

UTAH MINING 2019

Metals, Industrial Minerals, Coal, Uranium, and Unconventional Fuels

by Stephanie E. Mills, Andrew Rupke, Michael D. Vanden Berg, and Taylor Boden



CIRCULAR 130
UTAH GEOLOGICAL SURVEY

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UTAH DEPARTMENT OF NATURAL RESOURCES
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Cover photo: *Stacks of refined copper cathode produced from the Lisbon Valley copper mine in San Juan County.*

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2019 UTAH MINING INDUSTRY SUMMARY

The estimated combined value of Utah's extractive resource production in 2019 totaled \$6.5 billion, including production of metals and industrial minerals (\$3.5 billion), natural gas (\$760 million), crude oil (\$1.8 billion), and coal (\$480 million) (figure 1). Utah's diverse mining industry accounted for \$3.9 billion (61%) of total extractive resource production, an increase of \$92 million (2.4%) from 2018, but 26% lower than peak values reached in 2011 (\$5.3 billion, nominal dollars). Mining activities in Utah currently produce base metals, precious metals, industrial minerals, and coal (figure 2). Base metal production contributed \$1.8 billion and includes copper, magnesium, beryllium, and molybdenum. Notably, copper accounts for 67% (\$1.2 billion) of Utah's base metal production value (figure 3). Precious metals produced in Utah include gold and silver, and 2019 production was valued at \$375 million (figure 3). Precious metal production value increased by about 29% from 2018 to 2019, but base metal values decreased about 3%. Utah also produced several industrial mineral commodities including sand and gravel, crushed stone, salt, potash, cement, lime, phosphate, gilsonite, clay, gypsum, and others (figure 2). The estimated value of industrial mineral production in 2019 was \$1.3 billion, a 6% increase over

the revised 2018 estimate (figure 3). The most valuable industrial mineral group in 2019, estimated at \$483 million, was the brine- and evaporite-derived commodities of potash, salt, and magnesium chloride. In contrast to other minable commodities, the value of Utah coal production again decreased in 2019 to \$480 million, down from \$499 million in 2018 (figure 3). Notably, Utah remains the only state to produce magnesium metal, beryllium concentrate, potassium sulfate, and gilsonite; of these mineral commodities, magnesium, beryllium, and potash (includes potassium sulfate) are included in the U.S. Department of the Interior's 2018 list of critical minerals (Fortier and others, 2018).

Historically, Utah has been a significant producer of iron, uranium, and vanadium, but production of these commodities has been suspended due to low prices or exhausted reserves. Energy Fuels Resources operates the White Mesa uranium-vanadium mill in San Juan County, which has continued to produce uranium from alternative feeds (material not sourced from Energy Fuels' mines) since the suspension of mining in 2012. In 2019, the mill for the first time since 2008 did not produce any uranium, as it transitioned to producing vanadium from pond tailings. Uranium production at the mill from alternate feeds is set to restart in 2020.

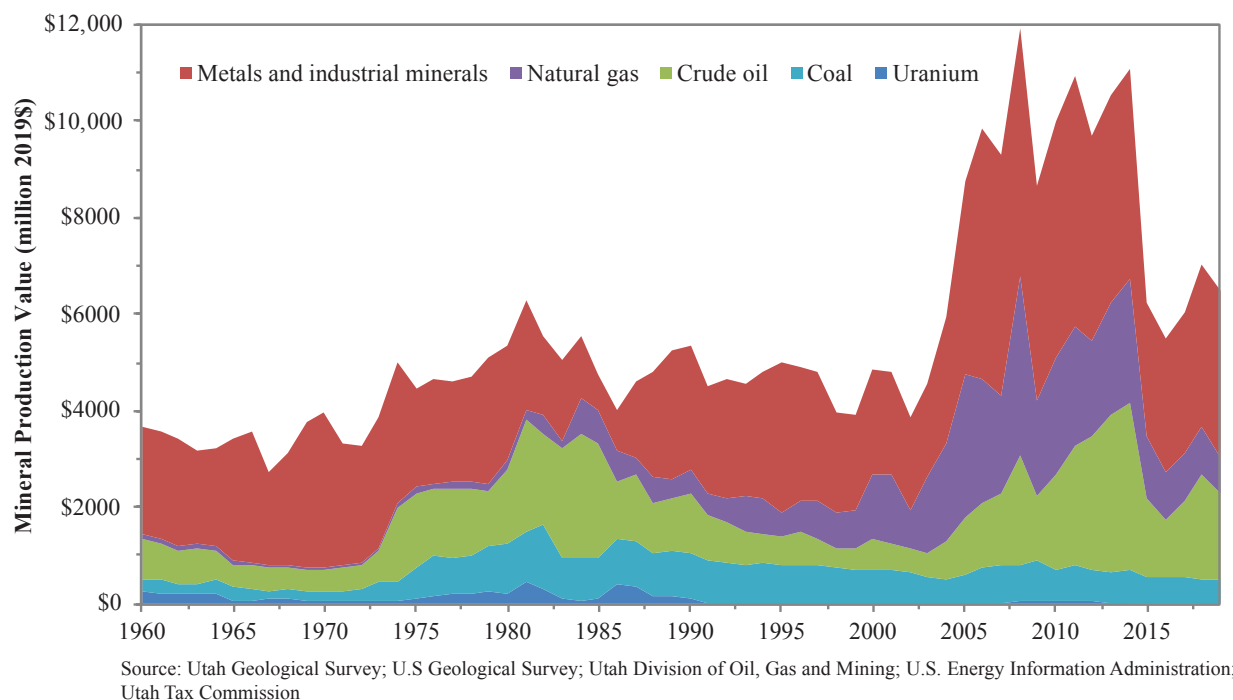


Figure 1. Annual value of Utah energy and mineral production, inflation adjusted to 2019 dollars, 1960–2019.

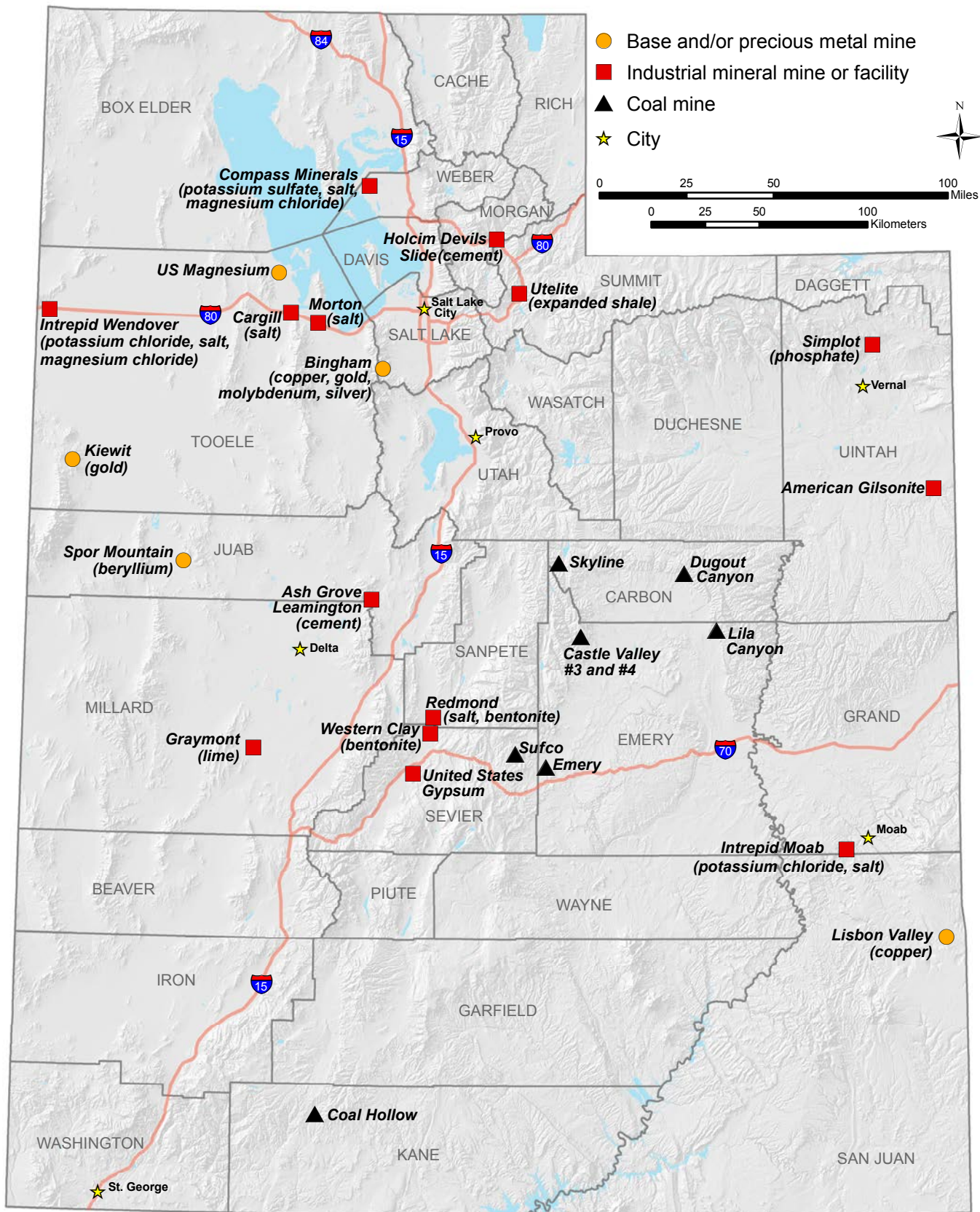


Figure 2. Select base and precious metal, industrial mineral, and coal production locations in Utah.

For 2019, the U.S. Geological Survey (USGS) ranked Utah as 7th nationally (up one position from 2018) for production of nonfuel minerals, which includes metals and industrial minerals (table 1). The USGS estimated Utah’s nonfuel mineral production value at \$3.3 billion (compared to the Utah Geological Survey estimate of \$3.4 billion), which accounts for 3.85% of the U.S. total, and lists Utah’s principal commodities contributing to the overall value as copper, gold, molybdenum concentrates, salt, and sand and gravel for construction (USGS, 2020a). The overall value of nonfuel production in the United States was estimated at over \$86 billion, two-thirds of that value coming from industrial minerals and the remaining one-third coming from metals production (figure 4). Utah has ranked among the top ten states for nonfuel mineral production for the past decade. In addition, Utah ranked as the 11th largest coal producer out of 23 coal-producing states in 2019 and accounted for 2.0% of total U.S. coal production (U.S. Energy Information Association, 2020a).

In the 2019 Fraser Institute annual survey of mining companies, Utah was ranked as the 14th most favorable state/nation out of 76 international jurisdictions (82nd percentile) in terms of overall investment attractiveness with regard to mining (table 1) (Stedman and others, 2020). Although this ranking represents a seven spot decrease from 2018, Utah remains the 5th

most favorable jurisdiction in the contiguous United States. The investment attractiveness index takes into account a combination of a region’s geologic favorability and the disposition of government policies toward exploration and development.

The minerals regulatory program within the Utah Division of Oil, Gas and Mining (DOG M) approved 4 large mine permits, 11 small mine permits, and 8 exploration permits in 2019 (table 1). The large mine permits were for two sand and gravel mines, one salt mine, and a natural soil amendment/fertilizer mine (Azomite). The small mine permits included sand and gravel, humic shale, septarian nodule, alabaster, landscape boulder, and calcite mines. Eight exploration permits were approved for uranium, frac sand, precious metals, and oil sand (Paul Baker, DOGM, written communication, April 2020).

The Utah School and Institutional Trust Lands Administration (SITLA), which manages about 3.4 million acres of state-owned lands in Utah, issued 41 new mineral leases in 2019, up from 36 in 2018 (table 1, figure 5). These leases were issued for the following commodities: sand and gravel (12), geothermal (11), metalliferous minerals (9), building stone (2), volcanic materials (2), bituminous/asphaltic (oil) sand (2), clay (1), limestone (1), and mineral salts (1) (Jerry Mansfield, SITLA, written communication, March 2020).

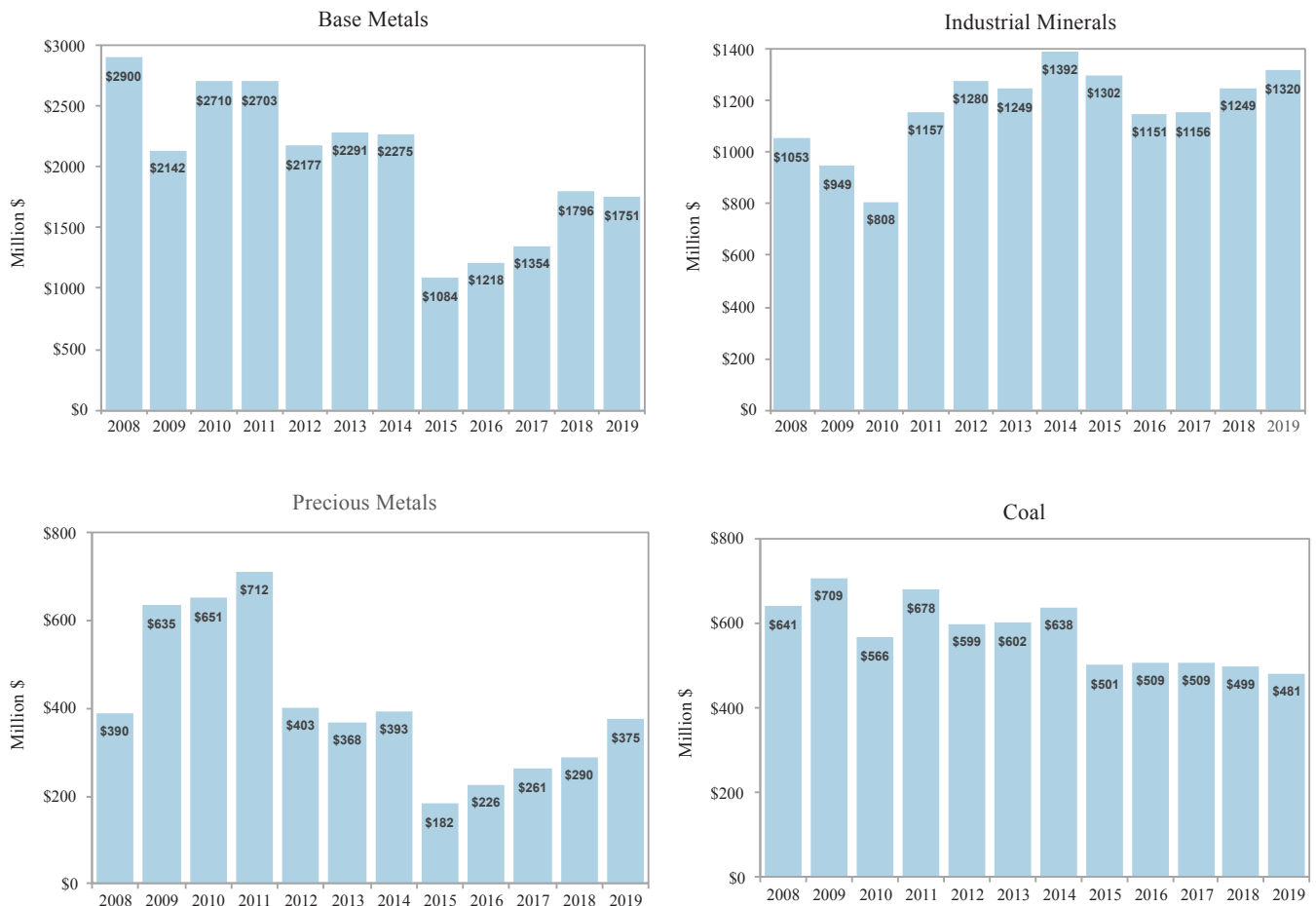


Figure 3. Annual value of Utah mineral production in nominal dollars, 2008–2019.

Table 1. Utah mining rankings and statistics.

Utah mining ranking or statistic	2013	2014	2015	2016	2017	2018	2019
USGS rank of U.S. nonfuel mineral production value (metals and industrial minerals)	7th	5th	8th	10th	8th	8th	7th
Fraser Institute annual survey of mining companies (favorability of mining jurisdiction)	15th of 112	14th of 122	9th of 109	11th of 104	15th of 91	7th of 83	14th of 76
U.S. EIA rank for coal production by state	14th	13th	14th	10th	11th	12th	11th
New DOGM approved large mine permits	4	2	2	0	0	1	4
New DOGM approved small mine permits	13	11	12	7	11	13	11
New DOGM approved exploration permits	9	14	17	11	9	6	8
SITLA mineral leases issued	62	56	32	53	57	36	41
New BLM mining claims filed	2360	3107	975	5366	5709	5361	2283
Total BLM mining claims (end of year)	19,487	19,770	18,520	21,497	21,936	22,976	21,625

Note: USGS = U.S. Geological Survey, EIA = U.S. Energy Information Administration, DOGM = Utah Division of Oil, Gas and Mining, SITLA = Utah School and Institutional Trust Lands Administration, BLM = U.S. Bureau of Land Management

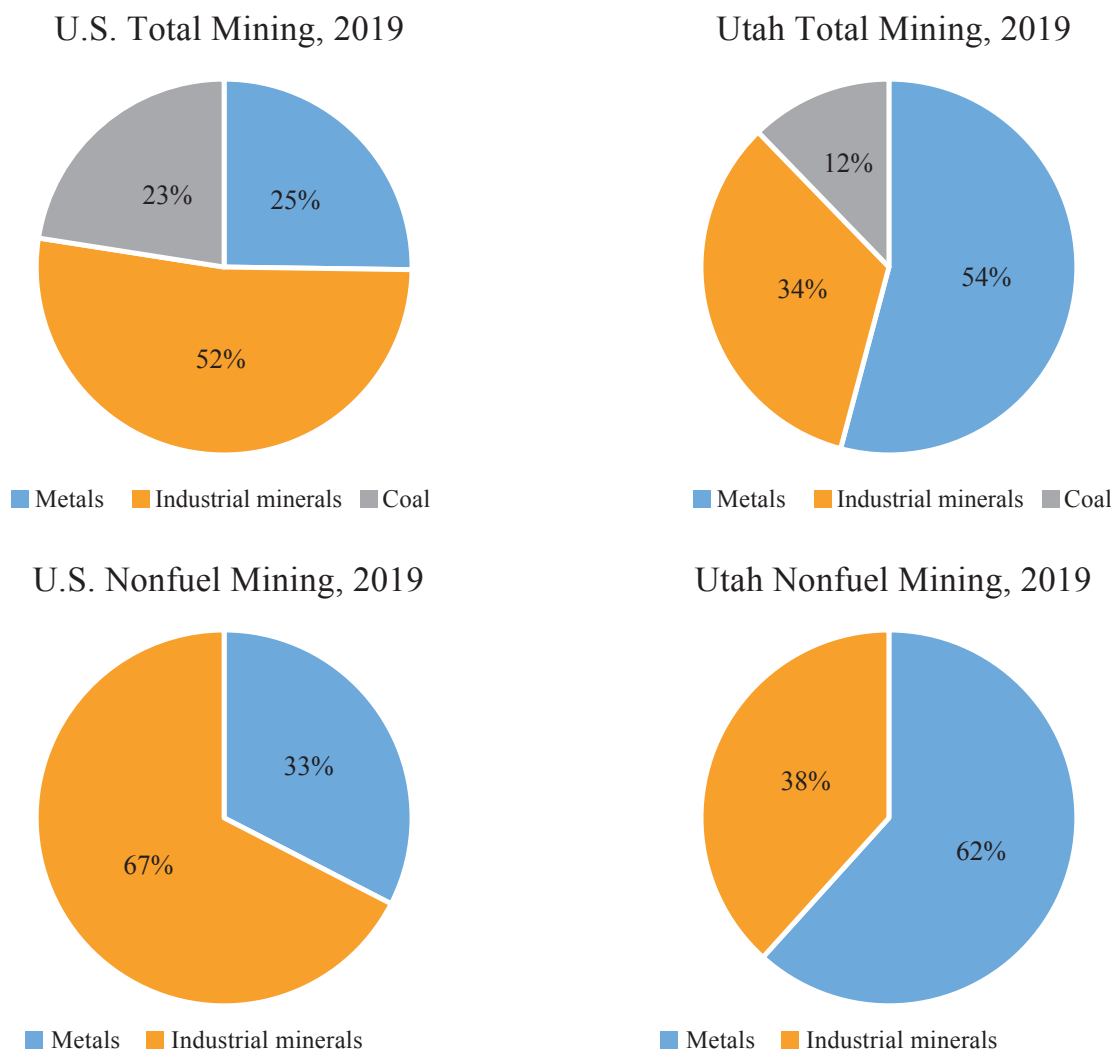


Figure 4. Comparison of United States and Utah mining sectors, 2019. U.S. data source: U.S. Geological Survey.

