# UTAH MINING 2020

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

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

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***Cover Photo:*** *Bonanza grade gold sample from the T2 structure at the Trixie mine, Tintic district. Bonanza ore grades in the T2 footwall breccia average >340 g/t, with a maximum of >10,000 g/t recorded to date. Sample shown here is composed of bladed barite and quartz cavity-fill with striking green xocomecatlite, a rare copper tellurate. Photo courtesy of Tintic Consolidated Metals.*

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# UTAH MINING 2020

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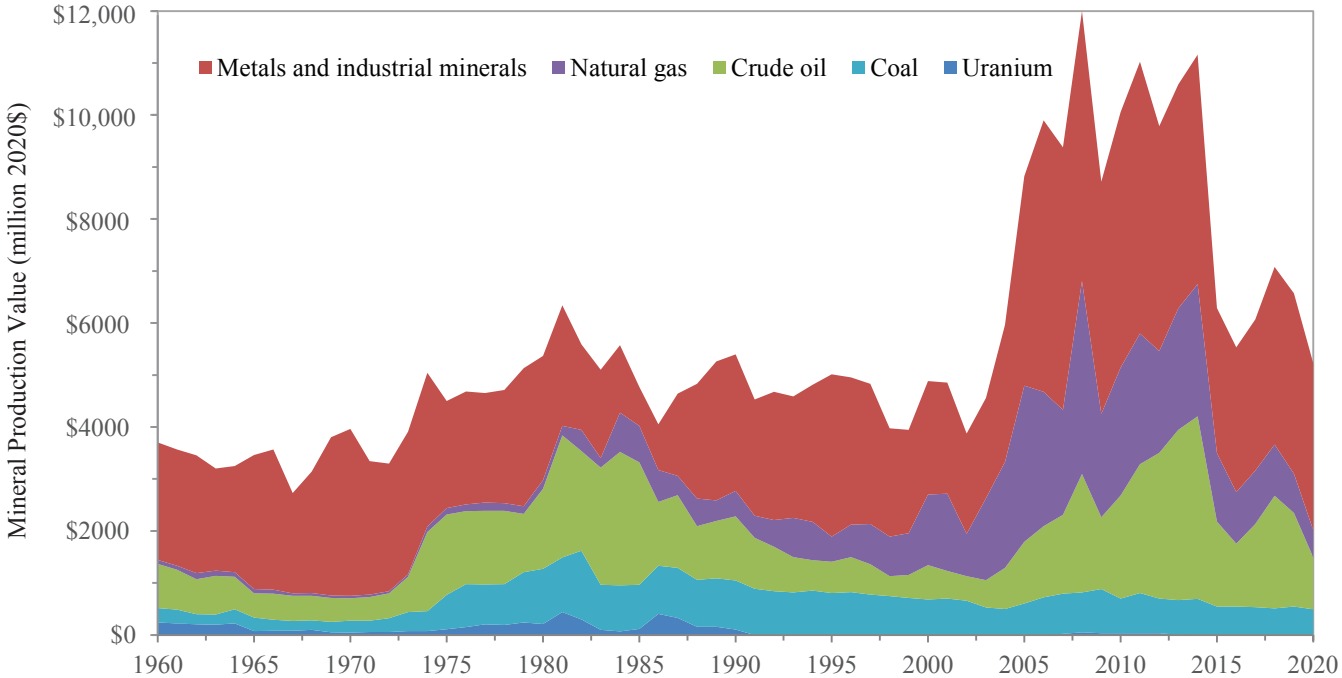
## INTRODUCTION

### 2020 Utah Mining Industry Summary

The estimated combined value of Utah's extractive resource production in 2020 totaled $5.3 billion, including production of metals and industrial minerals ($3.2 billion), natural gas ($530 million), crude oil ($1.0 billion), and coal ($500 million) (figure 1). Utah's diverse mining industry (metals, industrial minerals, and coal) accounted for $3.7 billion (71%) of total extractive resource production, a decrease of $260 million (6.6%) from 2019, and 29% 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 $1.5 billion and includes copper, magnesium, beryllium, and molybdenum (figure 3). Notably, copper accounted for 57% ($860 million) of Utah's base metal production value. Precious metals produced in Utah include gold and silver, and 2020 production was valued at $350 million (figure 3). Precious metal production value decreased by about 6.1% from 2019 to 2020, and base metal values decreased about 13%. Industrial minerals produced in Utah include sand and gravel, crushed stone, salt, potash, cement, lime, phosphate, lithium, uintaite (Gilsonite®), clay, gypsum, and other commodities (figure 2). The estimated value of industrial mineral production in 2020 was $1.4 billion, a 2.6% increase over the revised 2019 estimate (figure 3). The most valuable industrial mineral group in 2020, estimated at $460 million, was the brine- and evaporite-derived commodities of potash, salt, and magnesium chloride. The value of Utah coal production decreased 9.1% in 2020 to $500 million, down from $540 million in 2019 (figure 3). Notably, Utah remains the only state to produce magnesium metal, beryllium concentrate, potassium sulfate, and uintaite (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). Lithium, also considered a critical mineral, was produced in Utah for the first time in 2020, making Utah one of only two lithium-producing states.




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

***Figure 1.*** *Annual value of Utah energy and mineral production, inflation adjusted to 2020 dollars, 1960–2020.*

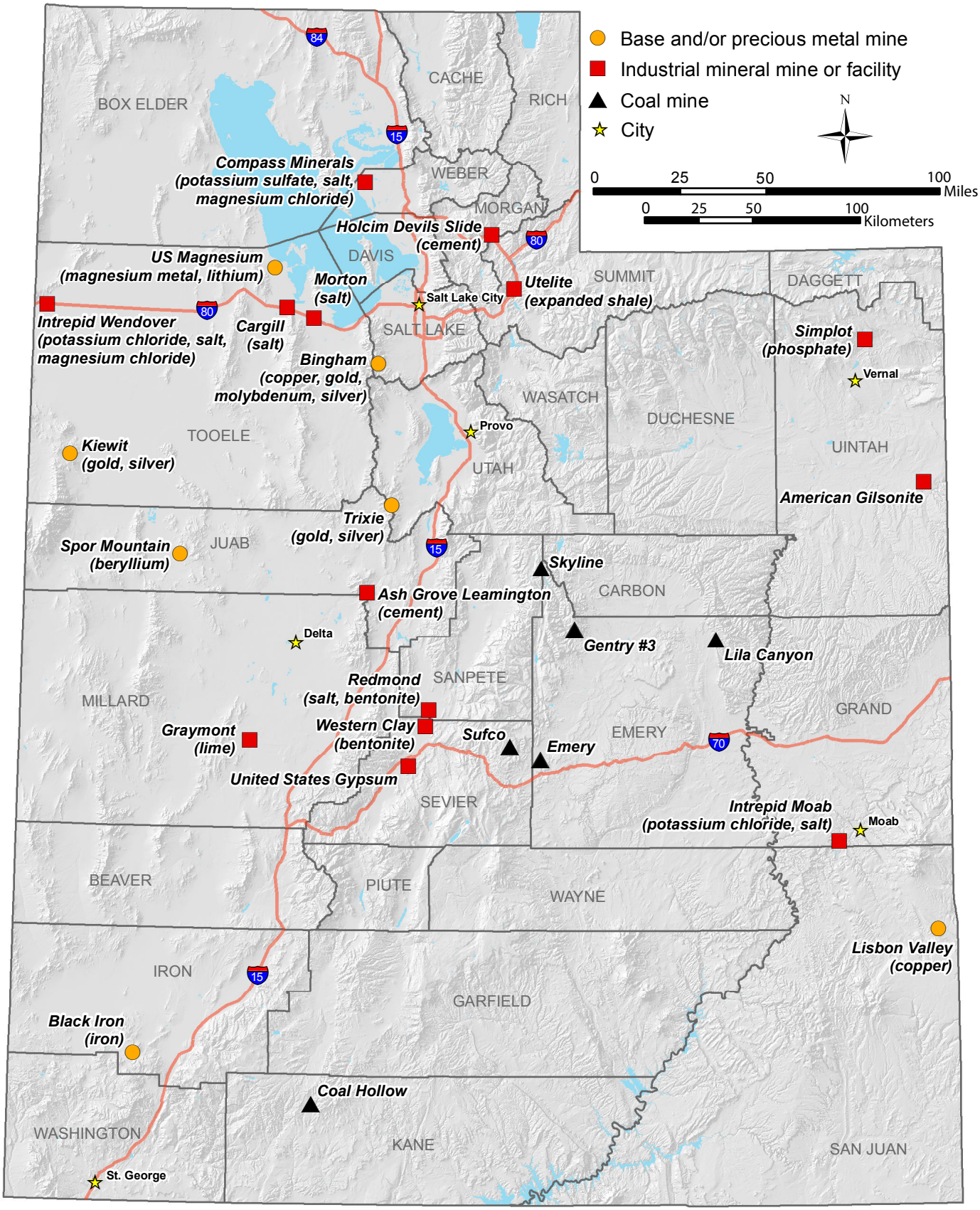



***Figure 2.*** *Select base and precious metal, industrial mineral, and coal production locations active in 2020 in Utah.*

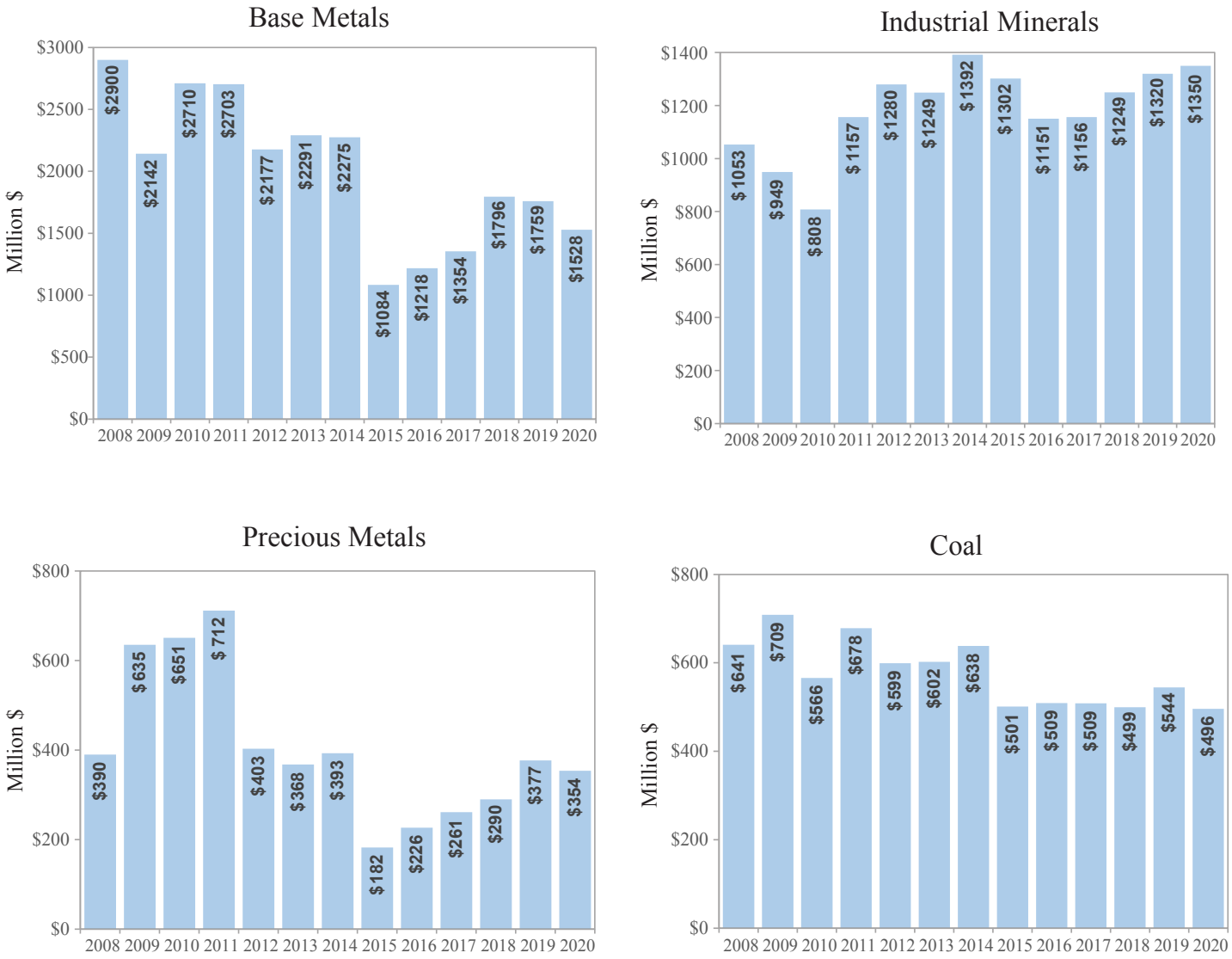



***Figure 3.*** *Annual value of Utah mineral production in nominal dollars, 2008–2020. Data source: Utah Geological Survey.*

For 2020, the U.S. Geological Survey (USGS) ranked Utah as 8th nationally (down one position from 2019) for production of nonfuel minerals, which include metals and industrial minerals (table 1). The USGS estimated Utah's nonfuel mineral production value at $3.2 billion (equivalent to the Utah Geological Survey [UGS] estimate of $3.2 billion), which accounted for 3.8% of the U.S. total, with cement, copper, gold, molybdenum concentrates, salt, and sand and gravel for construction listed as principal commodities (USGS, 2021a). The overall value of nonfuel production in the United States was estimated at over $82 billion, with two-thirds of that value coming from industrial minerals and the remaining one-third from metals production (figure 4). Utah has ranked among the top 10 states for nonfuel mineral production for the past decade. In addition, Utah was the 10th largest coal producer of 22 coal-producing states in 2020 and accounted for 2.5% of total U.S. coal production (U.S. Energy Information Association [EIA], 2021a).

