UTAH'S EXTRACTIVE RESOURCE INDUSTRIES 2014

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

CIRCULAR 120
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a division of
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2015

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Cover photo: *The Lisbon Valley copper mine, San Juan County, October 2013. This view is to the north with the La Sal Mountains on the horizon (photo courtesy of the Lisbon Valley Mining Co., LLC).*

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ABSTRACT

During 2014, Utah extractive resource industries produced energy and mineral commodities with an estimated gross value of $10.2 billion. On an inflation-adjusted basis, this is a $511 million (5%) increase from 2013, and $861 million (8%) less than the 2008 record high of $11.1 billion. Total energy production in 2014 was valued at $6.2 billion, which includes $3.2 billion from crude oil production, $2.4 billion from natural gas and natural gas liquids production, and $0.6 billion from coal production. Nonfuel mineral production was valued at $4.0 billion, including $2.2 billion from base metal production, $1.4 billion from industrial mineral production, and $0.4 billion from precious metal production.

U.S. Geological Survey preliminary 2014 data ranked Utah 5th nationally in the value of nonfuel mineral production, accounting for approximately 5.4% of the United States total. In 2014, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value of $1.5 billion 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 2014 were the brine- and evaporite-derived products potash, salt, and magnesium chloride, which had an estimated value of $484 million. Notably, Utah remains the only state in the nation to produce magnesium metal, beryllium concentrate, potash as potassium sulfate, and gilsonite.

From 2013 to 2014, oil and gas exploration and development activity in Utah declined; the number of permitted wells decreased from 1611 to 1388, and the number of wells drilled decreased from 1003 to 893. Utah coal production increased 5.8% in 2014, but is expected to decrease in 2015 due to weak domestic demand. Continuing low uranium prices in 2014 have made production from uranium mining operations in Utah uneconomic. Overall, mineral exploration and development was down in 2014, with exploration focused primarily on potash, phosphate, and gold. More than 3000 new unpatented mining claims were filed in Utah in 2014, and 19,770 active unpatented mining claims were on file with the Bureau of Land Management at year end. The number of new claims and the total number of active claims both increased during 2014.

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 2013 production and economic values became available in the fourth quarter of 2014, and for this report we used those numbers to update values published in *Utah's Extractive Resource Industries 2013* (Boden and others, 2014). 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 compilation methods. The 1996–2014 Utah mineral/mining summaries are available on the UGS website at http://geology.utah.gov/popular/general-geology/rocks-and-minerals/#tab-id-6.

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 compiled for this report. Additional data were obtained by the UGS from 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 165 years has been important to Utah and the United States. Mining plays a vital role in Utah's economy and is the oldest nonagricultural industry in the state, employing thousands directly in mining, processing, and transportation, and indirectly in supporting occupations. The 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 nominal value of Utah energy and mineral production reached a record high in 2008 of $10 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.

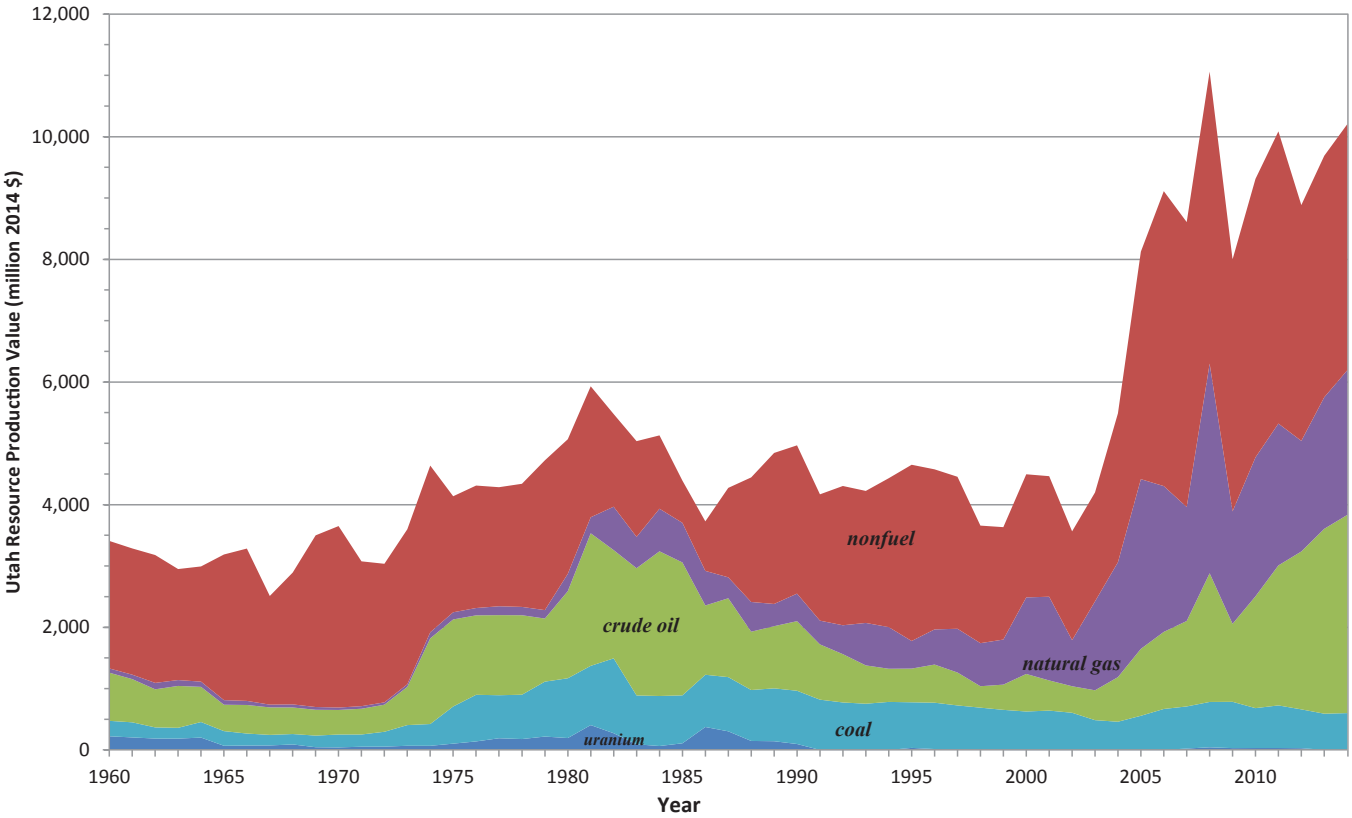
The contribution of energy and mineral production to the Utah Gross Domestic Product (GDP), compared to the value of all goods and services statewide, decreased from 6% in the 1960s to 1.3% in the early 2000s as the state economy grew and diversified. Over the past several years the contribution of the energy and mineral industries to the Utah GDP has ranged between 2% and 3% (U.S. Bureau of Economic Analysis, 2015). 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 2014 was $10.2 billion, a 5% increase from the 2013 inflation-adjusted value. The 2014 energy and mineral production value is the second highest since the 2008 inflation-adjusted value record of $11.1 billion (figure 1). Oil and gas prices remained relatively high from 2013 to the end of the third quarter of 2014, after which they significantly decreased. From 2013 to 2014, prices decreased for gold, silver, copper, iron ore, and beryllium, while prices increased for molybdenum and magnesium metal. Industrial minerals prices were mixed and varied slightly from 2013, with a notable increase for potassium sulfate and decrease for potassium chloride. Base metal production value remained more or less flat from 2013 to 2014, despite decreases in copper and iron ore production, which were offset by Kennecott Utah Copper (KUC) doubling molybdenum production. A significant increase in gold production in 2014 resulted in higher precious metals group value, but the overall value of the entire metals group remained fundamentally flat from 2013. Industrial minerals value increased from 2013 to 2014 and has experienced fairly steady growth since 2005. This growth has been supported by construction projects and high production and prices for brine-derived potash products. The value of Utah coal increased slightly in 2014 as a result of increased coal production. Demand for Utah coal by electric utilities continues to diminish as out-of-state power plants convert from coal to natural gas, biomass, or close altogether. The combined value of Utah oil and gas production increased significantly during 2014. The increase in the value of oil largely followed the increase in oil production while prices declined late in the year, whereas the increased value of natural gas resulted from somewhat higher gas prices but decreased natural gas production in 2014. Energy Fuels Resources suspended production of uranium and vanadium from its Utah mines in 2013, because of low uranium prices. However, in 2014 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 2014 was $6.2 billion, and nonfuel mineral resource production was $4.0 billion. The oil industry sector contributed the largest value ($3.2 billion; 32% of total), followed by base metals ($2.2 billion; 22% of total), natural gas including natural gas liquids ($2.4 billion; 23% of total), industrial minerals ($1.4 billion; 14% of total), coal ($600 million; 6% of total), and precious metals ($388 million; 4% of total) (figures 2 and 3; table 1). Compared to 2013, the 2014 values for natural gas increased by $245 million (12%), oil by $265 million (9%), industrial minerals by $164 million (13%), precious metals by $20 million (5%), and coal by $21 million (4%), whereas base metals decreased by $5 million (-0.2%).

Commodity price indices peaked in July 2008, collapsed later that year, rebounded gradually to reach highs in 2011, and



Source: Utah Geological Survey; U.S Geological Survey; Utah Division of Oil, Gas, and Mining; U.S. Energy Information Administration; Utah Tax Commission

Note: 2014 data are preliminary.

Figure 1. *Annual value of Utah energy and mineral production, inflation adjusted to 2014 dollars, 1960–2014.*

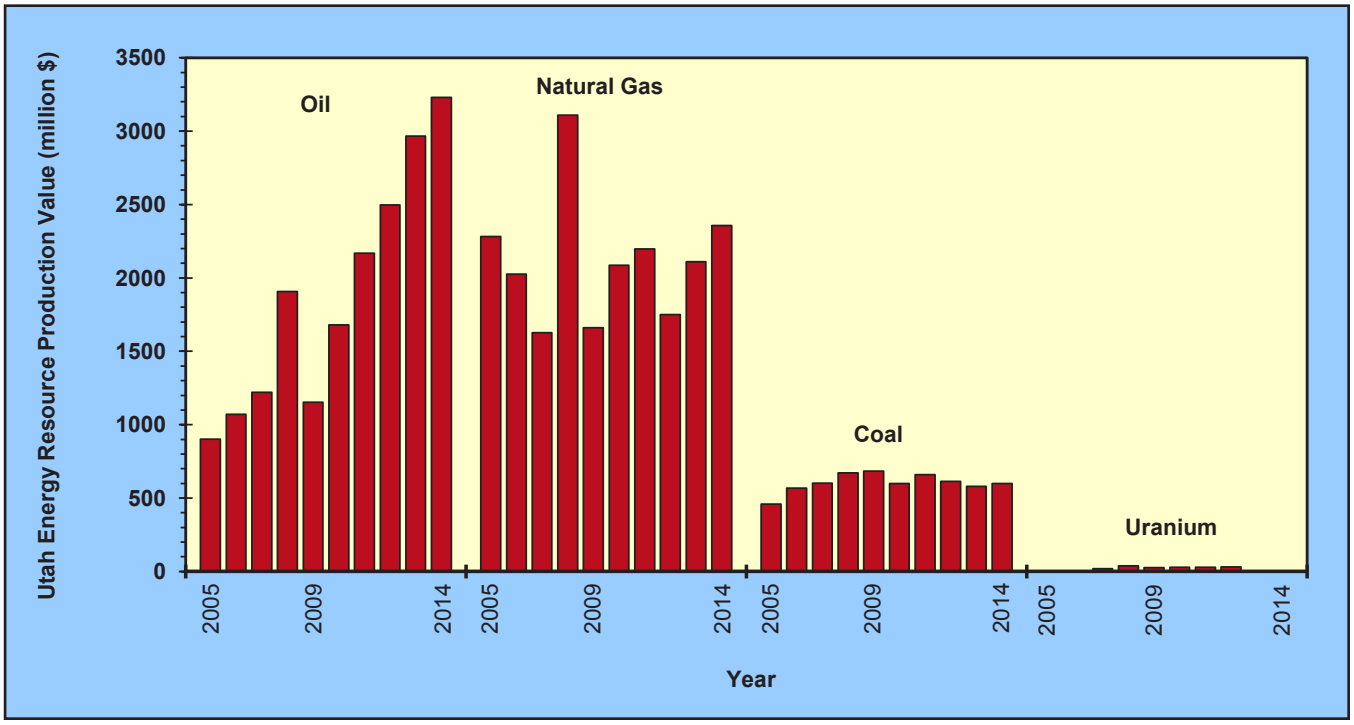


Figure 2. *Annual value of Utah energy resource production in nominal dollars, by industry sector, 2005–2014. Data compiled by the Utah Geological Survey.*

