximately 210,000 oz of gold and 198,000 oz of silver from 12 small open pits along a 3.5-mi-long northeast-trend (Krahulec, 2011). Cadillac compiled and digitized the historical exploration/mining data on the district in 2011 and drilled several holes into the Hamburg Extension target in 2011–12. Several of these holes cut significant mineralization including GS12-08 that intersected 101 ft of 2.05 ppm gold and 4.3 ppm silver.

Pilot Gold, Inc., acquired Cadillac Mining and their extensive Goldstrike property in 2014. Pilot assimilated and digitized the massive historical mine database, including over 1500 drill holes, some containing unmined oxide gold intercepts, and 100,000 blast holes. Subsequently, they produced a three-dimensional model of the geology and mineralization. They proceeded to drill an initial series of 18 angle test holes totaling about 9437 ft in 2015 (see cover photo). Highlights from this first round of drilling included:

- 20 feet grading 3.27 ppm gold in drill hole PGS002
- 130 feet grading 1.01 ppm gold in PGS003
- 135 feet grading 0.84 ppm gold in PGS004
- 115 feet grading 0.85 ppm gold in PGS007
- 75 feet grading 1.68 ppm gold in PGS008
- 120 feet grading 1.06 ppm gold in PGS010

- 50 feet grading 0.84 ppm gold in PGS011
- 60 feet grading 2.72 ppm gold in PGS012
- 235 feet grading 0.48 ppm gold in PGS013
- 130 feet grading 0.47 ppm gold in PGS014
- 90 feet grading 0.66 ppm gold in PGS016

Pilot has aggressive exploration plans and is budgeted to drill at least a hundred 500-ft deep holes in 2016 in the hope of producing a new resource estimate by year's end (Pilot Gold, 2016).

Drum Mountains

The Drum Mountains (Detroit mining district) has one of the most complex land ownership positions in the state (figure 7). Freeport-McMoRan Exploration Corporation acquired 1020 acres of SITLA land, about 1000 acres of patented mining claims, and staked an additional 400 unpatented lode claims in and around the central copper-gold area of the old mining district in the last few years. Freeport-McMoRan obtained exploration permits and drilled two deep core holes in 2015. One hole, drilled to 2500 ft on the patented claims near the Keystone mine, west of Porphyry Basin, was collared in the Middle Cambrian Pierson Cove Formation carbonates and was drilled down into the Lower Cambrian Prospect Mountain Quartzite. The hole cut 20 ft of 0.936 ppm gold and 22 ppm silver in a fault breccia at the contact between the Middle Cambrian Chisholm Formation and overlying Dome Limestone from 1340 to 1360 ft. This mineralization is contained in a limestone breccia with moderate hematite staining and wispy calcite-quartz veins and vugs. Ultimately, Freeport dropped their block of patented claims in 2015 due to the high holding costs of the fee land and their own current financial difficulties. The core from this hole (DM-15-01) was donated to the UGS. No information is available on the other deep hole drilled several miles to the north near the eastern margin of the Eocene Thomas Caldera.

In 2015, TroyMet Exploration Corp. signed an earn-in agreement with Renaissance Gold, Inc., on their Wildcat sediment-hosted gold-silver target northwest of the main Drum Mountain district. The Wildcat gold prospect has been previously explored by Gold Fields Mining Corp. and Newmont Mining Corp. This earlier work included a Gold Fields' drill intersection of 75 ft of 1.27 ppm gold. TroyMet analyzed the extensive data package and initiated a program of detailed mapping, geochemical sampling, and geophysical surveys, including ground magnetics and bi-directional Very Low Frequency Electromagnetics (VLF-EM). The geochemical work resulted in the identification of high-grade gold-silver, to 301.1 ppm gold and 134 ppm silver, as well as the identification of a very rare telluride mineral, carlfriesite $[\text{CaTe}_2\text{TeO}_8]$, previously unrecognized in the U.S. (figure 8). TroyMet has identified three prospective areas, including the North target, Core target, and the SE target. Drill follow-up at Wildcat is planned for 2016 (TroyMet, 2015).

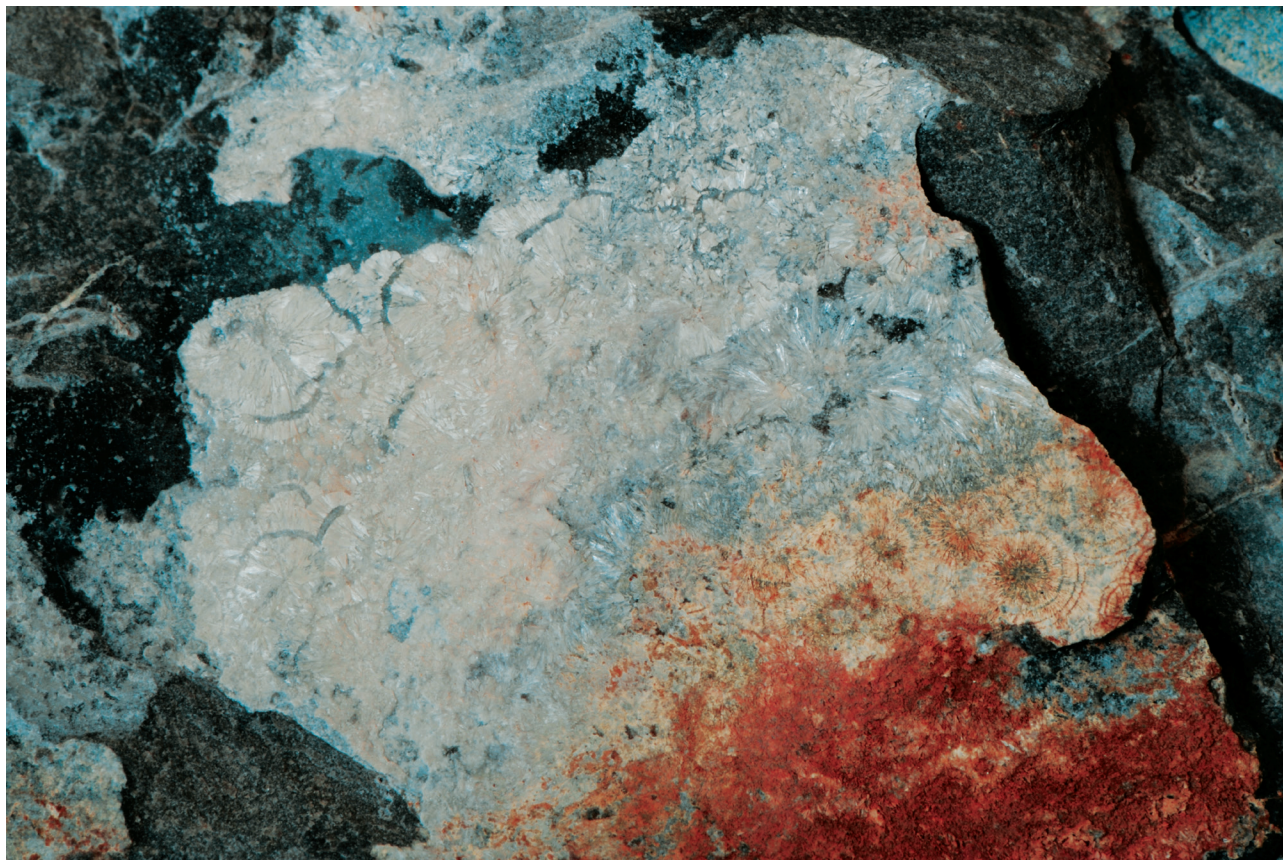


Figure 8. A crust of radiating white to peach-colored carlfriesite crystals up to 0.1 inch in diameter and a rock horizontal field of view of about 1.2 inches (rock portion only). Photograph courtesy of Mark Coolbaugh, consulting geologist.

Freeport-McMoRan, Newmont Mining Corporation, Pilot Gold, Inc., Renaissance Gold, Inc., Golden Dragon Capital, CS Mining, North Exploration, the Steele family, and other groups continue to hold land positions in the Drum Mountains of Juab and Millard Counties.

Gold Springs District

The Gold Springs mining district is located near the Nevada border in Iron County (figure 7). The district contains a Miocene low-sulfidation, epithermal, gold-silver quartz-adularia-calcite vein/stockwork deposit. TriMetals Mining, Inc., acquired a 6000-acre block of ground in 2014, released an updated NI 43-101 preliminary economic assessment (PEA) in 2015, and continued exploration drilling on the Gold Springs property. The measured and indicated resource on the Jumbo gold-silver stockwork is 13,591,000 st at 0.53 ppm gold and 13.6 ppm silver at a 0.3 ppm gold cutoff, not including a somewhat smaller inferred resource. The PEA calls for a 15,000 ton per day, open-pit, heap leach operation with a 2:1 stripping ratio (Lane and others, 2015). A 14-hole drilling program at the Jumbo deposit was completed in 2015 and highlights included a 5-ft interval of 118.95 ppm gold and 28.4 ppm silver in J-15-003 and a 25-ft interval of 2.24 ppm gold and 4.86 ppm silver in J-15-011.

Tintic District

In 2007, Quaterra Resources, Inc., acquired about 3200 acres of patented and unpatented mining claims encompassing the Southwest Tintic porphyry copper system in Juab County. The property includes a known historical resource of about 400 million st with 0.33% copper and 0.01% molybdenum (Krahulec and Briggs, 2006). In a 2009 joint venture with Quaterra, Freeport-McMoRan Exploration Corporation began an integrated program of geological mapping, geochemical sampling, and geophysical surveying; seven exploration holes were drilled in 2010 and 2011. Freeport-McMoRan acquired the property from Quaterra outright in 2015, but no additional drilling was undertaken.

Kennecott Exploration Company (KEC), through a joint venture with Chief Consolidated Mining Company, acquired a porphyry copper lithocap target near Big Hill in the center of the East Tintic district of Utah County (figure 7) and began work in 2010 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 holes were precolored with reverse circulation in 2011 and two of these holes were core drilled to completion in 2012. Three new deep holes

were drilled to completion in 2014 totaling 8820 ft; however, the property was dropped in 2015.