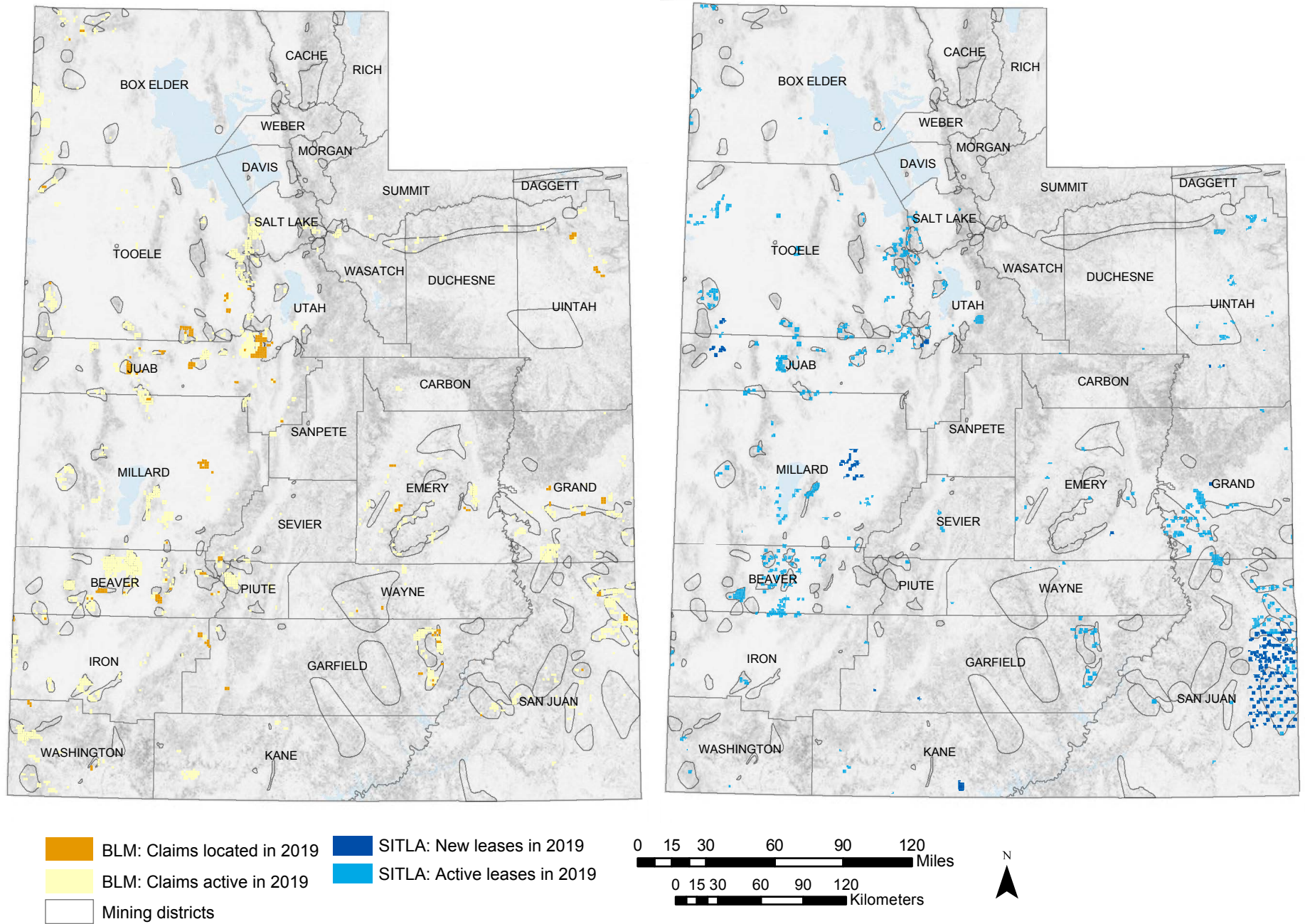


Figure 5. Location of active and new BLM claims and SITLA leases in 2019.

In 2019, 2283 new unpatented mining claims were filed on federal lands in Utah (figure 5). This represents a significant decrease, as over 5000 claims were filed each year from 2016 through 2018. In 2016 and 2017, there was an increased focus on lithium, and an uptick in vanadium and base metal claims in 2018. In 2019, claim activity mostly occurred in the following counties in decreasing order: Tooele (base and precious metals, pozzolan), Juab (base and precious metals, beryllium), San Juan (uranium-vanadium), and Garfield (uranium-vanadium), each recording over 250 new claims. At the end of 2019, the U.S. Bureau of Land Management (BLM) reported a total of 21,625 active unpatented mining claims in Utah, down 6% from 2018 (table 1) (Keyra Fernandez, Utah BLM, written communication, July 2020).

Contributions by the Utah mining industry to the state tax base during 2019 were significant (figure 6). The metal, industrial mineral (non-metal), sand and gravel, and coal mining industries paid over \$82 million in property taxes during the year (up 7% from 2018) and over \$13 million in mining-related severance taxes (up 32% from 2018). All extractive industries, including oil and gas, paid nearly \$80 million in federal mineral lease disbursements. Only about 1% of Utah's gross domestic product came from the mining industry in 2019, 1.3% if oil and gas are included. Mining employment in Utah remained steady from 2018 to 2019, but average wages increased nearly 6% (figure 7). According to the Utah Department of Workforce Services, the average annual mining wage in Utah in 2019 was \$78,384, which is substantially higher than the 2019 overall Utah average annual wage of \$49,620.

BASE AND PRECIOUS METALS

Production

Utah's base metal production value totaled \$1.75 billion in 2019, a 2.5% decrease from the 2018 revised total of \$1.79 billion. The production value of precious metals totaled \$375 million in 2019, a nearly 30% increase from 2018. Figure 8 shows production and value of copper, gold, silver, and molybdenum since 2000. In contrast to 2018 when global commodity prices followed the same generalized trends, base and precious metal prices in 2019 mostly followed opposite trajectories. Base metals, primarily copper, remained relatively steady for the first half of the year but from mid-year began experiencing price drops. The price drops were related to international trade tensions, such as tariffs being enacted by the United States and China, and increasing fears of recession. Gold, by contrast, experienced the largest price increase since 2010 and silver had the second best year in a decade. The price increases for precious metals drove increased precious metal production value in Utah. Despite the strong performance of precious metals, investment in the mineral industry has been declining since 2017, and eq-

uity financing dropped to a decadal low in 2019. Specifics for Utah's base and precious metal mining commodities are detailed in the sections below, listed in order of decreasing production value.

Bingham Canyon mine, owned by Kennecott Utah Copper Company (KUCC, owned by Rio Tinto), is located on the west bench of the Salt Lake Valley in the Oquirrh Mountains. Almost all copper and gold produced in Utah and all molybdenum and silver is produced by Bingham Canyon mine, which is a world class copper-molybdenum-gold porphyry deposit. Bingham's overall production value for all metals in 2019 is estimated at \$1.8 billion, a 1.5% increase from 2018 and over 85% of Utah's total metal production value. The slight increase in Bingham's production value for 2019 reflects an increase in gold and silver production as well as an increase in price for both commodities, as well as a substantial increase in molybdenum production. These factors served to offset a decrease in copper production. More details are available in each commodity section. Rio Tinto announced in December 2019 a new \$1.5 billion investment at Bingham Canyon for phase 2 of the south wall pushback, which is estimated to allow access to a new part of the ore body beginning in 2026 and extend mine life to 2032. Work on phase 2 will begin with completion of the phase 1 south wall pushback, which was a \$900 million investment due to be completed in early 2021 (Rio Tinto, 2020).

Bingham Canyon produced minor byproduct lead carbonate and crude selenium (containing platinum and palladium) from the copper concentration process; however no production numbers are available for these commodities. Bingham Canyon has also partnered with the U.S. Department of Energy's Critical Materials Institute to investigate recovering rhenium from the copper concentration process (as opposed to the more typical extraction from molybdenum) and has the potential to begin commercial production of ~2000 lbs per year in the near future.

Reserves and resources for Bingham Canyon remained relatively constant (table 2), with less than 1% decrease in total proven and probable reserve tonnage and grades remaining within 10% of 2018 values. The open pit measured, indicated, and inferred resource tonnage was nearly halved from 2018 due to conversion of resources to reserves and mine design changes. However, despite the lower tonnage, grades in the 2019 resource increased by more than 35% across the board, with the exception of molybdenum. The resource for the underground North Rim Skarn ore body remained unchanged.

Utah continues to be the global leader in beryllium production from the Spor Mountain mining district in Juab County, owned by Materion Corporation. Spor Mountain produced approximately 65% of global beryllium in 2019, a slight decrease from nearly 70% in 2018 due to increased production from China. Utah also continued as the sole U.S. producer of primary magnesium metal (versus secondary scrap) from U.S. Magnesium's Great Salt Lake brine facility. The White

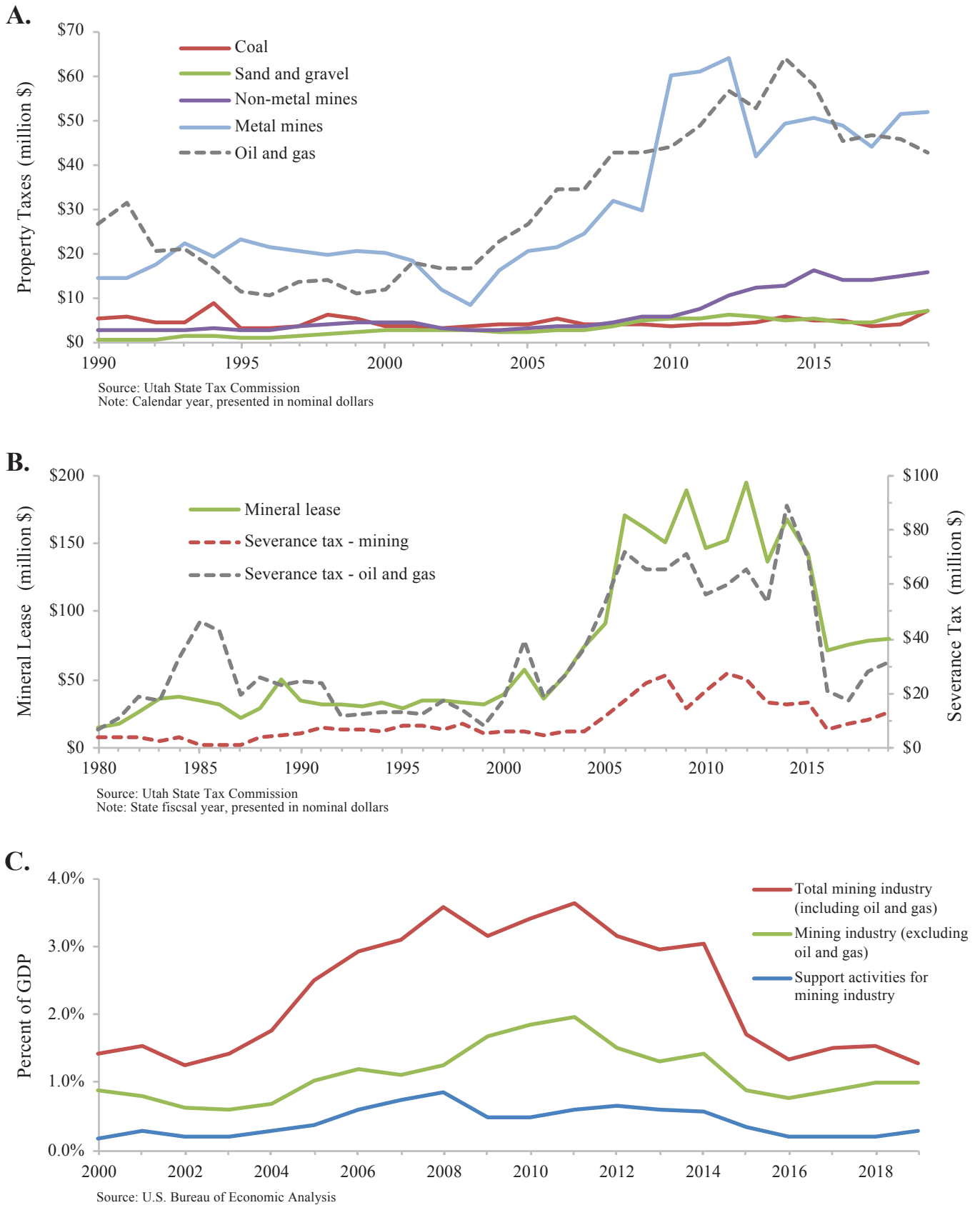


Figure 6. Utah mining economic indicators. **A.** Property taxes charged against the mining industry, 1990–2019. **B.** Mineral lease revenue and severance taxes, 1980–2019. **C.** Percentage of Utah's gross domestic product (GDP) from mining-related activities, 2000–2019.

Utah Annual Mining Employment

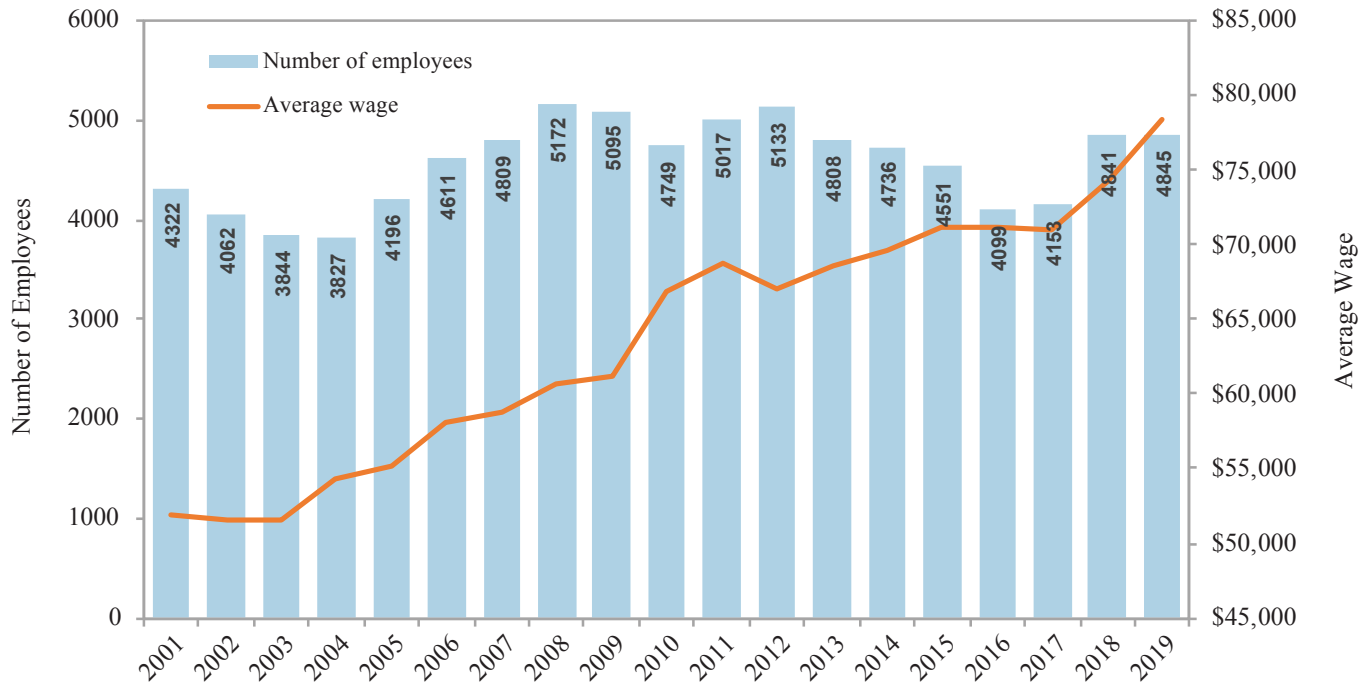


Figure 7. Average annual mining employment and salaries (in nominal dollars) in Utah. Includes metal, industrial mineral, and coal mines and facilities; excludes oil and gas. Source: Utah Department of Workforce Services.

Mesa Mill in southeast Utah, owned by Energy Fuels, produced the first vanadium concentrate in Utah since 2012. Beryllium, magnesium metal, and vanadium were all named as critical minerals by the USGS in 2018, though at the time this conferred no special status. As of May 2020 a bill has been introduced in the House of Representatives (American Critical Mineral Exploration and Innovation Act of 2020) to streamline the permitting for critical mineral mining projects.

Utah is also home to 5N Plus Semiconductors in St. George, which grows germanium crystals for aerospace applications and is one of only two germanium suppliers globally to the National Defense Stockpile. Western Zirconium in Ogden recycles zirconium scrap for the commercial nuclear fuel industry and the military. Neo Performance Materials, located in Blanding, recovered and refined gallium from scrap until this portion of business was shifted to Ontario and the plant was closed in 2019. These operations are not included in the production value calculations for this report as they are not primary mining operations.

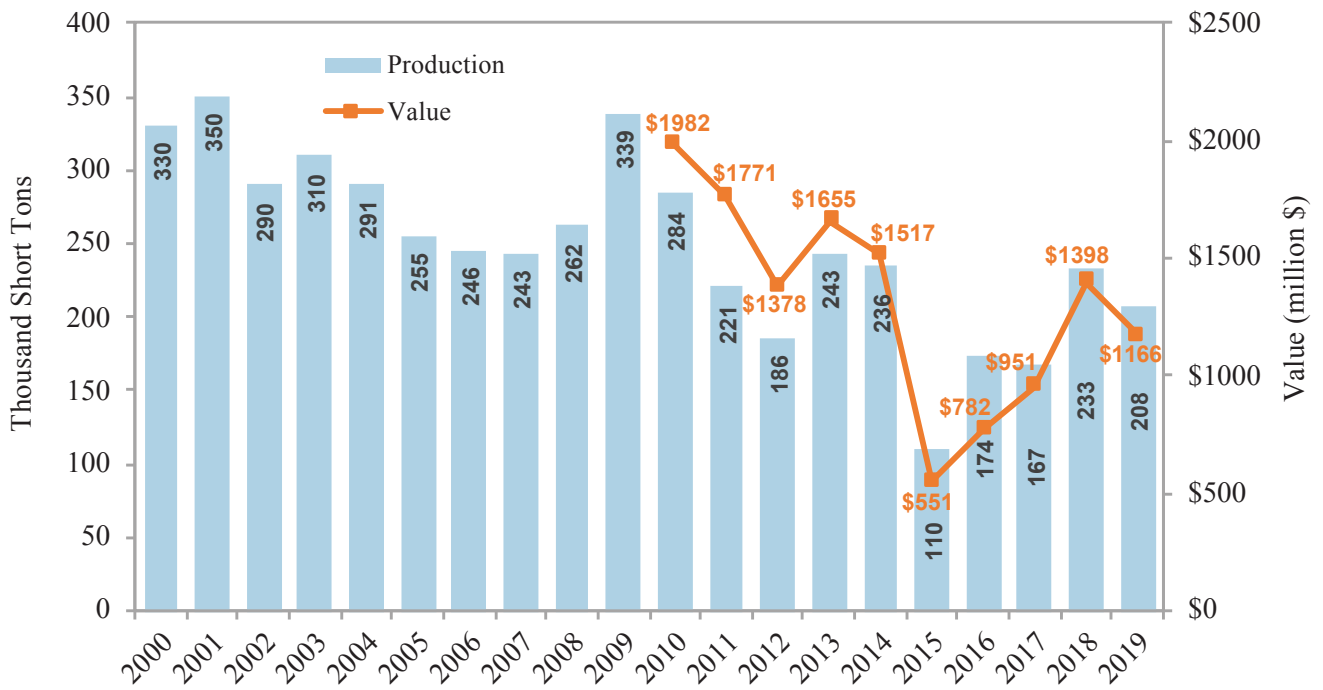
Copper

Utah's copper production in 2019 was 417 million lbs (208,000 tons), compared to 466 million lbs (233,000 tons) in 2018 (figure 8). The 10% decrease in production is attributed to lower grades at the Bingham Canyon mine, reduced output from Lisbon Valley copper mine, and the closure of the Tamra copper mine. Coupled with a lower copper price, overall production value in 2019 dropped by 16% to \$1.17 billion versus \$1.40 billion in 2018.

The KUCC Bingham Canyon open pit mine accounted for 99% of Utah's copper production, up from 96% in 2018. Mined copper output was decreased due to grade variability and overall lower grades, which is expected to continue into 2021, when the first phase of the south wall pushback is completed and mining shifts from the east wall to the south wall. Refined copper output was also down from 2018, impacted by a planned smelter shutdown and additional furnace maintenance. KUCC formally idled the coal power plant located east of the refinery in 2019 and purchased renewable energy certificates from Rocky Mountain Power. The closure of the coal plant reduces KUCC's annual carbon footprint by as much as 65% (more than a million tons of CO₂) (Rio Tinto, 2020). KUCC also recycles scrap copper, mainly from their own copper refining process but also from external sources. The recycling initiative resulted in 210,000 lbs (105 tons) copper recycled in 2019, which is estimated to be enough to wire 6500 new homes. Other 2019 activities at Bingham Canyon include implementing artificial intelligence at the concentrator to improve mineral recovery, and an updated cost evaluation for the eventual closure and environmental remediation of the mine site.