In the 2020 Fraser Institute annual survey of mining companies, Utah was ranked as the 25th most favorable state/nation out of 77 international jurisdictions (68th percentile) in terms of overall investment attractiveness with regard to mining (table 1) (Yunis and Aliakbari, 2021). This ranking represents an 11-spot decrease from 2019, primarily based on a drop in the perception of Utah's geologic favorability or mineral potential. 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. Utah is the 7th most favorable jurisdiction in the United States.

The minerals regulatory program within the Utah Division of Oil, Gas and Mining (OGM) approved two large mine permits, four small mine permits, and nine exploration permits in 2020 (table 1). The large mine permits were for two construction aggregate mines. The small mine permits included

***Table 1.*** *Utah mining rankings and statistics.*

| Utah mining ranking or statistic | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| USGS rank of U.S. nonfuel mineral production value (metals and industrial minerals) | 7th | 5th | 8th | 10th | 8th | 8th | 7th | 8th |
| 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 | 25th of 77 |
| U.S. EIA rank for coal production by state | 14th | 13th | 14th | 10th | 11th | 12th | 11th | 10th |
| New OGM approved large mine permits | 4 | 2 | 2 | 0 | 0 | 1 | 4 | 2 |
| New OGM approved small mine permits | 13 | 11 | 12 | 7 | 11 | 13 | 11 | 4 |
| New OGM approved exploration permits | 9 | 14 | 17 | 11 | 9 | 6 | 8 | 9 |
| SITLA mineral leases issued | 62 | 56 | 32 | 53 | 57 | 36 | 41 | 38 |
| New BLM mining claims filed | 2360 | 3107 | 975 | 5366 | 5709 | 5361 | 2283 | 3593 |
| Total BLM mining claims (end of year) | 19,487 | 19,770 | 18,520 | 21,497 | 21,936 | 22,976 | 21,625 | 23,062 |

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

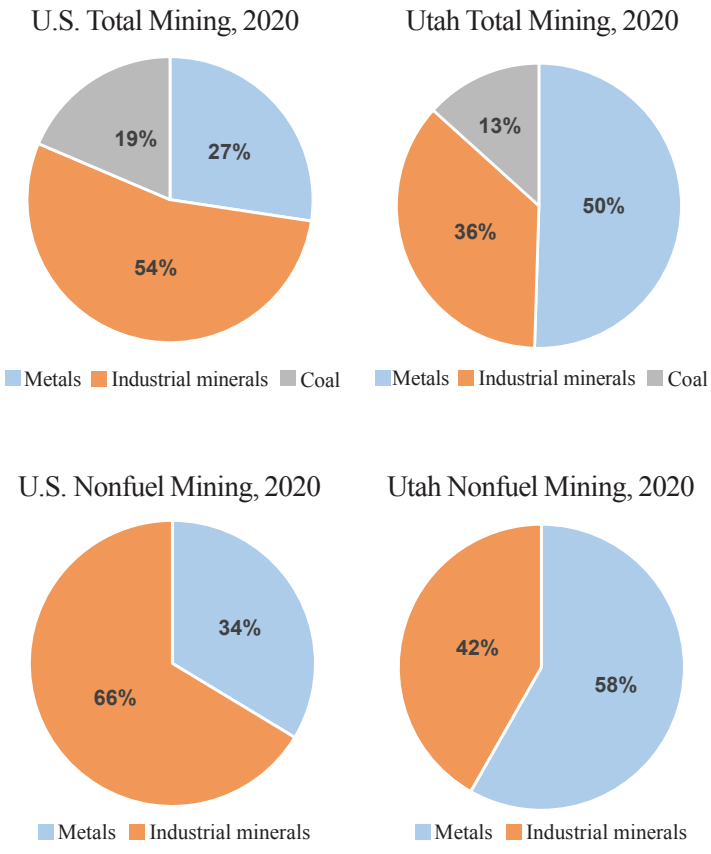


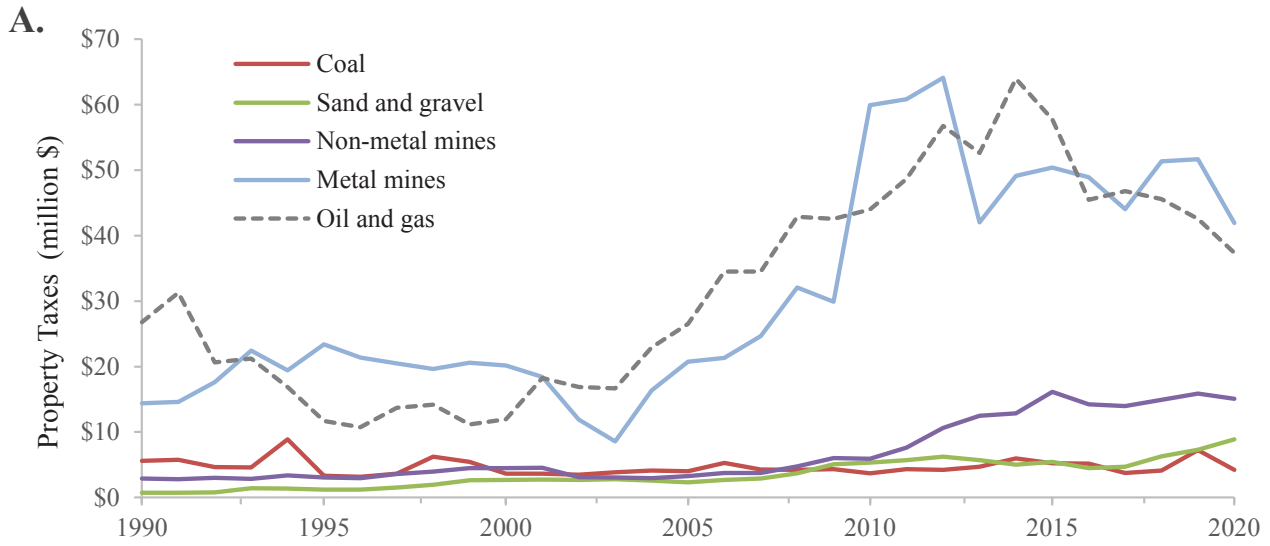

***Figure 4.*** *Production value comparison of United States and Utah mining sectors, 2020. U.S. data source: U.S. Geological Survey. Utah data source: Utah Geological Survey.*

three construction aggregate mines (including a limestone riprap mine) and a silver, gold, and lead prospect. Nine exploration permits were approved for base and precious metals (5), uintaite (Gilsonite®) (1), construction aggregate (2, including one for ballast), and fluorspar (1) (Paul Baker, OGM, written communication, February 2021).

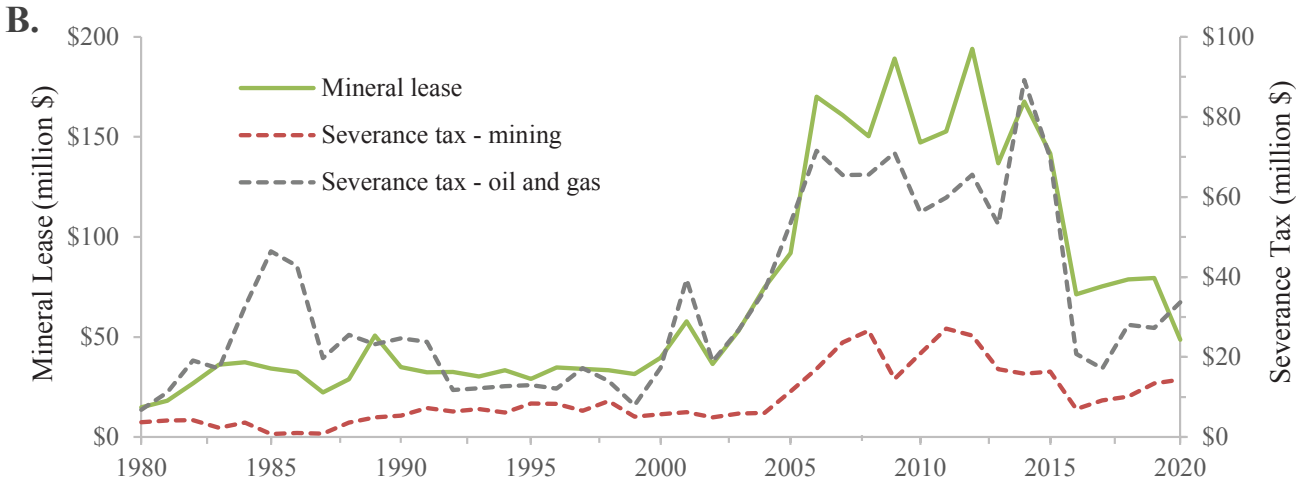
The Utah School and Institutional Trust Lands Administration (SITLA), which manages about 3.4 million acres of state-owned lands in Utah, issued 38 new mineral leases in 2020, down from 41 in 2019 (table 1). These leases were issued for the following commodities: metalliferous minerals (21), sand and gravel (15), building stone (1), and mineral salts (1) (Jerry Mansfield, SITLA, written communication, February 2021).

In 2020, 3593 new unpatented mining claims were filed on federal lands in Utah. In 2020, claim activity mostly occurred in the following counties in decreasing order: Tooele, Juab, Beaver, and Box Elder, each recording over 250 new claims. At the end of 2020, the U.S. Bureau of Land Management (BLM) reported a total of 23,062 active unpatented mining claims in Utah, up 7% from 2019 (table 1) (Keyra Fernandez, BLM Utah, written communication, March 2021).

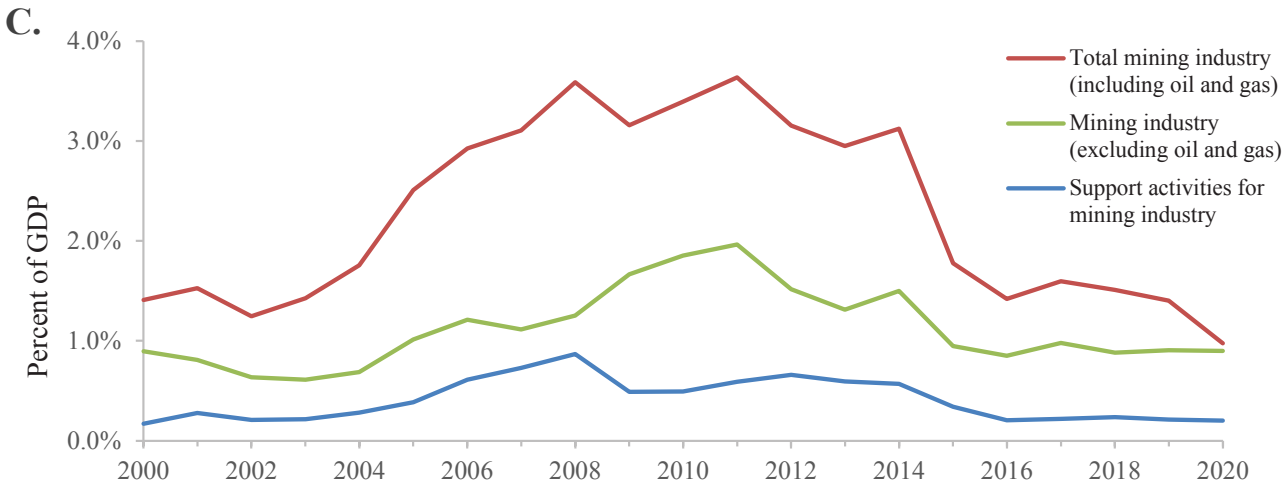
Contributions by the Utah mining industry to the state tax base during 2020 were significant (figure 5). The metal, industrial mineral (non-metal), sand and gravel, and coal mining industries paid over $70 million in property taxes during the year (down 15% from 2019) and over $14 million in mining-related




Source: Utah State Tax Commission
Note: Calendar year, presented in nominal dollars




Source: Utah State Tax Commission
Note: State fiscal year, presented in nominal dollars




Source: U.S. Bureau of Economic Analysis

***Figure 5.*** *Utah mining economic indicators.* ***A****. Property taxes charged against the mining industry, 1990–2020.* ***B.*** *Mineral lease revenue and severance taxes, 1980–2020.* ***C.*** *Percentage of Utah's gross domestic product (GDP) from mining-related activities, 2000–2020.*

severance taxes (up 7% from 2019). All extractive industries, including oil and gas, paid nearly $49 million in federal mineral lease disbursements. Only about 0.9% of Utah's gross domestic product came from the mining industry in 2020, 1.0% if oil and gas are included. Mining employment in Utah remained steady from 2019 to 2020, and had a modest wage increase of about 2% (figure 6). According to the Utah Department of Workforce Services, the average annual mining wage in Utah in 2020 was $79,644, which was 48% higher than the average annual wage in Utah ($53,892).