Iron Springs

The CML Iron Mountain mine (formerly the Comstock-Mountain Lion), in Iron County (figure 7), was acquired by Palladon Iron Corporation in 2005 and restructured into CML Metals Corp. in early 2010. The iron ore occurs as massive magnetite skarn/replacement deposits adjacent to Miocene monzonite laccoliths. Open-pit mining began in 2008, but ceased in 2009 due to market volatility and logistical problems. Palladon completed a NI 43-101 compliant resource estimate on the CML deposit showing a resource of 31.3 million st averaging 48.6% iron (SRK Consulting, 2009). CML resumed mining in July 2010 and run-of-mine ore was shipped from the rail load-out facility at the mine via the Union Pacific Railroad. A new concentrator was completed in early 2012 and operated at break-in capacity throughout 2012 and 2013, but had concentrate dewatering difficulties. In early 2014, the concentrator was refurbished with new hyperbaric filter dewatering units and the operation was approaching a shipping capacity of 2 million st per year in 2014, but the iron ore price collapsed late that year and the operation ceased production in October. The iron ore prices continued to decline throughout 2015 and the operation is not anticipated to resume operation in 2016.

Deer Trail Mine

The Deer Trail mine is in the Mt. Baldy-Ohio mining district on the east flank of the Tushar Mountains of Piute County (figure 7). Upper Paleozoic and Mesozoic sedimentary strata along the base of the range are unconformably overlain by Oligocene and Miocene flows and tuffs of the Marysvale volcanic field. Most of the production in the district (about 80%) has come from precious-metal-rich, polymetallic replacement ores in the Permian Toroweap Formation at the Deer Trail mine near the eastern base of the mountain. The Deer Trail mine was acquired by Western Pacific Resources Corp. in 2013; they rehabilitated the main workings and prepared an NI 43-101 (Martin, 2013). In 2014–15, they completed a 46-hole underground drill program on the 3400 zone; highlights included hole DT14-28 that intersected 12 ft of 1.51 ppm gold, 259 ppm silver, 2.53% lead, and 5.42% zinc and DT14-41 that intersected 7.6 ft of 8.86 ppm gold, 726 ppm silver, 0.4% lead, and 0.81% zinc. No additional work has been done on the property. To the west of Western Pacific's Deer Trail property holdings, Crown Mines, LLC controls a large block of unpatented mining claims on a porphyry target.

Thompson Knoll

Inland Explorations Ltd. was formed in 2006 specifically to conduct base metal exploration in the eastern Great Basin. The company has pursued a grassroots exploration program and acquired four Utah properties: Thompson Knolls, Dug-

way, Keg, and Dunes. Thompson Knolls lies on the west slope of the Confusion Range in west-central Millard County (figure 7). The Thompson Knolls targets include porphyry/skarn associated with a covered magnetic high and sediment-hosted gold-silver, similar to that in the Kings Canyon deposit, about 7.9 million tons at 0.93 ppm gold and 3.7 ppm silver (Krauhlec, 2011), a few miles to the northeast. In 2015, a 51% interest in the Thompson Knolls project was optioned to BCM Resources Corporation. BCM assimilated the previously generated exploration information, staked 25 new unpatented lode claims, completed two additional geophysical surveys, and produced an NI 43-101 technical report on the property (Redfern, 2016). The most notable previous result at Thomson Knolls is a 1996 exploration hole drilled by Centurion Mining Company (CKC-96-10) which intersected 30 ft of 8.31 ppm gold and 26.9 ppm silver from 250 to 280 ft (Redfern, 2016).

Cave Mine

Grand Central Silver Mines, Inc., controls the large (4779-acre) Cave mine property in the Bradshaw silver-gold-lead district of the southern Mineral Mountains, Beaver County (figure 7). Like the old cave mine, the greater Cave mine property targets include several small copper-gold skarns and high-grade, precious metal-rich, polymetallic carbonate replacement deposits. Initial exploration included surface and underground geological mapping, geochemical sampling, 93-line-mi ground magnetometer survey, and some IP surveying. Grand Central drilled two holes totaling over 1300 ft at the Cave mine in 2015. The best hole (GCDD-1) intersected 31.7 ft averaging 6.95% zinc, 59.1 ppm silver, 0.71 ppm gold, and 0.35% copper beginning at 76.5 ft.

INDUSTRIAL MINERALS

Production and Values

Industrial mineral production in Utah during 2015 had an estimated value of \$1.3 billion, which was a decrease of 5% from 2014 (figure 3). Industrial mineral production was 51% of the annual value of nonfuel minerals produced in Utah.

The largest overall contributors to the 2015 value of Utah industrial minerals production were the brine- and evaporite-derived products of potash, salt, and magnesium chloride. These products had a combined value of \$381 million, a 21% decrease in value from 2014, and account for 29% of total value of Utah industrial mineral production in 2015. 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 \$361 million. This commodity group accounted for 27% of total industrial mineral value in 2015, and was 26% more than the 2014 production value. The third-largest contribution to the value of industrial minerals production came from the

Portland cement and lime product group, which had a combined value of \$225 million that accounted for 17% of total industrial mineral value in 2015, and was a slight decrease in value from 2014. These three commodity groups contributed 74% of the total value of industrial minerals produced in Utah during 2015. The remainder came from, in decreasing order of value, sulfuric acid, phosphate, gilsonite, clay, expanded shale, and gypsum.

Potash, Salt, and Magnesium Chloride

The brine-derived commodities produced from Great Salt Lake include, in descending order of production, salt, magnesium chloride, and potash (in the form of potassium sulfate). Potash, in the form of potassium chloride, along with significant amounts of magnesium chloride and lesser amounts of salt, was also produced by operations in other parts of the state.

Potash production in Utah was about 351,000 st in 2015, and was the largest contributor to the value of the brine-derived commodity group. The 2015 value of potash produced in Utah was approximately \$198 million, a decrease of 22% from 2014. The lower value was due primarily to a significant decrease in the production of potassium sulfate, despite higher prices in 2015. Potassium chloride also experienced a decrease in production and value, also with slightly higher 2015 prices.

Potassium sulfate has a significantly higher market value, and usually larger production in Utah, than potassium chloride. Compass Minerals Ogden, Inc., produces potassium sulfate, whereas Intrepid Potash-Wendover and Intrepid Potash-Moab produce potassium chloride (figure 7).

Utah salt production in 2015 amounted to approximately 2.77 million st, and had a production value estimated at \$162 million. Some 80% of the salt was produced from Great Salt Lake brine by three operators: Compass Minerals Ogden, Inc., Cargill Salt Co., and Morton International (in descending production order) (figure 7). The remaining 20% came from Redmond Minerals, Inc., near Redmond in Sanpete County, Intrepid Potash-Wendover near Wendover in Tooele County, and Intrepid Potash-Moab near Moab in Grand County.

In 2015, magnesium chloride production in Utah decreased 14% from 2014 to 757,000 st, and had a production value of about \$21 million (ONRR, 2016). The magnesium chloride brine was produced by Intrepid Potash-Wendover and Compass Minerals Ogden, Inc.; the latter also produces small amounts of magnesium chloride flake.

The most significant source of brine-derived products in Utah is Great Salt Lake (figure 9). Estimated total solids production from Great Salt Lake in 2015, including magnesium metal,



Figure 9. Morton International's operation and evaporation pond complex in the south part of Great Salt Lake. View from Stansbury Mountains.

magnesium chloride, potash, and salt, is estimated to be 2.6 million st. Our method of estimating total solids production from the lake has changed in an effort to produce a more consistent estimate in the future. This change resulted in our 2014 estimate being revised downward. The total solids production number does not include all byproducts from all producers. The 2015 value of mineral and brine production from Great Salt Lake is estimated at \$590 million.

Sand and Gravel, Crushed Stone, and Dimension Stone

Sand and gravel, crushed stone, and dimension stone are produced by many private, county, state, and federal entities. Given the numerous producers of this commodity group, it was impractical for the UGS to send annual production surveys to all of the operations. However, the UGS does compile data from selected operators to track these commodities and uses USGS data for production and value estimates. During 2015, approximately 39.8 million st of sand and gravel worth \$287 million was produced in Utah (USGS, 2016b). About 9.7 million st of crushed stone worth \$73.4 million was also produced (USGS, 2016b), as well as several thousand st of dimension stone. The 2015 total production value for this commodity group increased from 2014 by 26% to approximately \$361 million. The increased value resulted from moderate increases in production and slight increases in prices for sand and gravel and crushed stone.

Portland Cement, Lime, and Limestone

Together, Ash Grove Cement Co. and Holcim, Inc., produced about 1.6 million st of Portland cement in Utah during 2015, having an estimated value of \$153 million. Ash Grove Cement Co. operates the Leamington quarry and plant east of Leamington in Juab County, while Holcim, Inc., operates the Devil's Slide quarry and plant east of Morgan in Morgan County (figure 7). In 2015, Portland cement production was flat from 2014, but production value increased about 6% due to an increase in the price of cement (USGS, 2016a). Besides limestone, the Ash Grove and Holcim mines also produce small amounts of sandstone, clay, and shale, which are minor feedstock for their cement plants.

During 2015, Graymont Western U.S., Inc., was the sole producer of lime in Utah. In the past, Lhoist North America produced dolomitic lime, but their quarry and plant in Tooele County have been idle since 2008. Lime production decreased approximately 11% from 2014 to 2015. Graymont Western U.S. produces high-calcium quicklime and dolomitic quicklime from their quarry and plant in the Cricket Mountains about 35 miles southwest of Delta in Millard County (figure 7). The annual production capacity of their plants is about 1.5 million st. During 2015, about 3.4 million st of limestone was produced in Utah for uses other than crushed stone. More than half of the production was chemical-grade limestone from Graymont Western U.S. Inc., while Ash Grove Cement Co.

and Holcim, Inc., produced most of the remainder for cement. The Cotter Corp. in San Juan County produced about 15,000 st of limestone for flue-gas desulfurization at coal-fired power plants. Limestone is primarily used in the manufacture of cement and lime products, for flue-gas desulfurization, and as a safety product for the coal mining industry as "rock dust."