First quarter 2020 results from Bingham Canyon show a 33% decrease in mined copper from first quarter 2019, which is due to overall lower grade ore, grade variability, and pit sequencing. The low grades are expected to continue through 2020 to 2021 and the anticipated transition from east wall to south wall mining. The Salt Lake City area also experienced a magnitude 5.7 earthquake on March 18, 2020. The epicenter of the earthquake was in Magna, about 2.5 miles east of the KUCC tail-

Utah Copper Production



Utah Gold Production

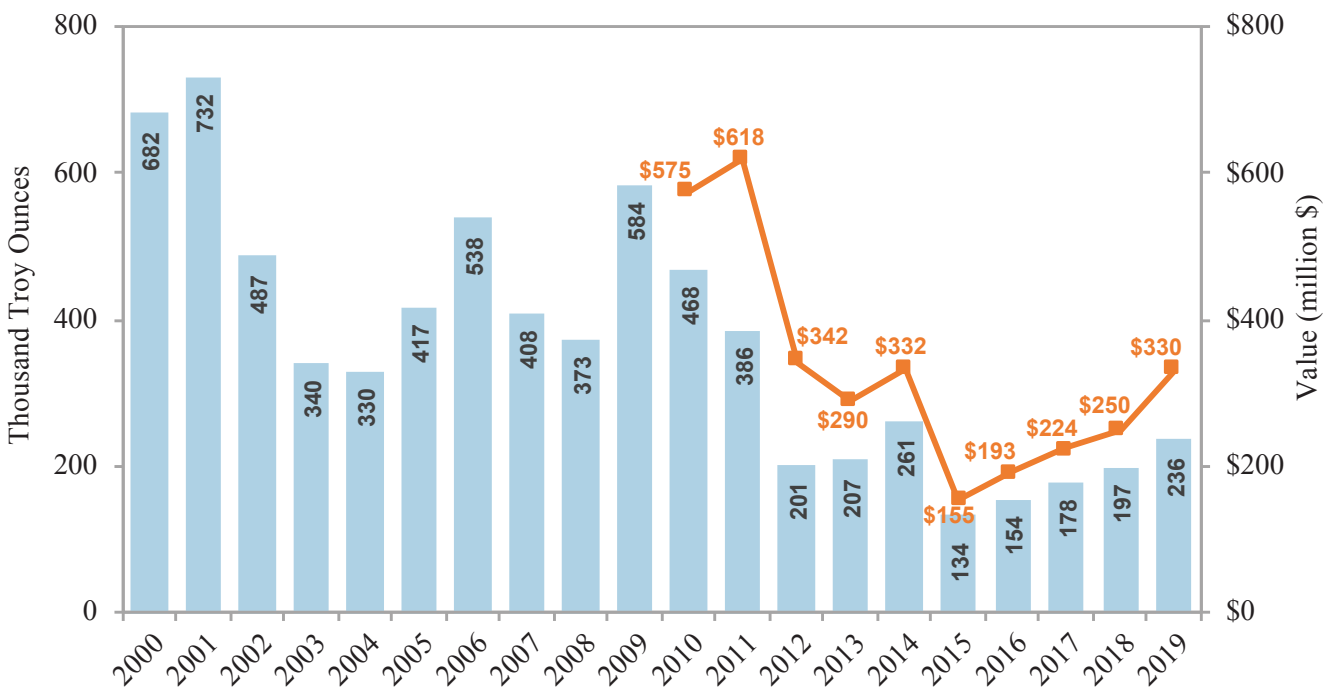
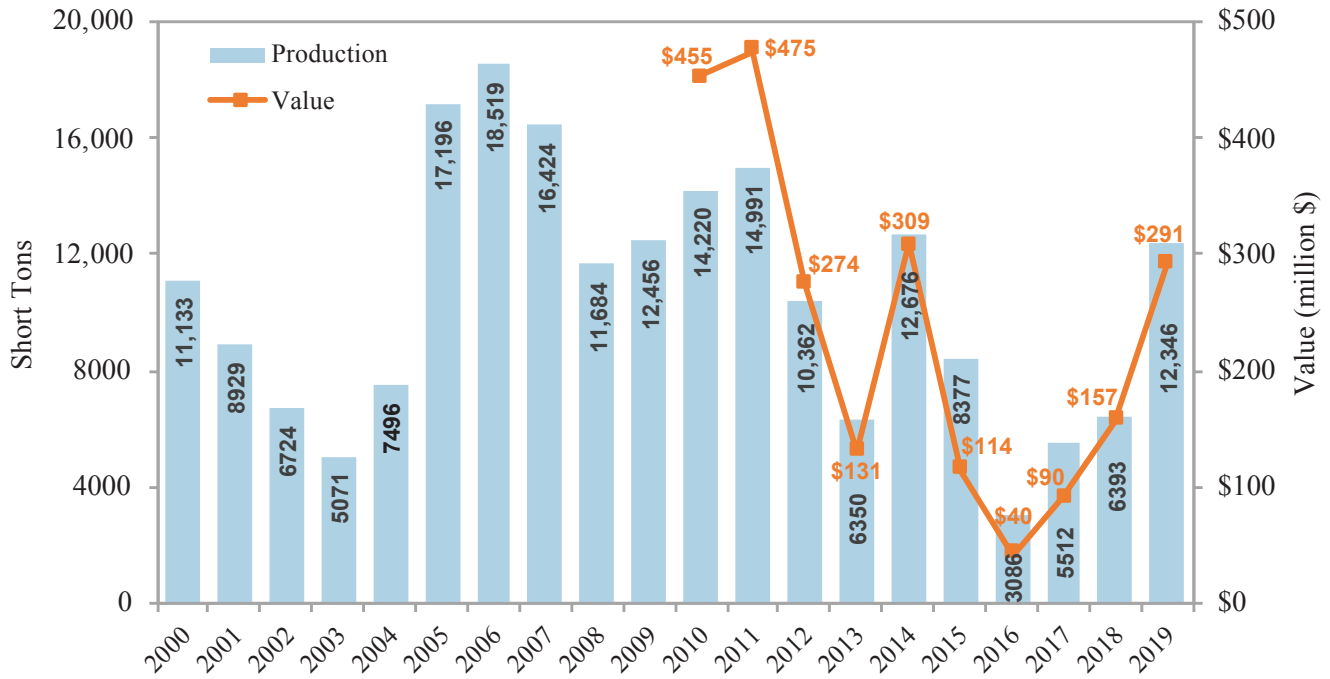


Figure 8. Production (since 2000) and value (since 2010) of select metals. Value in nominal dollars.

Utah Molybdenum Production



Utah Silver Production

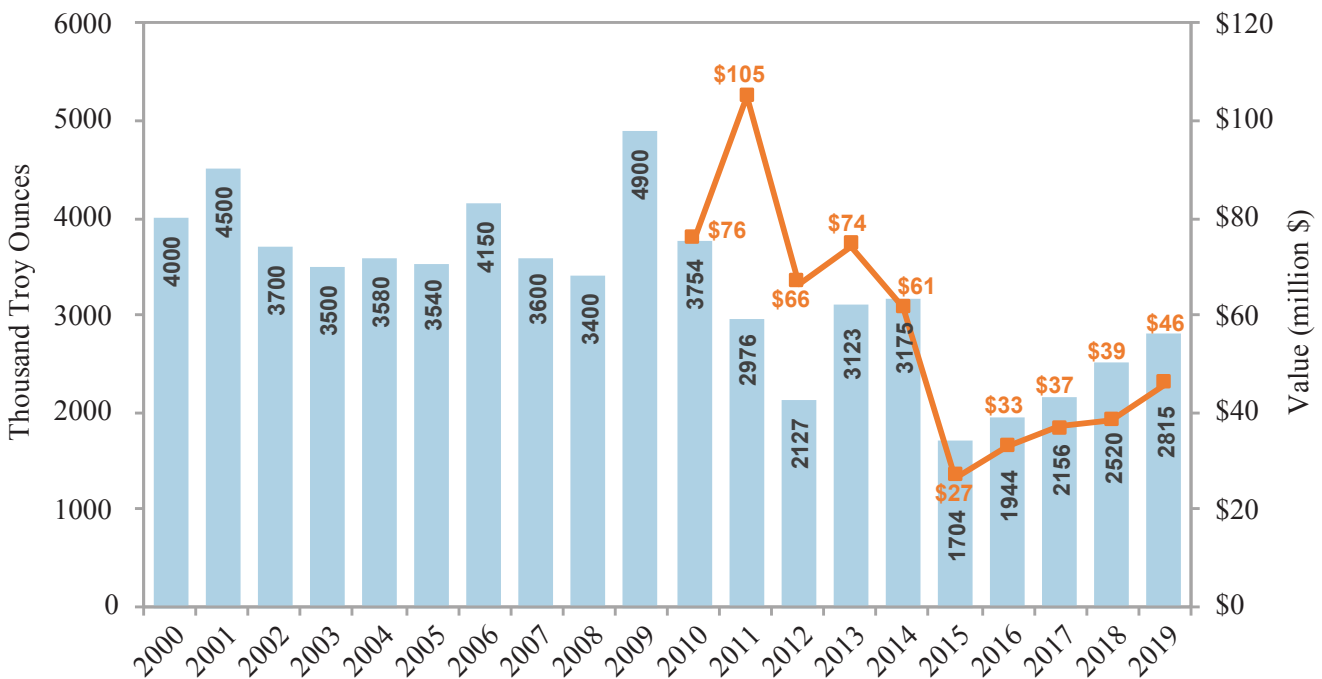


Figure 8. Continued.

Table 2. Bingham Canyon mine 2018-2019 production, reserves, and resources.

	Production		Reserves				Resources					
	Amount Mined		Total (P+P)				Open Pit Total (M+I+I)				North Rim Skarn Total (M+I+I)	
	2019	2018	2019 Tonnage	2018 Tonnage	2019 Grade	2018 Grade	2019 Tonnage	2018 Tonnage	2019 Grade	2018 Grade	2019 ¹ Tonnage	2019 ¹ Grade
Copper	206,000 ton	225,000 ton	675M ton	680M ton	0.43%	0.42%	46M ton	90M ton	0.39%	0.28%	22M ton	3.65%
Molybdenum	12,350 ton	6,400 ton			0.03%	0.04%			0.02%	0.04%		na
Gold	234,700 oz	196,700 oz			0.15 g/t	0.15 g/t			0.15 g/t	0.09 g/t		1.47 g/t
Silver	2,815,000 oz	2,520,000 oz			1.85 g/t	1.85 g/t			1.91 g/t	1.40 g/t		19.05 g/t

Note: P+P = Proven + Probable; M+I+I = Measured + Indicated + Inferred
¹2019 and 2018 resource for the North Rim Skarn are the same.

ings impoundment, 5 miles east of the smelter, and 16 miles north of the open pit. Damage to the flash converting furnace at the smelter was identified following the earthquake requiring a full furnace rebuild. Rio Tinto lowered mined copper guidance from 584,000–628,000 tons to 524,000–573,000 tons for 2020 as a result. It is unclear when the earthquake damage will be fully repaired and the smelter returned to full capability.

Lisbon Valley copper mine did not carry out any active mining in 2019, having switched from open pit mining to reprocessing existing tailings in late 2018. However, through re-crushing leach pad material to a uniform size and improving aeration to reduce channelization, they were able to produce 4.7 million lbs (2400 tons) of copper through their solvent extraction-electrowinning (SX-EW) processing facility in 2019, which represents a 14% decrease in copper output from 2018. Lisbon Valley Mining Company (LVMC) actively pursued scientific studies and benchtop scale testing of in situ recovery (ISR) mining techniques through 2019, and in October 2019 filed an expanded Plan of Operation application with DOGM that would allow for the injection wells needed for the ISR method. LVMC planned to file an aquifer exemption request with the Utah Division of Water Quality in early 2020, which would allow pumping diluted solvent (in this case, sulfuric acid) into the groundwater around the ore bodies. LVMC's application planned to demonstrate the aquifer was isolated from other aquifers in the area that provide drinking water. However, with the onset of the COVID-19 pandemic, funding for the project fell through and the mine was abruptly shut down on March 18, 2020. DOGM issued an emergency order on March 20, 2020, that allowed the release of LVMC's \$6.1 million surety bond in order to mitigate environmental impacts of the mine shutting down. As of April 22, 2020, LVMC is required to complete full reclamation of the mine site by September 2021 unless active mining resumes. LVMC no longer holds active mining permits and will have to re-permit the operation and pay a new reclamation bond should they or any other company want to restart mining.

Tamra Mining's Rocky Range copper skarn mine in Beaver County had no active mining in 2019. The operation ceased active mining in late 2018 and moved to reprocessing tailings. Rocky Range is reported to have produced some copper cath-

ode in the first quarter of 2019 from their SX-EW and flotation facility, though production numbers are not available. Rocky Range has been on care and maintenance since first quarter 2019 with no indication of production restarting.

Copper is one of the most widely used metals globally and price often fluctuates with economic and industrial trends. Short-term copper prices have been subdued by geopolitical tensions, trade disputes, increasing fears of recession, and COVID-19 pandemic disruptions. However, long-term fundamentals for copper appear strong given that it is essential to basic infrastructure, renewable energy technology and electrical grids, and electrical vehicles.

Gold

Utah produced 235,560 troy oz of gold in 2019, all but 860 troy oz produced by the KUCC Bingham Canyon mine (figure 8). Utah's 2019 gold production was valued at \$330 million, a 32% increase from the \$250 million valuation in 2018. The substantial production value increase was the result of production at Bingham Canyon reaching 234,700 troy oz, a 20% production increase from 2018, and an improved gold price of \$1400/troy oz versus \$1272/troy oz in 2018.

Gold production at Bingham Canyon has been increasing since the 20-year low in 2015, and 2019 marks the highest level of production since 2014. Higher gold grades were encountered during 2019 mining at Bingham, despite the decreased copper grades. However, first quarter 2020 results from Bingham Canyon show a 21% decrease in mined gold from first quarter 2019, and a 19% decrease from fourth quarter 2019. Given the difficulties Bingham Canyon faces this year with grade variability, repairs from the earthquake, and impacts from the COVID-19 pandemic, 2020 gold production is anticipated to be lower.

The Kiewit Mine in the Gold Hill district of west Tooele County, 40 miles south of Wendover (figure 2), produced 860 troy oz of gold. Clifton Mining holds Kiewit's land position with mining operated by Desert Hawk Gold Corp. The operation is a small low-grade open-pit heap leach operation recov-

ering sediment-hosted gold. The Kiewit project was inactive through April 2019, with refurbishments of equipment starting in April, blasting in July, and crushing in August. A reported 285,000 tons of material were mined by year end with over 145,000 tons already crushed for heap leach. Exploration potential is known in the area and Newmont had a large exploration program until 2019, when all Great Basin exploration projects were dropped due to the merger with Goldcorp.

The price of gold in 2019 experienced the largest increase since 2010. As opposed to base metals, gold performs well in turbulent geopolitical and trade climates due to its status as a “safe haven” investment. Consolidation of major mining companies such as Barrick and Randgold, Newmont and Goldcorp, and Kirkland Lake and Detour Gold also increased investor confidence in the gold industry, which has been perceived as overdue for consolidation by market analysts. The gold price continued to increase in early 2020 given continued concerns over a recession and the compounding effect of the COVID-19 pandemic. Due to political uncertainty caused by an election year in the United States, the price of gold is anticipated to maintain the gains made so far and possibly increase.

Molybdenum

Utah produced 24,700,000 lbs (12,350 tons) of molybdenum in 2019, exclusively from the Bingham Canyon mine (figure 8). Production of molybdenum in 2019 was nearly double the 12,800,000 lbs (6,390 tons) produced in 2018, and with a moderate price increase of 10%, the production value for molybdenum reached \$291 million, or nearly 15% of total metals production value. The increased production of molybdenum is related to mining moving deeper on the east wall of the Bingham Canyon open pit. Molybdenum mineralization at Bingham Canyon has long been recognized to form what is variably referred to as an inverted cup, molar tooth, or shell shape in and around the 0.35% Cu zone, with deep high-grade roots. The roots of the molybdenum mineralization extend below the bottom of the open pit for more than half a mile, and the grade is estimated to be greater than 0.09% Mo with high-grade areas up to 0.3% Mo, versus the average of 0.05% in the shallower part of the ore body. The highest known molybdenum concentrations are in the east wall of the pit (Austin and Ballantyne, 2010). Given the architecture of the molybdenum mineralization at Bingham Canyon, the high molybdenum production is expected to continue through 2020 until the switch to south wall mining in 2021, where molybdenum grade is expected to decrease.

Molybdenum is primarily used in alloys, particularly stainless steel, and is widely used in the petroleum industry. Molybdenum production cuts in the mid-2010s coupled with stronger stainless steel demands and resurgence in the oil and gas market have driven the molybdenum price up in recent years. The price of molybdenum was relatively steady through 2019, but early 2020 has seen considerable price volatility, with prices rising and falling again by nearly 25%

since the start of the year. Given that molybdenum demand is largely driven by the oil and gas sector and considering the drastic cutback on drilling and production in 2020 due to COVID-19 pandemic impacts, it is anticipated the price will remain depressed through 2020.

Magnesium

U.S. Magnesium is the only facility producing magnesium metal from a primary source in the United States. The facility is located on the southwestern shore of Great Salt Lake, about 60 miles west of Salt Lake City in Tooele County (figure 2). Magnesium chloride concentrate is produced from Great Salt Lake brines through evaporation and subsequently converted to magnesium metal by an electrolytic process. The annual magnesium production capacity at the U.S. Magnesium plant is approximately 70,000 tons (specific data on production is confidential). The price for magnesium metal rose from \$2.17/lb in 2018 to \$2.35/lb in 2019 (USGS, 2020a). Magnesium was the fourth largest contributor to Utah’s base metal value in 2019. The United States is heavily import reliant on magnesium metal, which is why magnesium is considered a critical mineral.

Significant quantities of U.S. Magnesium’s production had previously been used by the adjacent Allegheny Technologies facility to produce titanium sponge. However, this plant was idled at the end of 2016 due to unfavorable market conditions and this has subsequently reduced demand from U.S. Magnesium’s plant and caused them to shut down part of their capacity. Magnesium is also used as a constituent of aluminum-based alloys, in castings and wrought products, in the desulfurization of iron and steel, and other minor uses (USGS, 2020a). Lithium is concentrated along with magnesium in U.S. Magnesium’s solar evaporation ponds, and U.S. Magnesium intends to start producing byproduct lithium in 2020 at an estimated capacity of about 10,000 tons per year. U.S. Magnesium also produces a number of other byproducts including salt and chlorine.

Beryllium

Beryllium production from Utah totaled 320,706 lbs (160 tons) in 2019, a slight decrease from 324,104 lbs (162 tons) in 2018. The average price of beryllium increased from \$268 in 2018 to \$299 in 2019, resulting in an overall 2019 production value of \$96 million, a 10% increase from 2018. Beryllium production from Utah comes exclusively from the Spor Mountain mine in central Juab County. Bertrandite ore is mined from open pits and then is trucked to Delta, where it is processed at a purpose-built beryllium mill into beryllium hydroxide, which is then shipped out of state for further refining. The mine, mill, and downstream refineries are owned by Materion Corporation. The beryllium mill in Delta also processed minor amounts of beryl ore from outside Utah in 2019, for a total mill production of 323,940 lbs (162 tons) beryllium.

Table 3. Spor Mountain mine 2018-2019 production and reserves.

Production		Reserves			
Amount Mined		Total (Proven + Probable)			
2019	2018	2019 Tonnage	2018 Tonnage	2019 Grade	2018 Grade
323,900 lbs	324,100 lbs	8.8M tons	9.0M tons	0.248% Be	0.249% Be

Proven and probable reserve tonnage at Spor Mountain (table 3) dropped by 2% from 2018 to 2019, while grade remained relatively stable. The reserves at Spor Mountain are estimated to be enough to maintain mining at current production levels for another 75 years (Materion, 2020).

The Spor Mountain mine is the largest producer of beryllium in the world, accounting for approximately 65% of the world's annual production in 2019, which is why it was named as a critical mineral by the USGS in 2018. Most current critical minerals have a high import reliance that make them sensitive to supply chain disruptions; however, in the case of beryllium, the criticality is due to the risk of a single source accounting for such a large amount of production and the potential for severe supply chain disruptions should anything compromise supply from Spor Mountain. Beryllium is an essential component in aerospace and defense applications due to being lightweight but able to withstand significant temperature variations and mechanical distortion.

In late 2019, Materion joined with Ucore Rare Metals Inc., a rare earth element (REE) explorer, to develop a strategic assessment of the heavy REE market and supply chain in the United States. This collaboration is in response to an open request from the Department of Defense Industrial Base Analysis and Sustainment program and is planned to include an engineering evaluation of U.S. heavy REE separation and refining capabilities. The goal of the bid is development of a fully domestic heavy REE supply chain. Materion's role in the bid is related to their expertise with advanced metals research and downstream supply chain access, rather than mining.

Silver

Bingham Canyon mine was the state's sole producer of silver in 2019. Silver production increased from 2.5 million troy oz to 2.8 million troy oz (figure 8). The average price of silver dropped from \$12.27 in 2018 to \$11.79 in 2019, but despite the drop the overall production value increased by nearly 15%. Gold and silver production from the mine are strongly correlated, and both metals are recovered from the anode slimes produced during the final phase of copper refining. Despite the strong production performance seen in 2019, first quarter 2020 results show mined silver production has dropped over 25% from first quarter 2019, and more than 10% from fourth quarter 2019. The grade variability during 2020, compounded by earthquake- and COVID-19-related delays, are expected to impact overall production at Bingham Canyon and 2020 produced silver is anticipated to be lower than 2019.

Silver is often seen as both a precious metal and an industrial metal. It is considered a financial investment during turbulent times, but less so than gold. Silver is also an essential commodity for many modern electronic and industrial applications, such as photovoltaic cells for solar panels. Geopolitical, trade, and economic tension were the main controls on silver prices in 2019 and drove silver to the second largest price increase in a decade. 2020 has had sharp fluctuations but overall growth in spot prices. Silver-backed exchange-traded funds (ETFs) since the start of 2020 are tracking the price of gold, rather than the price of silver, suggesting safe-haven investment is increasing during the current COVID-19 pandemic, political, and economic uncertainties. Silver's role as an investment vehicle may continue to grow as passively managed funds become more common. Considering currency and industrial factors, it is anticipated silver price will keep current gains and may increase moderately.

Vanadium

In 2019, vanadium was produced from the White Mesa Mill in Blanding for the first time since 2012. Production from the mill for 2019 totaled 1,807,000 lbs V_2O_5 and was produced from "pond return," or vanadium in the tailings pond not recovered from previous processing activities (Energy Fuels Inc., 2020). Due to a collapse of vanadium prices in 2019, vanadium production at the mill ceased in the fourth quarter of 2019, and the pond return program stopped in early 2020. An estimated 1.5 to 3 million lbs of recoverable V_2O_5 remains in the tailings pond, awaiting future recovery under improved market economics.

Test mining to target high-grade vanadium intervals began in late 2018 and was completed in April 2019. The test mining required refurbishment of the La Sal-Beaver and Pandora mines in Energy Fuels' La Sal mining complex and yielded a total of 11,000 tons of ore (figure 9). The 2018 test mining yielded approximately 5000 tons ore averaging 1.60% V_2O_5 and 0.19% U_3O_8 , and the 2019 mining yielded an additional 6000 tons ore averaging 1.44% V_2O_5 and 0.17% U_3O_8 . A weighted average yields a total of 11,000 tons ore at 0.18% U_3O_8 and 1.51% V_2O_5 , equivalent to 39,600 lbs U_3O_8 and 332,200 lbs V_2O_5 . Additional surface and underground step-out drilling was also carried out to explore potential expansions of the known vanadium and uranium resources. The La Sal complex currently contains a measured, indicated, and inferred resource of 4,460,000 lbs U_3O_8 and 23,428,000 lbs V_2O_5 .