## Critical Minerals

In 2018, the USGS designated 35 non-fuel minerals or mineral groups as critical minerals (Fortier and others, 2018). Critical minerals are defined as those necessary for economic or national security and have a supply chain vulnerable to disruption. In 2020, Utah produced eight critical minerals (helium, lithium, beryllium, magnesium metal, potash, rhenium, platinum, and palladium). The production of lithium, beryllium, magnesium metal, and potash are discussed in the relevant sections below. Mills and Rupke (2020) also provide a more detailed summary of critical minerals in Utah. Rhenium, platinum, and palladium are all produced as byproducts from the Bingham Canyon mine. In May 2021, Rio Tinto also announced it would build a tellurium recovery plant at Bingham Canyon that is expected to come online in late 2021. Recently, helium has been produced by Paradox Resources LLC at a gas plant in Lisbon Valley. The plant purifies helium from natural gas streams, some of which are from Utah. They produced helium starting in 2019 and through 2020, but (temporarily?) discontinued helium production in 2021. As of 2021, helium is also being produced at the Harley Dome field by IACX Energy LLC.

In addition to the eight produced critical minerals, Utah hosts established resources of five more: fluorspar, vanadium, uranium, aluminum, and indium. Additional information on fluorspar and uranium is presented in the relevant sections below. In general, exploration for critical minerals in Utah still represents a relatively small portion of exploration expenditure. Ares Strategic Mining is currently developing the Lost Sheep fluorspar mine with plans to begin production in 2021. If successful, the addition of Bingham Canyon's new tellurium recovery plant and Lost Sheep fluorspar brings Utah's anticipated 2021 critical mineral production to 10 commodities. However, in a Federal Register notice in late 2021, the USGS released an updated draft critical mineral list and recommended removal of uranium, helium, potash, and rhenium from the list which will decrease the number of critical minerals that Utah produces.

Vanadium was a focus of exploration interest in 2019 but interest waned in 2020. Vanadium prices hit a decadal high in late 2018 and early 2019 on the expectation of increased vanadium demand from China (due to new standards for rebar production), the potential for vanadium redox flow batteries, and anticipated demand from the domestic airline industry.

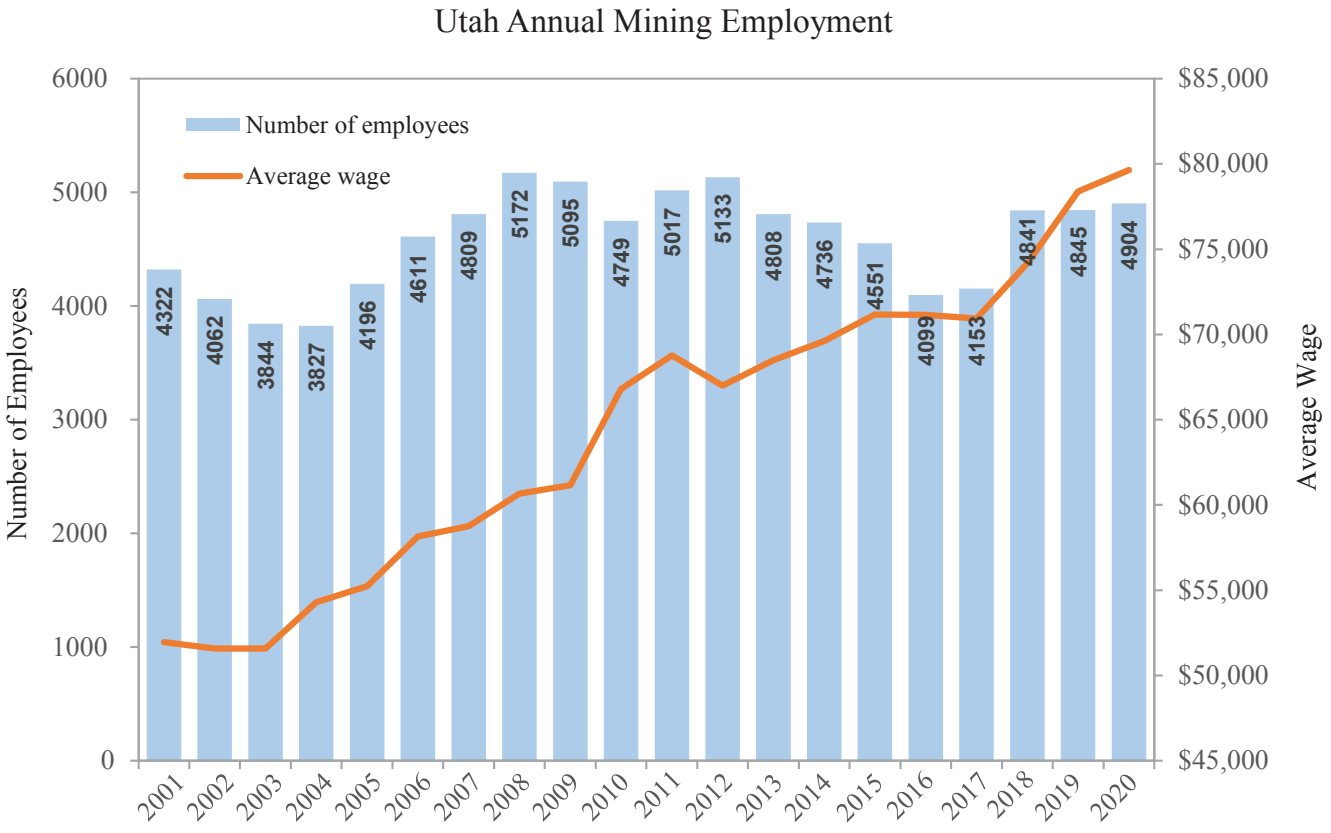



***Figure 6.*** *Average annual mining employment and salaries (in nominal dollars) in Utah. Includes metal, industrial mineral, and coal mines and facilities; excludes oil and gas. Source: Utah Department of Workforce Services.*

However, substantial new demand from China has yet to materialize, as has a stable market for vanadium redox flow batteries. Vanadium alloy demand from the airline industry took a substantial hit with the grounding of Boeing's new 737 Max in March 2019 and suspension of further aircraft production in January 2020. Production is not expected to recover until 2022, despite the 737 Max being cleared to fly as of November 2020. Most vanadium exploration in Utah in 2020 shifted to a primary focus on uranium with vanadium as a secondary target. Notably, a Section 232 investigation into vanadium was launched in June 2020 by AMG Vanadium and U.S. Vanadium LLC. The Section 232 investigation is similar to those that resulted in steel and aluminum tariffs in 2018, and to the one launched by the uranium industry in 2018 that did not result in any direct tariffs but spurred funding to develop a domestic uranium stockpile (see Uranium section).

West of Snake Valley on the northwestern corner of the Fish Springs Range, the West Desert Cu-Zn-In skarn hosts the only established resource of indium in the United States (indicated and inferred resource of 2.9 billion lbs [1,455,600 short tons (st)] Zn, 316 million lbs [157,800 st] Cu, and 3.5 million lbs [800 st] In [Dyer and others, 2014]). InZinc, the owner of the West Desert project, signed a Letter of Intent in late 2020 to option the West Desert project to American West Metals, a private Australian exploration company.

In addition to the onset of helium production from an existing gas plant, a few companies are also exploring for new helium sources in Utah. Twin Bridges Resources is exploring for helium in southeast Emery County (the Bowknot project) and drilled a well in early 2021 to evaluate a potential resource. North American Helium, Five-Nines Energy, and Desert Eagle Operating also have land holdings in Emery and Grand Counties that they intend to explore.

AMP Utah has a rare earth element (REE) exploration project in Snake Valley east of the Ibapah batholith focused on Pleistocene Lake Bonneville beach gravels, which were evaluated for placer U and Th in the late 1970s and noted for having elevated REE values (Krahulec, 2011). Previous exploration in 2008 cited total rare earth oxide (TREO) values up to 0.8%, though they averaged closer to 0.1%. Despite a large surface area covered by the potential gravel deposits (3000 x 40,000 ft), the estimated thickness is only ~30 ft.

## BASE AND PRECIOUS METALS

### Production

Utah's base metal production value totaled $1.53 billion in 2020, a 13% decrease from the 2019 revised total of $1.76 billion. The production value of precious metals totaled $356 million in 2020, a 6% decrease from 2019. Figure 7 shows the annual production and value of copper, gold, silver, and molybdenum since 2000.

Like many other sectors across the economy, the global mining industry faced significant challenges during 2020 due to the COVID-19 pandemic. In March 2020 when many operations were forced to shut down and fears over the decimation of global supply chains dominated, commodity prices across the board experienced drastic drops and the outlook in the sector was bleak. However, mining was declared an essential industry in many nations, allowing operations to restart, and China's early economic recovery from the pandemic spurred strong growth in industrial activity during the second half of the year. Many commodities, such as gold, silver, copper, and iron finished 2020 at stronger price points than they had started the year. Global mining companies such as BHP, Barrick, and Newmont were able to pay out unexpectedly high dividends, and Rio Tinto's total 2020 payout was an all-time high for the company. Significant commodity price declines in 2021 are forecast to be unlikely, and both operational and exploration budgets are anticipated to recover or exceed 2019 levels.

Almost all gold and silver and all copper and molybdenum produced in Utah in 2020 was produced by Bingham Canyon mine, which is a world-class copper-molybdenum-gold porphyry deposit. Despite Rio Tinto's record 2020 payout, the Bingham Canyon mine, owned by Kennecott Utah Copper Company (KUCC, a Rio Tinto company), experienced hardship during 2020. Bingham's overall production value for all metals in 2020 is estimated at $1.62 billion, an 11% decrease from 2019. Bingham Canyon was impacted by the same COVID-19 pandemic-related issues as the rest of the global mining sector and also had to contend with the fallout from a magnitude 5.7 earthquake that Salt Lake Valley experienced on March 18, 2020. The mine and associated refineries are located on the west bench of Salt Lake Valley in the Oquirrh Mountains, and the epicenter of the earthquake in Magna was about 2.5 mi east of the KUCC tailings impoundment, 5 mi east of the smelter, and 16 mi north of the open pit. The earthquake damaged the flash converting furnace to the point where a full furnace rebuild was required. Moreover, unexpected issues identified during a 45-day planned maintenance shutdown of the smelter in May-June delayed the restart of the refinery to October 2020 (Rio Tinto, 2021).

Besides the COVID-19 pandemic and earthquake issues, mined copper production at Bingham Canyon declined due to low grades encountered in the east wall (more detail in the Copper section). The low copper and precious metal grades associated with the east wall are expected to continue through the first part of 2021 until the first $900 million phase of the south wall pushback is completed, after which mining will shift to the south wall and copper grade will improve. The initial pushback is expected to extend mine life to 2026. In December 2019, Rio Tinto also announced investment in a second $1.5 billion phase of the south wall pushback, which will extend mine life to 2032. Bingham Canyon ore reserves remained relatively consistent, reflecting normal mine depletion in tonnage and relatively stable grades. The open pit resource grew from 22 million to 314 million st following a significant pit design change, though grades remained relatively constant.