Sulfuric Acid

In 2015, the KUC Bingham Canyon mine produced 870,000 st of sulfuric acid (H_2SO_4), about 5% more than in 2014. The sulfuric acid is a byproduct of the KUC copper-gold-silver smelting process. The UGS estimates sulfuric acid prices average about \$140/st, giving Utah's production an approximate value of \$122 million. Although sulfuric acid has been recovered at the Bingham copper smelter since 1917, the commodity has only recently been included in the UGS production survey. Currently, sulfuric acid is the fourth-most valuable industrial mineral commodity produced in Utah. 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.

Phosphate

Simplot Phosphates continues to be the only active phosphate producer in Utah. The phosphate operation is located 12 miles north of Vernal in Uintah County (figure 7). In 2015, the mine produced approximately 3.7 million st of ore, about 10% less than in 2014. The ore yields about 1.4 million st of phosphate concentrate (P_2O_5) after processing. The concentrate is transported in slurry through a 96-mile underground pipeline to the Simplot fertilizer plant near Rock Springs, Wyoming. More than 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, 2016a).

Gilsonite

Gilsonite is a shiny, black, solid hydrocarbon that occurs in a swarm of laterally and vertically extensive veins in the Uinta Basin. It has been mined since the late 1880s in Utah and Colorado. In 2015, American Gilsonite Company was the only significant producer, mining and processing gilsonite at their operation in southeastern Uintah County (figure 7). Over the last decade, gilsonite production from the Uinta Basin has ranged between 60,000 and 85,000 st per year. Small quantities of gilsonite may have been produced by other small Utah mines, but this production is inconsistently reported and would not make a significant impact on the total amount of gilsonite produced in Utah. Utah is the only place in the world that contains large deposits of gilsonite, and it has been shipped worldwide for use in numerous and diverse products including asphalt paving mixes, coatings, inks, paints, and oil and gas well drilling additives (Boden and Tripp, 2012).

Expanded Shale

Expanded shale in Utah is produced by Utelite at their quarry and plant near Wanship in Summit County (figure 7). The company produced approximately 175,000 st of raw shale in 2015, which was used as the feedstock to produce expanded shale. Expanded shale is a lightweight aggregate, sometimes called “bloated shale,” and is mainly used by the construction industry. It is produced by rapidly heating high-purity shale from the Cretaceous Frontier Formation to about 2000°F, causing it to expand and vitrify. The resulting aggregate is durable, inert, uniform in size, and lightweight, with a density about one-half that of conventional aggregates. The material is used in roof tile, concrete block, structural concrete, and horticulture additives, as well as for highway construction and geotechnical fill. About half of Utelite’s production is used locally along the Wasatch Front, and the rest is shipped out of state.

Bentonite, Common Clay, and High-Alumina Clay

Production of bentonite, common clay, and high-alumina clay in Utah during 2015 was about 190,000 st, a 29% decrease from 2014 production. These commodities were produced by many small and large mines, often on an intermittent basis. Consequently, production and value figures are rough estimates and are subject to significant change on a year-to-year basis. Bentonite was produced by Western Clay Co. and Redmond Minerals, Inc. Uses for bentonite include well drilling and foundry operations, various civil engineering applications, and as litter-box filler. The largest producers of common clay and high-alumina clay were Interstate Brick Co., and Holcim, Inc. Common clay is largely used to make bricks, whereas high-alumina clay is used to make Portland cement.

Gypsum

Four operators reported combined Utah gypsum production of about 304,000 st in 2015, 16% more than 2014 production. The 2015 production had an estimated value of \$3.9 million, a 9% increase compared to 2014. The higher value was due to an increase in both production and price (USGS, 2016a) of crude gypsum. Higher value calcined gypsum production was down slightly in 2015 from 2014. The four Utah gypsum producers were Sunroc Corp., United States Gypsum Co., Diamond K Gypsum, Inc., and Nephi Gypsum (in descending production order). Two gypsum wallboard plants are located near Sigurd in Sevier County. The plant operated by United States Gypsum was active in 2015 (figure 7), but the plant operated by Georgia Pacific remains idle due to economic considerations. Utah gypsum is primarily used in raw or crude form by regional cement companies as an additive to retard the setting time of cement, and by the agriculture industry as a soil conditioner. Lesser amounts of the higher value calcined gypsum are used to make wallboard.

Exploration and Development Activity

Industrial minerals exploration and development in Utah varies according to the commodity. The development of high-value, internationally traded commodities, like potash, are relatively immune to fluctuating shipping costs and vary with international demand and the global economy. In contrast, the development of low-value commodities, like sand and gravel, are constrained by shipping costs and consequently, are sensitive to regional economic conditions. Similar to the metals exploration and development activity section, the information presented in this section is derived primarily from company websites, press releases, the UGS annual industry survey, and DOGM records. Industrial mineral exploration developments are summarized in table 3.

Several potash projects are located in Utah, but activity on these projects was limited during 2015. Sennen Potash Corp. completed one drill hole in San Juan County during late 2014, and released a preliminary NI 43-101 resource evaluation during 2015. They have defined an inferred potash resource of 207.6 million st with a grade of 26.96% K₂O, based on two intersections from their Johnson 1 well. The intersections were in cycle 18 of the Paradox Formation and were 23 ft at 26.96% K₂O and 17 ft at 22.6% K₂O (Stirrett and Shewfelt, 2015). Pinnacle Potash International completed a drilling program in early 2015 that was mostly conducted during 2014 at their project near Crescent Junction in Grand County; no information is available on their results. Crystal Peak Minerals work on their Sevier Lake project during 2015 was limited to initial work on a feasibility study. No activity occurred at the Blawn Mountain alunite project in Beaver County, but the company did announce that they were considering reducing initial production rates to lessen up-front capital costs. Both the Sevier Lake project and the Blawn Mountain project are focused on producing potassium sulfate, which is a more valuable commodity than potassium chloride. Compass Minerals, an active potash producer in Utah, is currently improving the seal of its evaporation ponds around Great Salt Lake. The pond improvements are expected to reduce their Great Salt Lake brine consumption by 20%.

During 2015, Applied Minerals, Inc., announced that it had secured sales contracts for both halloysite and iron oxide products as it continues to develop its underground mine in Juab County. In the past few years, phosphate projects in the Uinta Basin have been advanced, but activity during 2015 was minimal. No onsite development occurred, but Utah Phosphate Company (Agrium) continued to evaluate the economics of their Ashley Creek project based on previously collected exploration data. Some companies and exploration groups expressed interest in lithium in Utah during 2015 in response to expected increases in lithium prices and demand. Lithium interest tended to focus on western Utah and the Paradox Basin.

URANIUM

Historically, Utah is the third-ranking uranium-producing state, with the vast majority of this production coming from the Colorado Plateau. The spot price of U_3O_8 has been especially volatile over the last decade with spikes to \$136/lb in June 2007 and lows less than \$45/lb in 2009–2010. The spot price rebounded to \$73/lb in early 2011, but fell back below \$50/lb after the March 2011 Fukushima nuclear power plant disaster in Japan. Uranium prices have remained low (generally less than \$40/lb) throughout 2012, 2013, 2014, and 2015, only to fall farther, below \$35/lb, in late 2015. Uranium exploration and development in Utah has varied directly with these spot price fluctuations. However, unlike the volatile spot price, long-term contract U_3O_8 prices have declined slowly to about \$44/lb.

The continuing low uranium prices resulted in a halt to all of Utah's uranium mining operations in late 2012 and the final shipments of ore to the mill in early 2013. The Energy Fuels White Mesa mill (figure 7) continues operations intermittently using higher grade uranium ore from their breccia pipe de-

posits in Arizona. The Utah uranium mines have all closed because Energy Fuels could purchase U_3O_8 on the spot market for less than the production cost at their Utah mines. This business strategy has the added corporate benefit of preserving their existing ore reserves for times of higher prices. We estimate that Utah's uranium mines will become economic when long-term U_3O_8 prices again surpass \$60–\$70/lb.

In the last few years of low spot prices, the uranium industry in Utah was consolidated by Energy Fuels, Inc., and Anfield Resources, as they acquired most of the promising uranium mines and prospects. The most significant known Utah uranium properties are listed in table 4.

COAL

Production and Values

Six Utah coal operators produced 14.5 million st of coal valued at \$508 million from nine underground mines and one surface mine in 2015 (figures 6 and 10). Overall production

Table 3. Industrial mineral exploration and development projects in Utah, 2015.

Property	Deposit Type	County	Company	Progress
Blawn Mountain	Potash; alunite alteration	Beaver	Potash Ridge Corporation	Minimal activity in 2015; considering a reduced initial production rate for startup; completed preliminary feasibility study in 2013
Crescent Junction	Potash; Paradox Basin, deep evaporites	Grand	Pinnacle Potash International	Completed a potash exploration hole in early 2015 from a program that was mostly completed in 2014
Green River	Potash; Paradox Basin, deep evaporites	Grand	American Potash Corp.	No activity in 2015
Hatch Point	Potash; Paradox Basin, deep evaporites	San Juan	K2O Utah, LLC (Potash Minerals Limited)	No activity in 2015; Released updated JORC-compliant resource estimate in 2013
Lisbon Valley	Potash; Paradox Basin, deep evaporites	San Juan	Potash Green Utah, LLC (North American Potash Developments, Inc.)	No activity in 2015
Monument	Potash; Paradox Basin, deep evaporites	San Juan	Sennen Potash Corp.	Completed one exploration drill hole in late 2014; released a NI 43-101 technical report during 2015
Sevier Lake	Potash; Sevier (Dry) Lake, shallow brine	Millard	Crystal Peak Minerals, Inc. (EPM Mining Ventures, Inc.)	Began initial feasibility study work in 2015; completed preliminary feasibility study in 2013
Ashley Creek	Phosphate (Meade Peak Member of the Phosphoria Fm.)	Uintah	Utah Phosphate Company (Agrium)	Activity in 2015 limited to evaluation of previously collected exploration data and economics of the project
Diamond Mountain Phosphate	Phosphate (Meade Peak Member of the Phosphoria Fm.)	Uintah	Utah Mineral Resources, LLC (Strata Minerals Inc.)	No activity in 2015
Dragon Mine	Halloysite specialty clay and iron oxide pigments	Juab	Applied Minerals, Inc.	Announced sales contracts of both halloysite and iron oxide products during 2015

Table 4. Uranium projects in Utah, 2015.