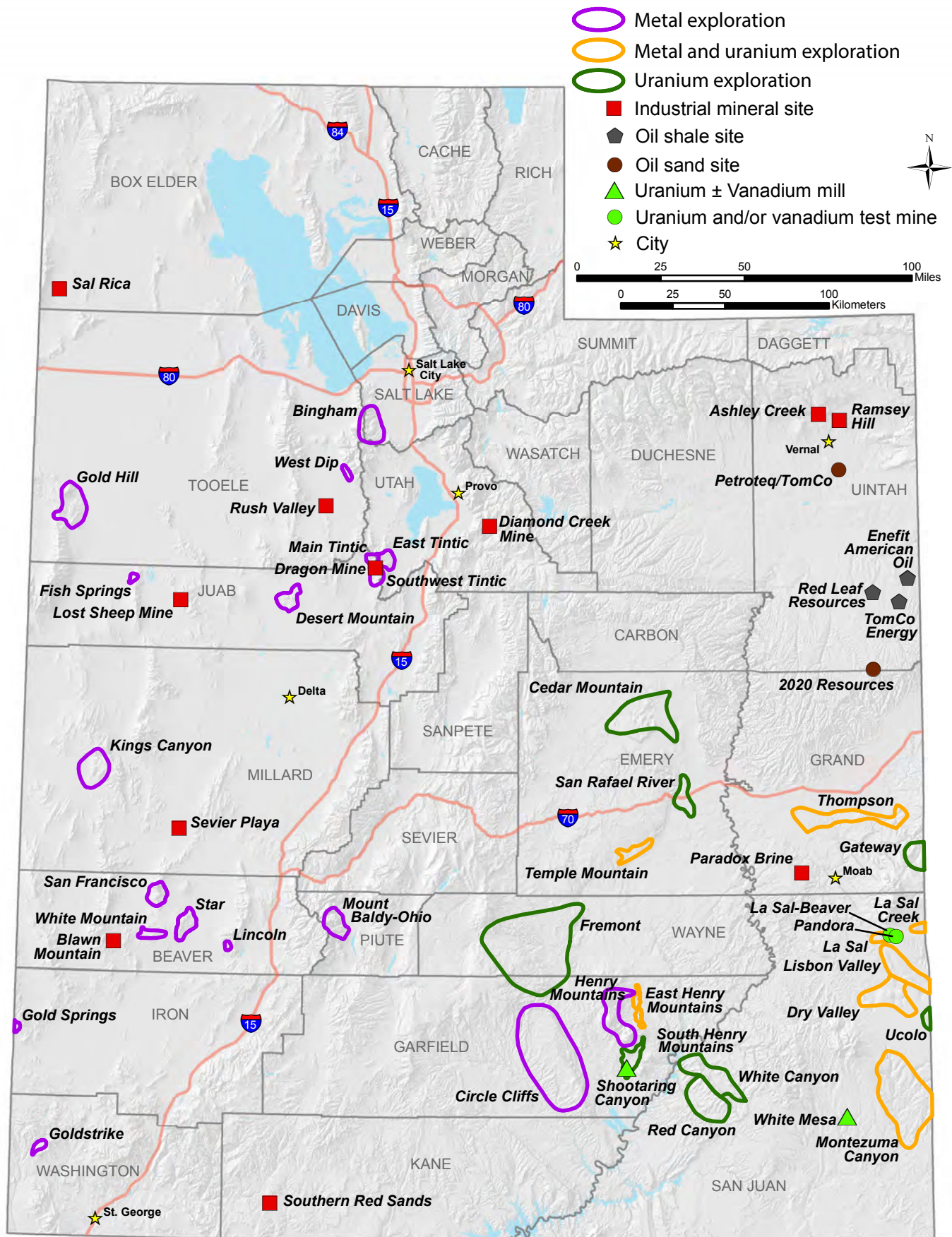


Figure 9. Select base and precious metal, industrial mineral, uranium-vanadium, oil shale, and oil sand exploration and development activity locations in Utah.

Vanadium production is not included in the 2019 Utah production numbers because material was sourced from the tailings pond material, rather than from ore mined in Utah. Although ore from Utah may have been part of the material in the tailings pond, it is not possible to obtain firm numbers. The material recovered during test mining may represent a future ore stream for the mill.

The vanadium price started 2019 having fallen drastically from a decadal high of over \$30/lb V_2O_5 in late 2018. Though at the beginning of 2019 the price appeared to stabilize around \$16/lb V_2O_5 , by mid-year the price had dropped by more than 50% to around \$8/lb V_2O_5 , where it has remained since. The high 2018 price was driven by expectations of higher demand due to China increasing the vanadium requirement in construction rebar, which has thus far failed to materialize. In the long term, vanadium redox flow batteries (VRBs) may become a more significant component of the renewable energy landscape due to their large-scale energy storage ability. However, the future size of the VRB market is unclear. Vanadium was identified as a critical mineral by the USGS in 2018 because it is essential to modern infrastructure (e.g., metallurgical alloys) yet the United States has a high import reliance (94%).

Exploration and Development

The information compiled in this section is from a variety of sources, including the UGS annual industry survey of mine operators, the Prospectors and Developers Association of Canada annual mining finance report (Prospectors and Developers Association of Canada, 2020), mining company websites, press releases, technical reports, personal communication with industry geologists, and the DOGM website (accessed May 2020).

Global trends in exploration and development activity and funding in the metallic minerals industry are closely tied to commodity market performance, although changes to exploration spending can often lag investment fluctuations, as in 2019. Exploration spending increased in 2017 and 2018, despite decreasing investment in the minerals industry. The decrease in investment caught up with exploration in 2019 and as a result saw a 19% decrease in global exploration financing from 2018 (and a 60% decrease from 2017), and a 3.5% decrease in global exploration spending from 2018 to 2019. Overall investment in the minerals sector continued to drop to a new decadal low, so a substantial increase in exploration spending in 2020 is unlikely. Exploration financing by commodity reflected global trends in 2019, with precious metals taking the largest share (78%) of exploration financing, the largest share since 2012. Gold and copper were the leading commodities in terms of exploration spending. Battery metals, especially lithium, saw a sharp decrease in exploration financing, following increases in 2017 and 2018. As in 2018, greenfields projects in 2019 made up the smallest portion

of exploration expenditure, and the share of global exploration by juniors has decreased by more than 20% in the last decade, as majors now contribute more than 50% of global exploration spending.

The impacts of the 2019 exploration financing and spending decreases were felt in Utah. Only four projects totalling 55,000 ft were drilled in 2019, versus six projects in 2018 totalling over 135,000 ft drilled. A large part of the reduction in feet drilled is due to the Goldstrike project having established a resource estimate and transitioning focus to metallurgical testing. However, Goldstrike alone cannot account for the almost 60% reduction in feet drilled in 2019, and this metric shows clearly the impact of reduced investment in junior and grassroots programs, and the reticence of majors to undertake large drilling programs for deep targets. Despite the grim picture given by the drilling numbers, exploration in Utah was quietly active, with many companies moving to expand and improve their land position while delaying traditional exploration activities. Land acquisition was most active related to vanadium projects, though several long-term base metal explorers such as Freeport-McMoRan in Southwest Tintic also increased their holdings. Details of some of Utah's larger exploration programs are presented below, and a broader look at exploration in Utah in 2019 is shown on figure 9 and summarized in table 4.

Precious Metals

The Gold Springs deposit, located in the Gold Springs district straddling the border with Nevada in Iron County, had a 14-hole reverse-circulation (RC) drilling program totalling 6090 ft in 2019. The program covered the Homestake target and the best hole, HS-19-007, included 20 ft averaging 21.9 g/t Au and 69.3 g/t Ag and 235 ft averaging 0.7 g/t Au and 1.9 g/t Ag. Hole HS-19-012 was drilled 1250 ft to the south and intersected a stacked set of three veins, totaling a mineralized interval of 125 ft averaging 0.63 g/t Au and 2.6 g/t Ag. The Homestake target is across the border in the Nevada portion of the Gold Springs project; however, the drilling results are included here because the majority of the Gold Springs resource is located in Utah. The total measured, indicated, and inferred geologic resource for the project is 780,000 troy oz Au and nearly 13 million troy oz Ag (Lane and others, 2017). Over 65% of the gold resource and 75% of the silver resource is located in Utah. TriMetals Mining, the exploration company, re-branded in 2019 to Gold Springs Resources. The company had planned a 28,500 ft drilling program for the second quarter 2020 around the Jumbo targets in Utah with a goal of publishing a new resource estimate by year end. However, with the economic and logistical disruptions caused by the COVID-19 pandemic, current exploration plans have been deferred.

The Goldstrike deposit, located in the Goldstrike district in northwest Washington County, had a 31,500 ft RC drilling program in 2019. This program was a follow-up to the 81,000 ft

Table 4. Select metal exploration and development projects in Utah, 2019. Districts are shown on figure 9.

County	District	Project	Commodity	Company ¹	Progress
Beaver	Lincoln	Cave Mine	Polymetallic	Grand Central Silver Mines Inc.	Expanded land position on ten BLM sections covering the Lincoln district
Beaver	San Francisco	Frisco	Polymetallic	Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.)	Entered joint venture agreement with Rio Tinto late 2019; field mapping, sampling, ground magnetics survey
Beaver	San Francisco	Frisco	Cu-Au	Rio Tinto Exploration	Entered joint venture agreement with Alderan late 2019; data compilation and review
Beaver	Star	Milford	Polymetallic	TAO Commodities Ltd.	Drilled 1995 ft diamond core (4 holes), intersected vein with true width intercept of 2.2 ft and high of 12.4 g/t Ag and 1.4% Zn
Beaver	White Mountain	White Mountain	Au	Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.)	Acquired land position, data review and target delineation, structural mapping, sampling
Emery	Temple Mountain	Temple Mountain	V-U	American Battery Metals Corp.	Acquired and expanded land position; exploration program delayed
Garfield	Circle Cliffs	Colt Mesa	Cu-Co	Glacier Lake Resources Inc.	Property dropped
Garfield	East Henry Mtns.	Desert Eagle	V-U	Global Vanadium Corp. (Global Vanadium Nevada Corp.)	Published NI 43-101 report in January 2019 (not locatable on SEDAR or company website)
Garfield	East Henry Mtns.	Cottonwood	V-U	Nortec Minerals Corp.	Acquired 1800 acre project from Utah Mineral Resources LLC in March 2019
Garfield	Henry Mountains	Bromide Basin	Au-Cu	Prolific Mining Corp.	Expanded land position on two BLM sections
Grand	Thompson	Copper Ridge	Cu	Delecta Ltd.	Proposed purchase of American Vanadium in November; acquisition terminated in December
Grand	Thompson	Cisco	V-U	American Vanadium Corp. (Cisco Minerals Inc.)	Expanded land position on six BLM sections
Grand	Thompson	Yellow Cat	V-U	Anson Resources Ltd.	Acquired 396 claims; geochemical sampling
Iron	Gold Springs	Gold Springs	Au-Ag	Gold Springs Resources Corp. (TriMetals Mining, Inc.)	Drilled 6,090 ft RC (14 holes) including 20 ft at 21.9 g/t Au, 69.3 g/t Ag; re-branded to Gold Springs Resources
Juab	Desert Mountain	Coyote Knoll	Ag-Au	Desert Mountain Gold, LLC	Dropped small mine and exploration permits in March 2019
Juab	Fish Springs	West Desert Skarn	Zn-Cu-In	InZinc Mining Ltd.	Target refinement following 2018 results; Utah Test and Training Range expansion consideration
Juab	Main Tintic	Tintic	Polymetallic	High Power Exploration Inc.	Regional IP survey, detailed mapping over CRD targets
Juab/Utah	East Tintic, Main Tintic	Tintic	Au-Cu	Tintic Consolidated Metals, LLC	Mine refurbishment, surface mapping and sampling, target delineation
Juab/Utah	Southwest Tintic	Southwest Tintic	Cu-Mo	Freeport-McMoRan Exploration Corp.	Expanded land position on 25 BLM sections south and east of SWT orebody
Millard	Kings Canyon	Thompson Knolls	Cu-Au	BCM Resources Corp./ Inland Exploration	Core review, 3D modelling, target refinement
Piute	Mount Baldy-Ohio	Deer Trail	Cu-Au	DT Mining, LLC	Acquired mine claim from Quintana WRP Holding Company, including Notice of Intent to Commence Large Mining Operations
Salt Lake/Tooele	Bingham	Bingham Orbit	Cu	Rio Tinto Exploration	Drilled 14,952 ft diamond core (5 holes); field mapping and sampling (86 rock and 318 soils samples)
San Juan	La Sal	Uravan	V-U	Spey Resources Corp.	Optioned ground in La Sal area from Geoxplor Corp. in January 2019, dropped project later in the year
San Juan	La Sal	Torado	V-U	Caelan Capital Corp. (Alba Minerals Ltd.)	Proposed acquisition of V-U prospects from Journey Exploration Inc. in May 2019; acquisition terminated August 2019
San Juan	La Sal Creek	Wray Mesa	V-U	United Battery Metals Corp.	Project dropped
San Juan	Lisbon Valley	Lisbon Valley	Cu	Lisbon Valley Mining Company, LLC	Expanded land position on five BLM sections; ISR studies and benchtop testing
San Juan	Montezuma Canyon, Dry Valley	San Juan Vanadium	V-U	North American Vanadium Corp.	Entered Other Business Arrangement lease with SITLA, subsequently cancelled
Tooele	Gold Hill	Kiewit	Au-Ag	Desert Hawk Gold Corp. and Clifton Mining Company	Expanded land position with 44 additional patented claims
Tooele	West Dip	West Mercur	Au	Rush Valley Exploration Inc.	Acquired two additional SITLA leases
Washington	Goldstrike	Goldstrike	Au	Liberty Gold Corp.	Drilled 31,500 ft RC including 1.40 g/t over 65 ft; phase 2 metallurgical testing with final Au extractions up to 95%

¹Parentheses indicate alternative or previous company names.

RC program in 2018 which helped to establish the initial indicated and inferred mineral resource of 1.14 million troy oz Au at an average grade of 0.54 g/t Au (SRK Consulting, 2018). Highlights from the 2019 drilling include 65 ft averaging 1.4 g/t Au, including 30 ft averaging 2.9 g/t Au, from 305 ft depth and 90 ft averaging 1.15 g/t Au, including 20 ft at 3.4 g/t Au, from 25 ft depth. Drilling focused on the Western, Main, and Dip Slope zones to further extend the resource, and the drilling demonstrated that mineralization in the existing resource model is still open to extension. Liberty Gold also undertook a second phase of metallurgical testing in 2019, following initial metallurgical work used in the 2018 Preliminary Economic Assessment (PEA) of the project. Goldstrike is a sediment-hosted oxide gold deposit with metallurgy favorable for heap leach extraction. The 2019 phase 2 metallurgical testing for simple heap leach mining demonstrated more than 80% of leachable gold was extracted in 10 days, and up to 95% was extracted in 50 days. The completion of 2019 mining and metallurgical testing marks the end of the current exploration push at Goldstrike, as the company is now shifting focus to its Black Pine project in Idaho. Work at Goldstrike in 2020 will involve reclamation of disturbance to allow for further drilling and examining options to secure water rights for mining.

In Beaver County, TAO Commodities conducted a four-hole diamond-core drill program on their Milford project in the Star district in 2019. The program targeted a silver-lead-zinc vein in the Silver Bear prospect, and hole SBDH-02 intersected the vein at a depth of 230 ft. True width of the vein is estimated at 2.2 ft, and the best two samples yielded a weighted average of 12.4 g/t Ag and 1.4% Zn. No other mineralization was intercepted. Following these results, TAO shifted focus to two other prospects, Moccasin and Captain Jack, and expanded the exploration focus to include gold. Mapping and reconnaissance sampling in late 2019 led TAO to develop a more structured exploration plan for 2020, including gridded soil sampling, detailed mapping, and evaluation of geophysical techniques.

Base Metals

The Bingham Orbit, referring to the area around the world-class Bingham Canyon Cu-Mo-Au porphyry in the Oquirrh Mountains, includes known but untapped deposits such as the Stockton porphyry and the Hidden Treasure skarn, as well as historic mining districts such as the Ophir district. Rio Tinto has been an active explorer in the Bingham Orbit for several years, both in search of new targets and seeking to extend known mineralization, typically focused on copper porphyry and skarn deposits. In 2019 Rio Tinto conducted a five-hole diamond core program totaling nearly 15,000 ft. In addition to drilling, the exploration program included mapping and sampling of both rock chip (86 samples) and soil samples (318 samples).

Rio Tinto, in a joint venture with Alderan Resources, was also active in the San Francisco mining district in Beaver County,

home of the Horn Silver and Cactus mines. The main area of the Frisco project is held by Alderan Resources, who drilled 10 diamond-core holes in 2018 targeting skarn and deep copper porphyry mineralization. Rio Tinto held ground around Alderan's claims, and in late 2019 the two companies entered into an earn-in and joint venture agreement. No drilling took place in 2019, as Alderan focused on following up the 2018 results with further field mapping and ground magnetic surveys, and Rio Tinto began reviewing Alderan's previous skarn and porphyry exploration. Rio Tinto began a diamond core drill program in Frisco in early summer 2020.

Alderan Resources holds several other properties in Beaver County in the White Mountain, Star, and Bradshaw districts but has yet to carry out a significant exploration program on these targets. In Spring 2020, Alderan began a joint venture with Tamra Mining, owner of the defunct Rocky Range mine, to explore the Valley-Crossroads target in Beaver County and the Drum Mountains district in Juab and Millard Counties with a focus on copper and gold.

The greater Tintic area, including Main, East, and Southwest Tintic, has had a resurgence of activity in 2018 and 2019. The most historically productive area of the East district (Burgin, Tintic Standard, North Lily mines) is held by Tintic Consolidated Metals (TCM), which took over the claims held by Chief Consolidated in early 2019. TCM began refurbishing the main shaft of the historic Trixie gold mine in late 2019 and has re-established access to the upper 625 level of the mine and commenced underground drilling from this level as of June 2020. Initial production is expected from the Trixie mine in 2021. TCM is also evaluating the potential of restarting the Burgin base metal mine, which is known to have 2.3 million tons indicated and inferred ore containing 18.5 million troy oz Ag, 40,000 troy oz Au, 281,000 tons Pb, and 102,000 oz Zn (Tietz and others, 2011), but the mine is under water and would require substantial refurbishment. In addition to mine operations, TCM is also advancing a robust portfolio of near-mine (e.g., North Lily) and regional exploration targets for base metal and porphyry copper deposits in East Tintic, and plans to drill test a number of high-grade gold exploration targets from surface in 2020. High Powered Exploration (HPX) entered the district in 2018 and holds ground to the west of Tintic Consolidated in the East district, in the Main district, and south into the Southwest district. HPX intended to begin a diamond drilling program in 2019, but drilling was delayed in favor of a regional induced-polarization (IP) survey and detailed prospect-scale mapping focused on carbonate-replacement style targets. Exploration plans for 2020 are focused on drilling to target a deep-seated porphyry genetically related to the shallow carbonate-replacement deposits; however, COVID-19 related disruptions may delay the planned drill program.

Freeport-McMoRan has held the main area of the Southwest Tintic district since 2014, including the Southwest Tintic ore body (estimated 1.5 billion tons at 0.21% Cu and 0.01% Mo)

and the Diamond Gulch chalcocite blanket (estimated 88 million tons at 0.16% Cu). Mineralization in the Southwest Tintic ore body does not begin until 1000 ft, and the depth of the resource has thus far stymied development. Freeport has focused on extending the deposit as well as looking for higher grade mineralization to improve the project economics. Three holes were drilled in late 2018 totaling 13,275 ft, one of the few deep exploration programs active in Utah. No drilling took place in 2019, with results from the 2018 program being reviewed and plans developed for the next stage of exploration. Freeport significantly expanded their land position to the south and east of the deposit in 2019, adding ground in an additional 25 BLM sections.

The trend of exploration in historical mining districts was not limited to Tintic, with DT Mining taking over the mining lease of the Deer Trail mine in the Mount Baldy-Ohio mining district in Piute County from Quintana in early 2019. The Deer Trail mine was actively mined from the early 1900s to 1981, but has not produced since. The mine has changed hands several times in the 2010s, with the last active phase of exploration in 2014 by Western Pacific Resources. The Deer Trail mine has been described as hosting manto, carbonate-replacement, polymetallic vein, and epithermal vein mineralization, and has produced significant silver and gold with secondary lead and zinc. Given the association with an intrusive stock, the presence of epithermal veins, and extensive alunite alteration, several geologists and explorationists have theorized that the district could host blind porphyry mineralization (e.g., Krahulec, 2018).

InZinc's West Desert Zn-Cu-In project is located in the Fish Springs district of western Juab County, about 70 miles west of Eureka. The West Desert deposit is a skarn hosted in Paleozoic basement intruded by an Eocene quartz monzonite. The current 2014 resource estimate for the project states an indicated and inferred resource of 2.9 billion lbs (1,455,600 tons) Zn, 316 million lbs (157,800 tons) Cu, and 3.5 million lbs (800 tons) In (Dyer and others, 2014). U.S. consumption for indium in 2019 was estimated to be 120 tons, meaning the West Desert project contains enough known indium to supply the United States for nearly seven years. At present the United States is 100% import reliant for indium, resulting in indium being one of the current critical minerals.

InZinc drilled five holes in 2018, and 2019 was spent evaluating results for further target delineation and future drill planning. Potentially complicating the land position of the project is the Utah Test and Training Range (UTTR) Land Exchange. The land exchange is in response to the federal National Defense Authorization Act for Fiscal Year 2017, which seeks to expand the range of the existing UTTR by closing BLM lands and acquiring SITLA lands through trade. The boundary of the expanded UTTR is now proposed to follow the Pony Express-Overland Stage Trail road that gives access to the West Desert project, such that west of the road falls within the UTTR.

While the West Desert deposit itself does not fall within the expansion area, the proposed site of the tailings impoundment does. The impact of the UTTR expansion on the mine plan is unclear as proposed closures may only be temporary or still allow for certain types of activities.

Vanadium

Vanadium had the most land position activity in 2019, with multiple companies expanding land position, acquiring land position, or dropping land position, all within the Colorado Plateau (San Juan, Emery, Grant, and Garfield Counties). Very little active exploration was carried out, likely due to the sharp drop in the price of vanadium in late 2018 and early 2019.

American Battery Metals took a position in the Temple Mountain district in Emery County in early 2019, focused on the Calyx Bench area. Temple Mountain is the seventh largest historical vanadium producing area on the plateau, but has some of the highest known vanadium grades. Vanadium mineralization is hosted in the Moss Back Member of the Triassic Chinle Formation and is associated with collapse breccias. American Battery Metals intended to begin an aggressive exploration program including a radon flux geophysical survey, trenching, sampling, and a 10-hole RC program for 3000 ft in spring 2019. The radon flux geophysical survey was completed; however, drilling was deferred. In May, American Battery Metals expanded their holdings by another 52 claims, doubling their land position. Little activity has occurred since.