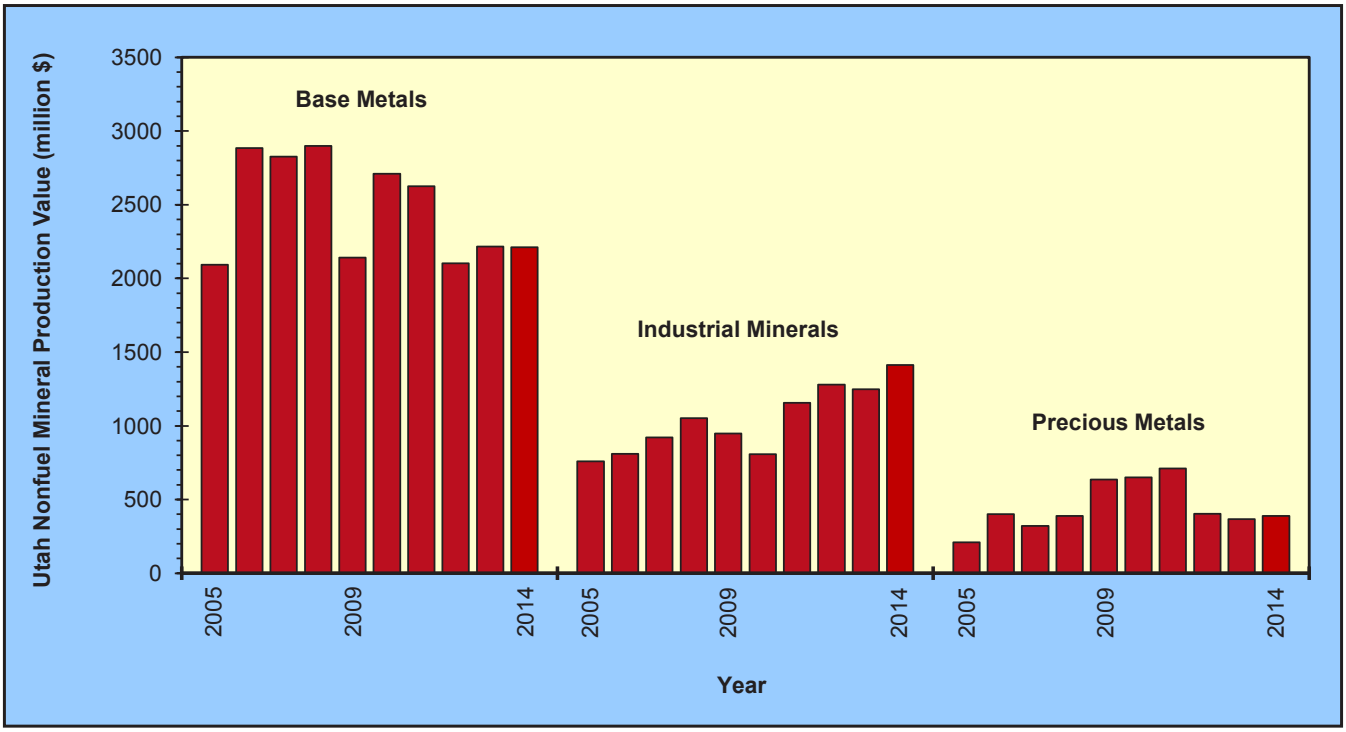


Figure 3. *Annual value of Utah nonfuel mineral production in nominal dollars, by industry sector, 2005–2014. Data compiled by the Utah Geological Survey.*

Table 1. *Utah nonfuel mineral and energy resource production values in nominal dollars, by industry sector, 2005–2014. Values are in millions.*

Year	Base Metals	Industrial Minerals	Precious Metals	Coal	Uranium	Oil	Gas	Total Value
2005	$2093	$759	$209	$459	$0	$900	$2283	$6703
2006	$2885	$811	$400	$569	$0	$1070	$2025	$7760
2007	$2827	$921	$322	$601	$20	$1221	$1628	$7540
2008	$2900	$1053	$390	$672	$39	$1908	$3109	$10071
2009	$2142	$949	$635	$684	$27	$1152	$1661	$7250
2010	$2710	$808	$651	$599	$28	$1679	$2087	$8562
2011	$2625	$1156	$711	$660	$29	$2169	$2198	$9548
2012	$2104	$1280	$403	$614	$31	$2500	$1750	$8682
2013	$2217*	$1249*	$368*	$579	$0	$2966*	$2111*	$9490*
2014**	$2212	$1413	$388	$600	$0	$3231	$2358	$10202

Notes: Gas includes natural gas and natural gas liquids; sulfuric acid was added to industrial minerals in 2011.

*Revised data

**Estimated data

have subsequently declined from 2012 to 2014. Mineral exploration and development has declined with the commodity prices over the past two years, and the primary focus has shifted from copper and iron ore to potash, phosphate, and gold.

Despite slumping metal prices, the number of new unpatented mining claims filed in Utah increased significantly from less than 2000 in 2013 to over 3000 in 2014. Tooele (gold), Iron (gold-silver), Juab (gold-silver-copper), Washington (gold), and Garfield (gold-copper) Counties were the most active; each recorded over 300 new claims filed in 2014. At the end of 2014, the Bureau of Land Management (BLM) had a total of 19,770 active unpatented mining claims in Utah, up slightly from 2013 (Opie Abeyta, Utah BLM, written communication, April 2015).

The Utah School and Institutional Trust Lands Administration (SITLA), which manages about 4.4 million acres of state-owned lands in Utah, celebrates its 20th year as an independent agency managing Utah's trust land assets in 2014. SITLA had record total trust assets of over $2.1 billion in 2014. SITLA issued new leases and/or contracts on 56 mineral tracts in 2014, down 10% from 2013. These leases were issued for the following commodities: metalliferous minerals (27), sand & gravel (14), building stone (4), clay (2), potash (2), gilsonite (2), bituminous sand (1), geothermal (1), limestone (1), gemstone/fossil (1), and oil shale (1) (Jerry Mansfield, SITLA, written communication, April 2015).

The Utah DOGM approved two new large mine permits, 11 small mine permits, and 14 exploration notices of intent (NOI) in 2013. One new large mine permit is for industrial minerals and the other is for precious metals. Eight of the small mine permits are for industrial minerals, two are for base metals, and one is for uranium. Eight of the new NOIs are for industrial minerals and six are for base and/or precious metals (Doug Burnett, DOGM, written communication, April 2015).

National Rankings

Preliminary USGS data show Utah ranked 5th nationally in 2014 for the value of nonfuel mineral production, accounting for about 5.4% of the United States total (USGS, 2015a). 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 increased in 2014 to an estimated $4.2 billion. Between 2005 and 2014, the value of Utah nonfuel mineral production has fluctuated between $3 and $4.5 billion (figure 4), with a notable decrease in 2009 associated with the recession, and in 2012 from significant decreases in base and precious metals production by KUC. Utah remains the only U.S. state to produce magnesium metal, beryllium concentrate, potash as potassium sulfate, and gilsonite. In the 2014 Fraser Institute annual survey of mining companies, Utah was ranked as the 14th most favorable state/nation (89th percentile) out of the 122 international jurisdictions included in the survey in terms of overall investment attractiveness with regard to mining (Jackson, 2015). 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 13th for 2014 coal production (U.S. EIA, 2015a), 11th for 2014

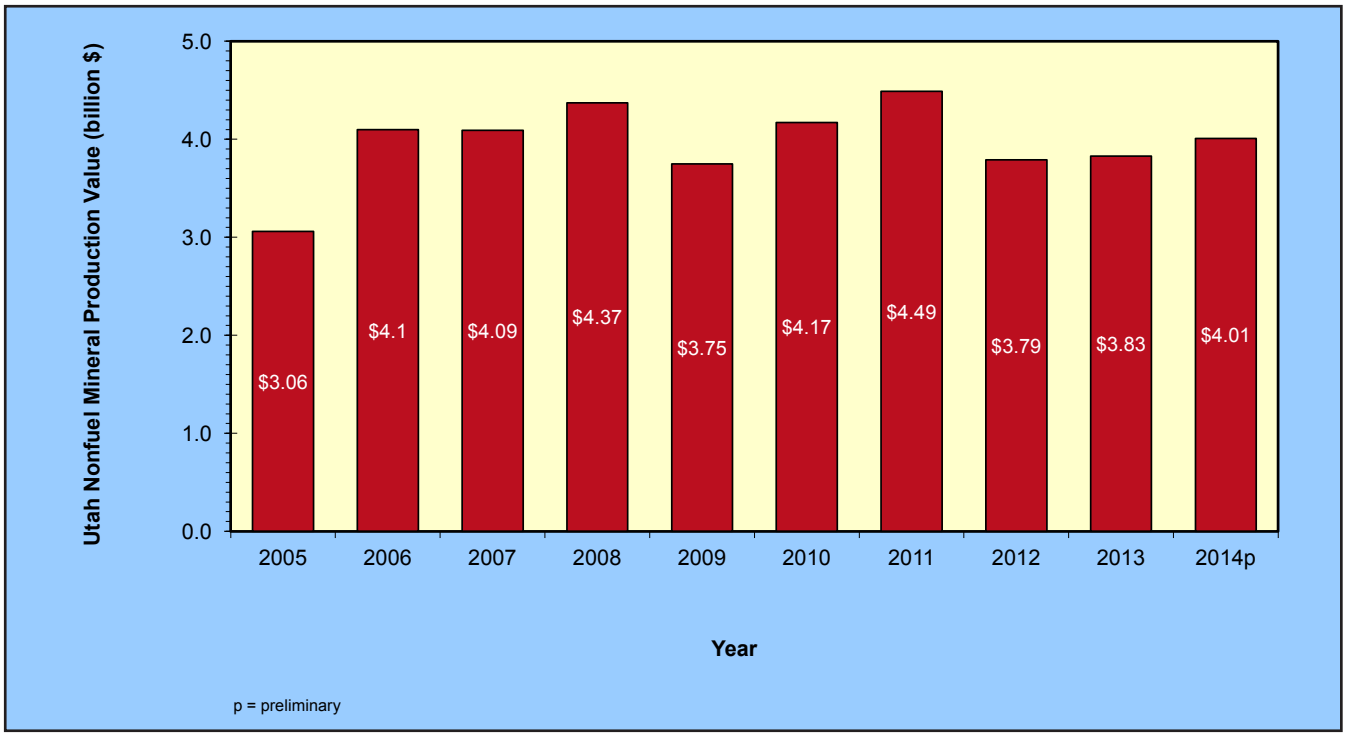


Figure 4. *Annual value of Utah nonfuel mineral production in nominal dollars, 2005–2014. Source: Utah Geological Survey*

oil production (U.S. EIA, 2015b), and 10th (2013 ranking) for natural gas production (U.S. EIA, 2015c).

Outlook for 2015

Of the nonfuel mineral-producing companies surveyed for this report, 35% plan to increase production, 35% anticipate less production, and 30% project duplicating 2014 production in 2015. The massive April 2013 landslide of approximately 165 million short tons (st) of waste rock from the northeast highwall into the bottom of KUC's Bingham Canyon open pit copper-gold-molybdenum-silver mine will continue to have significant negative consequences on Utah's nonfuel mineral production in 2015 and 2016. Bingham is expected to produce significantly less metal in 2015 than 2014 as KUC works to stabilize the east side of the pit. Falling iron ore prices caused CML Metals Inc. to close their Iron Mountain mine in late 2014. In addition, Utah's uranium mines remain closed due to the low uranium price that is expected to stay low throughout 2015. Commodity prices overall have continued to slide from 2012 to 2015 albeit more slowly in 2014 to 2015. The decreased output from Bingham, the Iron Mountain closure, and declining metal prices are likely to result in Utah having a significantly lower value for nonfuel mineral production in 2015. Production of potassium chloride is expected to decrease, while production of the higher value potassium sulfate is expected to increase. Other industrial minerals production will probably remain stable or perhaps increase slightly with an improving housing and construction market. Nonfuel mineral exploration activities in Utah during 2015 are not expected to change significantly from 2014. Most nonfuel exploration activities planned in 2015 are focused on potash, phosphate, and gold.

Utah coal production is expected to decrease in 2015 to 15.0 million st, while prices should remain steady (figure 5; table 2). Continued coal production declines are mostly demand related. Depressed crude oil prices are expected to dampen development throughout Utah until demand and prices return to a new balance in the next few years. 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.

BASE AND PRECIOUS METALS

Production and Values

Base and precious metals produced in Utah during 2014 have an estimated value of $2.6 billion, which accounts for 65% of the annual value of nonfuel minerals produced in Utah. Overall, base and precious metal production values remained fairly flat through 2013 and 2014. The estimated base metal production value in 2014 was $2.2 billion, which accounted for 55% of the annual value of Utah nonfuel mineral production (figure 3; table 1). Utah's base metal production value in 2014 was flat compared with 2013, and had a large increase in molybdenum production and a slight decrease in copper production from 2013. The base metals, in decreasing order of 2014 total value, are copper (69%), molybdenum (14%), magnesium (12%), iron (4%), and beryllium (1%).