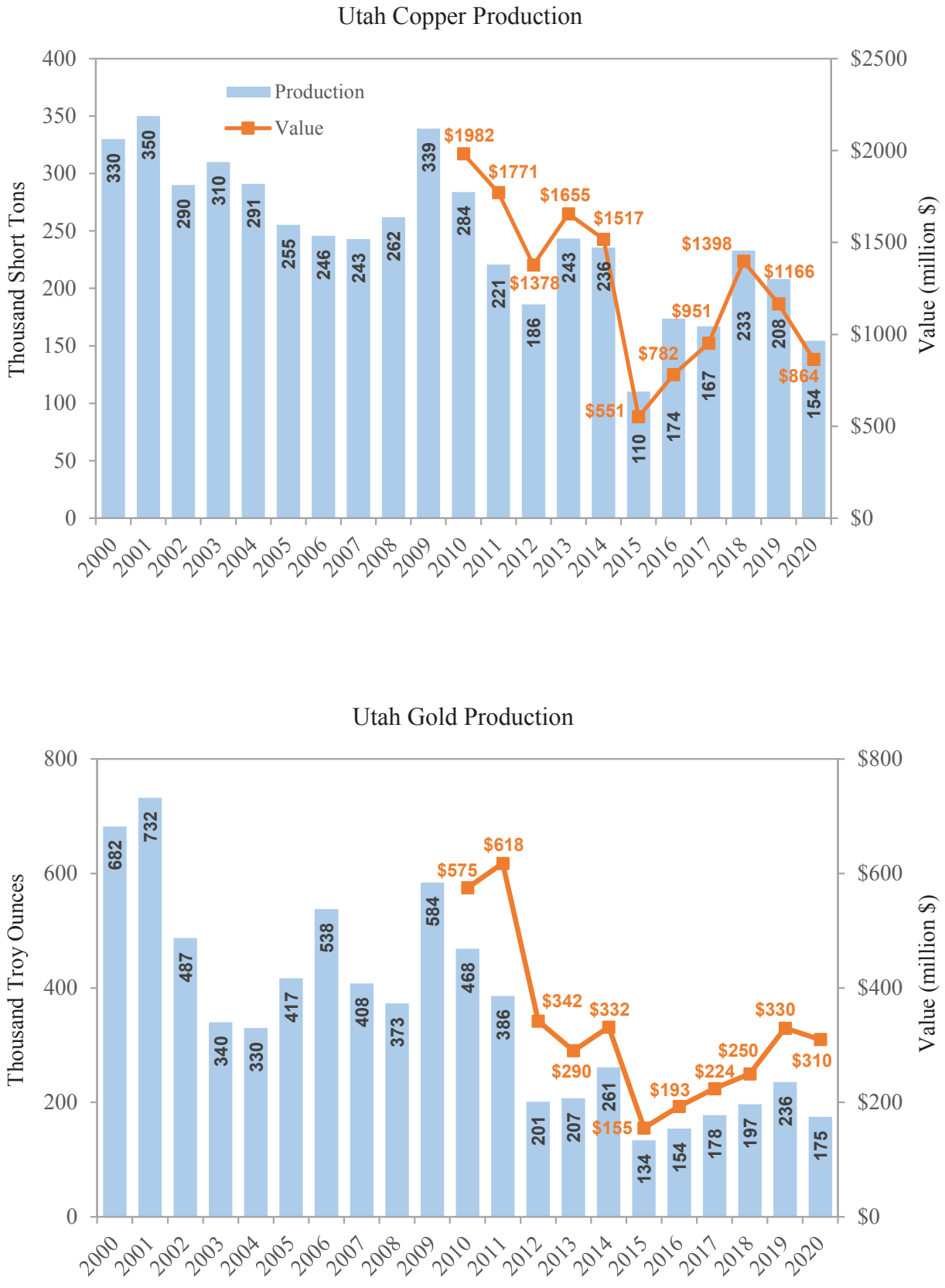
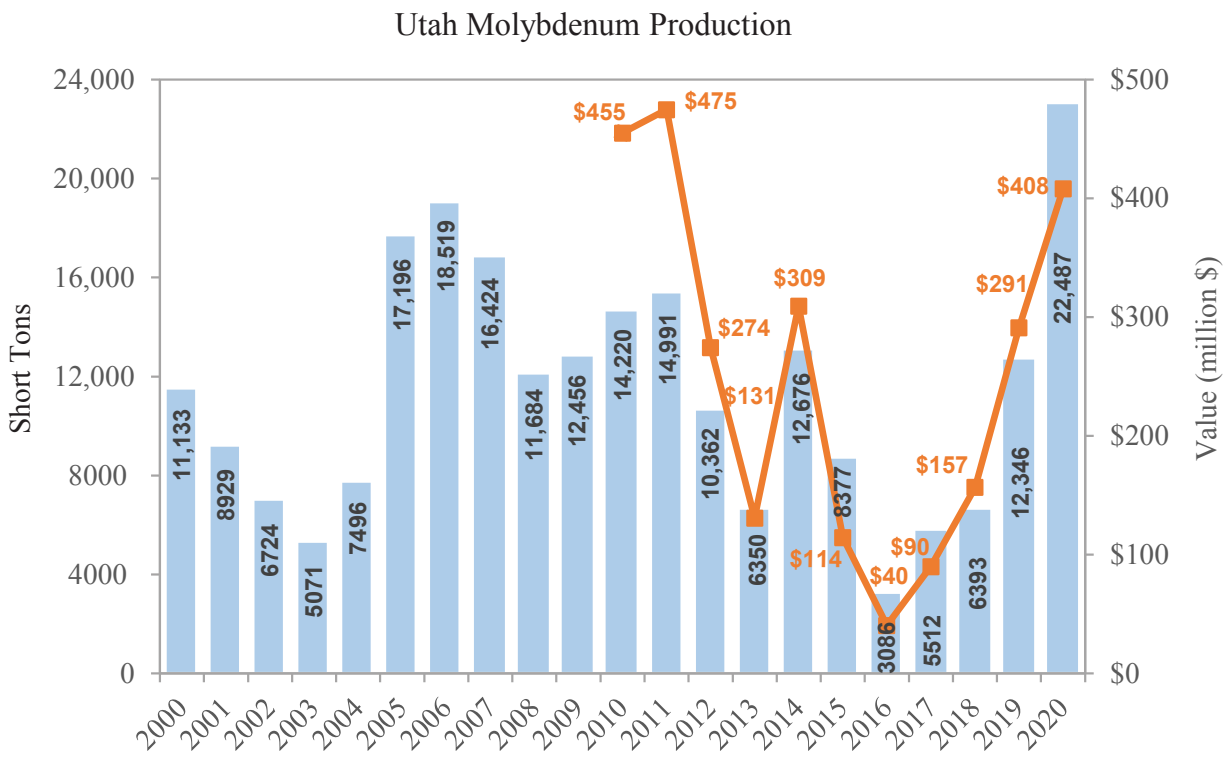



***Figure 7.*** *Production (since 2000) and value (since 2010) of select metals. Value in nominal dollars. Data source: Utah Geological Survey.*



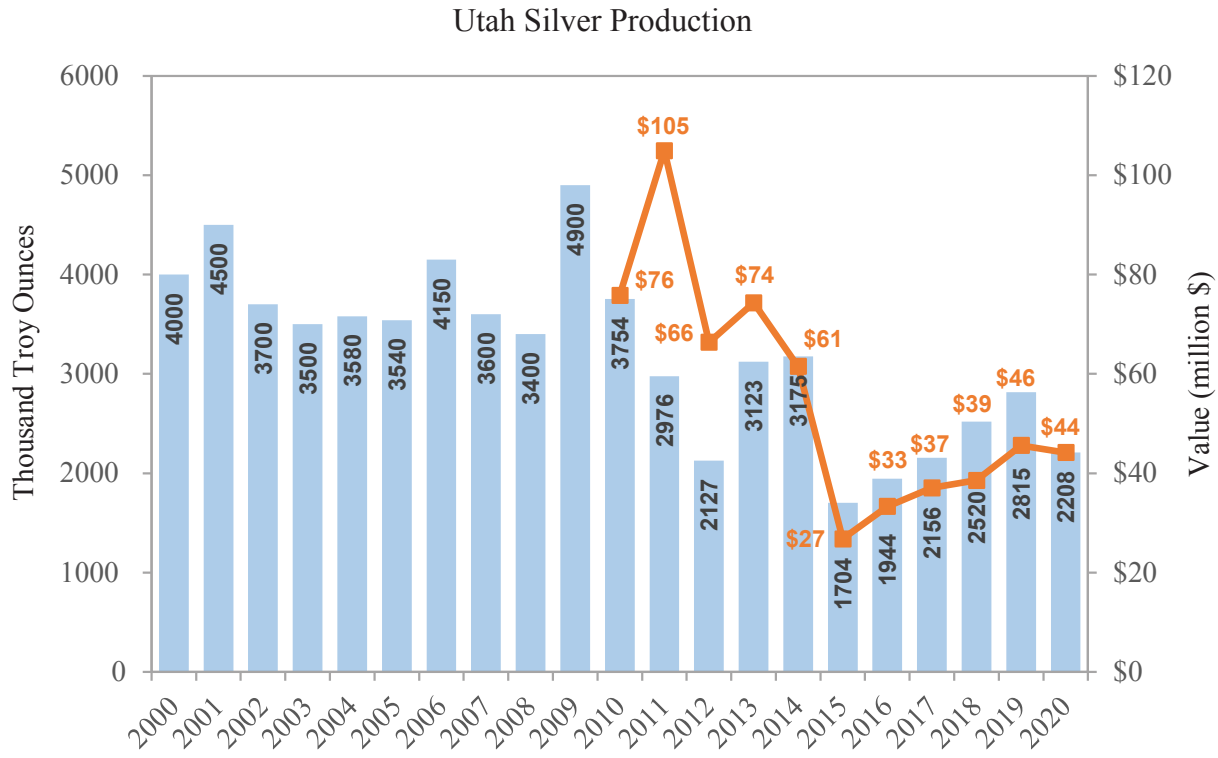




***Figure 7.*** *Continued.*

Utah continued to be the global leader and only domestic producer of beryllium. Beryllium ore is mined from the Spor Mountain mining district in Juab County (mining districts throughout this publication refer to the locations and boundaries summarized by Krahulec, 2018). The ore is processed at a mill in Delta; both mine and mill are owned by Materion Corporation. Enough beryllium was produced in 2020 to account for 90% of domestic beryllium consumption and 63% of global beryllium consumption. 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. Iron production restarted in Utah in 2020 for the first time since 2014 with the resumption of mining at the previously idled Black Iron mine (previously known as the Iron Mountain mine) in the Iron Springs mining district, Iron County.

Specifics for Utah's base and precious metal mining commodities are detailed in the sections below, listed in order of decreasing production value.

## Copper

Utah's copper production in 2020 was 309 million lbs (154,000 st), compared to 417 million lbs (208,000 st) in 2019 (figure 7). The Bingham Canyon mine was Utah's only copper producer in 2020 after the abrupt shut-down of the Lisbon Valley copper mine in early 2020, with the mine having already suspended open pit operations. The 26% decrease in production is attributed to lower grades at the Bingham Canyon mine, which will continue through 2021 until mining shifts to the south wall later in the year. Average copper price was essentially unchanged from 2019 to 2020, so the lower production value in 2020 ($864 million versus $1,170 million in 2019) is entirely driven by lower production.

Mined copper at Bingham Canyon, the metric on which production value is calculated in this report, was not as impacted by the COVID-19 pandemic and earthquake effects as refined copper. Refined copper totaled 185 million lbs (92,600 st) in 2020, down from 407 million lbs (203,500 st) in 2019.

Lisbon Valley copper mine did not carry out any active mining in 2020, having switched from open-pit mining to leaching of stacked ore through their solution extraction electrowinning (SX-EW) facility in late 2018. Lisbon Valley Mining Company (LVMC) was investigating the potential of applying in situ recovery (ISR) mining techniques through 2019, and in October 2019 filed an expanded Plan of Operations application with the BLM that would allow for the injection wells needed for the ISR method. LVMC also filed an aquifer exemption request with the Utah Division of Water Quality, which would allow pumping diluted solvent (in this case, sulfuric acid) into the groundwater around the ore bodies. However, during the onset of the COVID-19 pandemic, LVMC's funding collapsed and the mine was abruptly shut down on March 18, 2020. OGM issued an emergency order on March 20, 2020, that allowed the release of LVMC's $6.1 million surety bond to mitigate environmental impacts of the mine shutting down. As of April 22, 2020, LVMC was required to complete full reclamation of the mine site by September 2021, though this requirement was lifted on February 3rd, 2021, due to LVMC re-permitting the operation, including a new surety bond.

Tamra Mining's Rocky Range copper skarn mine in Beaver County has had no active mining since late 2018 and no copper cathode production from their SX-EW and flotation facility since early 2019. There is no indication of operations restarting under the current owners, though in 2020 attempts to find a new operator were ramped up. Tamra entered into two exploration agreements with Alderan Resources in 2020 (see Exploration and Development), demonstrating that the district surrounding the Rocky Range mine still hosts significant mineral potential.

Copper experienced tumultuous price changes in 2020, despite general industry consensus of a strong long-term copper market. With the increasing focus on an energy transition from fossil-fuel-based to carbon neutral, the role of copper in energy production, storage, transmission, and end-use (e.g., electrification of vehicles) makes it one of the most essential commodities for the energy transition. However, despite strong fundamentals for copper, the red metal was not protected from the uncertainty surrounding the global minerals market in 2020. Following a relatively weak price in 2019, the price of copper cratered with the onset of the COVID-19 pandemic in March 2020 over concerns that the global industrial supply chain would collapse. The price recovered by mid-year and then continued growing on stronger-than-anticipated industrial recovery, ultimately reaching the highest price since the 2011 global commodity supercycle in February 2021.

## Gold

Utah produced 175,043 troy oz of gold in 2020, with production from the Bingham Canyon, Kiewit, and Trixie mines (figure 7). Utah's 2020 gold production was valued at $310 million, a 6% decrease from the $329 million valuation in 2019. The overall production value decrease was the result of lower production even as gold prices rose by $375/troy oz in 2020.

The vast majority of gold produced in Utah came from the Bingham Canyon mine. However, like copper, mined gold production at Bingham Canyon experienced a significant drop from 234,700 troy oz in 2019 to 171,200 troy oz in 2020. Combined pandemic and earthquake impacts plus the grade variability in the east wall all contributed to lower production in 2020. Production in 2021 is expected to recover to similar levels as 2019, with grade stabilizing later in the year with the shift to mining the south wall.

The Kiewit mine in the Gold Hill district of west Tooele County continued production in 2020, mining 475,000 st and recovering 3840 troy oz gold. Clifton Mining holds Kiewit's land position and Desert Hawk Gold Corp. is the operator. The mine is a low-grade open-pit heap leach operation recovering structur-

ally controlled disseminated sulfide gold from the large Jurassic granodiorite dominating the southern area of the Gold Hill district (the 2019 mining report [Mills and others, 2020] incorrectly stated this was a sediment-hosted gold deposit). Gold grade is generally <1 g/t, averaging about 0.2 g/t Au.