The largest land position was taken by North American Vanadium Corp., who entered into an Other Business Arrangement (OBA) metalliferous minerals lease agreement with SITLA in late 2018. This agreement gave North American Vanadium Corp. access to ground on 157 sections in San Juan County for 10 years, with exploration and reporting requirements for the first three years and a minimum exploration spend exceeding \$450,000. The exploration requirements included sampling, geophysical surveys, and drilling and required submission of a report on the work completed. However, North American Vanadium Corp.'s funding fell through and the leases were subsequently cancelled.

Global Vanadium Corp. holds the Desert Eagle project in the East Henry Mountains mining district in Garfield County. They acquired the project in late 2018 based on historical grades of up to 28% V₂O₅, high ratios of vanadium to uranium, and an overall favorable location covering outcropping Salt Wash Formation, the main vanadium ore host for the plateau. No exploration activity is known for 2019, though the company notes they completed an NI 43-101 technical report on the project in January 2019. The report is not available on their website or through SEDAR, the Canadian Securities Administrators filing platform, where NI 43-101 reports are published. Why the report has yet to be made publicly available is unclear.

INDUSTRIAL MINERALS

Production

Industrial mineral production in Utah during 2019 had an estimated value of \$1.3 billion (figure 3), which is an increase of 6% from the revised 2018 value (figure 3). The largest contributor was the brine- and evaporite-derived products that include potash, salt, and magnesium chloride. These products had a combined value of \$483 million, a 12% increase from 2018, and accounted for 37% of Utah's total industrial mineral production value in 2019. The second-largest contributor was the sand and gravel, crushed stone (including limestone and dolomite), and dimension stone commodity group. These products had a combined value of \$364 million in 2019, a 10% increase from 2018, and accounted for 28% of the industrial mineral total. The third-largest contribution to the value of industrial minerals production came from the Portland cement and lime product group. These products had a combined value of \$270 million in 2019, a 3% increase from 2018, and accounted for 20% of the total industrial mineral value. Together, these three commodity groups contributed 85% of the total 2019 value of industrial minerals produced in Utah. The remaining value came from phosphate, gilsonite, clay, expanded shale, and gypsum.

Potash, Salt, and Magnesium Chloride

The brine- and evaporite-derived commodities produced in Utah include potash, salt (NaCl), and magnesium chloride. Potash is produced as both potassium sulfate (or SOP) and potassium chloride (muriate of potash or MOP).

Potash production in Utah totaled 482,000 st in 2019 and contributed the most value to this commodity group (figure 10). The 2019 estimated value of produced potash is approximately \$252 million, an increase of 4% from 2018. The higher value is primarily due to an increase in production and price of potassium sulfate and a substantially higher price of potassium chloride. Potassium chloride production was somewhat lower in 2019 from 2018. Compass Minerals Ogden produces potassium sulfate from Great Salt Lake brine, Intrepid Potash-Wendover produces potassium chloride from shallow brines in the Great Salt Lake Desert, and Intrepid Potash-Moab produces potassium chloride from a solution mining operation targeting deep, subsurface evaporites of the Pennsylvanian-age Paradox Formation (figure 2). Potassium sulfate has a significantly higher market value than potassium chloride. The primary use of both types of potash is fertilizer.

Utah salt production in 2019 amounted to approximately 3.2 million st and had a production value estimated at \$200 million (figure 10). About 78% of the salt was produced from Great Salt Lake brine by three operators: Compass Minerals Ogden, Cargill Salt, and Morton International (figure 2), in descending production order. The remaining 22% came from Redmond Minerals, Intrepid Potash-Moab, Intrepid Potash-

Wendover, and Willow Creek Salt. Redmond Minerals operates an underground mine near Redmond in Sanpete County (figure 2) and produces salt from the Jurassic-age Arapien Shale. Willow Creek Salt also produces a small amount from a surface mine east of Redmond in the Arapien Shale and recently converted their small mine permit to a large mine permit with DOGM. Salt produced in Utah is used for a variety of purposes including road deicing, water treatment, and agricultural and industrial applications. Redmond Minerals also produces food-grade salt from their underground operation.

In 2019, magnesium chloride production in Utah increased to 717,000 st and had an estimated production value of about \$33 million. The magnesium chloride brine was produced by Intrepid Potash-Wendover and Compass Minerals Ogden; the latter also produces small amounts of magnesium chloride flake. Magnesium chloride is commonly used as a premium road deicer and as a dust suppressant for unpaved roads.

The most significant source of brine-derived products in Utah is Great Salt Lake. An estimated 3.1 million st of total materials was produced from Great Salt Lake brine in 2019, including salt, potash, magnesium chloride, and magnesium metal. Production in 2019 was slightly higher than 2018. This estimate does not account for all byproducts, such as chlorine gas and some byproduct salt, so the actual total production is somewhat higher. The estimated value of mineral and brine production from Great Salt Lake in 2019 was \$587 million, which is an increase of about 17% from 2018.

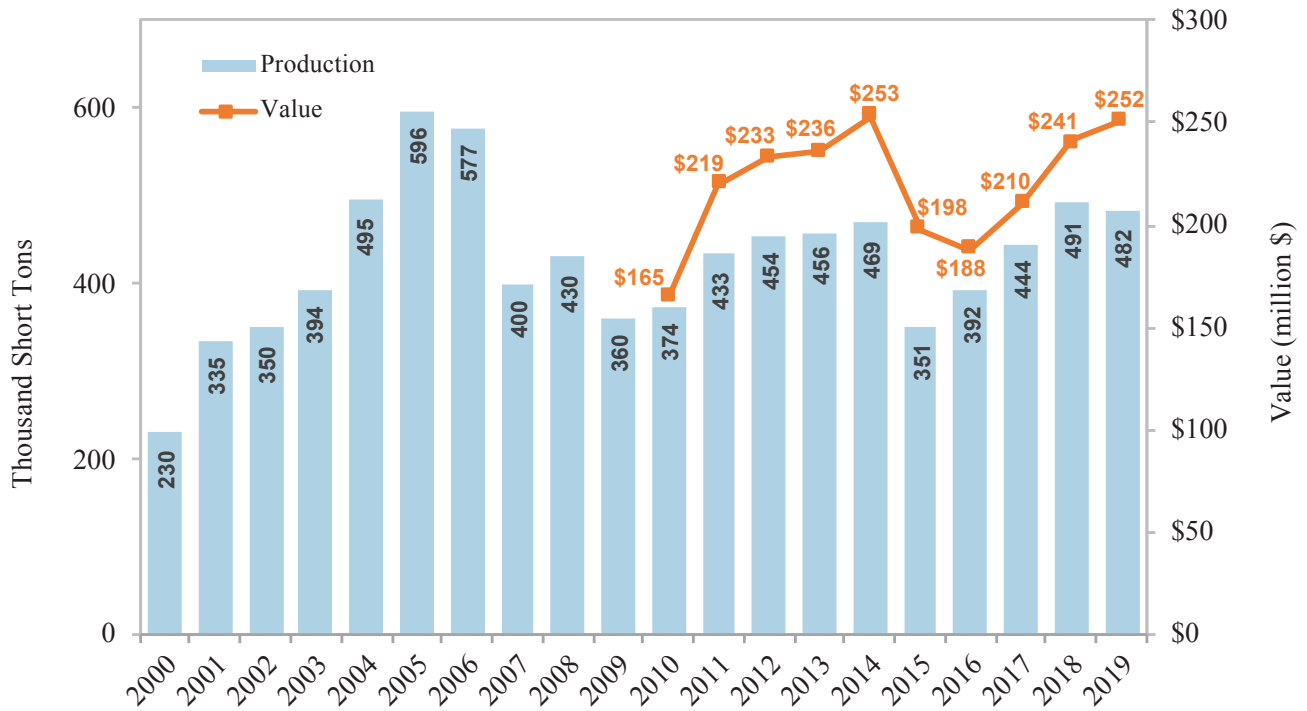
Sand and Gravel, Crushed Stone, and Dimension Stone

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 operators. However, the UGS does compile data from selected operators to track these commodities and uses USGS data for production and value estimates. During 2019, approximately 36 million st of sand and gravel was produced in Utah, up about 5% from revised 2018 estimates, and was worth \$267 million (USGS, 2020b). About 13 million st of crushed stone was worth \$94 million (USGS, 2020b), a 15% production increase from revised 2018 estimates, and several thousand tons of dimension stone was produced. Prices for crushed stone and sand and gravel increased slightly from 2018 to 2019. The recent construction boom in Utah, including large projects at the Salt Lake City International Airport and extensive residential projects, has kept construction aggregate demand relatively high (figure 11).

Portland Cement, Lime, and Limestone

Together Ash Grove Cement and LafargeHolcim produced about 1.7 million st of Portland cement in Utah during 2019, having an estimated value of \$193 million. Ash

Utah Potash Production (MOP + SOP)



Utah Salt Production

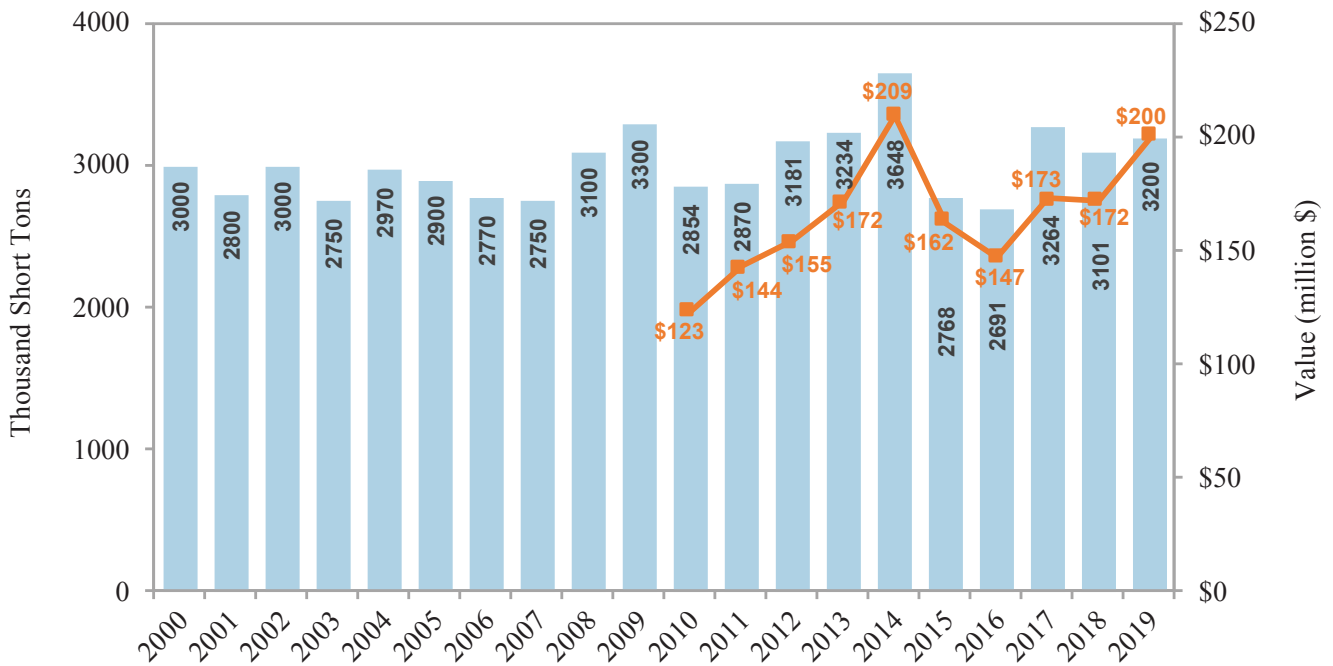
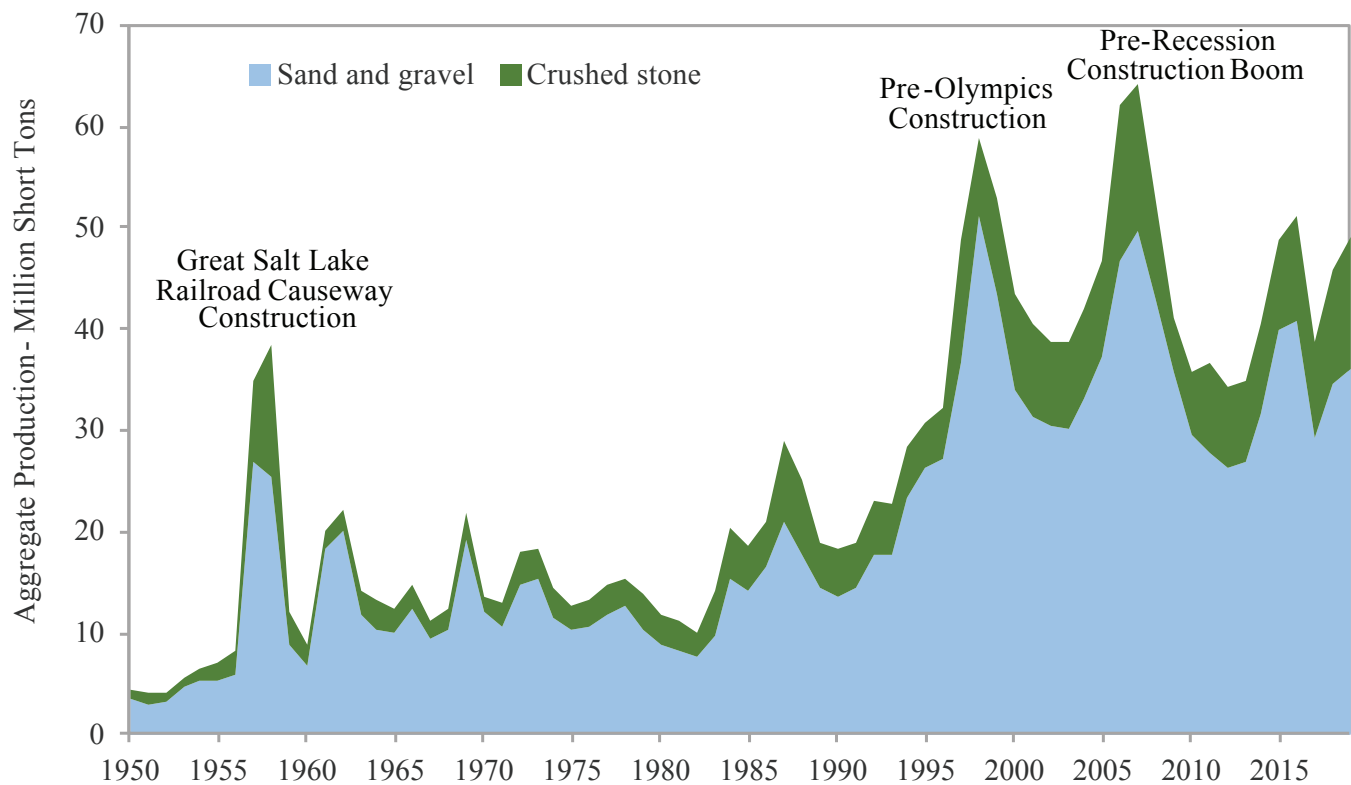


Figure 10. Production (since 2000) and value (since 2010) of potash (all types) and salt. Values in nominal dollars.



Source: U.S. Geological Survey

Figure 11. Utah aggregate production, 1950–2019.

Grove Cement operates the Leamington quarry and plant east of Leamington in Juab County, whereas LafargeHolcim operates the Devils Slide quarry and plant east of Morgan in Morgan County (figure 2). Portland cement production value increased 2% in 2019 due to modest increases in price (USGS, 2020a). Besides mining limestone for Portland cement, Ash Grove and Holcim also produce small amounts of sandstone, clay, and shale, which are lesser feedstock for their cement plants.

During 2019, Graymont Western U.S. was the sole producer of lime in Utah. Lime production increased about 6% in 2019. Graymont 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 2). Lime is used for flue gas desulfurization, steel production, and a variety of other construction, chemical, and industrial applications.

During 2019, several million st of limestone were produced for uses other than crushed stone. Most of that production was used to manufacture the aforementioned cement and lime, but a few smaller operations, such as Diamond Mountain Resources in Uintah County, produce limestone for flue-gas desulfurization at coal-fired power plants. Small amounts of limestone are also used as a safety product for the coal industry. Limestone “rock dust” is used to coat the walls of coal mines to keep coal dust from accumulating.

Phosphate

Simplot Phosphates continues to be the only active phosphate producer in Utah, mining the Meade Peak Member of the Permian Phosphoria Formation. The phosphate operation is located 12 miles north of Vernal in Uintah County (figure 2). In 2019, the mine produced nearly 3.5 million st of ore, which was 16% less than 2018 production. The ore yielded about 1.3 million st of phosphate concentrate (about 30% P_2O_5) after processing. The concentrate is transported in slurry through a 96-mile underground pipeline to the Simplot fertilizer plant near Rock Springs, Wyoming. More than 95% of the phosphate rock mined in the United States is used to manufacture phosphoric acids to make ammonium phosphate fertilizers and animal feed supplements (USGS, 2020a).

In 2019, Simplot completed permitting a significant revision to their mine plan with DOGM. They plan to expand their existing mine to the east (east of U.S. 191) on private property owned by the company. The expansion includes plans to continue production through the year 2076.

Gilsonite

Gilsonite is a shiny, black, solid hydrocarbon that occurs in a swarm of narrow, but laterally and vertically extensive veins in the Uinta Basin. It has been mined since the late 1880s,

mostly in Utah with some minor production in the Colorado part of the basin. In 2019, American Gilsonite Company was the primary producer, mining and processing gilsonite at their operation in southeastern Uintah County (figure 2). A small amount of gilsonite was also produced by Table Rock Minerals, LLC at the TRM #1 mine that is on a SITLA lease in the Uinta Basin south of Ouray in Uintah County. The mine began operating in 2018 and has the capacity to extract about 10,000 tons of gilsonite per year. The mine is in the Cottonwood vein.

Over the past decade, gilsonite production from the Uinta Basin has ranged between 20,000 and 85,000 st per year, depending on market conditions (specific production and price data are proprietary). Production for American Gilsonite was significantly reduced in 2016 as the company underwent Chapter 11 bankruptcy reorganization, but production increased in 2017 as the company emerged from bankruptcy and has been relatively steady since then. Utah is the only place in the world that contains large deposits of gilsonite, which has been shipped worldwide for use in numerous and diverse products including asphalt paving mixes, coatings, inks, and paints (Boden and Tripp, 2012). More recently, the oil and gas industry has used gilsonite as an additive in drilling fluids. Gilsonite helps control fluid loss and seepage, increase wellbore stability, prevent loss of circulation, and stabilize shale formations.

Bentonite, Common Clay, and High-Alumina Clay

Clay production in Utah totaled at least 321,000 st in 2019. Clay is produced at various small and large mines, often on an intermittent basis. Consequently, production and value estimates are subject to significant change on a year-to-year basis. Bentonite was produced by Western Clay and Redmond Minerals. Uses for bentonite include well drilling and foundry operations, various civil engineering applications, and as litter-box filler. Some of the largest producers of clay are Interstate Brick (common), Ash Grove Cement (high-alumina clay), and LafargeHolcim (high-alumina clay). Common clay is largely used to make bricks, whereas high-alumina clay is most commonly used to make Portland cement in Utah. Applied Minerals Inc. produced a small amount of specialty clay (halloysite) and iron oxide from the Dragon Mine in the Tintic Mountains. Applied Minerals has been actively researching potential applications and markets for halloysite over the past several years. In late 2019, Applied Minerals announced that it would supply a U.S.-based cement manufacturer with 30,000 tons per year of unmilled iron oxide. Previously, in 2018, they also sold about 4.5 million tons of mixed clay and iron oxide from existing surface piles for use as pozzolan, which is a cement alternative, extender, or enhancement.

Expanded Shale

Expanded shale in Utah is produced by Utelite at their quarry and plant near Wanship in Summit County (figure 2). In

2019, Utelite produced approximately 170,000 st of expanded shale, which is a lightweight aggregate sometimes called “bloating shale” mainly used by the construction industry. Expanded shale is produced by rapidly heating high-purity shale, derived from the Cretaceous-age Frontier Formation, to about 2000°F causing it to expand and vitrify. The resulting aggregate is durable, inert, uniform in size, and lightweight, having a density about one-half that of conventional aggregates. The material is used in roof tile, concrete block, structural concrete, and horticulture additives, as well as for highway construction and geotechnical fill. About half of Utelite’s production is used locally along the Wasatch Front and the rest is shipped out of state.

Gypsum

Four operators reported combined gypsum production in Utah of about 421,000 st in 2019, a modest increase from the 2018 reported production. The estimated value of 2019 gypsum production is \$5.5 million, 11% higher than 2018. Higher value calcined gypsum production was up from 2018 to 2019, while lower value crude gypsum production was about the same. The four Utah gypsum producers were Progressive Contracting, Inc., United States Gypsum Co., Sunroc Corp., and Diamond K Gypsum (in descending production order). Two gypsum wallboard plants are located near Sigurd in Sevier County, but only the United States Gypsum plant is active (figure 2). 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

Exploration and development activities involving industrial mineral commodities in Utah included potash, lithium, hydraulic fracturing sand (frac sand), fluorspar, pozzolan, and phosphate (table 5). This summary generally does not include information on development of smaller aggregate or construction material operations, which are difficult to track but often make up a significant component of industrial mineral development. The information for this section is derived primarily from company websites, press releases, DOGM records, and personal communications.

Potash

For the past decade or so, interest in Utah potash has led to several potash exploration projects, but recent, relatively low potassium chloride (or MOP) prices have resulted in project advancement being focused on potassium sulfate (or SOP) projects. Following a completed feasibility study in 2018 (Brebner and others, 2018), a final environmental impact statement was published and a Record of Decision was awarded by the BLM in 2019 to Crystal Peak Minerals’ Sevier Playa

potash project. They have also received tentative approval of their mine permit from DOGM. Crystal Peak Minerals is developing an SOP project in a shallow brine deposit on the Sevier Playa/Lake in Millard County (figure 9). The company intends to use solar ponds and a processing plant to produce about 370,000 st of SOP per year with an estimated mine life of 30 years. Reportedly, the company is seeking additional funding to initiate the project.