Precious metal production value for Utah in 2014 is estimated at $388 million, or 10% of the value of nonfuel minerals produced in Utah, and is distributed between gold (86%) and

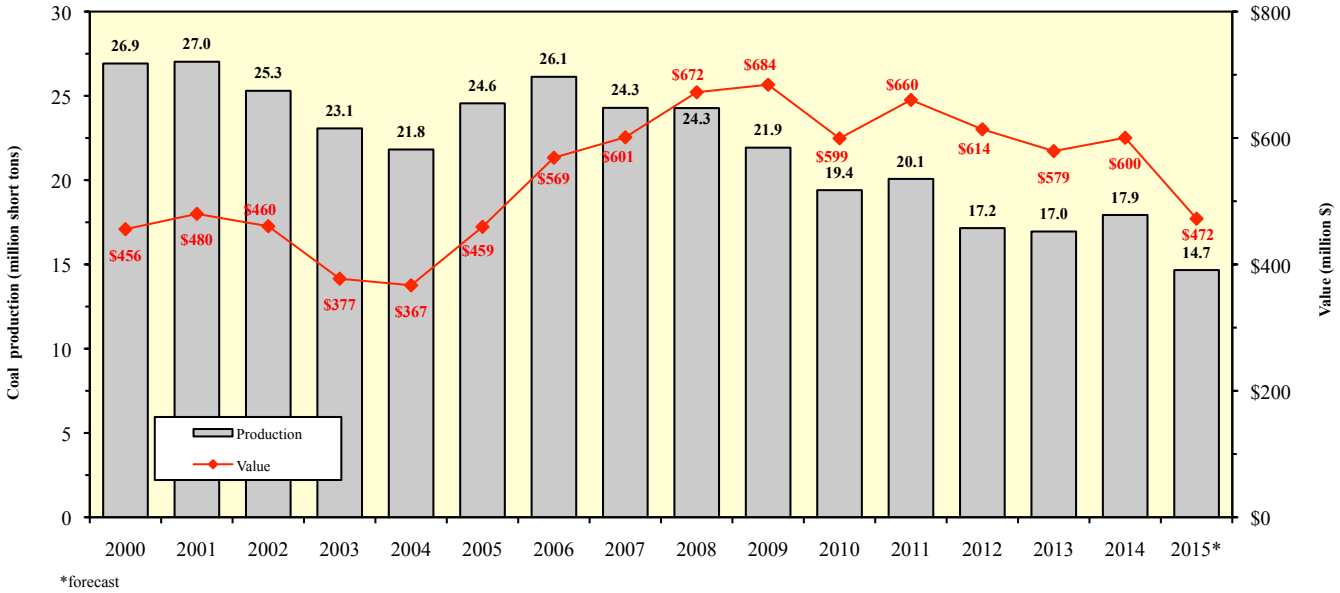


Figure 5. *Utah annual coal production and value in nominal dollars, 2000–2015.*

Table 2. Coal production in Utah by coal mine, 2009–2015.

Company	Mine	County	Coalfield	2009	2010	2011	2012	2013	2014	2015*
				thousand short tons						
Canyon Fuel Company, LLC – Bowie Resources Partners, LLC[1]	Dugout Canyon	Carbon	Book Cliffs	3,291	2,307	2,395	1,588	561	676	800
	Skyline #3	Carbon	Wasatch Plateau	2,910	3,050	2,950	1,954	3,135	4,170	4,000
	SUFCO	Sevier	Wasatch Plateau	6,748	6,398	6,498	5,651	5,959	6,639	6,400
CONSOL Energy	Emery	Emery	Emery	1,238	999	–	–	4	–	
Castle Valley Mining, LLC – Rhino Resource Partners, LP[2]	Castle Valley #4	Emery	Wasatch Plateau	651	–	592	1,004	875	1,061	1,000
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	1,500
UtahAmerican Energy, Inc. – Murray Energy Corp.	Lila Canyon	Emery	Book Cliffs	–	72	157	304	257	335	350
Alton Coal Development, LLC	Coal Hollow	Kane	Alton	–	–	403	570	747	555	600
Total				**21,928**	**19,405**	**20,074**	**17,155**	**16,953**	**17,933**	**14,665**

Source: Utah Geological Survey coal company questionnaires

*Forecast

[1]Owned by Arch Coal until summer 2013

[2]Owned by C.W. Mining (Co-op) until summer 2010, mine formerly called Bear Canyon

silver (14%) (figure 3; table 1). Precious metal production value increased by 5% from 2013 to 2014, due to significantly higher 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 6). The combined value of metals produced by KUC in 2014 is estimated at $2.15 billion, a 3.5% increase from 2013 and accounts for 54% of the value of nonfuel minerals produced in Utah. The Bingham Canyon mine was the second-largest copper and molybdenum, fifth-largest silver, and eighth-largest gold producer in the U.S. during 2014.

Copper

In 2014, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value of $1.52 billion, an 8% decrease in value from 2013. The KUC Bingham Canyon mine produced most of this copper; their 2014 production amounted to 225,000 st, which is 7000 st less than their production in 2013 (Rio Tinto, 2015). The average copper price decreased about 5% from 2013 to $3.22/lb (USGS, 2015a), and KUC production for 2014 has an estimated value of $1.45 billion, a decrease of about 8% from 2013.

Lisbon Valley Mining Company operates a copper mine and processing facility about 30 miles southeast of Moab in San Juan County (figure 6). About 7500 st of copper was produced by the company in 2014, which is slightly less than in 2013. The 2014 production has an estimated value of $48 million at the 2014 average copper price (USGS, 2015a). CS Mining produced about 430,000 st of ore in 2014 from its Sunrise and Hidden Treasure copper mines in Beaver County. Copper is combined with a number of metals to create alloys for a wide variety of applications and is used to produce a wide range of products including electrical wiring, electronic components, and pipe for plumbing, refrigeration, and heating systems.

Molybdenum

Utah molybdenum production in 2014 came solely from the KUC Bingham Canyon mine and was recovered as a byproduct from the copper operation. Approximately 12,700 st of molybdenum were produced in 2014, which is twice as much as in 2013 (Rio Tinto, 2015). The average price of molybdenum increased by 18% during 2014 to $12.20/lb (USGS, 2015a). At the 2014 average price, Utah molybdenum production has an estimated value of $309 million, a 138% increase from 2013 that reflects the large increase in production and higher prices. This valuation makes molybdenum the second-most valuable base metal produced in Utah during 2014. 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, 2015a).

Magnesium

U.S. 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 6). Magnesium chloride concentrate is produced from Great Salt Lake brines through evaporation and converted to magnesium metal by an electrolytic process. The annual magnesium production capacity at the U.S. Magnesium plant is about 70,000 st. The price for magnesium metal remained flat from 2013, averaging $2.15/lb in 2014 (USGS, 2015a). Assuming plant operation at full capacity, Utah 2014 magnesium production has an estimated value of $300 million. Magnesium ranked third as a contributor to Utah base metal values in 2014. Significant quantities of U.S. Magnesium's production are used by a nearby plant, operated by Allegheny Technologies Inc., to produce titanium sponge. Nationally, other 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 uses (USGS, 2015a).

Iron Ore

Iron ore in Utah is mostly produced by CML Metals, Inc., from their Iron Mountain project; a redevelopment of the Comstock-Mountain Lion iron mine located about 19 miles west of Cedar City in Iron County (figure 6). In 2014, CML Metals produced about 1.1 million st of concentrate at 65% iron, which has an estimated value of $100 million at an average price of $91.63/st (USGS, 2015a). CML Metals produced 22% less iron ore concentrate in 2014 than in 2013, due to suspension of mining and concentrate plant operations in October of 2014 as a result of significantly reduced iron ore prices (CML Metals, 2015). Iron ore production ranks fourth in contribution to 2014 Utah base metal production value. Iron ore from the Iron Mountain project was transported by rail to a port in southern California and shipped overseas.

Beryllium

Utah remains the United States' sole producer of beryllium ore from the mineral bertrandite [$Be_4Si_2O_7(OH)_2$]. Materion Natural Resources, Inc., mines bertrandite from the Spor Mountain area about 42 miles northwest of Delta in Juab County (figure 6). 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, metal, and oxide (USGS, 2015a). About 162,000 st of bertrandite ore was mined in 2014 from the Topaz mine at Spor Mountain. Beryllium concentrate production from Utah in 2014 is estimated to be 273 st, a 21% increase from 2013. The average beryllium price for 2014 ($204/lb) was slightly lower than in 2013 (USGS, 2015a).

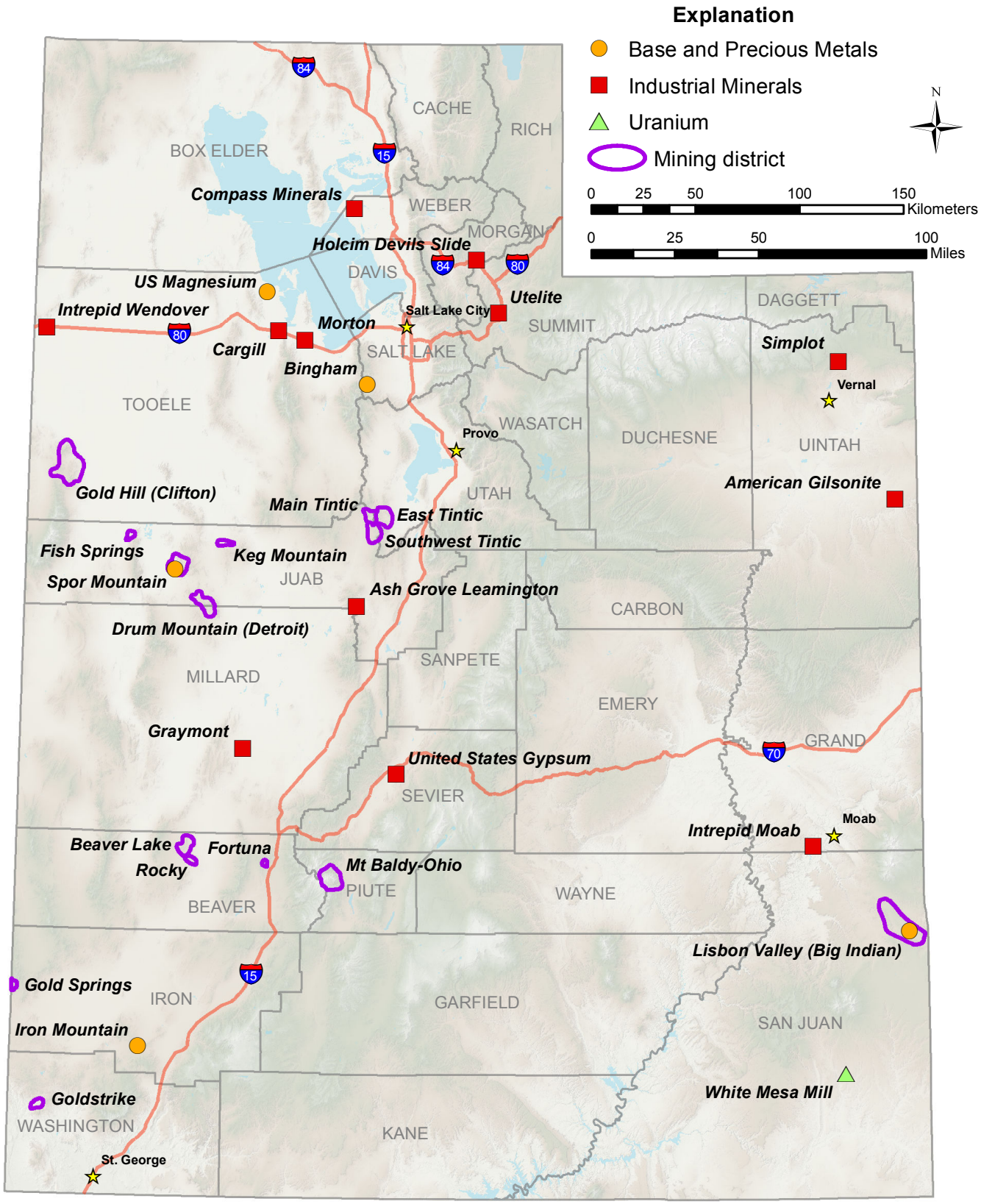


Figure 6. Base and precious metals, selected industrial minerals, and uranium production and development activity locations in Utah during 2014.

The value of contained beryllium from the concentrate production is estimated to be $23.3 million, a 19% increase from 2013. Beryllium ranked fifth as a contributor to Utah 2014 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.

Gold

In 2014, approximately 261,200 troy ounces (oz) of gold were produced in Utah, which was about a 26% increase from 2013. Nearly all of this gold was from the KUC Bingham Canyon mine, where it is recovered as a byproduct from the copper ore (Rio Tinto, 2015). About 400 troy oz of gold came from residual leaching of existing heaps at the KUC Barneys Canyon mine, which ceased active mining in 2001 after ore exhaustion and is located 2.5 miles north of the Bingham Canyon operation. About 1000 troy oz of gold were produced by the Desert Hawk Gold Corp. from their mine in the Gold Hill district in western Tooele County. The average gold price in 2014 was $1270/troy oz, a 10% decrease from the 2013 price (USGS, 2015a). Utah gold production during 2014 at the 2014 average price has a value of $332 million, which is 13% more than the 2013 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 of gold and silver produced in Utah.