A new gold producer in 2020 was the Trixie mine in the East Tintic mining district, Juab County. Trixie is a historical, high-grade Au-Ag epithermal underground mine with accessory base metal mineralization that operated from 1965 until 1995, and briefly again from 2000 to 2002. Tintic Consolidated Metals (TCM) refurbished the mine down to the 625 level in 2020 and recommenced production, pouring the first gold bar in November 2020. As part of recommencing production at the Trixie mine, TCM also made a substantial new bonanza-grade orebody discovery, which is discussed in more detail in the metals Exploration and Development section. Because production started late in the year, only a small amount of ore was mined in 2020. Notably, grades varied between 3 g/t and >100 g/t Au, which were the highest grades of any of the current gold operations in Utah. Production is expected to increase substantially in 2021.

Gold, the traditional safe-haven investment, did not experience a substantial drop in price when the COVID-19 pandemic was recognized globally in March 2020. In the face of economic insecurity, investment in gold increased substantially and the gold price spent an extended period above $1,900/troy oz in 2020, with spot prices reaching over $2,000/troy oz, only slightly below the multi-decadal price high seen in 2011. The strength of gold was also helped by 2020 being an election year in the United States, as uncertainty around future economic policy traditionally sees an uptick in gold investment. The price of gold peaked in August 2020 and has retreated slightly, although it remains higher than prices over the past five years.

## Molybdenum

Utah produced 45,000,000 lbs (22,490 st) of molybdenum in 2020, exclusively from the Bingham Canyon mine (figure 7). Of all commodities produced by Bingham Canyon, molybdenum by far had the best year in terms of production. Molydenite, the ore mineral of molybdenum, is not refined at Bingham Canyon. The molybdenite is concentrated, dried, and shipped to other refineries in Arizona and Mexico. As a result, the shut-down of the flash converting furnace and then the smelter did not impact molybdenum as it did copper, gold, and silver. Taking advantage of both the impaired refinery stream and the high molybdenum grades in the east wall where mining is currently taking place, KUCC adjusted pit sequencing to optimize molybdenum production. By year end, molybdenum concentrate production had increased by 82% from 2019. The substantial increase in Bingham Canyon's molybdenum production was felt on a national scale, as U.S. mine output of molybdenum increased by 13%, almost entirely due to the increase at Bingham. The increased output from Bingham also offset production delays at other molybdenum producers caused by the COVID-19 pandemic.

The price of molybdenum was highly volatile in early 2020, with prices rising and falling again by nearly 25%. However, after mid-year molybdenum joined the bevy of other metals in a strong resurgence driven by increased global industrial activity. By the end of 2020 molybdenum prices had returned to 2019 levels and appeared to be stabilizing. Molybdenum is primarily used in alloys, particularly stainless steel alloys widely used in the petroleum industry.

## 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 mi west of Salt Lake City in Tooele County (figure 2). Magnesium chloride concentrate is produced from Great Salt Lake brines through evaporation and is subsequently converted to magnesium metal by an electrolytic process. The annual magnesium production capacity at the U.S. Magnesium plant is approximately 70,000 st (specific data on production is confidential). The price for magnesium metal rose from $2.45/lb in 2019 to $2.50/lb in 2020 (USGS, 2021a). Magnesium was the third largest contributor to Utah's base metal value in 2020. 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, 2021a). U.S. Magnesium also produces a number of byproducts including lithium, salt, and chlorine. Lithium is discussed further in the industrial minerals section.

## Beryllium

Beryllium production from Utah totaled 333,840 lbs (167 st) in 2020, a modest increase over the 320,700 lbs (160 st) produced in 2019. The average price of beryllium was unchanged from 2019 to 2020, resulting in an overall 2020 production value of $94 million, a 4% increase from 2019.

Beryllium production from Utah comes exclusively from the Spor Mountain mine in central Juab County (figure 2). 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. In some years, the Delta mill also processed beryl ore from outside Utah, as was the case in 2019. However, in 2020 only ore from Utah was processed (Materion,

2021). The proven and probable reserves at Spor Mountain are estimated to be enough to maintain mining at current production levels for another 75 years.

The Spor Mountain mine is the largest producer of beryllium in the world, accounting for approximately 63% of the world's annual production in 2020. Beryllium was named a critical mineral in 2018 not because the United States lacks beryllium production, but rather because so much production is dependent upon a single source. The risk of catastrophic supply chain failure should the Spor Mountain mine be compromised is considered a vulnerability. Beryllium is an essential component in aerospace and defense applications due to being lightweight but able to withstand significant temperature variations and mechanical distortion. Being a boutique metal, beryllium is less subject to substantial shifts in commodity price, and Spor Mountain's 2021 production is anticipated to be similar to 2020.

### Silver

The Bingham Canyon mine was the state's main producer of silver in 2020, though both the Kiewit and Trixie mines produced minor amounts of silver in addition to gold. Silver production levels were the most consistent between 2019 and 2020 out of Bingham's commodities, despite the 2020 earthquake and COVID-19 pandemic. Mined silver still decreased from 2.8 million troy oz in 2019 to 2.2 million troy oz in 2020 (figure 7). The average price of silver per troy oz rose from $17.17 in 2019 to $20.00 in 2020, but Utah's production value decreased by 9% to $44 million due to lower production.

Silver, considered a precious and industrial metal, followed gold's price trajectory early in the year as a safe-haven investment, and then continued with strong price growth in the second half of the year's resurgence of industrial activity. Silver experienced more extreme price fluctuations than gold, gaining an astounding 137% from the price low to the price high for the year, though the overall average annual gain of $2.83 per troy oz (15%) was modest.

### Iron

Iron production returned to Utah in 2020 after last production in 2014. Black Iron LLC (currently rebranding to Utah Iron LLC) reopened the Black Iron mine (previously known as the Iron Mountain mine) west of Cedar City, in the Iron Springs mining district. Iron mineralization occurs as massive magnetite skarn/replacement deposits adjacent to Miocene monzonite laccoliths. Production resumed in September 2020, and from September to December the mine produced 96,000 st of magnetite ore. Run of mine ore at Black Iron is estimated to average 48.6% Fe, based on a 2009 NI 43-101 report (SRK Consulting, 2009). Using this grade as a guide it is assumed the ore contained approximately 93 million lbs iron. The concentration facility at Black Iron has resumed operation, which concentrates the run of mine ore to approximately 65% Fe prior to transport by rail to the West Coast and shipment overseas for further processing. The company intends to ramp up production to 400,000 st in 2021 and is evaluating new production targets inside the Iron Springs district. Refurbishment and reclamation works were ongoing in 2020, with 36 acres of historical production area reclaimed and a 3-mi water pipeline project underway to improve water recycling in the milling process.

Like copper, iron was a standout performer overall in the 2020 commodity market. Following a similar cycle of initial price shock at the onset of the pandemic, iron prices began recovering in May 2020 and the price continued to improve for the remainder of the year, ending well above 2019 prices and reaching levels not seen since the global commodity supercycle in 2011 and 2012. The strength of iron ore's recovery has been based on both the strength of the industrial recovery globally (but particularly in China) and a market deficit due to reduced Brazilian iron ore exports.

## 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 S&P Global world exploration report (S&P Global, 2021), mining company websites, press releases, technical reports, personal communication with industry geologists, and the OGM website.

The UGS conducted a survey in early 2021 of active exploration companies in Utah regarding a number of topics related to 2020 exploration including expenditure, employment, and perception of Utah's geology and permitting. Of the 63 companies contacted, the UGS received 26 responses (41% response rate). Fifty percent of respondents explore for combined base and precious metal targets, 27% explore for precious metal-only targets, 19% explore for energy minerals, and 4% for industrial minerals. Key findings from the survey include:

- Exploration expenditure increased from 2019 to 2020 for the majority of respondents (50%), and 58% of respondents expect to spend more to much more in 2021 (figures 8 and 9).

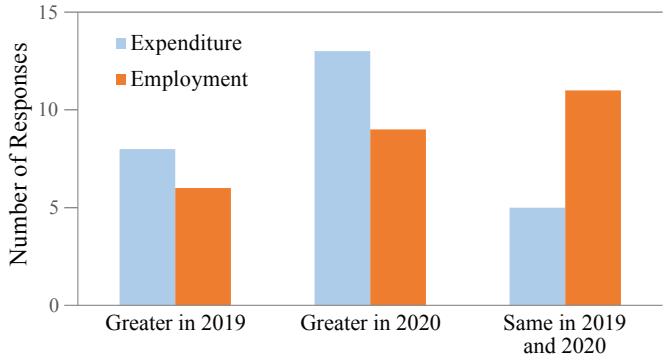



***Figure 8.*** *Exploration expenditure and employment in 2019 vs. 2020. Data source: Utah Geological Survey industry survey.*

- Exploration employment remained stable for most respondents (42%) from 2019 to 2020 and increased for 35% of respondents (figure 8).
- Respondents were equally divided on the impact of the COVID-19 pandemic on exploration activities. Roughly one-third of respondents considered the impact low (low to moderately low = 34%), one-third neutral (neutral = 34%), and one-third high (moderately high to high = 32%, figure 10).
- Utah's exploration attractiveness ranked highly on favorable geology, potential for new discoveries, and access to public lands (likely in reference to grassroots exploration on mainly BLM and SITLA land, figure 11). Utah's exploration attractiveness was negatively impacted by time/costs required to permit and access to public lands (likely in reference to the difficulty of consolidating a land position in historical mining areas with patented claims).

The Utah exploration survey indicates that although exploration slowed during the first half of 2020, momentum picked up in the second half and is expected to continue into 2021. Five projects totaling roughly 67,000 ft were drilled in 2020, versus four projects totaling 55,000 ft drilled in 2019. The 2020 drilling included large programs in the Tintic district in Juab County, at the Frisco project in Beaver County, and at the Detroit project in Juab County, discussed below. Drilling is planned for at least 10 projects in 2021, with drilling already commenced at one project (Black Rock target in the Valley/Crossroads project).

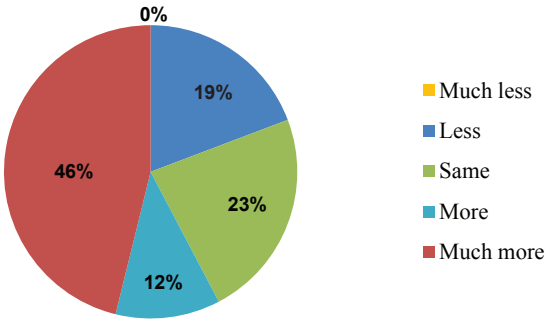



***Figure 9.*** *Anticipated 2021 metals exploration expenditures versus 2020 expenditures (percent of respondents). Data source: Utah Geological Survey industry survey.*

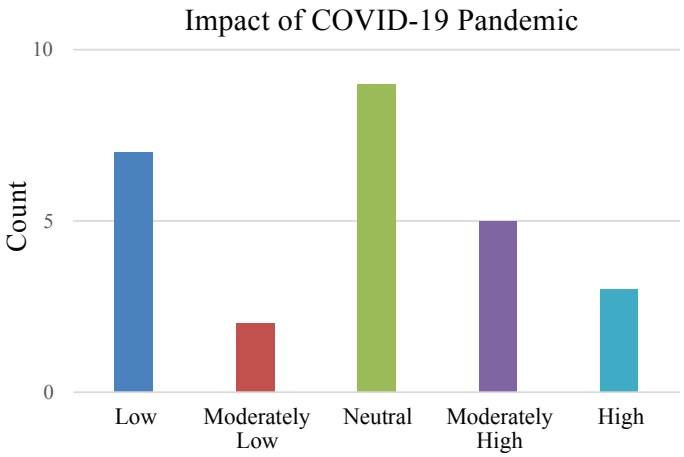



***Figure 10.*** *Impact of COVID-19 pandemic on exploration activities in Utah. Results are based on survey of active exploration companies.*