SOPerior Fertilizer Corporation (formerly Potash Ridge Corporation) has a project in the Blawn Mountain area in Beaver County (figure 9) to produce SOP and potentially alumina from alunite. The alumina resource was added to their prefeasibility study in 2017 (Kerr and others, 2017), but the project has not advanced substantially in the last few years. In the past decade, a few companies have completed potash-related drilling programs in the Paradox Basin, but limited activity has occurred in the last couple of years on any Paradox Basin projects. Exploration in the Paradox Basin focuses on MOP production rather than SOP.

Lithium

Following increased demand and rising prices for battery materials, Utah has become a target for lithium exploration in the past few years and the focus has been on Utah's potential in brine resources. Thousands of lithium claims were staked in Utah during 2016 and 2017 amidst rising prices and projected demand; however, relatively few claims were staked in 2018 and 2019. As previously mentioned, US Magnesium is poised to become Utah's first lithium producer, producing lithium as a byproduct of their magnesium refining process from Great Salt Lake brine. Other projects have targeted brines in a variety of other locations throughout the state, but activity in 2019, outside the Great Salt Lake area, was mostly limited to the Paradox Basin and Pilot Valley.

Anson Resources holds a large block of claims (their Paradox Basin Brine project) near Moab in Grand County (figure 9) and re-entered four oil and gas wells during 2018 and 2019 to test brine flow rates and chemistry from the Paradox Formation.

Table 5. Select industrial mineral exploration and development projects in Utah, 2019.

Project	Commodity; Deposit	Location	County	Company	Progress
AMP Trace mine 1	Soil amendment; volcanic tuff	North of Fayette	Sanpete	Azomite Mineral Products, Inc.	Converted their small mine permit to a large mine permit in 2019; Azomite produces a soil amendment from a (Oligocene?) volcanic tuff
Blawn Mountain	Potash (SOP) and alumina; alunite alteration	Blawn Mountain; Wah Wah Mtns.	Beaver	SOPerior Fertilizer Corp. (formerly Potash Ridge Corp.)	Changed name of company; completed prefeasibility study in 2017; minimal reported activity in 2018 and 2019
Diamond Creek mine	Phosphate; Meade Peak Mbr. of Phosphoria Fm.	Diamond Fork	Utah	Falcon Isle Resources	Defined a small resource of about 74,000 tons of phosphate rock; intends to mine a few thousand tons per year as organically certified phosphate; completed a mine permit with DOGM in early 2020
Lost Sheep mine	Fluorspar; breccia pipes	Spor Mountain district	Juab	Ares Strategic Mining	Acquired the Lost Sheep mine in 2019/2020 to restart and expand fluorspar production; completed a 17-hole, 4000-foot drilling program in mid-2020
Paradox Basin Brine	Lithium; brine	Paradox Basin	Grand	Anson Resources Ltd	Re-entered four O&G wells for brine samples in 2018 and 2019; released a JORC resource estimate containing 210,000 tons of lithium carbonate equivalent; evaluating byproduct bromine, boron, and iodine
Ramsey Hill	Frac sand	North of Vernal	Uintah	Ramsey Hill Exploration	Began producing frac sand from a mine north of Vernal in 2019; received a conditional use permit from Uintah County
Rush Valley	Pozzolan; volcanic ash	Rush Valley	Tooele	Geofortis	Drilled 39 holes (2300 feet) to evaluate a potential pozzolan deposit in the Salt Lake Formation; the material has been approved for use in concrete by UDOT
Sal Rica	Lithium; shallow brine	Pilot Valley	Box Elder	Westwater Resources	Completed some limited brine sampling in shallow auger holes during 2017; received water rights for 1500 acre-feet per year in early 2019
Sevier Playa	Potash (SOP); shallow brine	Sevier Playa/Dry Lake	Millard	Crystal Peak Minerals Inc.	Published feasibility study in early 2018; final EIS published and Record of Decision awarded by BLM in 2019; tentative approval of mine permit by DOGM

Analyses of brine from the tested wells have yielded lithium concentrations up to 253 ppm. They also released a JORC-compliant resource estimate in 2019 and updated that estimate in 2020 (Anson Resources, 2020). Their most recent estimate contains an indicated and inferred 210,000 tons of lithium carbonate equivalent in brine. This resource is found in multiple, deep subsurface horizons and average lithium concentrations for the horizons are estimated to range from 73 to 175 ppm. Anson is also evaluating coproduct/byproduct bromine, boron, and iodine. At Pilot Valley in Box Elder County, Westwater Resources was awarded a water right for 1500 acre-feet per year in early 2019 for their Sal Rica project (figure 9), but they reported minimal other activity. The Sal Rica project is focused on a lithium resource in a shallow brine aquifer that shows lithium concentrations up to around 100 ppm.

Frac Sand

As horizontal oil and gas wells reach ever greater lengths—laterals in the Uinta Basin now reach up to 11,000 feet—oil and gas companies have increased the amount of frac sand used in hydraulic fracturing stimulations, up to 22 million pounds per well. As a result, demand for frac sand increased and specifications for frac sand shifted or relaxed to some degree. Changing specifications opened more opportunity for producing frac sand from sources in Utah that may not have met traditional specs. Frac sand is typically mined from unconsolidated sand deposits or friable sandstone, and ideally, the sand grains from these deposits are well rounded, strong, and appropriately sized. Over the past few years, companies have investigated potential resources in southwestern Utah, western Utah, central Utah, and the Uinta Basin. One company, Ramsey Hill Exploration, began producing frac sand in late 2019 at a mine on private land north of Vernal to supply the Uinta Basin (figure 9). They are currently operating under a conditional use permit from Uintah County. Other companies are also investigating frac sand opportunities in the Uinta Basin. Southern Red Sands LLC (formerly Integrated Sands) held a large land position that included SITLA and federal lands in Kane County during 2019 (figure 9). They intended to produce about 700,000 tons per year of 30/50, 40/70, and 100 mesh proppant from eolian sands in the area, but, due to local opposition and possibly market dynamics, abandoned those plans in early 2020. Interest in Utah frac sand may wane significantly in the near term due to historic drops in oil price during 2020 that have led to reduced oil and gas drilling in the Uinta Basin and elsewhere.

Fluorspar

During 2019, Ares Strategic Mining began acquisition of the Lost Sheep fluorspar mine in the Spor Mountain district in Juab County (figure 9) in anticipation of re-starting and expanding production. Historically, the Lost Sheep mine is the most productive fluorspar mine in Utah and has produced about 170,000 tons of fluorspar from a series of breccia pipes. DOGM records indicate that the mine produced about 8000 tons of ore from 1993 to 2007 and reported a nominal amount

of production in 2018. Ares completed the acquisition of the mine in early 2020 and subsequently completed a 17-hole, 4000-foot drilling program in mid-2020 to delineate the fluorspar resource. An NI 43-101 technical report for the property was completed in 2019 (Hughes, 2019) prior to the recent drilling, but the report did not include a resource estimate. The mine has an active small mine permit with DOGM. Fluorspar is considered a critical mineral and the United States is almost completely import reliant for the mineral, so if the Lost Sheep mine resumed significant production it would likely be the largest fluorspar producer in the United States.

Pozzolan

Pozzolan is a material, typically high in silica and alumina, that has cementitious properties and can be used as an alternative to cement or to extend or enhance cement. Natural pozzolans are commonly volcanic. The benefits of pozzolans over conventional cement production include manufacturing cost reduction and greenhouse gas emission reduction. Interest in natural pozzolanic material has increased recently as availability of fly ash, a common manufactured pozzolan, has decreased. Multiple companies have been looking at potential natural pozzolan resources in Utah, and one company, Geofortis, has done some exploration and evaluation of volcanic ash in Rush Valley, Tooele County (figure 9). In 2019 and possibly early 2020, they drilled a total of 2300 feet in 39 holes to evaluate the potential deposit in the Tertiary-age Salt Lake Formation. In May 2020, Geofortis announced that they received approval from the Utah Department of Transportation (UDOT) for use of their pozzolan in concrete.

Phosphate

In early 2020, Falcon Isle Resources received approval for a small mine permit from DOGM to produce modest amounts of organically certified phosphate from their Diamond Creek phosphate mine near Diamond Fork, Utah County (figure 9). They intend to extract a few thousand tons of phosphate rock per year from a roughly 7-foot-thick zone of the Meade Peak Member of the Permian-age Phosphoria Formation that grades approximately 25% to 30% P_2O_5 . The company has currently outlined a resource of about 74,000 tons in a 3.3-acre area. The area was previously mined in 1980 but has since been idle. Utah Phosphate Company (a subsidiary of Nutrien) has been evaluating an industrial-scale phosphate project at Ashley Creek in Uintah County (figure 9), which is west of Simplot's phosphate operation, but little advancement of the Ashley Creek project has occurred in the past few years.

URANIUM

The most significant development in uranium during 2019 was the progression of the Section 232 of the Trade Expan-

sion Act of 1962 petition submitted to the U.S. Department of Commerce by Energy Fuels and Ur-Energy in January 2018. The petition was predicated on uranium imports from countries such as Russia, Kazakhstan, Uzbekistan (together estimated to represent more than 40% of U.S. demand), and China undercutting U.S. uranium production due to being heavily state-subsidized. The remedies recommended by the uranium companies were to implement an import quota (effectively reserving 25% of the U.S. market for domestic production), and requiring U.S. federal agencies to purchase domestic uranium. The Department of Commerce initiated the petition investigation in July 2018, and their findings were submitted to the White House in April 2019. Acceptance of at least some of the uranium companies' suggestions was widely expected, based on previously enacted Section 232 tariffs on aluminum and steel. However, in July 2019 the Trump administration declined to take any regulatory action, instead issuing a Presidential Memorandum to create a Nuclear Fuel Working Group tasked with examining the entire nuclear fuel chain, from mining to end use (energy, defense, etc.). Despite the decision not to take regulatory action under Section 232, in February 2020 when the President's Budget was released, it included \$150 million annually for 10 years (totalling \$1.5 billion) to create a U.S. uranium reserve and thereby support domestic uranium miners. The President's Budget will likely receive significant reworking as it goes through Congress, so it remains to be seen what the final iteration of the proposed uranium reserve will be. In the United States in 2019, 91% of uranium used in nuclear power reactors was imported, the highest amount of foreign-sourced uranium since 2016 (U.S. EIA, 2020c). Domestic production of uranium concentrate in 2019 totalled 170,000 lbs, which is an 89% decrease from the 1.65 million lbs produced in 2018, and is one of the starkest metrics by which the decline in the domestic uranium industry can be seen (U.S. EIA, 2020d).

Uranium prices in 2019 loosely followed the progression of the Section 232 petition. Prices began to lift in summer 2018 and remained around \$27/lb U_3O_8 until late spring 2019. Prices dropped slightly to hover around \$25/lb U_3O_8 until February 2020, when prices began increasing and surpassed \$33/lb U_3O_8 as of April 2020, the highest prices since 2016. Factors driving the increase in uranium prices include the potential for domestic uranium protection, structural undersupply in the current market, recovery of nuclear output to pre-Fukushima levels, and the compounding complications of the COVID-19 pandemic disruptions. Major global uranium producers such as Cameco and Kazatomprom have been cutting production due to long-term depression of uranium prices, and existing stockpiles are dwindling as a result of the reduced production. Current global uranium consumption sits around 180 to 190 million lbs U_3O_8 , but global production in recent years has been 120 to 140 million lbs. The situation has only worsened in 2020 with significant disruptions to more than 50% of global uranium operations due to COVID-19. Given that the supply

shortage underpinning the price increase is unlikely to be remedied in the short term, uranium prices are expected to continue increasing in 2020.

Production

No uranium concentrate was produced in Utah in 2019. Active uranium mining has been suspended in Utah since 2012; however, uranium concentrate had continued to be produced at the White Mesa Mill from tailings and alternate feeds since cessation of mining. In 2019, Energy Fuels, owner of the White Mesa Mill, focused solely on vanadium extraction at the facility, resulting in the first year that no uranium was produced out of Utah since the mill's refurbishment in 2008. Energy Fuels has since suspended vanadium refinement and uranium concentrate production in 2020 is expected to be 120,000 to 170,000 lbs U_3O_8 from in-circuit material left over from the 2019 vanadium processing, and from alternate feeds. The in-circuit material and alternate feeds are expected to keep the mill operating during 2020 (Energy Fuels Inc., 2020). However, in January 2020 Energy Fuels laid off one-third of its workforce in Utah (24 of 79 employees) due to the price of uranium remaining below the production costs. Energy Fuels is the largest private employer in San Juan County, and estimates of layoff impacts have compared the loss of 24 jobs in San Juan County as equivalent to the loss of over 4900 jobs in the higher population density Wasatch Front. Despite Energy Fuels' employment of many local residents, members of the nearby Ute Mountain Ute tribe marched in May 2019 for the third year over concerns of negative impacts from the mill.

As discussed in the vanadium production section, Energy Fuels also undertook a small test mining project in their La Sal and Pandora mines from late 2018 to early 2019 (figure 9). A total of 11,000 tons of ore was mined at an average grade of 0.18% U_3O_8 and 1.51% V_2O_5 , the equivalent of 39,600 lbs U_3O_8 and 332,200 lbs V_2O_5 . The test mining is not included in the 2019 production numbers because it did not represent the intention to become an economic mining operation. The test mining involved refurbishment of the La Sal-Beaver and Pandora mines, which are now pursuing operational readiness should the uranium price reach an economic level to support active mining again in 2020. Step-out exploration holes were also drilled during the test mining phase to explore potential expansions of the known ore body. Energy Fuels' La Sal complex currently contains a measured, indicated, and inferred resource of 4,460,000 lbs U_3O_8 and 23,428,000 lbs V_2O_5 .

Energy Fuels continued to pursue additional processing capabilities at the White Mesa Mill in 2019, such as seeking permitting that would allow copper recovery. The hope of recovering copper is related to the company's Canyon mine in Arizona, which has a measured and indicated resource of 12 million lbs Cu in addition to the uranium resource. Energy Fuels also applied to the Utah Division of Waste Management and Radiation Control in April 2019 to amend their radioactive materials license to be able to accept radioactive waste

from overseas, such as from the Silmet rare metals processing plant in Estonia. In early 2020, Energy Fuels announced they would also begin investigations into the ability of the mill to process rare earth element ores.

Anfield Energy (previously Anfield Resources), which owns several past-producing uranium mines and the idled Shootaring Canyon conventional uranium mill 50 miles south of Hanksville, advanced their Utah Pollutant Discharge Elimination System (UPDES) permit application for the Velvet mine with the Utah Division of Water Quality (DWQ). In October 2019, DWQ issued a public notice for their intention to grant the UPDES permit, and the public comment period closed in November 2019. The Velvet-Wood deposit (combined Velvet and Wood mines) historically produced about 4 million lbs U_3O_8 and 5 million lbs V_2O_5 , and was last operational in 1984. The historical measured, indicated, and inferred resource for the deposit is estimated to be 5.24 million lbs U_3O_8 at an average grade of 0.271% U_3O_8 (Beahm and McNulty, 2016). Anfield also applied for a license renewal for the Shootaring Canyon mill in 2017, and the application is currently under review by the Division of Waste Management and Radiation Control. Anfield acquired the Shootaring Canyon mill in 2015; however, the mill has not operated since 1982. The facility is licensed for 750 tons of ore per day via conventional acid-leach extraction and is one of only three licensed conventional uranium mills in the United States (White Mesa being one of the other two). An estimated 370,000 lbs U_3O_8 is present in surface stockpiles associated with the mill.

Exploration and Development Activity

Exploration for uranium in Utah remained subdued in 2019 given the uncertainty about uranium price, the Section 232 petition, and the Nuclear Fuel Working Group. A number of small uranium exploration companies hold ground in Utah, but very few conducted any active exploration work. A selection of Utah's uranium resources and exploration projects is listed in table 6. Gone Fission Mining expanded their position into one additional BLM section on the border of the Red Canyon mining district in San Juan County. Voyager Energy took a land position in 12 BLM sections in Wayne and Garfield Counties, in the Fremont, South Henry Mountains, and East Henry Mountains districts. As described above, Energy Fuels completed step-out drilling as part of their test mining activities in the La Sal mining district in San Juan County. The most notable activity related to the claims of Voyager Energy, subsequently acquired in late 2019 by GTi Resources, who developed an aggressive exploration plan in early 2020. Thor Mining (Vanadium King project in and around the Thompson mining district, Grand County, through acquisition of American Vanadium Corp./Cisco Minerals) and TNT Mines (East Canyon project in Dry Valley district, San Juan County, through acquisition of Vanacorp) also acquired lands on Utah's Colorado Plateau and both have exploration plans for 2020.

COAL

Production

Five Utah coal operators produced 14.3 million st of coal valued at \$481 million from seven underground mines and one surface mine in 2019 (figures 12, 13, and 14; table 7). After decreasing slightly in 2018, production increased by 4.3% in 2019, mainly due to increased production at the Lila Canyon, Skyline, and Emery mines. In contrast, the Sufco and Coal Hollow mines experienced decreased production in 2019 due to difficult mining conditions, and the Dugout mine went idle in the third quarter of 2019. After several years of decline, employment at active or recently active mines increased 6.2% in 2019 to 1397 employees—an 18% increase from a low of 1185 employees in 2016—but is still far below the 2028 employees recorded in 2008 (figure 15). Employment is expected to drop slightly in 2020 due to the idling of the Dugout mine. Demand at Utah coal-fired power plants was fairly stable from 2000 to 2015 at about 15.2 million st a year, but from 2016 to 2019, demand has dropped to an average of 11.8 million st per year (figure 16). In addition, fuel switching or closure at other U.S. coal-fired power plants outside of Utah has reduced domestic demand for Utah coal to near historical lows. However, Utah operators have recently taken advantage of a strengthening foreign export market, sending an estimated 2.2 million st of coal overseas to Asia in 2019 (figure 17). Even with the export market contributing a steady 2.0 million tons toward Utah's coal demand, Utah's total production is expected to decrease slightly to about 13.9 million st in 2020.

In 2019, the vast majority of Utah coal, 9.3 million st, was produced from the Wasatch Plateau coalfield; 4.1 million st came from mines in the Book Cliffs coalfield, 0.7 million st from the Emery coalfield, and 0.2 million st from the Alton coalfield (figure 14; table 7). The majority of Utah coal in 2019, 92% (13.3 million st), was produced from federal land, whereas only 0.2% (28,000 st) was from state-owned land (figure 15). Federal coal production has dominated in Utah since 2011, when the now-closed 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, from 48% in 2011 to 84% in 2012. The remainder of Utah's 2019 coal production came from private lands (7.4%, 1.1 million st) at the Castle Valley, Emery, and Coal Hollow mines.

The total amount of Utah coal distributed to the U.S. market in 2019 was 11.3 million st, about 400,000 st more than 2018 (figure 17). As recently as 2008, Utah operators distributed 24.9 million st of coal—over 9.2 million st was exported to other states and 15.7 million st was used in-state. In 2019, only 2.1 million st of Utah coal was shipped to other states, while 9.2 million st was used locally. The vast majority of Utah coal, about 83% (9.4 million st), went to the electric utility market

Table 6. Select uranium projects in Utah, 2019. District locations are shown on figure 9.

County	District	Property	Company	2019 Activity	Existing Resource ¹
Emery	Cedar Mountain, San Rafael River, Temple Mountain	Tidwell District Area	enCore Energy Corp.		2.3M t at 0.07% U ₃ O ₈ historic resource
Emery	San Rafael River	San Rafael	Western Uranium and Vanadium Corporation		571,400 t at 0.26% U ₃ O ₈ historic indicated and inferred resource
Garfield	South Henry Mountains	Frank M	Anfield Energy Inc.		1.1M t at 0.10% U ₃ O ₈ indicated resource
Garfield	South Henry Mountains	Henry Mountains Complex	Energy Fuels, Inc.		4M t at 0.26% U ₃ O ₈ measured, indicated, and inferred resource
Garfield, San Juan, Wayne	Fremont, South Henry Mountains, East Henry Mountains	Henry Mountains Project	Voyager Energy Pty Ltd	Expanded land position on 12 BLM sections; entered in to acquisition agreement with GTi Resources	
Grand	Gateway	Whirlwind	Energy Fuels, Inc.		625,000 t at 0.25% U ₃ O ₈ indicated and inferred resource
San Juan	La Sal	La Sal Complex	Energy Fuels, Inc.	Refurbishment and test mining yielding 11,000 t at 0.18% U ₃ O ₈ and 1.51% V ₂ O ₅ (La Sal-Beaver and Pandora mines)	1.3M t at 0.17% U ₃ O ₈ measured, indicated, and inferred resource
San Juan	Lisbon Valley	Velvet-Wood	Anfield Energy Inc.	Advanced Utah Pollutant Discharge Elimination System permit application with Utah Division of Water Quality	810,800 t at 0.29% U ₃ O ₈ measured and indicated resource
San Juan	Red Canyon	Daneros	Energy Fuels, Inc.		27,000 t at 0.36% U ₃ O ₈ measured, indicated, and inferred resource
San Juan	Red Canyon	Red Canyon	Gone Fission LLC	Expanded land position on 1 BLM section	
San Juan	Ucolo	Sage Plains	Energy Fuels, Inc.		23,000 t at 0.16% U ₃ O ₈ measured, indicated, and inferred resource
San Juan	Ucolo	Sage	Western Uranium and Vanadium Corporation		141,000 t at 0.21% U ₃ O ₈ historic measured, indicated, and inferred resource
San Juan	Undefined	White Mesa Mill	Energy Fuels, Inc.	Uranium production idled in favor of vanadium production	
San Juan	Undefined	Shootaring Canyon Mill	Anfield Energy Inc.	Continuation of 2017 license renewal application with Division of Waste Management and Radiation Control	897,800 t at 0.147% U ₃ O ₈ measured, indicated, and inferred resource
San Juan	White Canyon	White Canyon District	enCore Energy Corp.		162,000 t at 0.139% U ₃ O ₈ historic resource

¹t = ton; M = million

mainly within the state (figure 18). Utah coal deliveries to the industrial sector decreased slightly to 1.9 million st in 2019, which is significantly less than peak deliveries of 4.4 million st in 2003. Total annual domestic deliveries of Utah coal in 2020 are expected to remain in the 10 to 11 million st range, consistent with low overall domestic demand.