Silver

Most of the silver produced in Utah during 2014 came from the KUC Bingham Canyon mine and was recovered as a byproduct from the copper ore. Total silver production in 2014 was about 2,935,000 troy oz (Rio Tinto, 2015), a 6% decrease from 2013. The average silver price in 2014 was $19.03/troy oz (USGS, 2015a), a 20% decrease from the 2013 average price. Utah silver production during 2014 at the 2014 average price has a value of $56 million, 25% less than the 2013 valuation.

Exploration and Development Activity

The information in this section is largely 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://linux1.ogm.utah.gov/WebStuff/wwwroot/minerals/mineralsfilesbypermitinfo.php). The location of selected exploration areas in 2014 is shown in figure 6.

Metals had a third consecutive poor year in 2014; copper, gold, silver, iron ore, beryllium, and vanadium prices all continued to slide. Falling iron ore prices caused CML Metals Inc. to close their Iron Mountain mine in late 2014. Overall metallic mineral exploration activity was also down in 2014. The significant known Utah base and precious metal properties are shown in figure 6 and summarized in table 3.

Bingham Canyon

The massive Manefay pit wall failures at the Bingham Canyon open pit mine (figure 6) on April 10, 2013, brought about 165 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. The second slide was followed 11 minutes later by a small, shallow, induced earthquake (~2.5 magnitude) beneath the mine followed by a series of 15 smaller aftershocks over the next six days (Pankow and others, 2014). Notably, 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. Roughly half of the slide has been removed from the pit to date (figure 7). KUC has still not completely recovered from these slides and does not expect to do so until 2016.

In response to the slide, Kennecott purchased two new shovels, 20 haul trucks, 30 dozers, nine excavators, and three drills. The mine is expected to ramp production back up through 2015 and regain its full operating capacity in 2016. Overall, Bingham's metal output was up slightly in 2014. However, Bingham is expected to produce significantly less metal in 2015 than 2014 as KUC works to stabilize the east side of the pit by further stripping and dewatering. Less production from the pit leaves the KUC smelter at Magna with an excess capacity, which allowed for increased toll smelting of compatible outside copper concentrates in 2015.

Kennecott Exploration Company continued a near mine exploration drilling program in the Oquirrh Mountains in 2014. Five additional deep core holes were finished in the Bingham mine area; three holes totaling 16,533 ft were drilled at Apex (west of the mine) and two holes totaling 6466 ft were completed at Lark (east of the mine). Additional exploration/development drilling is planned for 2015 (Russ Franklin, Kennecott Exploration Company, written communication, May 2015).

Lisbon Valley Copper

The Lisbon Valley Mining Company operates a sediment-hosted, open-pit, heap leach, solvent extraction and electrowinning (SX-EW) copper operation situated in the Lisbon Valley mining district of San Juan County (figure 6). The company began copper 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. Mine copper cathode production in 2014 is estimated to be down slightly from 2013.

Table 3. *Miscellaneous metal exploration projects in Utah, 2014.*

Property	Commodity	District	County	Company	Progress
Blair Project	Silver-Gold	Antelope Range	Iron	Tuvera Exploration, Inc.; Silver Peak Exploration	State section acquired and unpatented claims staked
Bingham	Copper	Bingham	Salt Lake	Kennecott Utah Copper Company	Ongoing deep, near mine exploration drilling
Cave Mine	Polymetallic	Bradshaw	Beaver	Grand Central Silver Mines, Inc.	Integration of mapping, sampling, and geophysics
Drum Mtn.	Polymetallic	Drum Mountains	Juab - Millard	Freeport-McMoRan Exploration Corp.	Acquired large fee, state, and federal land positions
Wildcat	Gold-Silver	Drum Mountains	Juab	Renaissance Gold Inc.	No new holes drilled, work planned for 2015
West Desert (Crypto)	Polymetallic	Fish Springs	Juab	InZinc Mining Ltd.	NI 43-101* and PEA** completed
Fortuna North	Gold-Silver	Fortuna	Beaver	Kinross Gold Corp.	Completed 17 holes, but dropped the property
Dutch Mountain	Gold-Silver	Gold Hill	Tooele	Newmont USA Ltd.	Staked about 700 unpatented claims
Kiewit Deposit	Gold-Silver	Gold Hill	Tooele	Desert Hawk Gold Corp.	Open pit — heap leach successfully started
Jumbo	Gold-Silver	Gold Springs	Iron	TriMetals Mining, Inc.	21 new holes and NI 43-101* completed
Goldstrike	Gold-Silver	Goldstrike	Washington	Pilot Gold, Inc.	Pilot Gold acquires property from Cadillac
Bromide Basin	Gold-Copper	Henry Mountain	Garfield	Bromide Mining LLC	Staked large block of claims
Iron Mountain	Iron	Iron Springs	Iron	CML Metals Corp.	Operating iron ore mine closed due to low prices
Keg	Polymetallic	Keg Mountian	Juab	Inland Explorations Ltd.; Pacific Imperial	Two deep holes and NI 43-101* completed
Kings Canyon	Gold	Kings Canyon	Millard	Pine Cliff Energy Ltd.	NI 43-101* completed
Thompson Knoll	Polymetallic	Kings Canyon	Millard	Inland Explorations Ltd.	Integration of mapping, sampling, and geophysics
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.	Staked a large block of claims and started drilling
Deer Trail	Polymetallic	Mount Baldy	Piute	Western Pacific Resources Corp.	NI 43-101* and underground drilling completed
Milford Copper	Copper- Silver	Rocky Range	Beaver	CS Mining, LLC	Operating copper mine with ongoing exploration
TUG	Gold-Silver	Tecoma	Box Elder	West Kirkland Mining, Inc.	NI 43-101* Completed
Big Hill	Copper	Tintic East	Utah - Juab	Kennecott Exploration Company	Two deep holes completed in 2014
Burgin	Lead-Silver	Tintic East	Utah	Chief Consolidated Mining Company	NI 43-101* Completed (Tietz and others, 2011)
SWT Porphyry	Copper	Tintic Southwest	Juab	Freeport-McMoRan Exploration Corp.	Freeport purchased the property from Quaterra
Little Bingham	Copper	West Tintic	Juab	Cerberus Venture, LLC	Property acquired

*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.

**Preliminary Economic Assessment. A PEA is a preliminary economic assessment.

Figure 7. *View to the north in the Bingham Canyon open pit porphyry copper-gold-molybdenum mine, taken October 10, 2014. The remnants of the April 10, 2013, 165-million-ton Manefay landslide (rock avalanche) are approximately outlined in the lower portion of the pit. A small part of the 1150-foot high headwall scarp is just visible on the far right-hand margin of the image. For scale, the smallest benches are about 50 feet high.*

Rocky and Beaver Lake Districts

CS Mining, LLC controls a group of small, Oligocene (~30 Ma) copper deposits in the Rocky and Beaver Lake mining districts of Beaver County (figure 6). These properties include seven partially delineated prograde, anhydrous copper skarns and a breccia pipe. In 2009, a flotation mill was completed and open pit mining started on the Hidden Treasure copper skarn. The mill began production at 1200 st/d in May 2009 and produced a limited amount of copper concentrate. However, the mill experienced poor copper recovery due to the mixed oxide-sulfide nature of the skarn ore and operations were halted near the end of 2009. The mine and mill were restarted in 2012. Ore production was significantly lower in 2014 at 429,491 st, but at a better copper grade. CS Mining is estimated to have produced about 13,000 st of copper concentrate in 2014. The copper concentrates are trucked to the KUC smelter at Magna, Utah. The operation continues to suffer from low, but steadily improving, copper recovery from the flotation plant. CS Mining is also currently constructing a new agitation leach SX-EW plant to reprocess the flotation mill tailings and recover additional metal from the copper oxides and carbonates. This new plant is scheduled to open in the fourth quarter of 2015 and should yield a significantly increased total copper recovery.

In addition, CS Mining has an aggressive exploration and development drill program to find and delineate new copper resources. They anticipate moving the primary mining operation to the newly defined Niagara Hill copper skarn, and recent exploration success has been obtained at the Copper Ranch skarn (Dave Hartshorn, CS Mining, oral communication, April 2015).

Spor Mountain

The Spor Mountain mining district lies on the west flank of the Thomas Range in west-central Juab County (figure 6), and is the world's premier beryllium producer. The beryllium deposits are the result of epithermal carbonate replacement in Miocene tuffaceous sediments along northeast-trending, half-graben faults. An estimated 3 million st of ore with an average grade of over 0.2% beryllium has been mined from 10 small- to medium-sized pits in the district since production began in the late 1960s. Materion Corporation has proven and probable reserves of 9,641,000 st at 0.251% beryllium, which at current production rates would support more than 50 years of beryllium hydroxide production. Annual ore production from the operation averaged approximately 80,000 st in the past, but in 2013 Materion announced plans to significantly expand their beryllium operation. The mine increased ore production to 110,670 st in 2013 and 162,600 st in 2014, which is the mine's highest production of beryllium ore (bertrandite) since 1980 (Greg Gregory, Materion Corporation, written communication, May 2015).

Iron Springs

The CML mine (formerly the Comstock-Mountain Lion) (figure 6), in Iron County, 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. In 2009, Palladon completed a Canadian NI 43-101 compliant resource estimate on the CML deposit showing a resource of 31.35 million st averaging 48.6% iron (SRK Consulting, 2009). CML resumed mining in July 2010 and run-of-mine ore was shipped from the new rail load-out facility at the mine by 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 de-

watering units and the operation was expected to approach a shipping capacity of 2 million st per year in 2014, but the iron ore price collapsed late in the year and the operation ceased production in October. CML mined approximately 1.35 million st in 2014 (CML Metals, 2015).

Gold Hill District

Clifton Mining Company and Desert Hawk Gold Corp. agreed in 2009 to jointly develop Clifton's mineral properties in the Gold Hill district of western Tooele County (figure 6). 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. The Kiewit deposit contains a crudely estimated 2 million st averaging about 0.93 parts per million (ppm) gold. Desert Hawk reports recovering approximately 1000 troy oz of gold in 2014.

Newmont Mining Corporation holds a large block of land on Dutch Mountain in the northern portion of the Gold Hill district, north of the Eocene (~40 Ma) Gold Hill quartz monzonite stock. Dutch Mountain has had previous drilling programs by Battle Mountain Gold (Duval), Atlas Precious Metals, and Goldfields Mining Corp. for sedimentary rock-hosted gold mineralization.

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 6). 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%) comes from precious-metal-rich, polymetallic replacement ores in the Permian Toroweap Formation at the Deer Trail mine near the base of the east face of the mountain. Between 1975 and 1995, the Deer Trail mine and the ground to the west was explored by a succession of major mining companies including Phelps Dodge Corporation, Duval Corporation, Noranda Exploration, Inc., Goldfields Mining Corporation, Cominco American, Inc., Battle Mountain Gold Company, LAC Minerals, Ltd., American Barrick Resources, Inc., and others (Martin, 2013).

The Deer Trail mine was acquired by Western Pacific Resources Corp. in 2013; they rehabilitated the main workings and prepared a NI 43-101 (Martin, 2013). In 2014, 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. West of Western Pacific's mine holdings, Crown Mines, LLC controls a large block of unpatented mining claims.

Drum Mountains

The Drum Mountains (Detroit mining district) remained one of the most competitive metal exploration areas in the state in 2014 (figure 6), although little physical work has been done. 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 copper-gold area of the old mining district. Freeport-McMoRan has obtained drilling permits and plans to begin drilling in 2015.

Renaissance Gold, Inc., Newmont Mining Corporation, Pilot Gold, Inc., Golden Dragon Capital, CS Mining, LLC, North Exploration, LLC, and the Steele family also have land positions in the Drum Mountains of Juab and Millard Counties for gold and/or copper.

Gold Springs District

The Gold Springs mining district is located near the western margin of Iron County (figure 6). The district contains a small, historical, low-sulfidation, epithermal, gold-silver quartz-adularia-calcite vein/stockwork deposit. In 2014, TriMetals Mining, Inc., acquired a 6000 acre block of ground, released an updated NI 43-101, and continued exploration drilling on the Gold Springs property. The indicated resource on the Jumbo gold-silver stockwork is 9,143,000 st at 0.55 ppm gold and 14.1 ppm silver at a 0.3 ppm gold cutoff, having a somewhat smaller inferred resource (Lane and Katsura, 2014). Highlights of the 21-hole 2014 drilling program (not included in the resource estimate) include 120 ft of 1.39 ppm gold and 37.85 ppm silver in hole J-14-018.