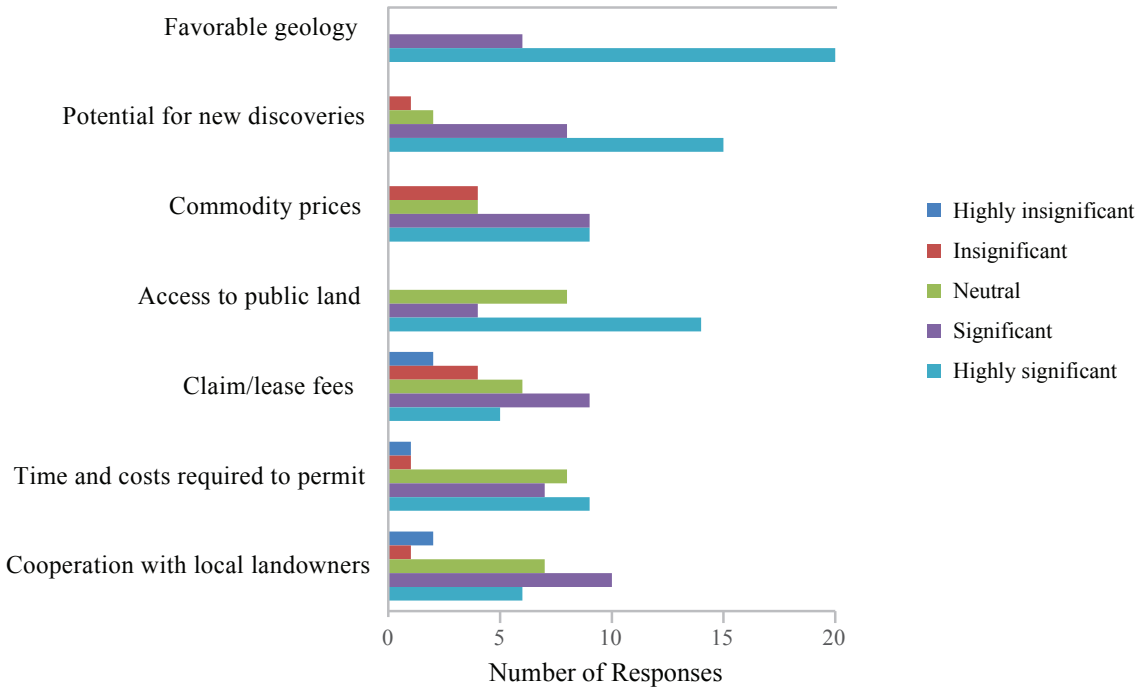



***Figure 11.*** *Impact ranking of different factors contributing to Utah's exploration attractiveness. Data source: Utah Geological Survey industry survey.*

Global trends in exploration and development were similar to those observed in Utah. The global nonferrous exploration budget in 2020 dropped by 11% from 2019 ($9.8 billion to $8.7 billion), far less than was forecast in March 2020 when exploration indices saw the most drastic drop. By year-end, the equity market support for exploration was above 2019 levels, with explorers capitalizing on rising prices and easing COVID-19 restrictions in the second half of the year. Gold accounted for over 50% of the global exploration budget, and copper was second at 21% of the global budget. However, copper also experienced the most substantial drop in the 2020 exploration budget, decreasing by 24% from 2019 levels.

The direct effects of the COVID-19 pandemic globally impacted grassroots exploration more extremely, as compared to late-stage exploration and mine site exploration. The trend of decreasing focus and investment in grassroots-stage exploration has been observed for several years, resulting in a major drop in discovery rates for gold and copper deposits. Despite the blow to grassroots exploration, junior and intermediate companies (those typically dominating the grassroots space) were able to raise the most exploration funding since 2012.

Details of some of Utah's larger exploration programs are presented below, and a broader look at exploration in Utah in 2020 is shown on figure 12 and summarized in table 2.

## Trixie Mine, Au-Ag – East Tintic District, Juab County

The highlight of Utah's 2020 precious metal exploration came from the historical Trixie Au-Ag (Cu-Pb-Zn) mine in the East Tintic mining district. Tintic Consolidated Metals (TCM), which holds the core of the historical East and Main Tintic districts, has been focused on redevelopment of the Trixie gold mine since acquiring the property in early 2019. In 2020, redevelopment activities led to the discovery of a significant new bonanza grade vein system adjacent to historical mine developments, the re-commencement of Trixie's mining operations, and pouring of the first gold in November. The ultra-high grade ores in the newly discovered vein system have exceeded 10,000 g/t to date, a staggeringly impressive result from one of Utah's most long-lived and extensively worked districts. The new vein system has also gained notoriety for its unique mineralogy, including the occurrence of xocomecatlite ($Cu_3[TeO_4][OH]_4$), a rare, bright green copper tellurate known only in seven localities worldwide, two of which are now in the greater Tintic area (see cover photo).

TCM commenced refurbishment of the main shaft at the Trixie mine in late 2019, and regained access to the upper 625 level in early 2020. Refurbishment of the 625 level was completed by mid-2020, allowing the company to commence underground drilling on a resource target identified in the footwall to the areas of historical mining. An exploration drift was developed towards the target and, within 45 ft of the historical workings, a new, never before tapped ultra-high grade Au-Ag vein was intersected; the vein was named the T2 structure. TCM commenced preliminary mining along the T2 structure and by the end of 2020 had developed over 350 ft of strike length along the new multi-ounce-grade vein, which reported consistent Au values of >35–70 g/t along strike. Thus far, channel face sampling has yielded 3500 g/t Au and >6500 g/t Ag over a continuous width of 8 ft.

Mineralization in the T2 structure remains open in all directions, and, significantly, the structure dips steeply eastward, away from the historical mine development at depth. Access to the next underground level of the Trixie mine, the 750 level, was achieved in 2020 and lateral development from the 750 level onto the T2 structure was planned to start in early 2021. Significant depth potential for the T2 structure was inferred and will be the focus of resource definition drilling and exploration development efforts in 2021. A new reserve and resource estimate for the Trixie mine is anticipated in late 2021.

TCM also completed two surface exploration holes at its Trixie West target during 2020, targeting a north-south-trending structural corridor located 2000 ft west of the Trixie underground operation. Follow-up drilling was planned for 2021 and 2022. In addition to the Trixie mine, the company is in the process of developing an exploration program at the historical Eureka Standard Ag-Pb-Au-Cu mine located approximately 2000 feet north of the Trixie operation. Drilling of a previously identified high-grade target beneath the Eureka Standard mine is planned for 2021, and the company intends to reopen the mine within two years targeting this high-grade ore shoot. TCM is also developing a porphyry exploration program to explore for a deep porphyry copper-gold system underlying the East Tintic District and will be the focus of ongoing regional exploration activities beyond 2021.

## Frisco Project, Cu-Au (Ag-Zn-Pb) – San Francisco District, Beaver County

Another significant base- and precious-metal project undertaken in 2020 was that of the Frisco project in Beaver County, located in the San Francisco mining district. The Frisco project is a complex historical Cu-Au-Zn-Ag-Pb mining area with multiple mineralization targets, though the district is most likely viable for production with the discovery of a large porphyry copper deposit. Alderan Resources holds the core of the Frisco project and signed an earn-in joint venture agreement with Kennecott Exploration Company (KEX, a subsidiary of Rio Tinto) in late 2019. KEX led exploration in the district in 2020 with a nine-hole diamond drilling program totaling 36,100 ft that tested three targets. The first target was the Cactus Breccia area, host to historical Cu-Au production from tourmaline breccias. The second tar-

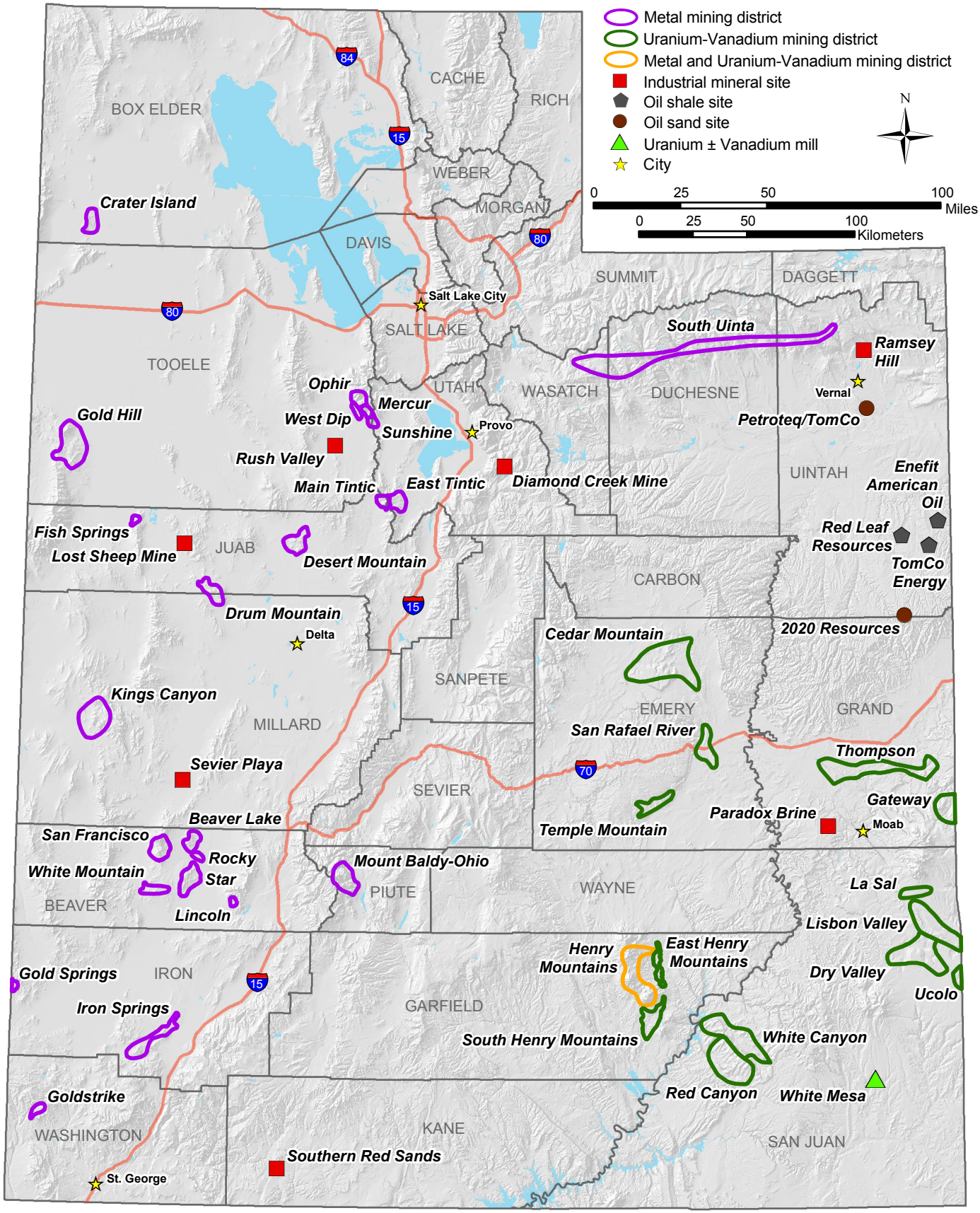



***Figure 12.*** *Select base and precious metal, industrial mineral, uranium-vanadium, oil shale, and oil sand exploration and development activity locations in Utah.*

***Table 2.*** *Select metal exploration and development projects in Utah, 2020. Districts are shown on figure 12.*

| Project | District[1] | Commodity | County | Company[2] | Progress |
|---|---|---|---|---|---|
| Black Iron | Iron Springs | Fe | Iron | Utah Iron LLC (Black Iron LLC) | Reviewed two potential exploration targets for future production development |
| Bonneville Gravels | Undefined | REEs | Juab | AMP Utah LLC | Expanded land position on 6 BLM sections and 2 SITLA leases east of the southern Deep Creek Range |
| Bromide Basin | Henry Mountains | Au-Cu | Garfield | Prolific Mining Corp. | Expanded land position on 1 SITLA lease in the Henry Mountains district |
| Cave Mine | Lincoln | Polymetallic | Beaver | Grand Central Silver Mines Inc. | Expanded land position on 1 BLM section in Bradshaw district |
| Coyote | Desert Mountain | Ag-Au | Juab | Gold Bull Resources Corp. | Acquired project and undertook IP survey and geochemical sampling (up to 12.25 g/t Au and 5,570 g/t Ag); plans futher geophysics and soil sampling |
| Dal Cuinn | South Uinta | Ag | Duchesne | Dal Cuinn Exploration & Mining | Advanced mining feasability plan in preparation for production development |
| Deer Trail | Mount Baldy-Ohio | Cu-Au | Piute | DT Mining LLC (MAG Silver Corp.) | Initial ~21,000-ft drill program (results pending), underground 2D seismic, 3D modelling, surface and undergorund mapping, core relogging, geochronology; follow-up drilling planned in 2021 |
| Detroit | Drum Mountains | Au-Cu-Mo | Juab | Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.) | Drilled 3688 ft diamond core (7 holes) with 270 ft at 0.41 g/t Au from 118 ft depth (with 22 ft at 1.98 g/t Au from 277 ft depth), geologic mapping, ground magnetics, soil, stream, and rock chip geochemistry (up to 7 g/t Au from rock chip); follow-up drilling planned in 2021 |
| Frisco | San Francisco | Polymetallic | Beaver | Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.) and Kennecott Exploration Company (Rio Tinto) | Drilled 31,600 ft diamond core (9 holes) with 240 ft at 1.1% Cu, 0.35 g/t Au, 4.5 g/t Ag, and 37.9 ppm Mo from 718 ft depth (including 134 ft at 1.9% Cu, 0.62 g/t Au, 7.1 g/t Ag, and 62.8 ppm Mo from 826 ft depth); follow-up drilling planned in 2021 |
| Gold Springs | Gold Springs | Au-Ag | Iron | Gold Springs Resources Corp. (TriMetals Mining Inc.) | CSAMT geophysical survey, geologic and structural mapping; drilling planned for 2021 |
| Goldstrike | Goldstrike | Au | Washington | Liberty Gold Corp. | Review of 2020 drilling and planning 2021 drilling (proposed 49,000 ft RC drill program) |
| Milford | Star | Polymetallic | Beaver | TAO Commodities Ltd. | Rock chip and soil sampling at Moccasin and Captain Jack prospects (rock chip results up to 17.4 g/t Au, 1.71 % Cu, and 8760 g/t Ag); expanded land position on 10 BLM claims in Star district |
| Thompson Knolls | Kings Canyon | Cu | Millard | BCM Resources Corp. and Inland Explorations Ltd. | Geological modelling and target refinement; drilling planned for 2021 |
| Tintic | Main Tintic | Polymetallic | Juab | High Power Exploration Inc. | Geologic mapping, sampling, drill target finalization; drilling planned for 2021 |
| Tintic | East Tintic | Au-Cu | Juab/Utah | Tintic Consolidated Metals LLC | Discovery of bonanza grade T2 structure at Trixie mine (>10,000 g/t Au), recommencement of Au production from Trixie mine, 2 surface exploration holes at Trixie West; follow up drilling at Trixie, Trixie West, and Eureka Standard planned for 2021 |