Property	District	County	Company	Progress
Whirlwind	Beaver Mesa	Grand	Energy Fuels, Inc	Permitted resource: 656,000 lb U ₃ O ₈
Cedar Mountain	Cedar Mountain	Emery	enCore Energy Corp.	Acquired from Energy Fuels
Rim-Columbus	Dry Valley	San Juan	Energy Fuels, Inc.	Permitted resource: 660,000 lb U ₃ O ₈
Marcy-Look	Elk Ridge	San Juan	enCore Energy Corp.	Acquired from Energy Fuels
Blue Jay	Fry Canyon	San Juan	enCore Energy Corp.	Acquired from Energy Fuels
Frank M	Henry Mountain	Garfield	Anfield Resources, Inc.	Resource: 1.1 M tons at 0.1% U ₃ O ₈
Shootaring Canyon U Mill	Henry Mountain	Garfield	Anfield Resources, Inc.	Acquired from Uranium One, Inc.
Tony M-Bullfrog	Henry Mountain	Garfield	Energy Fuels, Inc.	Permitted resource: 1.684 M tons at 0.24% U ₃ O ₈
Energy Queen (Hecla Shaft)	La Sal	San Juan	Energy Fuels, Inc.	Permitted resource: 1.2 M lb U ₃ O ₈
Pandora-Snowball- Beaver	La Sal	San Juan	Energy Fuels, Inc.	On stand-by: 1.2 M lb U ₃ O ₈ reserve
La Sal #2	Lisbon Valley	San Juan	Laramide Resources Ltd.	Resource: 808,000 tons at 0.167% U ₃ O ₈
Velvet-Wood	Lisbon Valley	San Juan	Anfield Resources Inc.	New NI 43-101* completed (Beahm, 2015)
San Rafael	San Rafael River	Emery	Baobab Asset Management LLC.	Indicated resource: 758,050 tons at 0.23% U ₃ O ₈
Thompson Project	Thompson	Grand	Energy Fuels, Inc.	Acquired 6672 acres
Sage Plain (Calliham-Sage)	Ucolo	San Juan	Energy Fuels, Inc.	New NI 43-101* completed (Peters, 2015)
Daneros (Lark Royal)	White Canyon	San Juan	Energy Fuels, Inc.	On stand-by: 740,000 lb U ₃ O ₈ inferred resource
Geitus	White Canyon	San Juan	enCore Energy Corp.	Resource: 40,000 ton at 0.3% U ₃ O ₈

* An NI 43-101 is a Canadian National Instrument technical report prepared to a codified set of rules for public reporting of mineral exploration and development data on properties operated by companies listed on Canadian stock exchanges.

was 19% lower than in 2014, mainly due to the closing of the Deer Creek and West Ridge mines. Two new mines opened in 2015, the Castle Valley #3 mine, which is in the same area as the Castle Valley #4 but is within a different coal bed, and the Burton #1 mine, the underground extension of the Coal Hollow mine in southwestern Utah. In addition, the longwall mining machine used at West Ridge was shifted to the Lila Canyon mine, increasing production to make up for the West Ridge loss. The Emery mine, which has been idle/shut down since 2010, was sold to new owners at the end of 2015; plans are to resume production in late 2016 if markets can be found for their coal. Even with relatively steady demand from Utah's coal-fired power plants, fuel switching or closure at other U.S. coal-fired power plants outside of Utah is keeping demand for Utah coal near historic lows. Utah coal production is expected to drop another 3% in 2016 to 14.1 million st as demand continues to stagnate.

In 2015, the majority of Utah coal, 11.5 million st, was produced from the Wasatch Plateau coalfield, with 2.7 million st coming from mines in the Book Cliffs coalfield and 327,000 st from the Alton coalfield. The majority of Utah coal for 2015, 88% (12.8 million st) was produced from federal land, while only 5.6% (0.8 million st) was from state-owned land. In July 2011, the Deer Creek mine's state-owned Mill Fork coal tract reverted back to federal ownership after a 22.3 million st coal production threshold was reached. This reversion dramatically increased the amount of coal produced on federal land in 2012, from 48.0% in 2011 to 84.2% in 2012. The remainder of the 2015 production was from private lands (4.7%, 0.7 million st) at the Castle Valley, Coal Hollow, and Skyline mines, and county land near the Skyline mine (1.5%, 0.2 million st).

Utah coal mines face steady reserve depletion and difficult mining conditions. In addition, the demand for Utah coal has

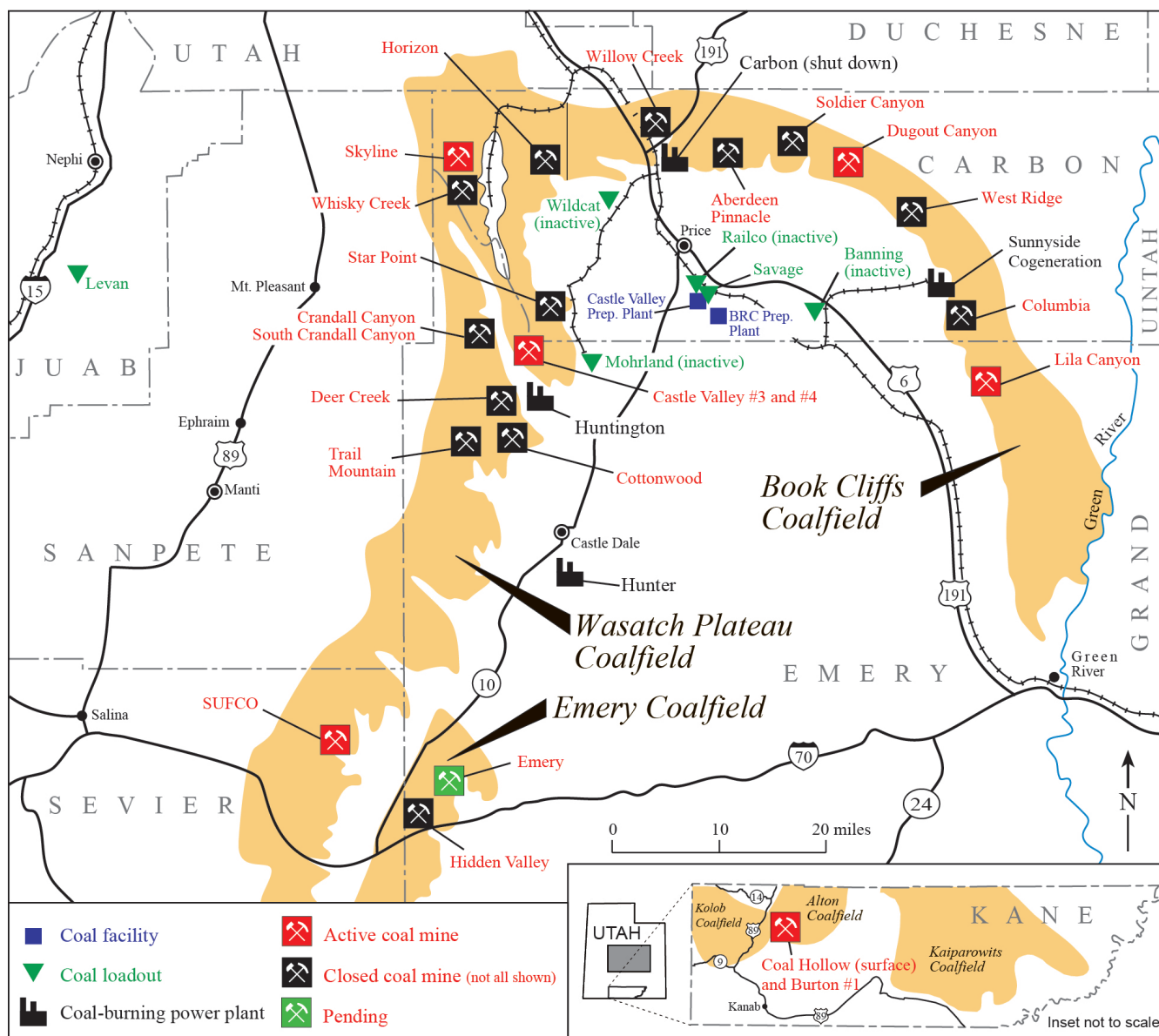


Figure 10. Location and status (at time of publication) of Utah coal mines and associated facilities.

sharply decreased over the past few years as power plants have switched from coal- to natural-gas-fired generation. In particular, several coal-fired generation plants in California and Nevada, both significant markets for Utah coal, are closing or converting to natural gas to comply with stricter air-quality standards. For example, the Carbon coal-fired power plant outside Helper, Utah, closed in April 2015 as it was cost prohibitive to retrofit the old plant with new EPA-mandated emission-reducing technology. This removed about 600,000 st of coal from the Utah market. The California market is also starting to influence Utah's in-state demand since the Intermountain Power Plant (IPP) north of Delta, Utah, is mostly owned by the City of Los Angeles. This owner has already stated that it will no longer purchase power from IPP after its current power purchase agreement expires in 2027, unless IPP converts to natural gas or implements carbon capture and storage technology. Thus, the average annual coal production total for Utah

will likely be in the 14–15 million st range until at least 2027, after which there could be a significant reduction in demand.