Tintic District

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 6). KEC 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 precollared 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 no results have been released (Russ Franklin, Kennecott Exploration Company, written communication, May 2015).

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 400 million st with 0.33% copper and 0.01% molybdenum (Krahulec and Briggs, 2006). In a 2009 joint venture with Quaterra, Free-

port-McMoRan Exploration Corporation began an integrated program of geological mapping, geochemical sampling, and geophysical surveying; seven exploration holes were drilled in 2010 and 2011. No additional drilling was undertaken in 2014, but Freeport-McMoRan Exploration continues to hold the property.

Fish Springs District

In 2005, Lithic Resources, Ltd., acquired the Crypto zinc-iron ±copper ±indium skarn in the Fish Springs mining district of western Juab County (figure 6). In 2009, Lithic completed a 33,000-ft core drilling program and defined two new mineral resources (indicated and inferred) on a shallow oxide zone that included 2.0 million st with an average 8.73% zinc, 0.38% copper, and 14.82 ppm indium, as well as a deep sulfide zone that contains 9.6 million st with an average 7.56% zinc, 0.41% copper, and 46.82 ppm indium. Metallurgical studies of the sulfide resource show the indium is contained in sphalerite and is recoverable (Nilsson and others, 2010).

In 2014, Lithic changed their name to InZinc Mining, Ltd., (referencing their indium and zinc resource) and changed the name of Crypto to the West Desert project. InZinc completed a positive preliminary economic assessment (PEA) that included a significant magnetite byproduct (Dyer and others, 2014). The mid-term outlook for zinc prices is good as a result of the anticipated closure of a couple of large zinc producers in 2015.

Goldstrike District

Cadillac Mining Corporation controlled 3800 acres covering the historic mining area of the Goldstrike sedimentary rock-hosted gold-silver mining district of Washington County (figure 6). Production from Goldstrike in the 1980s and 1990s totaled approximately 210,000 oz of gold and 198,000 oz of silver (Krahulec, 2011). Cadillac compiled and digitized the historic exploration/mining data on the district in 2011 and drilled three holes from a single pad on the Hamburg Extension target later that year. Two of these three initial reverse circulation holes (GS11-02 and 03) intersected 1.08 ppm gold over 240 ft and 1.25 ppm gold over 270 ft. Several follow-up holes in 2012 also intersected mineralization including GS12-07 that cut 99 ft of 1.56 ppm gold and 3.8 ppm silver, and GS12-08 that intersected 101 ft of 2.05 ppm gold and 4.3 ppm silver. Pilot Gold acquired Cadillac Mining and their Goldstrike property in 2014, and plan to renew exploration in 2015.

Fortuna District

In 2012, Kinross Gold USA, Inc., staked 305 claims in the Fortuna mining district of Beaver County (figure 6). The Fortuna district includes Miocene low-sulfidation, epithermal, gold-silver quartz-adularia-calcite veins. Kinross also acquired a previously filed block of 25 lode claims and a block of patented mining claims covering an additional 260 acres to the south. Kinross completed a total of 17 holes in 2013, but dropped the project in 2014.

Keg Mountain

In 2009, Inland Explorations Ltd. acquired the Keg Mountain copper-molybdenum target in Juab County (figure 6) and conducted a program of mapping, sampling, and geophysical surveying. In 2014, the 5080 acre property was optioned to Pacific Imperial Mines, Inc., and they prepared a NI 43-101 (Carter, 2014). Pacific Imperial completed two core holes on Lead Hill, one (14KMC-1) to 1506 ft and a second hole (14KMC-2) to 1355 ft. Analytical results from 155 samples in 14KMC-1 and 98 samples in 14KMC-2 yielded insufficient encouragement, and Pacific Imperial dropped the project.

INDUSTRIAL MINERALS

Production and Values

Industrial mineral production in Utah during 2014 had an estimated value of $1.41 billion, which was 35% of the annual value of nonfuel minerals produced in Utah (figure 3; table 1). Industrial mineral production value increased 13% from 2013 due to high prices and production for some important commodities.

The largest overall contributors to the 2014 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 $484 million, a 13% increase in value from 2013, and account for 34% of total value of Utah industrial mineral production in 2014. 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 $295 million. This commodity group accounted for 21% of total industrial mineral value in 2014, and was 22% more than the 2013 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 $223 million and accounted for 16% of total industrial mineral value in 2014, a 21% increase in value from 2013. These three commodity groups contributed 71% of the total value of industrial minerals produced in Utah during 2014. The remainder came from, in decreasing order of value, phosphate, sulfuric acid, 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 469,000 st in 2014, and was the largest contributor to the value of the brine-derived commodity group. The 2014 value of potash produced in Utah was approximately $253 million, an increase of 7% from 2013. The increasing value was due to an increase in the production and price of potassium sulfate, and was achieved even with lower potassium chloride production and price. Potassium sulfate has a significantly higher market value, and usually larger production in Utah, than potassium chloride. Compass Minerals Ogden, Inc., (formerly Great Salt Lake Minerals Corp.) produces potassium sulfate, whereas Intrepid Potash-Wendover and Intrepid Potash-Moab produce potassium chloride (figure 6).

Utah salt production in 2014 increased to 3.65 million st, and has a production value estimated at $209 million. The 22% increase in value from 2013 was due to an increase in salt market price and more accurate reporting of production. Some 83% of the salt was produced from Great Salt Lake brine by four operators: Compass Minerals Ogden, Inc., Cargill Salt Co., Morton International, and U.S. Magnesium, LLC (in descending production order) (figure 6). The remaining 17% 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 descending production order).

In 2014, magnesium chloride production in Utah increased 14% from 2013 to 880,000 st, and has a production value of about $22 million (ONRR, 2015). 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. Estimated total solids production from Great Salt Lake in 2014, including magnesium metal, magnesium chloride, potash, and salt, is estimated to be 3.6 million st, which is an increase from the 3.4 million st produced in 2013. The 2014 value of the entire mineral and brine production from Great Salt Lake is estimated at $640 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 2014, approximately 31.5 million st of sand and gravel worth $219 million was produced in Utah (USGS, 2015b). About 9.91 million st of crushed stone worth $75.6 million was also produced (USGS, 2015b), as well as several thousand st of dimension stone. The 2014 total production value for this commodity group increased by 22% to approximately $295 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 2014, having an estimated value of $142 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 (figure 8) east of Morgan in Morgan County (figure 6). In 2014, both Portland cement production and value increased from 2013, as well as a slight increase in the price of cement (USGS, 2015a). 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 2014, 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 14% from 2013 to 2014. 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 6). The annual production capacity when both plants are in operation is over one million st.

During 2014, about 4 million st of limestone was produced in Utah. More than half of the production was chemical-grade limestone from Graymont Western U.S. Inc., while Ash Grove Cement Co., and Holcim, Inc., (in decreasing production order) produced most of the remainder for cement. The Cotter Corp. in San Juan County and Diamond Mountain Resources in Uintah County produced about 200,000 st of limestone for flue-gas desulfurization at coal-fired power plants. Limestone is primarily used in the manufacture of cement and lime products (with lesser amounts used in various aspects of the construction industry), for flue-gas desulfurization, and as a safety product for the coal mining industry as "rock dust."

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 6). In 2014, the mine produced approximately 4.1 million st of ore, about 9% more than in 2013. The ore yields about 1.5 million st of phosphate concentrate (P_2O_5) after processing. The concentrate is transported in slurry through a 96-mile underground pipeline to the

Figure 8. *Holcim Devil's Slide cement plant and quarry in Twin Creek Limestone, Morgan County, Utah (photo taken July 2007, courtesy of Greg McDonald).*

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, 2015a).

Sulfuric Acid

In 2014, the KUC Bingham Canyon mine produced 830,000 st of sulfuric acid (H_2SO_4), about 9% less than in 2013. The sulfuric acid is a byproduct of the KUC copper-gold-silver smelting process. The UGS estimated sulfuric acid prices averaged about $140/st in 2014, giving Utah production an approximate value of $116 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 fifth-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.

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 2014, American Gilsonite Company was the only significant producer, mining and processing gilsonite at their operation in southeastern Uintah County (figure 6). 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).

Bentonite, Common Clay, and High-Alumina Clay

Production of bentonite, common clay, and high-alumina clay in Utah during 2014 was about 267,000 st, a 56% increase

from 2013 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., which together produced about 78% of the clay commodity group. Uses for bentonite include well drilling and foundry operations, various civil engineering applications, and litter-box filler. The largest producers of common clay and high-alumina clay were Interstate Brick Co., and Holcim, Inc., respectively. Common clay was largely used to make bricks, whereas high-alumina clay was used to make Portland cement.

Expanded Shale

Expanded shale in Utah is produced by Utelite, Inc. at their quarry and plant near Wanship in Summit County (figure 6). The company produced approximately 126,000 st in 2014, a slight decrease from 2013 production. 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. Their material is used in roof tile, concrete block, structural concrete, and horticulture additives, as well as for highway construction and geotechnical fill. Some of Utelite's production is used locally along the Wasatch Front, but much of it is shipped out of state.

Gypsum

Four operators reported combined Utah gypsum production of about 261,000 st in 2014, 6% less than 2013 production. The 2014 production had an estimated value of $3.47 million, a 4% increase compared to 2013. The higher value was due to slight increases in both production of higher valued calcined gypsum and the price of both crude and calcined gypsum (USGS, 2015a). 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 2014 (figure 6), 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 developments 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 4.

Potash

Potash exploration drilling in 2014 focused on the deep evaporites of the Pennsylvanian Paradox Formation in the Paradox Basin. Pinnacle Potash International completed multiple exploration drill holes for their Crescent Junction project, and Paradox Basin Resources Corp. (Sennen Potash Corp.) drilled one hole at their Monument project during late 2014. Paradox Basin Resources Corp. intersected a 20.6-ft-thick potash zone of 29.1% K_2O at a depth of slightly over 7000 ft, which is part of salt cycle 18 in the Paradox Formation. Gamma-ray logs from the hole indicate an additional 11-ft-thick potash zone grading 28 to 33% K_2O starting about 40 ft below the first potash zone. Details of Pinnacle Potash International's drilling are unavailable. At the end of 2013, K2O Utah, LLC (Potash Minerals Limited) released a JORC-compliant resource estimate of their Hatch Point project. The measured and indicated in-place resource estimate that includes potash zones from salt cycles 13 and 18 is 134 million st at about 12% K_2O (Potash Minerals Limited, 2013).

Two of the more advanced potash projects in Utah, Potash Ridge Corp.'s Blawn Mountain project and Peak Mineral, Inc.'s (EPM Mining Ventures, Inc.) Sevier Lake project, continued with project development, primarily on the regulatory and permitting fronts. Each project secured water rights during 2014, and Potash Ridge Corp. received a mining permit from DOGM. Both of these projects intend to produce potassium sulfate, and both projects completed preliminary feasibility studies in 2013. The Blawn Mountain deposit contains proven and probable reserves of 26.4 million st of potassium sulfate in alunite (Kerr and others, 2013), and the Sevier Lake deposit contains an estimated 34.7 million st of in-place measured and indicated potassium sulfate resource in shallow subsurface brines (Blois and others, 2013). Utah's potash projects are summarized in table 4.

Phosphate

During 2014, Simplot Phosphates, Utah's only phosphate producer, submitted a revision to their Vernal operation's mine plan to DOGM. The revision will expand their mining to the east of current operations and is expected to extend their mine life through 2024. Simplot also began construction of a new ammonia plant in Rock Springs. Ammonia is an important component in fertilizer production and the plant will be used

Table 4. *Industrial mineral exploration and development projects in Utah, 2014.*

Property	Deposit Type	County	Company	Progress
Blawn Mountain	Potash; alunite alteration	Beaver	Potash Ridge Corporation	Regulatory and permitting activity in 2014; completed preliminary feasibility study in 2013; completed 90 exploration drill holes from 2011 to 2013
Bounty Potash	Potash; Great Salt Lake Desert, shallow brine	Box Elder	Mesa Exploration Company	BLM rejected potash prospecting applications of 90- square-mile project at Pilot Valley
Crescent Junction	Potash; Paradox Basin, deep evaporites	Grand	Pinnacle Potash International	Completed multiple potash exploration drill holes on SITLA leases in 2014; completed one exploration drill hole in 2011
Green River	Potash; Paradox Basin, deep evaporites	Grand	American Potash Corp.	Plans to drill two exploration drill holes in 2015 (?)
Hatch Point	Potash; Paradox Basin, deep evaporites	San Juan	K2O Utah LLC (Potash Minerals Limited)	Released updated JORC-compliant resource estimate in 2013; completed three exploration drill holes in 2011 and 2012
Lisbon Valley	Potash; Paradox Basin, deep evaporites	San Juan	Potash Green Utah, LLC (North American Potash Developments Inc.)	Completed one exploration drill hole in 2011
Monument	Potash; Paradox Basin, deep evaporites	San Juan	Paradox Basin Resources Corp. (Sennen Potash Corp.)	Completed one exploration drill hole in early 2015
Paradox Basin	Potash; Paradox Basin, deep evaporites	Grand	Universal Potash Corporation	Pending prospect permit applications
Salt Wash, Whipsaw, White Cloud	Potash; Paradox Basin, deep brines and evaporites	Grand	Mesa Exploration Company	Pending prospect permit applications
Sevier Lake	Potash; Sevier (Dry) Lake, shallow brine	Millard	Peak Minerals Inc. (EPM Mining Ventures Inc.)	Regulatory and permitting activity in 2014; completed preliminary feasibility study in 2013; completed 431 exploration drill holes from 2011 to 2013
Ashley Creek	Phosphate (Meade Peak Member of the Phosphoria Fm.)	Uintah	Utah Phosphate Company (Agrium)	Continued project development and evaluation of previous drilling; completed 76 exploration drill holes from 2011 to 2013
Diamond Mountain Phosphate	Phosphate (Meade Peak Member of the Phosphoria Fm.)	Uintah	Utah Mineral Resources, LLC (Strata Minerals, Inc.)	Released an NI 43-101-compliant resource estimate and completed 17 exploration drill holes in 2014
Dragon Mine	Halloysite specialty clay and iron oxide pigments	Juab	Applied Minerals Inc.	Completed a new processing plant to bring total production capacity to 55,000 st per year

to support Simplot's phosphate production from both Utah and Idaho.