***Table 2.*** *Continued.*

| Project | District[1] | Commodity | County | Company[2] | Progress |
|---|---|---|---|---|---|
| Valley/ Crossroads (Black Rock) | Rocky/Beaver Lake | Cu-Au | Beaver | Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.) | Acquired land position covering Valley skarn and Crossroads porphyry target, focused on Black Rock prospect with geological mapping and rock chip geochemistry (including up to 4.6 g/t Au, 10.15% Cu, 125 g/t Mo, 522 g/t Co, and 4.3 g/t Te); 3300-ft diamond core program commenced January 2021; expanded land position on 24 BLM sections |
| Valley/ Crossroads and Detroit | Rocky/Beaver Lake and Drum Mountains | Cu-Au | Beaver | Tamra Mining Company, LLC | Entered option agreement for Alderan Resources to earn in on the Detroit and Valley/ Crossroads exploration projects |
| West Desert | Fish Springs | Zn-Cu-In | Juab | InZinc Mining Ltd. | Letter of Intent to option West Desert project to American West Metals Limited. |
| West Mercur | West Dip, Mercur, Ophir, Sunshine | Au | Tooele | Ensign Gold Inc. (Rush Valley Exploration Inc.) | Acquisition of Rush Valley claims by Ensign Gold and expansion into greater Mercur orbit on 19 BLM claims and 1 SITLA lease; 2021 acquisition of Ensign Gold by Austral Gold Ltd. |
| Western Desert | Crater Island | Au-Cu | Box Elder | Hawkstone Mining Ltd. | Staked 218 BLM claims and 3 state leases; geochemical sampling and target delineation |
| White Mountain | White Mountain | Au | Beaver | Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.) | Geological mapping, ASTER analysis, ground magnetics; drilling planned for 2021 |
| Yellow Cat | Thompson | V-U | Grand | Anson Resources Ltd. (Blackstone Resources Inc.) | Review of historical drilling data, delineation of future exploration program |

[1]As defined in Krahulec (2018)
[2]Parentheses indicate alternative or previous company names.

get was the Accrington skarn, a Cu-Zn-Pb skarn previously intercepted by Alderan. The final target was the Reciprocity blind induced polarization (IP) anomaly, which is a 2.5-mi mineralized structure with indications of high-grade Au, Ag, Pb, and Zn. Drilling commenced in May with an initial four-hole, 6500-ft program starting in the Cactus Breccia. Hole SAWM0001 intersected 240 ft of Cu-Au mineralized tourmaline breccia averaging 1.1% Cu, 0.35 g/t Au, 4.5 g/t Ag, and 37.9 ppm Mo from 718 ft depth, including a higher-grade interval of 134 ft at 1.9% Cu, 0.62 g/t Au, 7.1 g/t Ag, and 62.8 ppm Mo from 826 ft depth. Within the higher-grade interval were areas of massive sulfide assaying up to 14% Cu. The SAWM0001 intercept represents the best intersection drilled to date at the Cactus Canyon prospect. The second drill hole (SAWM0002) also intersected two intervals of hydrothermal breccias from 108 ft and 180 ft depth that were unmineralized. Low-grade mineralization was intercepted at 554 ft depth, extending 39 ft and averaging 0.23 g/t Au. The success of SAWM0001 led Alderan to reprocess magnetic data to enhance magnetic features associated with the breccia pipes in the Cactus Canyon area, revealing several new circular magnetic-low anomalies approximately 330 by 670 ft in diameter as new targets. The tourmaline breccia success also prompted KEX to expand the initial drilling program to nine holes totaling 36,100 ft, completing six holes in the Cactus Canyon area, one in the Accrington skarn, and two in the Reciprocity IP target. Hole SAWM0004 at the Accrington skarn intersected a mineralized interval of 111 ft averaging 0.99% Cu, 0.14 g/t Au, and 13.3 g/t Ag from 500 ft depth. The skarn-hosted sulfides appear to be consistent with historical results and suggest lateral continuity of mineralization in the skarn area. The results of the first hole in the Reciprocity IP target included 260 ft of andesite porphyry with considerable pyrite and pyrrhotite but no mineralization, suggesting iron sulfide alteration was responsible for the IP anomaly as opposed to mineralization. Assays for the five expansion holes are still pending.

Activities at Frisco in 2021 are expected to include completion of SAWM0009, the second hole testing the Reciprocity IP target. The hole was stopped short of target depth in 2020 due to increasing COVID-19 cases at the time of drilling. In addition to the completion of SAWM0009, another three to four holes are expected. Potential targets for 2021 drilling include a chargeability anomaly southeast of the Cactus Breccia, a chargeability anomaly northwest of the Horn Silver mine, a larger step-out southwest of the Accrington skarn, and mapped but untested tourmaline breccias. KEX purchased WorldView-3 satellite data over the project in 2020 that will be used to refine targeting.

## Deer Trail Project, Ag-Zn-Pb-Cu – Mount Baldy-Ohio District, Piute County

The Deer Trail project in the Mount Baldy-Ohio mining district, Piute County, rapidly accelerated exploration in 2020. MAG Silver's subsidiary, DT Mining, moved to begin consolidating the district in late 2018, and in September 2020 MAG Silver formally acquired the consolidated project area, which includes the historical Deer Trail mine and surrounding Alunite Ridge area. The historical Deer Trail mine produced high-grade Ag-Au-Pb-Zn-Cu from carbonate replacement deposits (CRDs) until 1985, and the Alunite Ridge area ~3 mi west of the mine hosts numerous gold-quartz-alunite veins that were locally mined from 1914 to 1945. Historical high-grade Ag values from the Deer Trail mine range from 350 to 465 g/t Ag. Acquisition of the properties also came with extensive historical data, including surface and underground mapping, geochemical results, logs, core and chips from over 65,000 ft of historical drilling, a district-wide aeromagnetics survey, 9 line miles of Audio Magneto-Telluric (AMT) geophysics, 1.5 mi of U.S. Mine Safety and Health Administration (MSHA) certified underground workings, and an active mining permit.

With consolidation of the district for the first time since the early 1980s, MAG Silver cited the potential for an integrated district-scale exploration approach from high-grade Ag-Zn-Pb-Cu CRDs to related skarn and porphyry Cu-Mo mineralization. The possibility for further CRD targets is supported by the district's historically high Ag grades from known CRD mineralization, presence of deep-penetrating regional faulting, stratigraphic location at the top of a favorable carbonate section, and a well-developed plumbing system of faults and mineralization. The first focus of exploration is to project the geometry of the known CRD feeder structures into the inferred 900- to 1500-ft-thick Redwall Limestone at depth, considered the favorable host rock for further CRD and skarn development. The Molas Shale overlying the Redwall Limestone is theorized to act as a cap that could seal high-grade CRD or skarn mineralization at depth. The second focus of exploration is for porphyry Cu-Mo mineralization. Previous drilling between the Deer Trail mine and Alunite Ridge was not thought to intercept porphyry-style mineralization, but while relogging historical drill holes, MAG geologists recognized unsampled, substantial quartz-molybdenite veins in pervasive phyllic-altered volcano-sedimentary rocks. Both the molybdenite veins and the phyllic alteration are interpreted as characteristic of what would be expected near a porphyry deposit.

Activities at the Deer Trail project in 2020 included surface and underground mapping, historical data review and integration, core relogging, geophysics reprocessing, and development of a 3D model integrating the historical data and MAG's CRD exploration model. Geochronological work was also undertaken yielding new 28 to 31 Ma U-Pb zircon and $^{40}Ar/^{39}Ar$ dates, placing the deposit 12 million years older than previous dates and strengthening a relationship to the "Bingham Family" of porphyries. As part of the detailed relogging, core was systematically photographed under short-wave ultraviolet light to evaluate changes in calcite fluorescence thought to reflect mineralization-related geochemical dispersion. In October, a 2D underground seismic survey with ~1-mi penetration was completed to determine depth to, and geometry of, the Redwall Limestone, as well as highlight any major structures. A 21,000-ft phase I surface drill program commenced in November to test depth to the Redwall, trace known steeply dipping CRD feeder structures into the Redwall, and locate massive sulfide mineralization controlled by the feeder structures. The drill program consists of 8 to 10 holes at 2000 to 2600 ft depth, and results are pending.

Exploration in 2021 will be informed by the results of the phase I drilling; however, phase II drilling is already being planned. Additionally, ~30,000 ft of historical core remains to be relogged and miles of underground workings to be mapped by MAG geologists. Surface mapping and sampling over the potential porphyry mineralization between Deer Trail and Alunite Ridge are in progress.

## Detroit Project, Au (Cu-Mo) – Drum Mountain District, Juab County

The Drum Mountain (Detroit) mining district in south-central Juab and north-central Millard Counties had renewed interest in 2020, currently from Alderan Resources. Alderan signed an option agreement with Tamra Resources, owners of the inactive Rocky Range mine and mill in Beaver County, to explore Tamra's claims in the Drum Mountain district in Juab County and in the Rocky/Beaver Lake districts in Beaver County (see Valley/Crossroads project below). The Drum Mountain district is a past Au and Mn producer, with lesser Cu. It is known to host Carlin-style gold (Drum mine) and subeconomic porphyry Cu-Mo mineralization (Basin Porphyry) with an overlying chalcocite blanket estimated to contain nearly 4,500,00 t Cu at 0.22%. Previous drilling was mainly shallow but extensive, comprising 124 holes for a total of 9500 ft (average hole depth of approximately 75 ft) that primarily targeted oxide gold zones but stopped in potentially mineralized sulfides.

Activities at the Detroit project in 2020 were split between focused exploration at the Mizpah prospect and regional exploration over the Detroit semi-regional project. Early work at the Mizpah prospect included historical drilling review, geologic mapping, ground magnetics, soil geochemistry, a bulk leach extractable gold (BLEG) stream sediment survey, and rock chip sampling of jasperoid outcrop, which returned values up to 7 g/t Au. From this reconnaissance work, Alderan planned and executed a seven-hole diamond core drill program totaling 3688 ft in October and November, submitting samples from six holes for assay. The holes targeted both Carlin-style targets (based on extensive jasperoid development, favorable host rocks and structures, historical

gold production, and Carlin-like geochemistry) and intrusion-related targets (based on two intense magnetic anomalies identified by ground magnetics and an intrusion-related geochemical signature).

Hole DD20M-002 tested for Carlin-style mineralization and intersected 57 ft of moderate to strong carbon-clay-pyrite breccia alteration from a depth of 161 to 218 ft. Hole DD20M-005 also tested for Carlin-style mineralization and intersected 59 ft of similar moderate to intense alteration from 64 ft depth. The drilling confirmed the favorable host stratigraphy dips about 25 degrees to the southwest, the existence of thick (57 ft) Carlin-style alteration, and a shallow depth of ~100 ft to the alteration. In addition to the two holes targeting Carlin-style mineralization, four holes (DD20M-003, DD20M-004, DD20M-006 and DD20M-007) intersected intrusion-related alteration and mineralization. Alteration included argillic, phyllic, and potassic (biotite) styles, and mineralization occurred as 2%–20% of disseminated and vein-hosted sulfides including dominant pyrite, molybdenite, and chalcopyrite. The best intercept from the program was from DD20M-006, which returned 270 ft at 0.41 g/t Au from 118 ft depth (including 22 ft at 1.98 g/t Au from 277 ft depth) over a broad sulfide-altered zone.

Work at the Detroit semi-regional project in 2020 included IP surveys, BLEG stream sediment sampling, and geologic mapping. The geochemical survey highlighted an anomalous and complex suite of pathfinder elements indicative of both Carlin-style mineralization and intrusion-related mineralization occurring over a significant area.

Following the 2020 drilling results, Alderan expanded their land position in early 2021 to follow the potential for at least one precious-metal-bearing porphyry system located at the boundary of their land position, and they now hold 9.5 $mi^2$ in the district. A third set of ground magnetics and IP surveys was planned for the first part of the year and drilling was expected in mid-June.