While full-year statistics are not yet available, the total amount of Utah coal distributed to market in 2015 is estimated at 14.6 million st. As recently as 2002, nearly 13.2 million st of Utah coal was exported to other states, while 10.1 million st was used in state (figure 11). In 2015, only 2.5 million st of Utah coal was shipped to other states, while 12.0 million st was used locally. The vast majority of Utah coal, 70%, goes to the electric utility market, mainly in state. The economic recession and low natural gas prices have greatly slowed demand for Utah coal in the industrial sector where deliveries totaled 2.5 million st in 2015, which was significantly less than peak deliveries of 4.4 million st in 2003. Coal deliveries in 2016 are expected to remain in the 14 to 15 million st range, reflecting lower overall production.

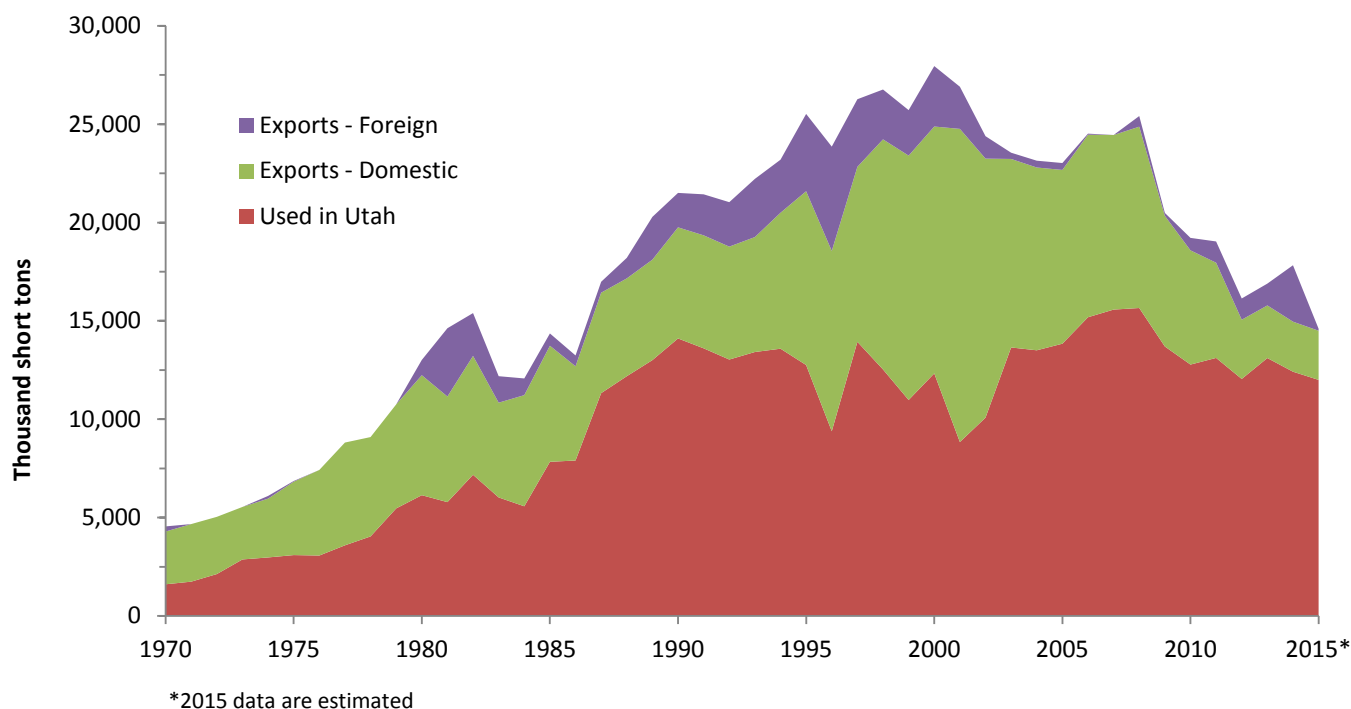


Figure 11. Distribution of Utah coal, 1970–2015.

Foreign exports of Utah coal averaged about 3.0 million st per year in the 1990s, peaking at 5.3 million st in 1996 (figure 11). Beginning in the early 2000s, foreign exports dropped dramatically, with no exports reported in 2007. Starting in 2008, Utah coal again began traveling to other countries, reaching 2.9 million st in 2014, before dropping again in 2015 to only about 100,000 st. Demand for coal in Asia remains strong, but Utah operators will need increased access to port facilities on the West Coast to allow this market to offset slowing domestic demand.

For detailed statistics on Utah's coal industry (including information previously published in the annual Utah coal report), refer to extensive data tables located on the UGS's Utah Energy and Mineral Statistics website: <http://geology.utah.gov/resources/energy/utah-energy-and-mineral-statistics/>.

Exploration and Development Activity

UtahAmerican Energy, Inc. – Murray Energy Corp.

Lila Canyon mine: The 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 1200-ft-long rock slopes and began development work in the Sunnyside coal bed, producing 72,000 st of coal in 2010. Mine development work continued from 2011 through 2015, and total coal production reached 157,000 st, 304,000 st, 257,000 st, 335,000 st, and 350,000 st, respectively. Coal production is expected to increase substantially in 2016, up to 1.5 million st, as the now-closed West Ridge mine's longwall mining equipment was installed in February. At full capacity, the mine could employ up

to 200 people and produce up to 4.5 million st of coal per year. However, the exact timing of reaching that level of production depends on the coal market. Coal is presently mined from federal leases where the merged upper and lower Sunnyside bed is about 13 ft thick. Up to 46 million st of recoverable coal is under lease, and approximately 32 million st of additional reserves are available on 4200 acres of federal land to the south.

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. Production at West Ridge has averaged 2.6 million st between 2012 and 2014, but production in 2015 decreased to about 1.6 million st as UtahAmerican depleted the remaining recoverable coal under lease and shut down operations in late November 2015. After refurbishment, the longwall equipment was moved to the Lila Canyon mine in February 2016.

Canyon Fuel Company – Bowie Resources Partners, LLC

Bowie Resource Partners, LLC bought Canyon Fuel Company (the Dugout, Sufco, and Skyline mines) from Arch Coal in summer 2013. Bowie, based in Louisville, Kentucky, owns the mines in a joint venture with Galena Private Equity Resources Fund, a unit of the Amsterdam-based commodity trader Trafigura Beheer BV. Trafigura sells the venture's coal production.

Dugout Canyon mine: The Dugout Canyon mine, located in the Book Cliffs coalfield, shut down its longwall mining machine in late 2012, resulting in coal production of only 561,000

st from the Rock Canyon bed in 2013, down significantly from the 1.6 million st produced in 2012 and the 2.4 million st produced in 2011. Currently, Dugout uses two continuous miners and produced about 763,000 st in 2015. A second continuous miner was brought online in 2015 and production could increase if more shifts are added and if coal market conditions warrant increased output, but currently, 2016 production is expected to remain near 700,000 st.

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 Winter Quarters lease in Carbon County. Production from this bed increased slightly in 2015 to 4.4 million st, but is expected to dip to 4.2 million st in 2016. Production on the Winter Quarters lease will be completed in 2018, after which mining will shift to the recently leased Flat Canyon federal coal tract in Sanpete County, near the border with Emery County. The Flat Canyon tract is estimated to contain up to 42 million st of recoverable coal reserves in the Lower O'Connor "B" and Flat Canyon beds.

Sufco mine: Sufco is Utah's largest coal producer and the 14th largest producing underground coal mine in the United States (2014 data). It is also the only active coal mine in Sevier County. Sufco produced 6.1 million st of coal in 2015 from the upper Hiawatha bed, 6.8% less than in 2014, but 23% less than record high production of 7.9 million st achieved during 2006. Production at Sufco is expected to remain near 6.0 million st in 2016 and production on current leases will last another two or three years before operations will need to shift to the yet-unleased Greens Hollow tract. On a separate note, the new Quitchupah Creek road opened in late 2013, significantly reducing coal haulage time and costs for trucks heading to the power plants in Emery County, Utah.

Greens Hollow tract: Near the Sufco mine, Canyon Fuel has nominated the federal Greens Hollow tract for leasing, located northwest of the already acquired Quitchupah lease. A draft Environmental Impact Study (EIS) was issued in the spring of 2009 and the Record of Decision, favoring the lease of the tract, was made in December 2011. The EIS was subsequently retracted until further study could be completed, and a new decision was issued in late 2015. Since the Greens Hollow tract already had an existing Record of Decision, this lease tract will not be affected by the new federal coal leasing moratorium declared by the BLM in January 2016. In September 2016, the BLM again postponed the lease sale pending another appeal by environmental groups. The Greens Hollow tract is thought to contain approximately 56 million st of reserves within the lower Hiawatha bed.

Fossil Rock Resources – Bowie Resources Partners, LLC

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, a subsidiary of Arch Coal, Inc., also the former owner of Canyon Fuel Company. Two coal leases were issued, one for 8204 acres covering lands within the 1998 land exchange Cottonwood Coal Tract

and the other for 600 acres within an adjacent SITLA section. In mid-2011, the Cottonwood lease was transferred to Fossil Rock Resources, a subsidiary of PacifiCorp and Rocky Mountain Power, as part of a settlement of litigation between the two companies. The Cottonwood tract is 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 49 million st. Following the announcement of the closure of the Deer Creek mine in early 2015, Fossil Rock Resources along with its coal reserves was sold to Bowie Resources. Fossil Rock plans to drill several exploratory wells on the Cottonwood tract in 2016.

Bronco Utah Operations, LLC

Emery mine: Bronco Utah Operations bought the Emery mine from CONSOL Energy in December 2015. The Emery mine produced about 1 million st annually from the Ferron Sandstone I bed from its opening in 2005 through 2010, when CONSOL idled the mine due to low coal demand. Bronco plans to develop new portals and underground workings in the I bed, with the capability of producing up to 1.0 to 1.5 million st per year using the continuous miner in some sections; actual production will depend on market conditions. If permits are established, the Emery mine could produce about 200,000 st in 2016 and employ up to 100 miners by the end of the year.