The demand for Utah coal has sharply decreased over the past few years as coal-fired power plants have closed or switched to natural-gas-fired generation. Nationally, the total summer capacity of coal-fired power plants dropped from 314,555 MW in 2010 to 226,786 MW in 2019, a 28% reduction, with an additional 15,700 MW of coal capacity set to retire between 2020 and 2024 (U.S. EIA, 2020b). Within Utah, the Carbon coal-fired power plant outside the town of Helper closed in

April 2015 because it was cost prohibitive to retrofit the old plant with new emission-reducing technology. This removed about 600,000 st of coal from the Utah market. Starting in 2016, annual consumption of coal at Utah's remaining coal-fired power plants dropped 19%, a reduction of about 2.8 million st (excluding the Bonanza plant in the Uinta Basin which is supplied with Colorado coal) (figure 16). Most of this reduction occurred at the Intermountain Power Plant (IPP) near the town of Delta (a reduction of about 1.2 million st between 2016 and 2018, and a further 500,000 st reduction in 2019) as the City of Los Angeles, the majority owner, has begun to purchase less electricity from the plant due to favoring renewable sources or natural gas-fired generation (figure 16). In fact, Los Angeles has stated it will no longer purchase any coal-fired electricity from IPP after its power purchase agreement

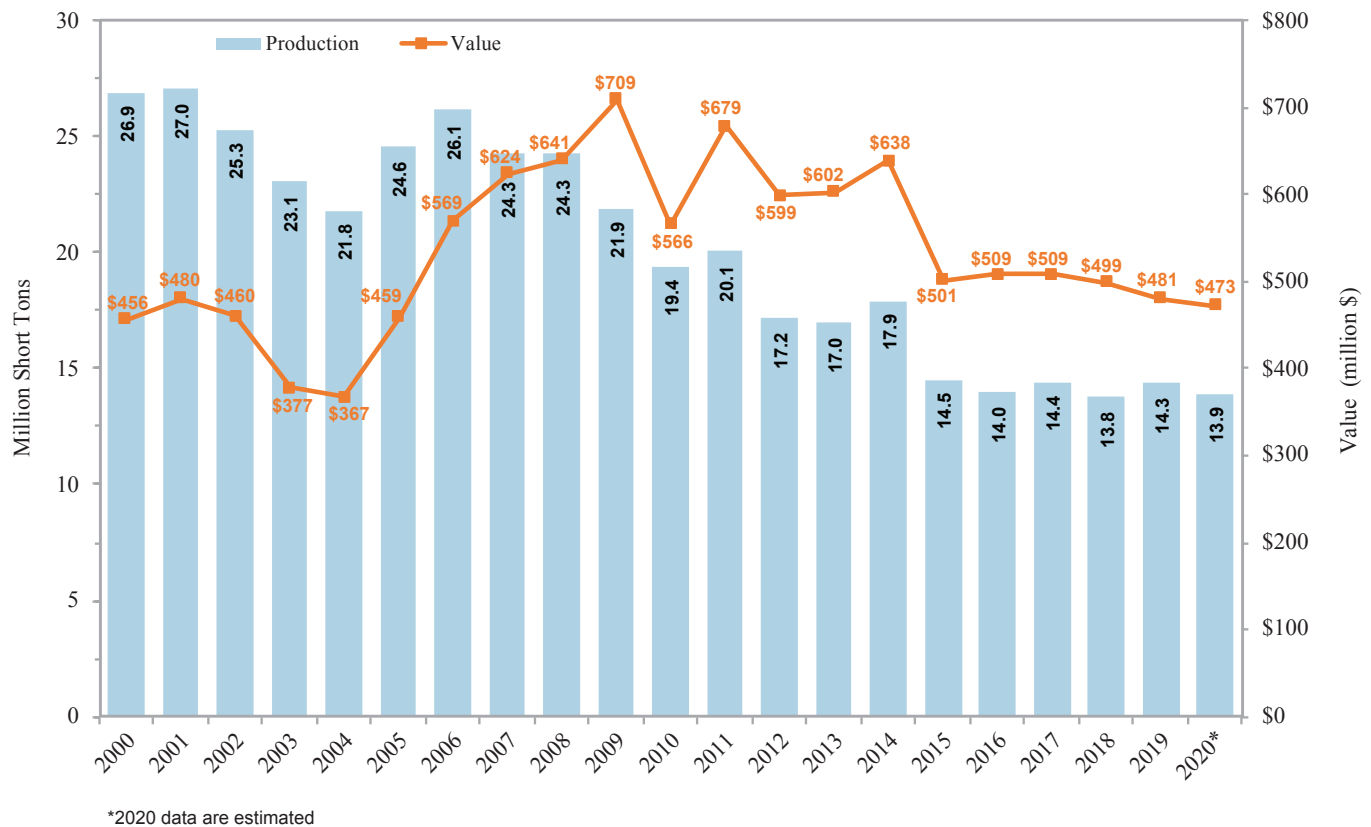


Figure 12. Utah annual coal production and value in nominal dollars, 2000–2020.

expires in 2025, at which time the plant will be converted to a combination of natural gas and “green” hydrogen. In addition, as new solar-generated electricity (mostly from California and Nevada, but also from Utah) floods the grid during the day, Utah’s Hunter and Huntington coal-fired power plants have been forced to throttle back their operations during these peak solar times, thus consuming less coal (about 300,000 st less at Hunter, before and after 2016, and 400,000 st less at Huntington) (figure 16). In California and Nevada, both significant past markets for Utah coal, several coal-fired generation plants have closed or converted to natural gas to comply with stricter air-quality standards. In Nevada, for example, the Reid Gardner coal-fired power plant shut down units 1 through 3 in 2014 and shut down unit 4 in 2017; Utah used to supply up to 1.5 million st of coal to Reid Gardner. In California, several co-generation plants that formerly used Utah coal have shut down or converted to natural gas in recent years. On the industrial side, Utah’s historically largest consumer of coal, Kennecott Utah Copper Company, has converted one of their coal units to natural gas and has shut down all other coal units (Kennecott has not burned coal since 2017). Overall, Kennecott’s electricity transition has removed nearly 500,000 tons of coal demand from the Utah market.

Foreign exports of Utah coal averaged about 2.9 million st per year in the 1990s, peaking at 5.3 million st in 1996 (figure 17). Beginning in the early 2000s, foreign exports dropped dramatically, with no exports reported in 2007. Starting in 2008, Utah coal exports revived, reaching 2.9 million st in 2014, be-

fore dropping again in 2015 to only about 0.7 million st and 1.0 million st in 2016. However, a recently expanding foreign export market has provided new opportunities for Utah coal operators. With diminished port capacity on the west coast of the United States (see discussion below in the section on Wolverine Fuels), Utah operators have sought out alternate port facilities (e.g., Guaymas, Mexico) to send their coal overseas. Utah operators have exported between 2 to 3 million st per year for the past three years and are expected to ship about 1.9 million tons of coal in 2020.

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

Exploration and Development

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-foot-long rock slopes and began development work in the Sunnyside coal bed, producing 72,000 st of coal in 2010. Mine development work continued from 2011 through 2015, and total coal production averaged about 300,000 st per year

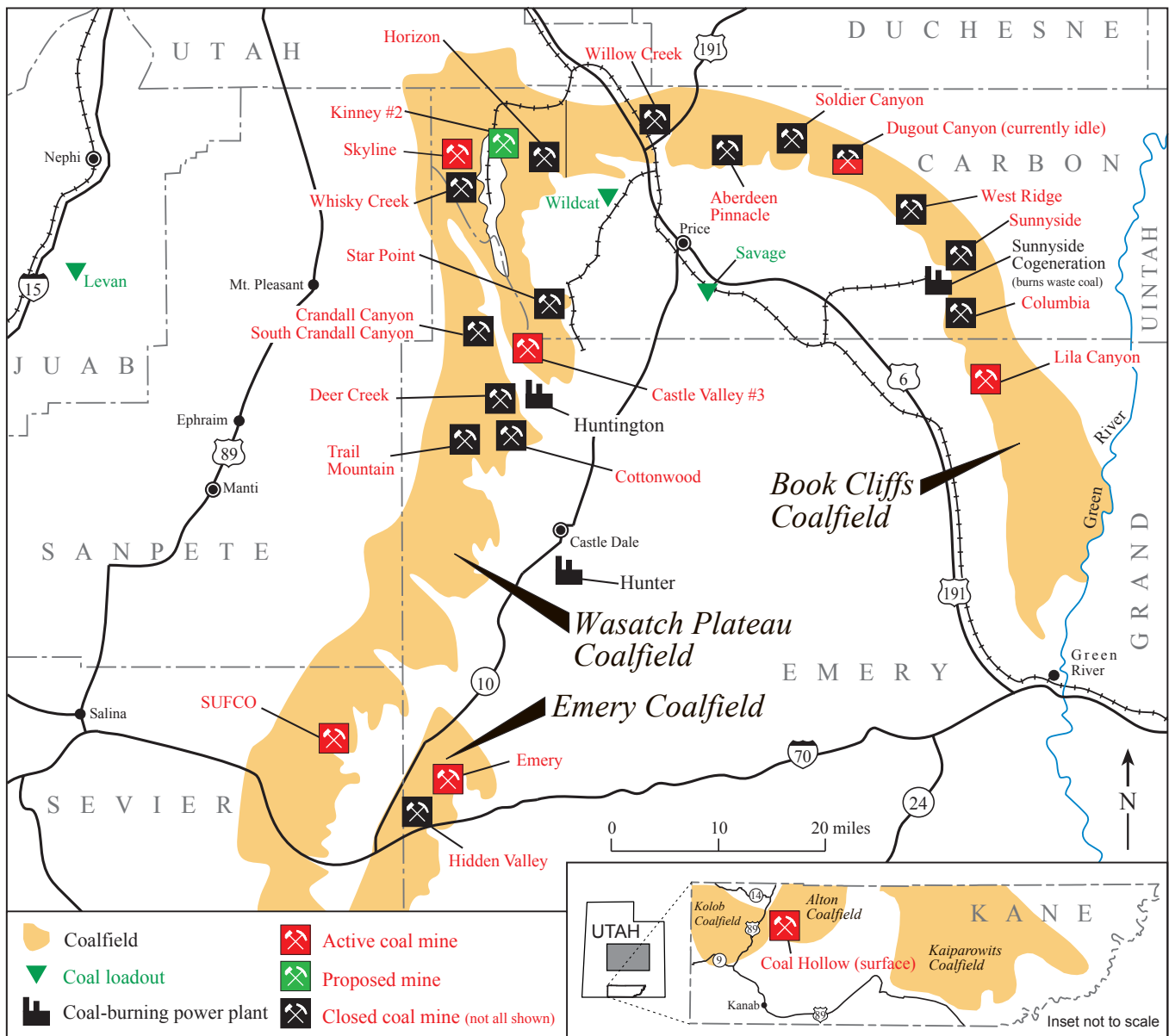


Figure 13. Location and status (at time of publication) of Utah coal mines and associated facilities.

during this time. Coal production increased substantially in 2016, up to 1.6 million st, after the closed West Ridge mine’s refurbished longwall mining equipment was installed, and production remained at the 1.6 million st level in 2017. UtahAmerican has aggressively and successfully pursued the foreign export market and as a result increased production to 2.8 million st in 2018 and 3.7 million st in 2019, with plans to mine about 3.3 million tons in 2020. This increase was also made possible by installing a new longwall mining machine that can cut a thicker seam of coal. Coal is presently mined from federal leases where the merged upper and lower Sunnyside bed is up to 13 feet thick. Current leases at Lila Canyon will support mining for up to 10 more years, with significant reserves in adjacent unleased areas.

Murray Energy filed for chapter 11 bankruptcy in October 2019, mostly related to financial issues from the domestic drop

in coal demand. It is unclear how or if bankruptcy will affect operations at Lila Canyon. In the meantime, UtahAmerican has requested lease modifications from the BLM to access roughly 9 million st of additional reserves to the south and east of current workings. These lease modifications will also allow underground access to two leased SITLA partials to the south.

Canyon Fuel Company – Wolverine Fuels, LLC

In late 2018, Bowie Resources rebranded to Wolverine Fuels, LLC, and moved their corporate headquarters to Sandy, Utah. Wolverine is majority-owned by Galena Private Equity Resources Fund, and Trafigura Trading, LLC is their exclusive marketing agent. Wolverine owns the three Canyon Fuel Company mines in Utah—Dugout, Skyline, and Sufco—and the currently idled Bowie #2 mine in Colorado, which last produced coal in 2016.

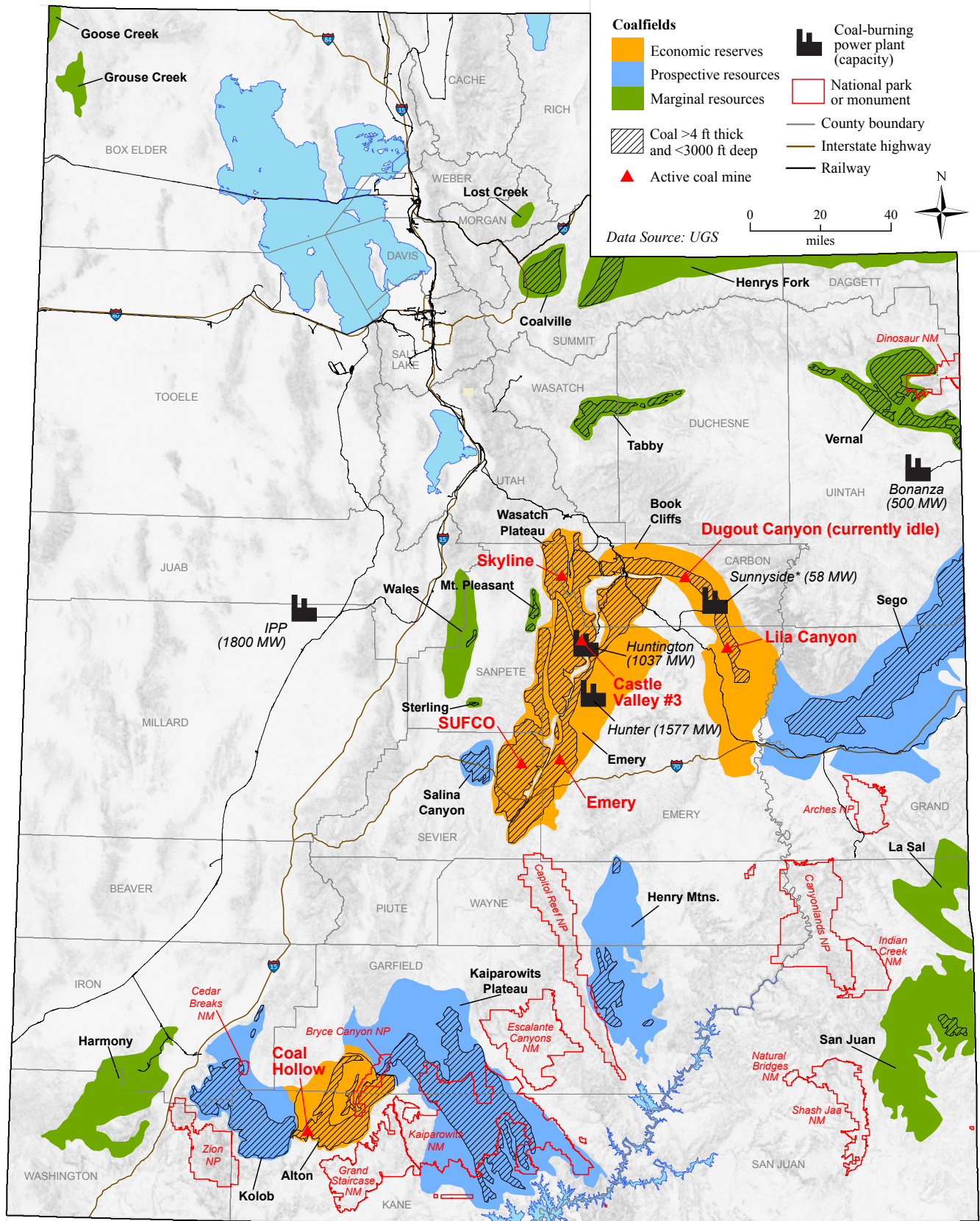


Figure 14. Location of active Utah coal mines and coalfields.

Table 7. Coal production in Utah by coal mine, 2009–2020.

Company	Mine ¹	County	Coalfield	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*
thousand short tons															
Canyon Fuel Company, LLC - Wolverine Fuels, LLC ²	Dugout Canyon	Carbon	Book Cliffs	3,291	2,307	2,395	1,588	561	676	763	650	626	557	430	--
	Skyline #3	Carbon/Sanpete/Emery ³	Wasatch Plateau	2,910	3,050	2,950	1,954	3,135	4,170	4,409	4,767	4,389	3,614	3,896	4,000
	SUFCO	Sevier	Wasatch Plateau	6,748	6,398	6,498	5,651	5,959	6,539	6,095	5,375	5,947	4,842	4,374	4,500
Bronco Utah Operations, LLC ⁴	Emery	Emery	Emery	1,238	999	--	--	4	--	--	--	135	442	694	800
Castle Valley Mining, LLC - Rhino Resource Partners, LP ⁵	Castle Valley #3	Emery	Wasatch Plateau	--	--	--	--	--	--	218	170	205	102	562	790
	Castle Valley #4	Emery	Wasatch Plateau	651	--	592	1,004	875	1,061	757	724	754	893	488	10
East Mountain Energy - PacifiCorp	Deer Creek	Emery	Wasatch Plateau	3,833	2,954	3,143	3,295	2,785	2,083	15	--	--	--	--	--
Hidden Splendor Resources, Inc. - America West Resources, Inc.	Horizon	Carbon	Wasatch Plateau	194	270	370	210	--	--	--	--	--	--	--	--
West Ridge Resources, Inc. - UtahAmerican Energy, Inc. - Murray Energy Corp.	West Ridge	Carbon	Book Cliffs	3,063	3,355	3,566	2,579	2,629	2,514	1,580	--	--	--	--	--
UtahAmerican Energy, Inc. - Murray Energy Corp.	Lila Canyon	Emery	Book Cliffs	--	72	157	304	257	335	350	1,587	1,638	2,816	3,664	3,300
Alton Coal Development, LLC	Coal Hollow	Kane	Alton	--	--	403	570	747	555	316	671	724	488	240	500
	Burton #1	Kane	Alton	--	--	--	--	--	--	11	34	--	--	--	--
Total				21,928	19,405	20,074	17,155	16,953	17,933	14,513	13,978	14,417	13,753	14,347	13,900

Source: UGS coal company questionnaires

*Forecast

¹All mines are underground except Coal Hollow, which is a surface mine.²Bowie Resources bought Canyon Fuel from Arch Coal in summer 2013. In late 2018, Bowie changed their name to Wolverine Fuels.³2019 production by county: Sanpete = 3,645,133 tons; Emery = 250,695 tons. 2018 production by county: Sanpete = 906,716 tons; Emery = 1,765,410 tons; Carbon = 941,447 tons. 2017 production by county: Sanpete = 43,949 tons; Emery = 136,203 tons; Carbon = 4,208,538 tons. 2009-2016: all production in Carbon County.⁴Bronco bought the Emery mine from CONSOL Energy in 2015.⁵Rhino bought the Castle Valley mines from C.W. Mining (Co-op) in summer 2010; mines were formerly called Bear Canyon.