The phosphate resource in Utah is found in the Meade Peak Member of the Permian Phosphoria Formation, which commonly occurs as a tongue within the Park City Formation. Exploration for phosphate resources in the southeastern part of the Uinta Mountains continued during 2014. West of Simplot's mine, Utah Phosphate Company (Agrium) continued with project planning and evaluation of previous drilling results at their Ashley Creek deposit. Utah Mineral Resources (Strata Minerals) continued exploration of their Diamond Mountain Phosphate project located east of Simplot's operation. The company completed a 17-hole drilling program during 2014 at their Diamond Mountain Phosphate project and released an NI 43-101 compliant resource. Henchel (2014) reported a measured and indicated resource for the Diamond Mountain Phosphate project of 37.4 million st at 19.75% P_2O_5 from a zone averaging 14.6 ft thick. The Diamond Mountain phosphate deposit was previously explored by US Steel during the late 1960s.

URANIUM

Historically, Utah is the third most productive uranium state, with the majority of its production from the Colorado Plateau. The spot price of U_3O_8 has been especially volatile over the last decade with spikes to $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 below $50/lb after the March 2011 Fukushima nuclear power plant disaster in Japan. Uranium prices have remained low (generally less than $45/lb) throughout 2012, 2013, and 2014. Uranium exploration and development in Utah has varied with spot price fluctuations. Unlike the volatile spot price, long-term contract U_3O_8 prices have declined slowly to about $50/lb. In the last few years of low spot prices, the uranium industry in Utah was consolidated by Energy Fuels, Inc., and to a lesser extent Anfield Resources, acquiring most of the promising uranium mines and prospects.

The continuing low uranium prices in 2013 (less than $40/lb of U_3O_8) finally resulted in a halt to uranium mining operations in Utah. The Energy Fuels White Mesa mill (figure 6) continued operations using higher grade uranium ore from breccia pipe deposits in Arizona, north of the Grand Canyon. The Utah mines were 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. The significant known Utah uranium properties are listed in table 5. In 2015, the White Mesa mill is expected to continue operations processing Arizona ore and alternate feed waste material.

COAL

Production and Values

Six Utah coal operators produced 17.9 million short tons (st) of coal valued at $600 million from one surface and seven underground mines in 2014 (figures 5 and 9). Overall production was higher than 2013 (+10.5%); the mines operated by Bowie Resources Partners and Castle Valley Mining increased production (individually +10 to +33%), while most other mines decreased production (-65%), providing an overall increase in annual coal production (table 2). The Horizon mine shut down in early 2013 and the Emery mine has been idle/shut down since 2010. Even with the Intermountain Power Plant (IPP) fully recovered from a generator failure in 2012, fuel switching or closure at other U.S. coal-fired power plants outside of Utah is keeping demand for Utah coal near historic lows. Consequently, production in 2015 is expected to decrease to 15.0 million st, with an estimated overall value of $483 million. Almost every Utah coal operator is expected to maintain 2014 production levels in 2015, except for the Deer Creek mine, which closed in January 2015, and the West Ridge mine, which is nearing the end of its reserve life. Thus, Utah will lose about 3 million tons of coal productive capacity from 2014 levels in 2015.

In 2014, the majority of Utah coal, 13.8 million st, was produced from the Wasatch Plateau coalfield, with 3.5 million st coming from mines in the Book Cliffs coalfield and 555,000 st from the Coal Hollow mine in the Alton coalfield. The majority of Utah coal for 2014, 83.9% (15.04 million st) was produced from federal land, while only 5.4% (0.98 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 2014 production was from private lands (10.7%, 1.92 million st) at the Castle Valley, Coal Hollow, and Skyline mines.

Utah coal mines face steady reserve depletion and difficult mining conditions. In addition, the demand for Utah coal has 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 IPP is mostly owned by the city of Los Angeles. This owner has already stated that it will no longer purchase power from the IPP after its current

Table 5. *Uranium projects in Utah, 2014.*

Property	District	County	Company	Progress
Whirlwind	Beaver Mesa	Grand	Energy Fuels, Inc.	Permitted resource: 656,000 lb U_3O_8
Rim-Columbus	Dry Valley	San Juan	Energy Fuels, Inc.	Permitted resource: 660,000 lb U_3O_8
Marcy-Look	Elk Ridge	San Juan	Energy Fuels, Inc.	Acquired 907 acres
Blue Jay	Fry Canyon	San Juan	Energy Fuels, Inc.	Acquired 289 acres
Frank M	Henry Mountain	Garfield	Anfield Resources Inc. (Uranium One, Inc.)	Resource: 2.2 M tons at 0.1% U_3O_8
Shootaring Canyon U Mill	Henry Mountain	Garfield	Anfield Resources Inc. (Uranium One, Inc.)	Mill acquired from Uranium One, Inc.
Tony M-Bullfrog	Henry Mountain	Garfield	Energy Fuels, Inc.	Permitted resource: 1.527 M tons at 0.24% U_3O_8
Energy Queen (Hecla Shaft)	La Sal	San Juan	Energy Fuels, Inc.	Permitted resource: 1.2 M lb U_3O_8
Pandora-Snowball-Beaver	La Sal	San Juan	Energy Fuels, Inc.	On stand-by: 1.2 M lb U_3O_8 reserve
La Sal #2	Lisbon Valley	San Juan	Laramide Resources Ltd.	Resource: 808,000 tons at 0.167% U_3O_8
Velvet-Wood	Lisbon Valley	San Juan	Anfield Resources Inc. (Uranium One, Inc.)	New NI 43-101* completed in 2014
San Rafael	San Rafael River	Emery	Baobab Asset Management LLC	Indicated resource: 758,050 tons at 0.23% U_3O_8
Thompson Project	Thompson	Grand	Energy Fuels, Inc.	Acquired 6672 acres
Sage Plain (Calliham-Sage)	Ucolo	San Juan	Baobab Asset Management LLC	Resource: 642,971 tons at 0.22% U_3O_8 and 1.39% V_2O_5
Daneros (Lark Royal)	White Canyon	San Juan	Energy Fuels, Inc.	On stand-by: 740,000 lb U_3O_8 inferred resource
Geitus	White Canyon	San Juan	Energy Fuels, Inc.	Resource: 40,000 ton at 0.3% U_3O_8

* An NI 43-101 is a Canadian National Instument 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.

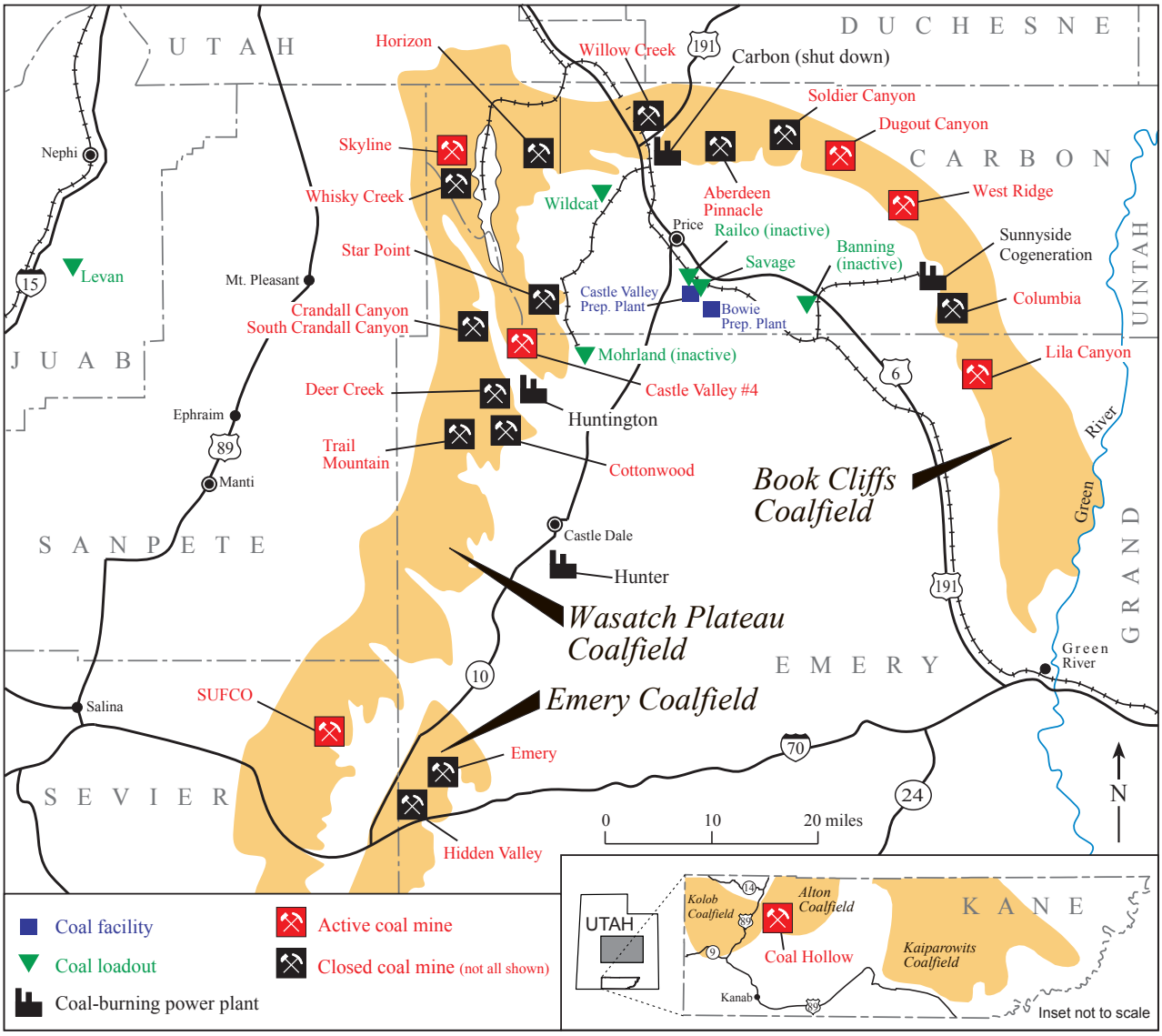


Figure 9. *Location and status (at time of printing) of Utah coal mines and associated facilities.*

power purchase agreement expires in 2027, unless the IPP converts to natural gas or implements carbon capture and storage technology. Thus, the average annual production total for Utah will likely be in the 15 to 16 million st range until 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 2014 is estimated at 17.8 million st, less than the 17.9 million st of coal produced for the year. As recently as 2010, over 4.3 million st of Utah coal was exported to other states, while 12.1 million st was used in state (figure 10). In 2014, only 3.4 million st of Utah coal was shipped to other states, while 11.9 million st was used locally, and 2.5 million st was shipped overseas. The vast majority of Utah coal, 76%, goes to the electric utility market, mainly in state. As a result of new regulations limiting coal-fired generation, demand for Utah coal in 2014 to produce electricity was 74% of what it had been in 2010. The economic recession and low natural gas prices also slowed demand for Utah coal in the industrial sector where deliveries totaled 2.6 million st in 2014, which was significantly less than peak deliveries of 4.4 million st in 2003. Coal deliveries in 2015 are expected to remain in the 16 million st range, reflecting lower overall production. In contrast to the weak domestic market, Utah has exported about 1.1 million st of coal to other countries over the last few years, in particular to Asia and Central America (figure 10). In 2014, over 2.5 million st of Utah coal were exported to overseas markets. Demand for coal in Asia is particularly strong, but Utah operators will need increased access to port facilities 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/.