Rhino Resource Partners, LP

Castle Valley mines: Rhino purchased the Bear Canyon mines from C.W. Mining in 2010 and changed their name to Castle Valley. Full-scale production using two continuous miners produced 1.1 million st from the Tank bed (#4 mine) in 2014. Total production in 2015 was about 975,000 st, divided between the reactivated Castle Valley #3 mine (218,000 st; Bear bed) and the #4 mine (757,000 st; Tank bed). Rhino reports that its western mines are contracted for about 1.0 million st of coal sales in 2016. Rhino estimates that about 5 million st of reserves still exist on leased land, but roughly 51 million st of recoverable reserves could be available in the Tank, Bear, and Hiawatha beds in the surrounding area.

Energy West Mining Company – PacifiCorp

Deer Creek mine: Production at the Deer Creek mine decreased to 2.1 million st in 2014, and the mine closed in early January 2015 after negligible production (15,000 st). During most of 2015, the Deer Creek mine began removing mining equipment and preparing the mine for permanent closure and reclamation.

America West Resources, Inc.

Hidden Splendor Resources, Inc. – Horizon mine: The Horizon mine, located approximately 11 miles west of Helper in the Wasatch Plateau coalfield, was closed in July 2012 after producing 210,000 st of coal for the year. The mine was closed after MSHA required extensive changes to the mine

plan and a portion of the operation sealed. In February 2013, the company filed for bankruptcy with a subsequent bankruptcy sale in April. The mine failed to sell as a whole and only some of the equipment was sold. Before the mine closed, America West estimated that 16 million st of recoverable coal remained on leased land.

Alton Coal Development

Coal Hollow and Burton #1 mines: In 2011, Alton Coal Development began production at a new coal mine in the Alton coalfield in southern Utah's Kane County. The Coal Hollow mine produces subbituminous Dakota Formation coal from the Smirl bed, which averages about 10,000 btu/lb, about 1% sulfur, and 8% ash. Surface-mining production at the company's Coal Hollow mine on private property peaked in 2013 at 747,000 st before decreasing to 316,000 st in 2015 as the reserves on the southern property were depleted. In the spring of 2014, highwall mining began in the mine's open pits in an effort to recover coal with less surface disturbance. Also during this time, permitting was underway to begin mining the northern fee tract, which commenced in 2016 with expected coal production to be about 450,000 st for the year. After having difficulty producing coal using the highwall mining machine, Alton Coal commenced underground room and pillar mining in late 2015 at the Burton #1 mine. Total production from the underground mine in 2015 was only 11,000 st, but this could increase to about 50,000 st in 2016. Alton Coal Development's application to acquire an adjacent federal coal lease, a process begun in 2004, was affected when a federal coal leasing moratorium was declared in January 2016 by the BLM. Since the BLM had not already issued a Record of Decision for Alton Coal's EIS for the proposed 40-million-ton federal leasing action, the lease application will not be allowed by the BLM to go forward. This has caused Alton Coal to submit a new application for a smaller emergency lease tract to allow the mine to stay in operation when its private coal reserves are depleted. If a federal lease is acquired, the operation would be a combination of surface and underground mines.

CRUDE OIL AND NATURAL GAS

Production and Values

Most of the statistical data presented here on oil and gas were taken from the DOGM website (<http://oilgas.ogm.utah.gov/index.htm>). At an estimated 2015 value of \$2.7 billion, oil and gas accounted for 84% of the total value of fuel commodities produced in Utah. During 2015, 37.1 million barrels of oil (bbls) (down 3.8 million bbls from 2014) and 417.0 billion cubic feet of gas (down 33.6 billion cubic feet from 2014) were produced from Utah oil and gas fields (figure 12). Oil and gas values decreased over \$2.8 billion (51%) between 2014 and 2015 as crude oil and natural gas prices decreased dramati-

cally, followed by decreases in production. Utah oil prices rose 69% between 2009 and 2013, but during the second half of 2014 prices dropped dramatically from \$89.45 per bbl in June to \$51.72 per bbl in December. During 2015, continued price weakness led to an average 2015 price per bbl of about \$41 for Utah oil, and the average 2015 price for natural gas was \$2.60 per thousand cubic feet (mcf). Natural gas production in Utah peaked in 2012 and has been declining ever since. The recent rapid drop in oil prices and the longer term gradual drop in gas prices have created a market environment that will dampen future petroleum company investment in Utah until prices return to attractive levels that encourage expanded exploration and drilling. By the end of 2016, oil and gas prices are expected to rise from the low levels seen in early 2016. Utah's 2015 oil and gas production came from 11,941 producing wells (4802 oil wells and 7139 gas wells), a decrease from the 12,259 producing wells in 2014 (5141 oil wells and 7118 gas wells).

Oil made the largest contribution to the value of Utah fuel production in 2015, with a value of \$1.5 billion, which was about 54% lower than the value in 2014. About 96% of the oil produced in Utah during 2015 came from Duchesne, Uintah, San Juan, and Sevier Counties (in decreasing production order). The five largest producing oil fields in 2015—Altamont (Duchesne), Monument Butte (Duchesne and Uintah), Greater Aneth (San Juan), North Myton Bench (Duchesne), and Bluebell (Duchesne and Uintah)—accounted for about 53% of Utah oil production.

Natural gas made the second-largest contribution to the value of fuel commodities produced in Utah during 2015, with an estimated value of \$1.2 billion (including natural gas liquids), a 48% decrease from 2014. About 96% of the gas produced in Utah during 2015 came from Uintah, Carbon, Duchesne, and San Juan Counties (in decreasing production order). The five largest producing gas fields in 2015 were Natural Buttes (Uintah), Drunkards Wash (Carbon), Red Wash (Uintah), Altamont (Duchesne), and Brundage Canyon (Duchesne). Together they accounted for 68% of the 2015 gas production. Notably, production from Natural Buttes accounted for more than half (51%) of the gas produced in Utah during 2015.

Exploration and Development Activity

Oil and gas exploration and development activity in Utah declined again during 2015. Compared to 2014, the number of wells permitted fell 59% (from 1389 to 570), and the number of wells started (spuds) decreased 83% (from 895 to 155). The most active counties in 2015 were Uintah with 451 new well permits and 105 well spuds, Duchesne with 77 new well permits and 37 well spuds, and Carbon with 26 new well permits and 8 new well spuds. These three counties accounted for 97% of the new well permits and 97% of the well spuds in Utah during 2015. The 313 new oil and gas wells completed during 2015 were less than the 931 wells completed in

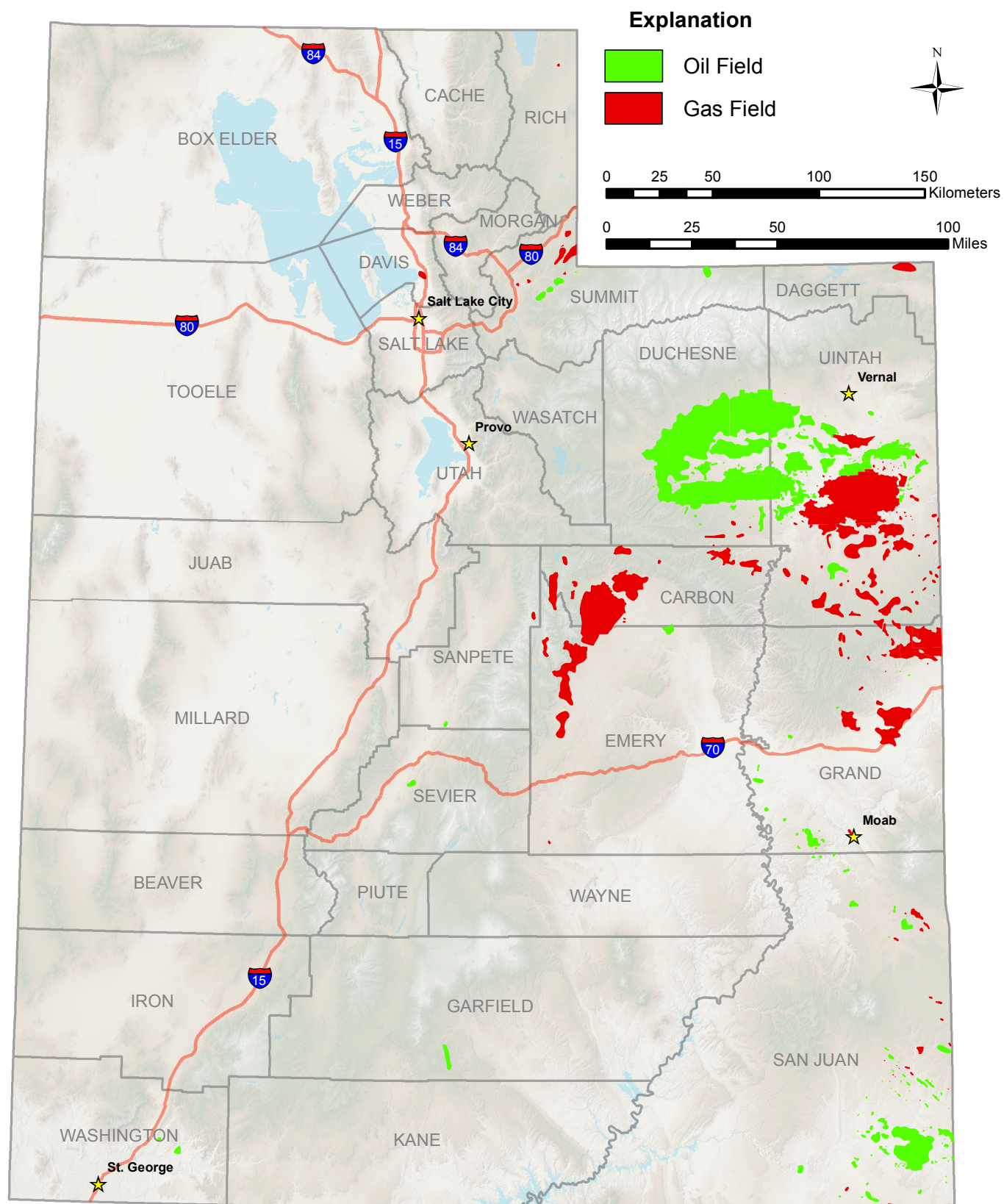


Figure 12. Location of oil and gas fields in Utah.