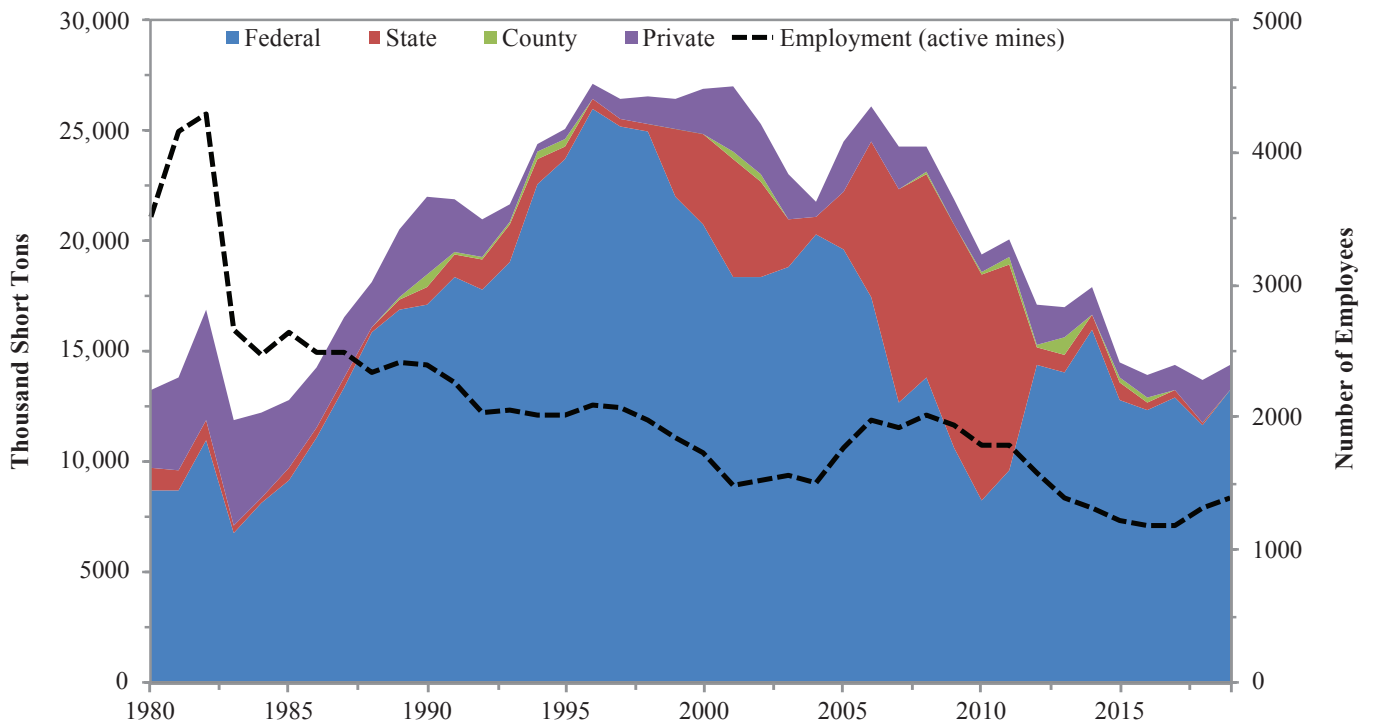
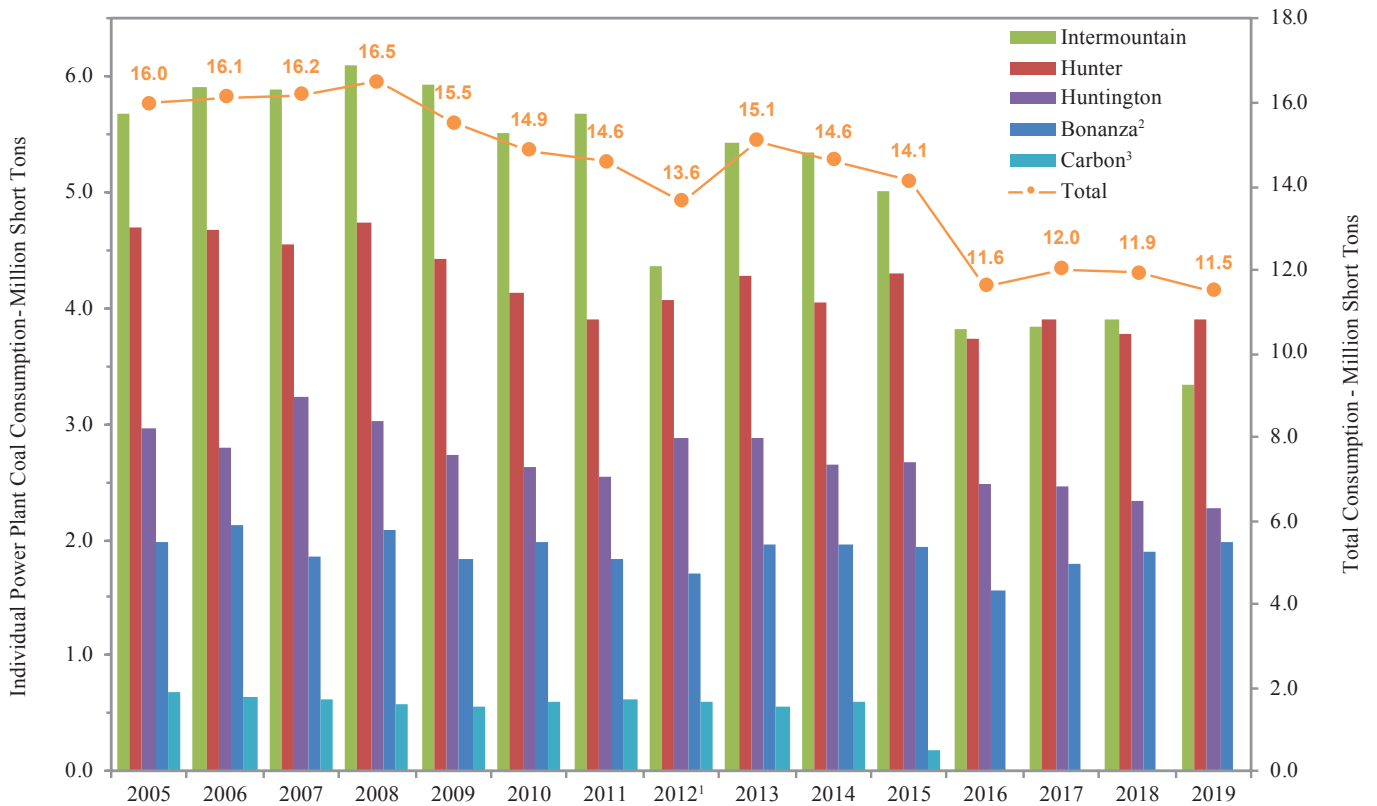


Figure 15. Coal production and employment in Utah by land ownership, 1980–2019.



¹ A generator at the Intermountain Power Plant was offline for several months in 2012, resulting in decreased coal consumption.

² The Bonanza power plant in the Uintah County gets its coal from the Deserado mine just over the border in Colorado.

³ The Carbon plant, Carbon County, shut down in spring 2015.

Figure 16. Consumption of coal at Utah power plants, 2005–2019.

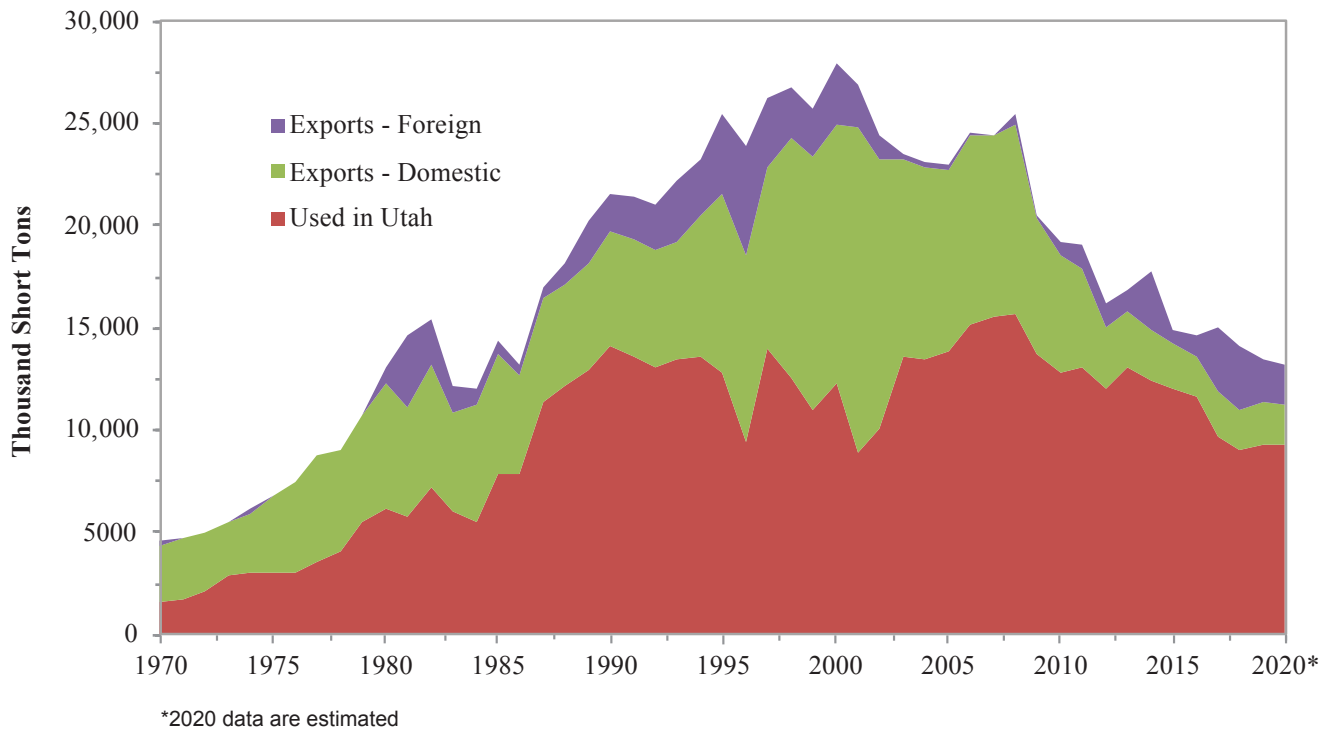


Figure 17. Distribution of Utah coal, 1970–2020.

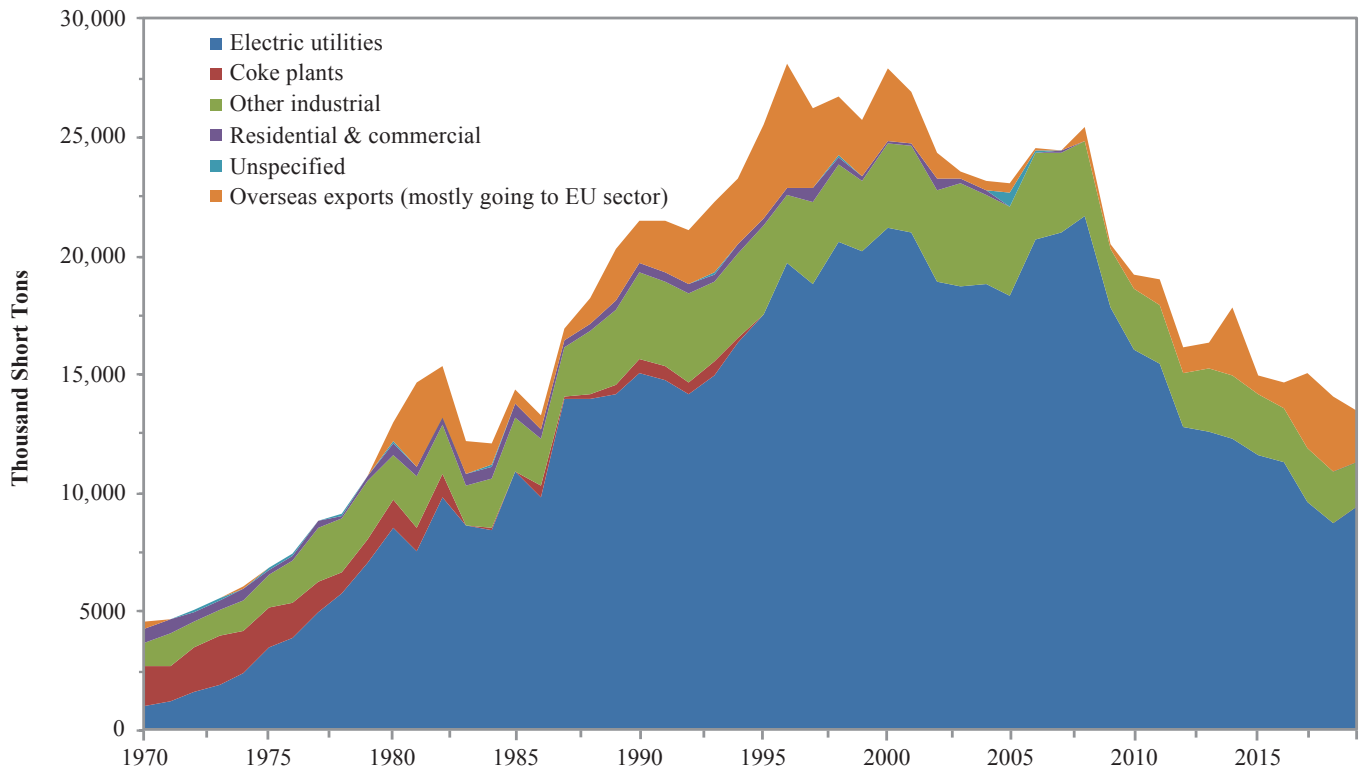


Figure 18. Distribution of Utah coal by end use, 1970–2019.

To access Asian markets, Wolverine Fuels ships significant amounts of coal out of the ports of Richmond and Stockton in California. In early 2020, the Richmond City Council passed an ordinance banning the storing and handling of coal within the city. Wolverine Fuels and others have filed lawsuits against the City of Richmond to try and invalidate this decision. The coal ban in Richmond follows a similar ban by the City of Oakland for the proposed Oakland port, which is also being challenged in court. With limited access to west coast port facilities, Utah coal operators will have to look elsewhere to supply the foreign coal market (e.g., Mexico, Gulf of Mexico, Canada). Most of these alternate options are more expensive than California ports.

Dugout Canyon mine: In 2012, Dugout operators completed mining the longwall panels in its current mine plan and switched to running a room-and-pillar operation because of the reduction in coal demand. This switch in mining method resulted in a large reduction in coal production, from a high of 4.6 million st in 2005 to only 561,000 st in 2013. Production in 2019 was from the Rock Canyon bed and totaled only 430,000 st before the mine was idled in the third quarter. When and if the Dugout Canyon mine will resume production is unknown.

Skyline mine: Canyon Fuel Company's Skyline mine, located in the Wasatch Plateau coalfield, has fully transitioned their mining operation to the Flat Canyon federal coal tract in Sanpete County, near the border with Emery County, after mining short longwall panels on the way. Continuous miners entered Flat Canyon in October 2017 and longwall production started in summer 2019. Production in 2018 was down due to this transition, totaling only 3.6 million st from three different counties: 941,000 st in Carbon, 1.8 million in Emery, and 907,000 in Sanpete. Production rebounded in 2019 to about 3.9 million st—3.6 million st in Sanpete County and 251,000 st from Emery County. Production in 2020, fully in the Flat Canyon area within the Lower O'Connor B bed, should increase again to about 4.0 million st. The Flat Canyon tract is estimated to contain up to 50 million st of recoverable coal reserves in the Lower O'Connor A and B beds, as well as minor reserves in the Flat Canyon bed.

Sufco mine: Sufco, the only active mine in Sevier County, is Utah's largest coal producer and is located in the Wasatch Plateau coalfield. Sufco coal production, from the upper Hiawatha bed, dropped in 2019 to 4.4 million st, 10% less than in 2018, and 45% less than the record high production of 7.9 million st achieved during 2006. Similar to Skyline, the lower production in 2018 and 2019 is related to underground operations slowly shifting to the newly leased Greens Hollow federal tract, as well as dealing with geologic problems along the way. Full production in Greens Hollow, which contains an estimated 56 million st of recoverable coal, will commence in 2020, mostly in the lower Hiawatha bed, and overall production should increase slightly to about 4.5 million st in 2020.

Fossil Rock Resources – Wolverine Fuels, LLC

Cottonwood tract: On December 31, 2007, SITLA held a sale of the Cottonwood Competitive Coal Leasing Unit. The tract was awarded to Ark Land Company, a subsidiary of Arch Coal, Inc. and the former owner of Canyon Fuel Company. Two coal leases were issued, one for 8204 acres covering lands within the 1998 land exchange Cottonwood Coal Tract and the other for 600 acres within an adjacent SITLA section. In mid-2011, the Cottonwood lease was transferred to Fossil Rock Resources, a subsidiary of PacifiCorp and Rocky Mountain Power, as part of a settlement of litigation between the two companies. The Cottonwood tract is adjacent to PacifiCorp's existing, but inactive, Trail Mountain federal lease. Total recoverable coal in the Hiawatha bed for the combined leases is estimated at about 49 million st. Following the announcement of the closure of the Deer Creek mine in early 2015, Fossil Rock Resources and its coal reserves were sold to Bowie Resources, now Wolverine Fuels. Wolverine has since continued exploration of the Cottonwood tract and has begun exploring the possibilities of re-opening the old Trail Mountain mine to access these reserves.

Bronco Utah Operations, LLC

Emery mine: Bronco Utah Operations bought the Emery mine from CONSOL Energy in December 2015. The Emery mine produced about 1 million st annually from the Ferron Sandstone I bed from 2005 through 2010, then CONSOL idled the mine due to low coal demand and shifting company priorities. Bronco developed new portals into the I bed in early 2017, producing 135,000 st that year and ramping up to 694,000 st in 2019. Production is expected to increase again in 2020 to about 800,000 st. The thick I seam, up to 12 feet, contains significant reserves to the south and could support mining for many years.

Rhino Resource Partners, LP

Castle Valley mines: Rhino purchased the Bear Canyon mines from C.W. Mining (Co-op) in 2010 and changed the mines' name to Castle Valley. Between 2011 and 2014, operators produced a total of 3.5 million st from the Tank bed (#4 mine). Production restarted in the Bear bed (#3 mine) in 2015, and in 2018, production commenced in the Blind bed (also #3 mine). Production totaled 1.0 million st in 2019: 488,000 st from the Tank (#4), 185,000 st from the Bear (#3), and 377,000 st from the Blind (#3). Rhino finished all mining in the Tank bed (#4 mine) in January 2020, and production will continue in the #3 mine in the Bear and Blind beds, with total production reaching about 800,000 st in 2020. Rhino recently acquired the now-closed Deer Creek mine's waste pile facility near the mouth of Huntington Canyon and purchased an air-jig cleaning plant that should be operational in summer 2020. Rhino Resource Partners filed for Chapter 11 bankruptcy in July 2020 due to decreases in coal demand. It is unclear if the filing will impact operations at their Utah mine.

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. The Coal Hollow mine produces subbituminous Dakota Formation coal from the Smirl bed, which averages about 10,000 Btu/ lb, about 1% sulfur, and 8% ash. Surface-mining production at the company's Coal Hollow mine on private property peaked in 2013 at 747,000 st before decreasing to 316,000 st in 2015 as the reserves on the southern property were depleted. In the spring of 2014, highwall mining began in the mine's open pits in an effort to recover coal with less surface disturbance. Also, during this time, permitting was underway to begin mining the northern fee tract, which commenced production in 2016. After operations moved to the north, the mine produced 671,000 st in 2016, 724,000 st in 2017, and 488,000 in 2018. Production in 2019 decreased to only 240,000 st due to significant flooding and mud problems in the spring of 2019.

Alton Coal's application to acquire an adjacent federal coal lease, a process begun in 2004, was delayed when the BLM declared a federal coal leasing moratorium in January 2016. After the presidential election and a change in federal administration, the BLM lifted the coal leasing moratorium in March 2017, providing a new opportunity for Alton Coal to pursue a lease on federal coal adjacent to its private leases. This federal lease was awarded in late 2018 and mine permits have now been finalized. Alton Coal exhausted reserves on the private land in early 2020 and has begun mining the federal lease. Operators plan to mine via surface methods to a specified stripping ratio and then utilize auger mining to reach additional coal. Production in 2020 is expected to increase to 500,000 st.

After experiencing difficulty producing coal using the high-wall mining machine in 2014, Alton Coal commenced underground room and pillar mining in late 2015 at the Burton #1 mine. Total production from the underground mine in 2015 and 2016 was only 45,000 st. Burton was idled in mid-2016 after there were problems establishing an approved roof control program. With the acquisition of the federal lease, the Burton mine was abandoned to focus on surface mining.

Coal Energy Group 3, LLC

Kinney #2 mine: The first permit application for the proposed Kinney #2 mine was submitted in 2008 by Carbon Resources, LLC, but several deficiencies and other issues delayed progress and the application file was closed several years later. Coal Energy Group 3, LLC, a related company, re-submitted the application to DOGM and after all deficiencies had been addressed, DOGM provided conditional approval in August 2019—final approval is still pending the posting of a reclamation bond. The proposed Kinney #2 underground mine would be located on 452 acres, a combination of private and Carbon County land, located about a half mile north of the town of Scofield, Utah. The proposed operation would use continuous

miners to produce from the Hiawatha coal bed, which averages 8 feet thick and is under about 700 feet of cover, with plans to mine about 800,000 st a year.

UNCONVENTIONAL FUELS

Oil Shale

The upper Green River Formation in the Uinta Basin of Utah contains one of the largest deposits of oil shale in the world. The oil shale deposit contains an estimated in-place resource of 1.3 trillion bbls (USGS Oil Shale Assessment Team, 2011) and a potential economic resource of 77 billion bbls (Vanden Berg, 2008). The richest Green River oil shale horizon is the Mahogany zone, where individual beds can yield up to 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.

The outcrop accessibility, low dip, and shallow cover of Utah oil shale deposits make conventional surface/underground mining and surface retort the preferred technology to recover oil from the shale. Currently, at least three companies are pursuing oil shale development in Utah: Enefit American Oil, Red Leaf Resources, and TomCo Energy. These companies all hold land in the southeastern Uinta Basin. Enefit American Oil is an Estonian company that has land holdings of over 27,000 acres (figure 9), including 18,000 acres of private land, 4000 acres of SITLA leases, and 5000 acres of federal land. Red Leaf Resources is a Utah company with multiple state oil shale leases (figure 9). Little activity was reported by Enefit or Red Leaf in 2019, likely due in large part to continued low crude oil prices. TomCo Energy is a United Kingdom-based oil shale company with 15,488 acres of SITLA leases (figure 9). In March 2019, TomCo released an oil resource estimation prepared by SRK Consulting under the guidelines of the 2018 Petroleum Resources Management System for two of their leases which cover an area of 2919 acres. SRK estimated a contingent resource (2C) of 131 million barrels and a prospective resource (2U) of 443 million barrels (McConachie and Kushkarina, 2019).

Oil Sand

North America has the largest oil sand (also known as tar sand or bituminous sand) resources in the world, the vast majority of which are in Canada. Utah oil sand deposits, though small compared to Canadian resources, contain the largest resource in the United States. The deposits hold roughly 23 to 29 billion barrels of in-place bitumen. The Uinta Basin of northeast Utah has 25 oil sand deposits containing an estimated 9 to 11 billion bbls. Twenty-two oil sand deposits containing another roughly estimated 14 to 18 billion bbls are in the central-southeast part of the state, and six minor deposits containing negligible oil occur in other parts of the state (Ritzma, 1979).

Similar to oil shale, conventional mining methods would likely be used to mine the oil sand for further processing. With the current low price for crude oil and the relative ease of recent oil production from tight oil reservoirs, there is less incentive for advancing bitumen extraction and upgrading techniques to move Utah's oil sand toward successful and sustainable development. Challenges facing oil sand extraction in Utah have included permitting and legal challenges, process efficiency, site accessibility, adequate infrastructure, water availability, environmental concerns, and the heterogeneity of reservoir deposits. However, despite these challenges and competition from traditional drilling, a few companies continue to pursue development of Utah's oil sand deposits.

2020 Resources (formerly USO [Utah] LLC and US Oil Sands) holds extraction rights on a large group of SITLA leases within the PR Springs oil sand deposit in the southern Uinta Basin (figure 9). This project has been developed over the last decade and has an active mine permit from DOGM. However, due to a variety of challenges, including low crude oil prices, little development has occurred in the last few years. Another Utah oil sand deposit that consistently generates interest is Asphalt Ridge because of its proximity to Vernal, Utah. Recently, Petroteq Energy and Tomco Energy entered into a partnership to explore oil sand extraction and production in the area (figure 9). At least one other company, Vivakor, has interests in the area. Development of these projects has also been limited.

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