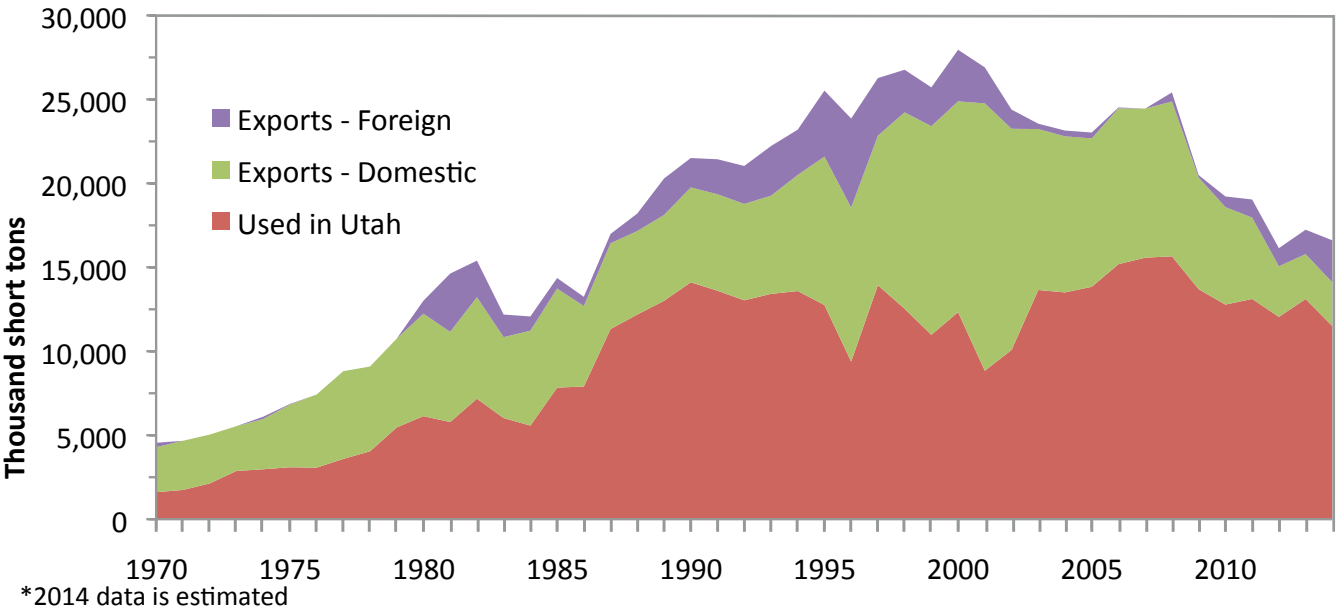


Figure 10. *Distribution of Utah coal, 1970–2014.*

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. Development work continued from 2011 through 2014, and total coal production reached 157,000 st, 304,000 st, 257,000 st, and 335,000 st respectively. Coal production is expected to remain at the 300,000 st level until longwall mining commences in 2016. At full capacity, the exact timing of which depends on the future coal market, the mine could employ up to 200 people and produce up to 4.5 million st of coal per year. Coal will be 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. The West Ridge mine produced 2.5 million st of coal in 2014, down slightly from 2.6 million st produced in 2013, but significantly less than the 3.6 million st produced in 2011. Production in 2015 is expected to decrease to about 1.5 million st as UtahAmerican depletes the remaining recoverable coal under lease and shuts down longwall operations by mid-2015, at which time the longwall equipment will be moved to the Lila Canyon mine.

Canyon Fuel Company – Bowie Resource 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 Amsterdam-based commodity trader Trafigura Beheer BV. Trafigura will sell 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 is only mining with one continuous miner and produced about 676,000 st in 2014. A second continuous miner is expected to be brought online in 2015 and production will increase to roughly 800,000 st depending on coal market conditions. Canyon Fuel estimates that the Dugout Canyon mine has about 12.1 million st of recoverable coal remaining under lease.

Skyline mine: Canyon Fuel Company's Skyline mine, located in the Wasatch Plateau coalfield, is currently mining in the Lower O'Connor "A" bed on their Winter Quarters lease in Carbon County. Production from this bed increased signifi-

cantly in 2014 to 4.2 million st and should remain at about this level in 2015. Canyon Fuel estimates that about 11.8 million st of coal can be recovered from current leases. Future production at the Skyline mine could come from the adjacent unleased federal Flat Canyon tract, estimated to contain 25 to 30 million st of recoverable coal reserves, and will hopefully be put up for lease during 2015.

Sufco mine: Sufco is Utah's largest coal producer and the 11th largest producing underground coal mine in the United States (2013 data). It is also the only active coal mine in Sevier County. Sufco produced 6.5 million st of coal in 2014 from the upper Hiawatha bed, 9.7% more than in 2013, but 21% less than record high production of 7.9 million st achieved during 2006. Production at Sufco is expected to decrease slightly to 6.4 million st in 2015. Canyon Fuel estimates that roughly 25.5 million st of reserves remain under lease in the upper and lower Hiawatha beds. On a separate note, the new Quitchupah Creek road opened in late 2013, significantly reducing coal haulage time 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 is expected in mid-2015. The Greens Hollow tract is thought to contain approximately 73 million st of reserves within the lower Hiawatha bed.

CONSOL Energy

Emery mine: CONSOL Energy's Emery mine, its only mine in the western United States, produced about 1 million st annually from the Ferron Sandstone I bed from its opening in 2005 through 2010. However, CONSOL indefinitely idled the mine in December 2010, citing lack of coal demand. The mine is currently up for sale.

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 in 2014, and production is expected to be about the same in 2015. Mine operators also plan to open the idled Castle Valley #3 mine (Bear and Hiawatha bed) in 2015, accessing the mine with new slopes from current operations in the #4 mine. Rhino estimates that about 6 million st of reserves still exist on leased land, but roughly 51 million st of recoverable reserves could be available in the Tank, Blind Canyon, and Hiawatha beds in the surrounding area.

Energy West Mining Company – PacifiCorp

Deer Creek mine: Production at the Deer Creek mine decreased to 2.1 million st in 2014, and the mine closed in January 2015 after negligible production (15,000 st) due to high operating costs. At the time of the mine closure, there were roughly 6.9 million st of remaining recoverable coal still under lease in the Hiawatha bed at the Deer Creek mine and an additional 49 million tons in the nearby Cottonwood tract.

Fossil Rock Fuels – PacifiCorp

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 Fuels, 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 Fuels also announced the coal reserves at Trail Mountain had been sold.

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 idled in July 2012 after producing 210,000 st of coal for the year. It was idled 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 mine: In 2011, Alton Coal Development began production at a new coal mine in the Alton coalfield in southern Utah's Kane County. Surface-mining production on the company's private property totaled 403,000 st for 2011 and increased to 555,000 st in 2014. Production in 2015 is expected to be at the 600,000 st level. In the spring of 2014, highwall mining began in the mine's open pits in an effort to recover coal with less surface disturbance (figure 11). In addition, operators plan to commence underground room and pillar mining in mid-to-late 2015. Full production at the Coal

Hollow mine could total 2.0 million st per year, but achieving that depends on the acquisition of surrounding federal lands. The BLM is still preparing a draft EIS for the proposed federal leasing action, a process begun in 2004. 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. If a federal lease is acquired, the operations could eventually go underground.

CRUDE OIL AND NATURAL GAS

Production and Values

Most of the statistical data presented here on oil and gas were taken from the DOGM web site (at: http://oilgas.ogm.utah.gov/index.htm). At an estimated 2014 value of $5.6 billion, oil and gas accounted for 90% of the total value of fuel commodities produced in Utah. During 2014, 40.9 million barrels of oil (bbls) (up 6.0 million bbls from 2013) and 453.2 billion cubic feet of gas (down 17.3 billion cubic feet from 2013) were produced from Utah oil and gas fields (figure 12). Oil and gas values increased about $510 million (10%) in 2014 as oil production increased, but prices fell late in the year, and declining gas production followed the slightly lower gas prices. Utah oil prices rose 57% between 2005 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, which will likely lead to a drop in future oil production after many years of steady increases. During the 2005–2013 period, gas prices declined by 50%, while dry gas production rose by 53%. However, even lower gas prices toward the end of 2014 finally lead to decreased annual gas production. 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 production in Utah until prices return to attractive levels to encourage expanded production. By the end of 2015, oil and gas prices are expected to rise slightly from the low levels of late 2014 and early 2015. Utah's 2014 oil and gas production came from 12,259 producing wells (5141 oil wells and 7118 gas wells), an increase from the 11,710 producing wells in 2013 (4702 oil wells and 7008 gas wells).

Oil made the largest contribution to the value of Utah fuel production in 2014, with a value of $3.2 billion, which was about $265 million (9%) more than in 2013. About 96% of the oil produced in Utah during 2014 came from Duchesne, Uintah, San Juan, and Sevier Counties (in decreasing production order). The five largest producing oil fields in 2014, Monument Butte (Duchesne and Uintah), Altamont (Duchesne), Greater Aneth (San Juan), Bluebell (Duchesne and Uintah), and North Myton Bench (Duchesne), accounted for about 51% of Utah oil production.

Natural gas made the second-largest contribution to the value of fuel commodities produced in Utah during 2014, with an estimated value of $2.4 billion (including natural gas liquids), a $245 million (12%) increase from 2013. About 96% of the gas produced in Utah during 2014 came from Uintah, Carbon, Duchesne, and San Juan Counties (in decreasing production order). The five largest producing gas fields in 2014 were Natural Buttes (Uintah), Drunkards Wash (Carbon), Brundage Canyon (Duchesne), Altamont (Duchesne), and Red Wash (Uintah). Together they accounted for 73% of the 2014 gas production. Notably, production from Natural Buttes accounted for more than half (57%) of the gas produced in Utah during 2014.

Exploration and Development Activity

Oil and gas exploration and development activity in Utah declined during 2014. Compared to 2013, the number of wells permitted fell 14% (from 1611 to 1388), and the number of wells started (spuds) decreased 11% (from 1003 to 893). The most active counties in 2014 were Uintah with 789 new well permits and 409 well spuds, Duchesne with 511 new well per-

Figure 11. *Highwall mining machine currently in use at the Coal Hollow open pit mine in southern Utah.*

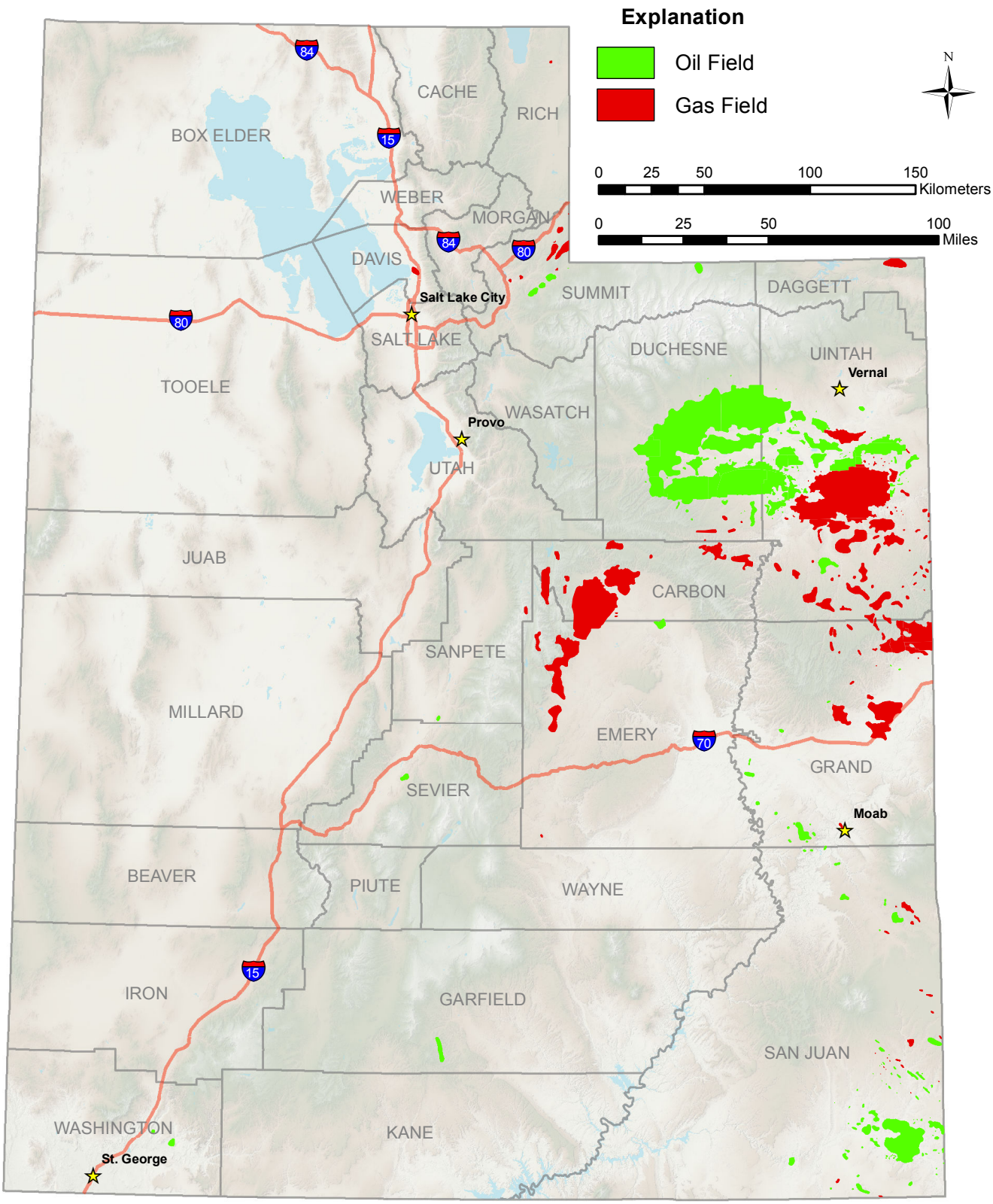


Figure 12. *Location of oil and gas fields in Utah.*

mits and 433 well spuds, and Carbon with 34 new well permits and 26 new well spuds. These three counties accounted for 96% of the new well permits and 97% of the well spuds in Utah during 2014. The 923 new oil and gas wells completed during 2014 were less than the 1013 wells completed in 2013. The new oil and gas wells completed in 2014 consist of 729 new wells within established field boundaries, 94 wells drilled adjacent to existing fields, and 100 wildcat wells drilled in unproven areas. The 923 new wells completed in 2014 include 53 dry holes that were plugged and abandoned, 697 oil wells, 169 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; this trend is expected to continue until gas prices increase.