2014. The new oil and gas wells completed in 2015 consist of 253 new wells within established field boundaries, 37 wells drilled adjacent to existing fields, and 23 wildcat wells drilled in unproven areas. The 313 new wells completed in 2015 include 8 dry holes that were plugged and abandoned, 157 oil wells, 139 gas wells, and 4 service wells (injection or disposal wells). The ratio of new oil wells to new gas wells drilled has increased in recent years in response to high oil prices and depressed gas prices; current rig activity indicates that even with both oil and gas prices now depressed there are still more wells being drilled for oil than for gas.

UNCONVENTIONAL FUELS—OIL SHALE AND OIL SAND

Exploration and Development Activity

Oil Shale

The upper Green River Formation in the Uinta Basin of Utah contains one of the largest deposits of oil shale in the world. The oil shale deposit contains an estimated in-place resource of 1.3 trillion bbls (USGS Oil Shale Assessment Team, 2011) and a potential economic resource of 77 billion bbls (Vanden Berg, 2008). The richest Green River oil shale horizon is the Mahogany zone, where individual beds can yield 80 gallons of oil per ton of rock. The Mahogany zone is 70 to 120 feet thick and is accessible via extensive outcrops along the eastern and southern flanks of the basin.

Company development activities: The outcrop accessibility, low dip, and shallow cover of Utah oil shale deposits make surface/underground mining and surface retort the preferred technology to recover oil from the shale. Currently, three companies are pursuing oil shale development in Utah: Enefit American Oil, Red Leaf Resources, and TomCo Energy.

Enefit American Oil is an Estonian company that acquired 100% of OSEC (Oil Shale Exploration Company), including their private land (the Skyline property, 21,000 acres), state leases (4,000 acres), and a U.S. BLM Research, Development, and Demonstration oil shale lease (5,000 acres). On the southern, private portion of its property Enefit's plan is to develop a 50,000 bbl/day oil shale operation, consisting of a surface/underground mine (that would process nearly 30 million st of shale per year), up to six surface retorts and circulating fluidized bed combustion units, and a shale oil upgrader. The project will commence in two 25,000 bbl/day stages; timing will depend on the acquisition of necessary permits and market conditions. Recent work has focused on drilling several wells and recovering core to prove up the resource and provide fresh mining-horizon samples for testing the company's specific retort technology. In addition, several water monitoring wells have been drilled. Although the project will begin on private land, a utility corridor that crosses BLM land is

planned to support the development. A draft Environmental Impact Statement for the corridor was released in April 2016. The BLM will respond to comments received by June 16, 2016, and the responses will be summarized and incorporated into the Final EIS later in 2016, with a final decision anticipated from the agency in 2017.

Red Leaf Resources is a Utah company having several state oil shale leases on the southeastern side of the Uinta Basin. Red Leaf has developed a modified in situ retort process called Ecoshale technology. The process involves surface mining oil shale from a pit, lining the pit with an impermeable clay layer, placing the oil shale back in the pit with a series of pipes, and covering the filled pit (capsule) with clay and top soil. Shale in the capsule is retorted by hot air circulating through the pipes. Reclamation can commence while the capsule is still retorting the shale. This process was tested on a pilot scale at the Seep Ridge lease and the company has acquired a large-mine permit to build a near-commercial-scale capsule. Red Leaf recently completed a preliminary, front-end, engineering-design commercial study for the EcoShale technology on its Seep Ridge lease in Utah for 30,000 barrels per day production facility. Based on the initial results, Red Leaf is now conducting an Early Production System (EPS) basis-of-design engineering study for an EPS capsule. This study should be completed in the fall of 2016, then move to an engineering phase. Commercial plans are to produce 10,000 bbl/day of oil from several capsules running simultaneously. In March 2012, Red Leaf announced a joint venture with Total E&P USA Oil Shale (a U.S. affiliate of Total USA). Total will fund an 80% share of the EPS expenses, which are estimated at approximately \$200 million. In addition, Red Leaf continues the pre-planning phase on its Holliday Block to identify permitting, power, unique mining requirements, and other infrastructure needed to create a second commercial oil shale project after Seep Ridge is operational.

TomCo Energy is a United Kingdom-based company with 2919 acres of SITLA leases in the Uinta Basin. The company plans to use the Red Leaf Ecoshale technology on their "Holliday block" property. The company has drilled nine exploratory wells to define their resource and has begun work to acquire the necessary development permits. SRK Consulting Limited reviewed the drilling and geological work over the Holliday Block, and issued an updated mineral resource statement upgrading the resource from 123 million bbls of oil in the Indicated category to 126 million bbls of oil in the Measured category, thereby providing increased confidence in the oil contained within the lease. TomCo is waiting for test results from Red Leaf's new larger scale capsule before commencing permitting and construction operations on their lease.

Oil Sand

North America has the greatest oil sand resources in the world, most of which are in Canada. Utah oil sands, though small compared to Canadian resources, are the largest resource in

the United States. Utah oil sand deposits contain 14 to 15 billion bbls of in-place oil, and have an additional inferred resource of 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 20 to over 250 square miles, as many as 13 pay zones, gross thickness ranging from 10 to more than 1000 feet, and overburden thickness ranging from zero to over 500 feet.

With the current glut of conventional crude oil and the attendant low price, there is less incentive for new drilling or the employment of bitumen extraction and upgrading techniques to move Utah's oil sands toward successful and sustainable development. Meanwhile, investment and investigation should continue into such factors as permitting, process efficiency, site accessibility, adequate infrastructure, water availability, environmental concerns, and greater understanding of the problems associated with the heterogeneity of reservoir sands to reduce investment risk and improve the economic viability of oil sand development in Utah when market conditions improve in the future.

Company development activities: US Oil Sands is the most active company seeking to develop Utah's oil sand resources. US Oil Sands holds 32,005 acres of bitumen extraction rights on leases within the PR Springs oil sand deposit in the southern Uinta Basin. In the summer of 2011, the company drilled more than 180 wells on their leases to define the resource. These assets contain approximately 184 million barrels of discovered resource, as described in a National Instrument 51-101 report, and represent the largest oil sands holdings in the United States. All lands are leased from SITLA and US Oil Sands owns 100% of the bitumen rights to these lands. US Oil Sands has two project areas: PR Springs, and the Cedar Camp-NW project areas. The primary area of development is the PR Spring Project Area, which consists of 5930 contiguous acres. Within a portion of this lease, the company has acquired all the necessary permits for development of a surface mine/solvent extraction project on which work commenced in the second half of 2013. The initial development is targeted to produce 2000 bbl/d of bitumen. The significant drop in crude oil prices in 2015 delayed financing and construction of the mining and bitumen extraction operations, which were most recently were announced to begin in late 2016. The Cedar Camp-NW Project Area holds 26,075 acres of exploration land, which will be assessed for future development.

Another of Utah's promising oil sand deposits is along Asphalt Ridge near Vernal, Utah. Several companies have tried to develop oil sand operations in the area in the past, but no commercial activity took place in 2015 besides limited extraction for use as road pavement. One company, MCW Energy Group, has pilot-scale tested operations on the northern side

of Asphalt Ridge, also using a solvent-based extraction technique. Prior to the decline of oil prices during 2015 and early 2016, MCW Energy produced approximately 10,000 bbls of oil from its 250 bbl/day pilot plant. Company plans call for resumed production in 2016 if oil prices reach a level where MCW's production is again economically viable. Production costs for MCW's plant were determined to be \$31.00/bbl by a company-sponsored engineering study. Feedstock will be drawn from MCW's oil sands resource at the Temple Mountain Energy lease site, which is reported to contain over 89 million bbls of oil. MCW is pursuing funding for a 2500 bbl/day plant on this site. The Sunnyside oil sand deposit, east of Price, Utah, also has received attention from companies, including one that has recently proposed to access the deposit via underground mining. However, as with other sites, low oil prices have hindered development economics.

NEW MINERALS INFORMATION

The following publications released in 2015 and early 2016 provide new information on the energy and mineral resources of Utah. Krahulec (2015) summarized the geology and mineralization of over 50 mining districts in the eastern Great Basin of western Utah related to Tertiary intrusive rocks. A number of new Canadian National Instrument 43-101 technical reports were completed on properties in Utah, including the Gold Springs district (Lane and others, 2015); Velvet-Wood, 2015 uranium property (Beahm, 2015); Sage Plain uranium property (Peters, 2015); and Thompson Knolls (Redfern, 2016). An interactive map to download Canadian National Instrument Technical Reports for Utah mineral properties is available on the UGS website at <http://geology.utah.gov/apps/reportviewer/index.html>.

Boden and others (2015) compiled production, values, and exploration and development activity for Utah's extractive resource industries for 2014. This and other UGS and Utah Geological Association publications are available through the Utah Department of Natural Resources Map and Bookstore (<http://mapstore.utah.gov>).

The UGS website has recently added features to use and/or download the Utah Mineral Occurrence System (UMOS) at <http://geology.utah.gov/resources/data-databases/utah-mineral-occurrence-system/> and detailed production and shapefile information on Utah mining districts at <http://geology.utah.gov/resources/data-databases/utah-mining-districts/>. The UGS also maintains a repository for Utah energy and mineral data at <http://geology.utah.gov/emp/energydata/index.htm>, which 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. Additional geographic information system (GIS) data on Utah is available for free download at <http://agrc.utah.gov> and <http://geology.utah.gov/resources/>.

RECLAMATION AND THE ENVIRONMENT

The U.S. Department of Energy (DOE) and the State of Utah agreed to move about 16 million st of old Atlas uranium mill tailings and associated contaminated materials located on a 480-acre site along the Colorado River near Moab. The primary sources of concern in these tailing are uranium and ammonia. The tailings are being moved 30 miles north to a site near Crescent Junction, Utah. The DOE transports the tailings by rail to a 250-acre disposal cell excavated in the very low permeability Cretaceous Mancos Shale. The project began shipping tailings in April 2009, moved 651,540 st in 2015, and has moved a total of 8,112,525 st by the end of 2015 (Donald Metzler, DOE, written communication, March 2016).