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 potentially 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), state leases, and a U.S. BLM Research, Development, and Demonstration oil shale lease. Enefit's plan is to develop a 50,000 bbl/day oil shale operation, consisting of a surface/underground mine (which 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 collect fresh mining-horizon samples for testing the company's specific retort technology. In addition, several water monitoring wells have recently been drilled. Although the project will begin on private land, a utility corridor that crosses BLM land is planned to support the development. An Environmental Impact Statement for the corridor is expected to be completed in late 2015.

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 has been tested on a pilot scale and the company recently acquired a large mining permit to build a much larger, near-commercial-scale capsule, currently under construction. Commercial plans are to produce 9500 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 early production system expenses, which are estimated at approximately $200 million.

TomCo Energy is a United Kingdom based company with SITLA leases in the Uinta Basin. The company plans to use the Red Leaf Ecoshale technology on their "Holiday block" property. The company has drilled nine exploratory wells to define their resource and has begun work to acquire the necessary development permits. TomCo is waiting for test results from Red Leaf's new larger-scale capsule before commencing 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 developed in Canada to move Utah's oil sands toward successful and sustainable development in the near future. Mean-

while, factors such as site accessibility, adequate infrastructure, water availability, environmental concerns, permitting, and the problems associated with the heterogeneity of reservoir sands should continue to be researched to realize economically viable oil sand development in Utah when market conditions improve in the future.

Company development activities: U.S. Oil Sands is the most active company seeking to develop Utah's oil sand resources. The company has several SITLA leases within the PR Springs oil sand deposit in the southern Uinta Basin. The company plans to surface mine the oil sand and extract the bitumen using a solvent-based technology. In the summer of 2011, the company drilled more than 180 wells on their leases to define the resource. The company recently acquired all necessary permits and capital to open its mine. Operations are scheduled to begin in the summer of 2015.

One of Utah's most 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 2014 besides limited extraction for use as road pavement. One company, MCW Energy Group, has begun pilot-scale test operations on the northern side of Asphalt Ridge, also using a solvent-based extraction technique. The company is in the process of buying the abandoned Temple Mountain Energy oil sand mine on the southern end of Asphalt Ridge. The Sunnyside oil sand deposit, east of Price, Utah, has also recently received attention from companies, including one that has proposed to access the deposit via underground mining.

NEW MINERALS INFORMATION

The following recent publications provide new information on the energy and mineral resources of Utah. Ganske and others (2014) produced a new Society of Economic Geologists guidebook on the Bingham and the Stockton porphyry copper-molybdenum-gold deposits. This guidebook includes an overview paper on Bingham, a new Bingham mine geology map, a paper on the discovery of the Stockton porphyry copper-gold resource, and road logs for Bingham and Stockton. Boden and others (2014) compiled production, values, and exploration and development activity for Utah's extractive resource industries for 2013. These and other publications are available through the Utah Department of Natural Resources Map and Bookstore (http://mapstore.utah.gov). Additional geographic information system (GIS) data on Utah is available for free download at http://agrc.utah.gov and http://geology.utah.gov/resources/. The UGS also maintains a comprehensive repository for Utah energy and mineral data at http://geology.utah.gov/emp/energydata/index.htm. The website contains over 130 tables and 50 figures (in both Excel and PDF formats) in nine chapters that are continuously updated as new data become available. Canadian National Instrument Technical Reports for mineral properties in Utah are available on the UGS website at http://geology.utah.gov/popular/general-geology/rocks-and-minerals/#tab-id-6.

RECLAMATION AND THE ENVIRONMENT

The U.S. Department of Energy (DOE) and the State of Utah agreed to move the 11.9 million st of old Atlas uranium mill tailings located along the Colorado River near Moab. The tailings are being moved 30 miles north to a site near Crescent Junction. The DOE transports the tailings by rail to a 250-acre disposal cell excavated in the impermeable Cretaceous Mancos Shale. The project began shipping tailings in April 2009, moved 847,719 st in 2014, and moved a total of 7,305,256 st by the end of 2014 (Donald Metzler, DOE, written communication, April 2015). At the current rate of transfer, it will take about six more years to remove the Atlas tailings completely from along the Colorado River.

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REFERENCES

Alexander, T.G., 2006, Generating wealth from the earth 1847–2000, *in* Whitley, C., editor, From the ground up—the history of mining in Utah: Logan, Utah State University Press, p. 37–57.

Blois, M.D.S., Hardy, M., Effner, S., and Henchel, L.D., 2013, NI 43-101 technical report-preliminary feasibility study of the Sevier Lake playa sulphate of potash project, Millard County, Utah: unpublished Canadian National Instrument (NI) 43-101 report prepared for EPM Mining Ventures, Inc., 390 p.

Boden, T., Vanden Berg, M.D., Krahulec, K., and Rupke, A., 2014, Utah's extractive resource industries 2013: Utah Geological Survey Circular 118, 29 p.

Boden, T., Vanden Berg, M.D., Krahulec, K., Tabet, D., and Gwynn, M., 2012, Utah's extractive resource industries 2011: Utah Geological Survey Circular 115, 27 p.

Boden, T., and Tripp, B.T., 2012, Gilsonite veins of the Uinta Basin, Utah: Utah Geological Survey Special Study 141, 50 p., 1 plate, CD.

Carter, N.C., 2014, Technical report on the Keg mineral property, Juab County, State of Utah, United States of America: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for Pacific Imperial Mines Inc., 45 p.

CML Metals, 2015, CML Care & Maintenance Update October 17, 2014: Online, http://www.palladonventures.com/s/PressReleases.asp, accessed March 2015.

Dyer, T.L., Tietz, P.G., and Austin, J.B., 2014, Technical report on the West Desert zinc-copper-indium-magnetite project preliminary economic assessment, Juab County, Utah: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for InZinc Mining Ltd., 188 p.

Ganske, R., Schroeder, K., and Krahulec, K., 2014, Uncovering the Bingham and Stockton Cu-Mo-Au porphyries: Society of Economic Geologists Guidebook 41, 120 p.

Gwynn, M., Krahulec, K., and Vanden Berg, M.D., 2011, Utah mining 2010: Utah Geological Survey Circular 114, 21 p.

Henchel, L.D., 2014, Technical report—Diamond Mountain phosphate project, Uintah County, Utah: unpublished Canadian National Instrument (NI) 43-101 report prepared for Strata Minerals Inc., 82 p.

Jackson, T., 2015, Survey of mining companies 2014: Online, https://www.fraserinstitute.org/uploadedFiles/fraser-ca/Content/research-news/research/publications/survey-of-mining-companies-2014.pdf, accessed April 2015.

Kerr, S., Henchel, L.D., Todd, J.N., Nash, R.I., and Nath, L.R., 2013, Technical report—resources and reserves of the Blawn Mountain project, Beaver County, Utah: unpublished Canadian National Instrument (NI) 43-101 report prepared for Potash Ridge Corp., 302 p.

Krahulec, K., 2006, Utah mining timeline, *in* Bon, R.L., Gloyn, R.W., and Park, G.M, editors, Mining districts of Utah: Utah Geological Association Publication 32, p. 1–5.

Krahulec, K., 2011, Sedimentary rock-hosted gold and silver deposits of the northeastern Basin and Range, Utah, *in* Steininger, R., and Pennell, B, editors, Great Basin evolution and metallogeny: Geological Society of Nevada 2010 Symposium Volume I, p. 31–62.

Krahulec, K., and Briggs, D.F., 2006, History, geology, and production of the Tintic mining district, Juab, Utah, and Tooele Counties, Utah, *in* Bon, R.L., Gloyn, R.W., and Park, G.M., editors, Mining districts of Utah: Utah Geological Association Publication 32, p. 121–150.

Lane, T., and Katsura, K., 2014, Updated technical report on the Gold Springs property, Utah/Nevada, USA: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for TriMetals Mining Inc., 224 p.

Martin, W., 2013, Technical report on the Deer Trail mine project, Piute County, Utah: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for Western Pacific Resources Corporation, 68 p.

Nilsson, J., Major, K., Durston, K., Tietz, P.G., Ristorcelli, S., and Staargaard, C.F., 2010, Preliminary economic assessment of the Crypto zinc-copper-indium project Juab County, Utah: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for Andover Venture Inc. and Chief Consolidated Mining Co., 152 p.

Office of Natural Resources Revenue, 2015, Office of Natural Resources Revenue statistical information: Online, http://statistics.onrr.gov/ReportTool.aspx, accessed April 2015.

Pankow, K.L., Moore, J.R., Hale, J.M., Koper, K.D., Kubacki, T., Whidden, K.M., and McCarter, M.K., 2014, Geological Society of America Today, v. 24, no. 1, p. 4–9.

Potash Minerals Limited, 2013, Resource update for JORC 2012 on Hatch Point potash project: unpublished report, 50 p.

Rio Tinto, 2015, Rio Tinto 2014 annual report: Online, http://www.riotinto.com/ar2014/pdfs/rio-tinto_2014-annual-report.pdf, accessed March 2015.

SRK Consulting, 2009, NI 43-101 preliminary economic assessment Palladon Ventures Ltd. Iron Mountain, Iron County, UT: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for Palladon Ventures Ltd., 158 p.

Stowe, C.H., 1975, Utah mineral industry statistics through 1973: Utah Geological and Mineral Survey Bulletin 106, 121 p.

Tietz, P.G., Prenn, N., Wood, J., and Gast, T., 2011, Technical report on the Burgin Extension deposit—preliminary economic assessment, Burgin Project, East Tintic mining district, Utah County, Utah, USA: unpublished Canadian National Instrument (NI) 43-101 technical report prepared for Andover Venture Inc. and Chief Consolidated Mining Co., 152 p.

U.S. Bureau of Economic Analysis, 2015, Gross domestic product by state: Online, http://www.bea.gov/regional/index.htm, accessed April 2015.

U.S. Energy Information Administration, 2015a, Quarterly coal report, 2014: Online, http://www.eia.gov/coal/production/quarterly/, accessed May 2015.

U.S. Energy Information Administration, 2015b, Crude oil production, 2014: Online, http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm, accessed May 2015.

U.S. Energy Information Administration, 2015c, Natural gas annual, 2013: Online, http://www.eia.gov/naturalgas/annual/, accessed May 2015.

U.S. Geological Survey, 2015a, U.S. Geological Survey mineral commodity summaries 2015: Online, http://minerals.usgs.gov/minerals/, accessed March 2015.

U.S. Geological Survey, 2015b, Crushed stone and sand and gravel in the fourth quarter 2013: Online, http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/mis-2014q4-stonc.pdf, accessed March, 2015.

U.S. Geological Survey Oil Shale Assessment Team, 2011, Oil shale resources in the Eocene

Green River Formation, greater Green River Basin, Wyoming, Colorado, and Utah: U.S. Geological Survey Data Series 69-DD, no pagination.

Utah Geological Survey, 2006, Utah—100 years of exploration: Utah Geological Survey Public Information Series 71, 20 p.

Vanden Berg, M.D., 2008, Basin-wide evaluation of the uppermost Green River Formation's oil-shale resource, Uinta Basin, Utah and Colorado: Utah Geological Survey Special Study 128, 19 p., 8 plates, CD.

Walker, G.L., and Smith, S.D., 1989, Survey methods and statistical summary of nonfuel minerals: Bureau of Mines Minerals Yearbook 1988, v. 2, p. 1–44.