In 2015, KUC began a significant \$100 million, five-year project to reduce the current angle of repose mine dump slope angles to a shallower grade on the east waste dumps that face Salt Lake Valley. The project will also require building new toe drains and cutoff dams keyed into bedrock below the dumps to take in this newly enlarged dump footprint. The shallower slope angle will help with surface-water management and facilitate revegetation efforts.

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APPENDIX
BINGHAM CANYON MINE HISTORICAL PRODUCTION STATISTICS

Appendix. Bingham Canyon mine historical production statistics.

Year	Ore Short Tons	Waste Short Tons	Waste to Ore Ratio	Copper Short Tons	Molybdenum Short Tons	Gold Thousand Ounces	Silver Thousand Ounces
1904-5	216,769	—	—	2,814	—	2	17
1906	231,125	—	—	2,713	—	2	16
1907	183,569	768,675	4.19	2,100	—	1	11
1908	2,422,064	2,773,279	1.15	28,448	—	20	182
1909	2,674,271	3,170,478	1.19	27,236	—	21	221
1910	4,340,245	5,846,265	1.35	44,510	—	40	424
1911	4,680,801	11,320,905	2.42	49,218	—	40	408
1912	5,315,321	9,713,232	1.83	48,088	—	34	346
1913	7,519,392	10,043,290	1.34	59,970	—	28	317
1914	6,470,166	11,857,252	1.83	60,890	—	35	362
1915	8,494,300	12,381,759	1.46	78,094	—	37	413
1916	10,994,000	12,278,092	1.12	98,365	—	46	506
1917	12,542,000	8,872,670	0.71	102,428	—	49	537
1918	12,160,700	8,441,117	0.69	97,084	—	49	520
1919	5,538,700	4,284,666	0.77	54,617	—	29	293
1920	5,556,800	6,102,847	1.10	52,308	—	27	286
1921	1,220,700	737,815	0.60	12,415	—	7	73
1922	4,364,251	2,288,341	0.52	43,922	—	28	286
1923	11,167,800	5,227,861	0.47	101,493	—	73	701
1924	12,126,600	12,949,912	1.07	111,762	—	77	725
1925	12,538,300	16,488,080	1.32	111,489	—	78	770
1926	13,880,100	17,932,338	1.29	122,013	—	86	845
1927	13,811,500	15,149,189	1.10	120,482	—	89	884
1928	16,558,500	14,996,011	0.91	140,539	—	104	1,019
1929	17,724,100	19,821,357	1.12	151,007	—	116	1,167
1930	9,552,500	13,846,715	1.45	82,722	—	64	626
1931	8,147,764	10,180,181	1.25	71,378	—	54	535
1932	3,169,411	3,650,930	1.15	28,739	—	25	247
1933	3,521,425	3,362,061	0.95	33,661	—	35	347
1934	4,086,800	4,981,560	1.22	39,473	—	44	373
1935	6,529,800	7,483,981	1.15	58,397	—	68	597
1936	13,773,900	14,859,346	1.08	121,609	272	117	1,057
1937	23,119,800	28,292,291	1.22	204,384	2,454	202	1,912
1938	11,704,900	18,617,345	1.59	100,786	1,616	98	910
1939	19,310,200	23,111,402	1.20	165,836	3,091	159	1,494
1940	25,950,500	30,884,201	1.19	225,326	4,292	223	2,103
1941	30,090,400	38,380,432	1.28	263,150	4,717	242	2,251
1942	33,093,200	39,716,089	1.20	291,311	5,622	287	2,627
1943	35,375,800	41,308,996	1.17	309,613	5,885	306	2,822
1944	29,274,200	32,962,007	1.13	262,791	5,789	284	2,487
1945	23,361,000	29,002,916	1.24	213,564	5,154	228	2,029
1946	11,831,400	13,776,826	1.16	106,419	2,727	131	1,163
1947	28,539,300	34,359,084	1.20	256,355	6,933	364	2,969
1948	24,454,000	33,480,555	1.37	220,667	5,601	312	2,622
1949	20,922,300	26,581,965	1.27	190,790	5,028	268	2,215
1950	31,037,800	41,344,160	1.33	274,786	7,344	413	3,290

Year	Ore Short Tons	Waste Short Tons	Waste to Ore Ratio	Copper Short Tons	Molybdenum Short Tons	Gold Thousand Ounces	Silver Thousand Ounces
1951	30,444,800	46,551,516	1.53	268,971	6,945	391	3,156
1952	32,036,100	46,910,576	1.46	277,773	8,042	403	3,279
1953	29,922,200	49,291,904	1.65	259,824	8,630	442	3,410
1954	24,079,400	35,856,641	1.49	205,619	6,683	361	2,598
1955	27,740,600	45,710,091	1.65	226,589	7,651	397	2,923
1956	32,321,100	55,209,730	1.71	245,714	7,650	379	2,924
1957	30,919,900	52,341,056	1.69	232,290	6,650	353	2,867
1958	24,086,800	39,045,654	1.62	182,305	5,458	280	2,143
1959	19,673,100	32,300,481	1.64	147,311	4,456	224	1,749
1960	28,060,300	49,221,324	1.75	209,546	6,411	352	2,624
1961	27,839,700	51,242,919	1.84	203,947	6,164	324	2,428
1962	29,175,000	54,454,286	1.87	202,636	6,112	299	2,412
1963	26,235,400	51,199,296	1.95	182,738	5,256	254	2,122
1964	24,456,400	57,497,136	2.35	174,638	5,229	243	1,939
1965	32,088,900	84,116,298	2.62	229,639	7,567	373	2,909
1966	33,477,700	66,304,900	1.98	219,559	7,060	364	2,885
1967	20,789,600	35,532,965	1.71	136,086	4,524	213	1,638
1968	28,343,900	68,786,040	2.43	175,172	5,358	265	2,250
1969	38,650,300	90,028,957	2.33	240,963	7,170	379	3,194
1970	40,147,500	100,195,997	2.50	245,298	7,634	355	2,904
1971	35,008,400	88,614,573	2.53	213,306	6,192	308	2,600
1972	34,951,700	92,452,181	2.65	210,714	6,746	318	2,682
1973	38,267,600	104,152,836	2.72	215,659	6,405	310	2,740
1974	35,277,300	107,389,674	3.04	194,755	4,628	255	2,419
1975	27,318,000	97,431,089	3.57	146,102	4,029	185	1,759
1976	29,567,100	113,213,082	3.83	158,039	3,226	168	1,793
1977	32,570,800	113,156,461	3.47	176,916	3,425	187	1,957
1978	35,937,700	115,625,007	3.22	190,562	4,860	219	2,224
1979	37,803,900	123,434,500	3.27	195,073	5,106	226	2,275
1980	31,578,500	99,976,515	3.17	157,787	3,665	174	1,766
1981	39,023,500	134,274,849	3.44	199,087	3,785	209	2,241
1982	36,877,600	118,011,880	3.20	193,049	2,560	177	2,162
1983	33,310,200	90,539,931	2.72	172,955	1,828	206	2,189
1984	21,963,700	33,566,100	1.53	124,038	1,703	145	1,514
1985	2,644,200	2,494,350	0.94	16,972	296	21	191
1986	444,900	2,086,050	4.69	2,207	6	3	29
1987	23,447,400	22,446,986	0.96	139,431	2,507	199	1,788
1988	35,041,833	26,688,301	0.76	209,906	949	305	2,518
1989	40,539,798	37,140,938	0.92	245,397	4,654	507	3,755
1990	41,341,940	51,030,720	1.23	252,542	5,739	420	3,379
1991	42,749,228	52,208,453	1.22	253,829	7,714	459	3,615
1992	54,524,742	46,531,639	0.85	310,909	9,529	532	4,318
1993	56,761,080	44,999,718	0.79	331,144	8,988	515	4,411
1994	59,291,955	50,000,000	0.84	335,645	9,620	510	4,358
1995	56,201,713	56,736,900	1.01	332,029	11,908	525	4,376
1996	56,330,004	59,063,400	1.05	322,152	12,308	615	4,739
1997	58,833,000	70,846,600	1.20	336,312	12,208	603	4,916

Year	Ore Short Tons	Waste Short Tons	Waste to Ore Ratio	Copper Short Tons	Molybdenum Short Tons	Gold Thousand Ounces	Silver Thousand Ounces
1998	57,646,600	83,646,933	1.45	328,706	6,981	366	4,247
1999	62,384,260	103,930,355	1.67	307,872	6,981	367	3,859
2000	64,663,123	105,148,397	1.63	325,950	11,122	529	3,939
2001	53,535,161	122,698,884	2.29	343,838	8,937	592	4,475
2002	44,885,696	119,966,099	2.67	286,257	6,671	412	3,663
2003	50,821,879	94,315,851	1.86	309,912	5,091	305	3,548
2004	50,400,000	92,041,110	1.83	290,729	7,490	308	3,584
2005	51,447,060	103,900,000	2.02	243,322	17,199	401	3,958
2006	60,600,000	102,400,000	1.69	292,824	18,522	523	4,214
2007	52,396,000	104,500,000	1.99	233,951	16,427	397	3,487
2008	54,170,000	115,351,000	2.13	262,395	12,821	368	3,414
2009	58,273,740	124,000,000	2.13	334,609	12,446	582	4,871
2010	68,332,332	142,814,574	2.09	275,405	14,222	466	3,754
2011	68,572,914	143,317,390	2.09	214,988	14,994	284	2,976
2012	48,646,393	161,019,561	3.31	179,924	10,322	200	2,086
2013	50,141,265	192,179,984	3.83	232,585	6,284	207	2,876
2014	46,999,102	177,168,866	3.77	225,202	12,679	260	2,935
2015	38,394,409	189,764,259	4.94	101,430	8,379	131	1,458
Total	3,149,984,901	6,047,702,237	1.92	19,938,797	539,329	26,689	234,418