## Gold Springs Deposit, Au-Ag – Gold Springs District, Iron County

The Gold Springs deposit is located in the Gold Springs mining district in Iron County, Utah, and Lincoln County, Nevada. 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. Gold Springs Resources (the company exploring the project) had planned a 28,500-ft drilling program for the second quarter of 2020 around the Jumbo targets in Utah. However, drilling was deferred due to the economic and logistical disruptions caused by the COVID-19 pandemic. Instead, the company completed a controlled-source audio-magnetotelluric (CSAMT) ground-based geophysical survey located mostly on the Utah side of the project. The CSAMT survey filled gaps in a previous survey over parts of the Jumbo trend and included the Central Jumbo target, the northern extension of the North Jumbo resource, the northern extension of the Juniper target, and the western extension of the South Jumbo Resource block, which also includes the Fitch and Snow targets. Results of the CSAMT survey:

- demonstrated high correlation between resistivity highs and gold-bearing drill intercepts at the North Jumbo, South Jumbo, and Thor resource and numerous other targets;
- extended the North Jumbo resistivity high 4900 ft north and 3300 ft south into the Central Jumbo target;
- highlighted a 6500-ft-long resistivity anomaly open to the north at the Juniper target, a 6500-ft-long resistivity anomaly at the North Jennie target, and a 6500-ft-long open resistivity anomaly at the Snow target; and
- indicated that the Tin Can, Charlie Ross, Pope, and Red Light targets may all be related to the same large system.

Other activities included the detailed geologic and structural mapping of the 32 known targets within the Gold Springs project area along with surface sampling to prepare these areas for future drill programs. Planned activities for 2021 include a drill program focused on the Jumbo Trend on the Utah part of the project with the goal of expanding the North and South Jumbo resource areas.

## Milford Project, Au-Ag (Pb-Zn-Cu) – Star (North Star) District, Beaver County

In Beaver County, the Milford project explored by TAO Commodities is located in the Star (North Star) mining district, approximately 15 mi west of the town of Milford. The Milford project initially began as a base metal project for prospective replacement-style and manto-style mineralization along structural corridors in the carbonate country rock. The Star district, a historical Pb-Ag producer with byproduct Zn, Cu, Au, and minor W, has had little modern exploration, with little to no known modern drilling. In 2019, TAO completed a four-hole diamond-core drill program targeting silver and base metal veins at the Silver Bear prospect. Drilling intercepted a 2.2-ft-wide vein (estimated true width) with up to 12.4 g/t Ag and 1.4% Zn. Following this drilling, TAO shifted focus to the Moccasin and Captain Jack prospects after reviewing old data and identifying anomalous Au samples, as well as potential for epithermal-style mineralization. The Captain Jack prospect (including Captain Jack West) is defined by altered silicified carbonate rocks with pitting after sulfides, copper oxide staining, and quartz veinlets. The Moccasin target extends along a northeast trend for 650 ft and is hosted in altered cherty carbonate with moderate to strong iron oxide staining, pitting after sulfides, rare remnant sulfides, and copper oxide staining.

TAO's exploration in 2020 continued to be focused on Au and Ag targets. They conducted a Phase 1 rock chip and soil sampling program in the first part of the year, followed by a Phase 2 soil sampling program in August. Both sampling campaigns covered the Captain Jack and Moccasin prospects. Phase 1 sampling at the Captain Jack prospect (14 rock chip samples, 102 soil samples on a 1950 x 2900 ft spacing) yielded rock chip results of up to 17.4 g/t Au, 1.71% Cu, and 8760 g/t Ag with anomalous As, Pb, Sb, and Zn. Soil samples yielded peak Au values of 0.026 g/t and 0.54 g/t Ag and defined a Au-Ag anomaly along a northeast trend and open to the northeast. Phase 1 sampling at the Moccasin prospect (13 rock chip samples, 107 soil samples on a 2300 x 2300 ft spacing) yielded rock chip results of up to 4.03 g/t Au, 1.98% Cu, and 1560 g/t Ag. Soil sampling at Moccasin defined a Ag-Pb-Zn-Au anomaly along two parallel northeast trends, with peak values of 0.02 g/t Au, 1.08 g/t Ag, 827 g/t Zn, and 550 g/t Pb. Both the Captain Jack and Moccasin targets showed weak copper anomalism, though not along the northeast trends defined by Au-Ag results. Following the positive results from Phase 1 sampling, TAO completed a Phase 2 soil sampling program aimed at extending the geochemical anomalies along interpreted mineralized trends. Phase 2 sampling at the Captain Jack prospect (2 rock chip samples, 43 soil samples on a 320 x 165 ft spacing) further defined a Au-Ag anomaly along trend, which remains open to the northeast. Phase 2 sampling at the Moccasin prospect (2 rock chip samples, 143 soil samples on a 650 x 165 ft spacing) extended the previously identified Ag soil anomaly at >0.2 g/t to over 1.5 km in length, still open to the SW. Rock chip sampling returned Ag values up to 65.1 g/t and Au values of 1.15 g/t.

Plans for the Captain Jack and Moccasin prospects in 2021 are unclear, as TAO acquired a heavy mineral sands project in Tennessee in mid-2020 that has become their main focus for current exploration.

## Valley/Crossroads Project, Cu-Au – Rocky and Beaver Lake Districts, Beaver County

As mentioned above, Alderan Resources signed an option agreement to explore two of Tamra Mining's properties, the first being the Detroit project discussed above and the second being the Valley/Crossroads (Black Rock) areas in the Rocky and Beaver Lake mining districts, Beaver County. The Rocky and Beaver Lake districts host known porphyry Cu, skarn, and Cu-Au breccia pipe mineralization. As with the Drum Mountain district, there are multiple targets in the Valley/Crossroads project, particularly given the lack of historical focus on gold in the area. Limited assays of previous skarn drill core showed 33 ft at 1.1% Cu and 0.29 g/t Au and 61 ft at 1.1% Cu and 1.54 g/t Au. Porphyry drill core yielded 350 ft at 0.16% Cu, with no Au data available.

The initial two targets identified at the time of signing the option agreement were the Valley skarn and the Crossroads (OK) porphyry. The Valley target was discovered by Anaconda in 1961 when they drilled a Cu skarn beneath minor Cu-Fe deposits. The known extent of the skarn is 3300 by 2460 ft at 200 to 330 ft thick from 985 to 2000 ft depth. Gold was rarely evaluated when the Valley target was discovered and hence the Au potential of the skarn is poorly constrained. The Crossroads (OK) target was discovered by Bear Creek Mining after drilling 175 ft of barren alluvium and volcanics and intersecting strongly altered quartz monzonite porphyry. Pyrite and potassic to phyllic alteration continued to the end of the hole at 510 ft, and the Crossroads porphyry is coincident with a large 1- by 1-mi IP anomaly. The Crossroads target also contains the OK breccia pipe, which was historically mined for high-grade ore and estimated to have produced 650,000 st of ore containing 15 million lbs Cu.

Alderan's regional work at the Valley/Crossroads area in 2020 included aeromagnetics and radiometrics, evaluating ASTER spectral data, and compilation and validation of extensive historical data caches. Regional soil and BLEG stream sediment surveys were planned. However, as work progressed, Alderan narrowed their focus to a single prospect in the Valley/Crossroads area called the Black Rock prospect. Black Rock is a Cu-Au polymetallic skarn and intrusion-related target within the Valley/Crossroads area and adjacent to the Frisco project. The area of interest is at the intersection of intrusive contacts and major structures and is characterized by calc-silicate skarn overprinted by oxidized hydrothermal chalcopyrite-bornite-pyrite mineralization with common specular hematite. By October 2020, Alderan had completed geological mapping and rock chip sampling at the Black Rock prospect, with rock chip assays returning up to 4.6 g/t Au, 10.15% Cu, 125 g/t Mo, 522 g/t Co, and 4.3 g/t Te. Forty samples were collected over a strike length of 1300 ft and a width of 650 ft, with geochemical anomalies remaining open in all directions.

As of January 2021, Alderan had commenced a 3300-ft drill program at Black Rock aiming to test the potential for thickening of the known skarn mineralization, as interpreted from the 3D inversion of aeromagnetics data. A soil sampling program is also planned for 2021.

## Coyote Project, Au-Ag – Desert Mountain District, Juab County

The Coyote Au-Ag project, which was acquired by Gold Bull Resources in 2020, is located in the Desert Mountain mining district in central Juab County. The Coyote project centers on the Coyote mine (also known as the Coyote Knoll mine) discovered in 1988. The mine exploited a moderately north-dipping low sulfidation Ag-Au vein hosted in Oligocene volcanics near the margin of the Desert Mountain caldera. Sporadic mining efforts in the late 1990s and early 2000s are estimated to have produced approximately 1000 troy oz Ag from the Coyote mine. The Coyote project area includes previous drilling results of up to 8.19 g/t Au and 1060 g/t Ag at 30 to 35 ft

depth, though the sporadic and shallow historical drilling has not adequately tested the main target/feeder zone. The shallow zone tested by previous drilling is typically leached of sulfides, hence optimism for deeper high-grade targets. The Coyote area also includes a 1475-ft-long outcropping mineralized trend which extends under cover and a 500-ft-long outcropping jasperoid vein.

Gold Bull's 2020 activities were largely focused on due diligence prior to acquiring the project and on preliminary reconnaissance. After signing a letter of intent to acquire the project in September 2020, Gold Bull undertook a geochemical sampling program and an IP geophysics survey in October. Geochemical sampling included 11 rock chip samples, and results yielded up to 12.25 g/t Au and 5570 g/t Ag. Additional anomalous results confirmed the presence of outcropping mineralization along >1550 ft of strike, open in both directions extending under cover. Sampling was focused around the Coyote mine to test the strike length of the known mineralized east-west structure that was the focus of historical mining.

Gold Bull announced in January 2021 that an initial 3D IP/resistivity geophysical survey would begin over the Coyote project early in the year. The company planned to follow up the IP results with geological mapping and soil sampling in hopes of an initial drill program later in the year.

### White Mountain Project, Au-Ag – White Mountain District, Beaver County

Another project active in Beaver County is the White Mountain low-sulfidation epithermal project in the White Mountain mining district explored by Alderan Resources. The White Mountain project area has extensive jasperoid development, volcanic breccias, and clay-silica-iron oxide and argillic alteration interpreted to be related to structurally controlled low sulfidation mineralization. The alteration is centered over a 3.5-mi-long, 4270-ft-wide, 100-ft-high ridge. Alderan is targeting both high-grade epithermal vein mineralization along major structures and disseminated mineralization, using the Ken Snyder mine in the Midas district (Nevada) as a geological model. Although the Au and Ag anomalies in the area are weak, White Mountain is proximal to the Frisco porphyry system to the north, potentially a significant heat and fluid source. Activities at White Mountain in 2020 included geological mapping, acquisition and evaluation of ASTER data, and ground magnetics. A four-hole 3300 ft drill program was planned for mid-year 2021.

### Western Desert Project, Au-Cu – Crater Island District, Box Elder County

In early 2020, Hawkstone Mining acquired the Western Desert Au-Cu project, located within the Crater Island district of Box Elder County. Known mineralization in the project area includes Au-Cu skarns and Ag-rich carbonate replacement deposits, and the project is proximal to a monzodiorite intrusive so the potential for porphyry and other intrusion-related mineralization is strong. Additionally, the project is hosted in the same sequence of Cambrian to Ordovician basement that hosts the Long Canyon gold mine 40 mi west and is considered prospective for Carlin-style gold mineralization. Preliminary target delineation and stream sediment/rock chip sampling was undertaken throughout 2020, leading to a focus on the Copper Blossom target, which is a large anticlinal structure proximal to a monzodiorite intrusion with northeast cross-faulting. Reconnaissance rock chip surface sampling yielded a maximum of 7 g/t Au, 1495 g/t Ag, 5.9% Cu, and >20% Pb in an area with visible alteration and copper mineralization. Planned activities in 2021 include geophysical surveys across multiple targets, including Copper Blossom, and follow-up drilling.

### Goldstrike Deposit, Au – Goldstrike District, Washington County

The Goldstrike deposit, located in the Goldstrike district in northwest Washington County, has an indicated and inferred mineral resource of 1.1 million troy oz Au at an average grade of 0.5 g/t Au with a cutoff grade of 0.2 g/t Au (SRK Consulting, 2018). This resource estimate only included drilling up to the end of 2017 and results for the Main, Dip Slope, Peg Leg, and Western zones. After completion of a 31,500-ft RC drilling program and phase 2 metallurgical testing at Goldstrike in 2019, minimal work was undertaken at the project in 2020 as Liberty Gold (the exploration company) shifted focus to the Black Pine project in Idaho. However, in 2021, Liberty Gold planned a 49,000-ft RC drill program with a goal to convert inferred gold ounces to indicated and to continue to de-risk and add value to the project. A 2100-ft sonic core drill program to obtain material from the historical heap leach pad for metallurgical work was also planned for 2021, as are environmental baseline studies and identifying water sources.

## INDUSTRIAL MINERALS

### Production

Industrial mineral production in Utah during 2020 had an estimated value of $1.35 billion, which is an increase of 2.6% from the revised 2019 value (figure 3). The largest contributor was the brine- and evaporite-derived products group that includes potash, salt, and magnesium chloride. These products had a combined value of $464 million, a 3.9% decrease from 2019, and accounted for 34% of Utah's total industrial mineral production value in 2020. 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 $415 million in 2020 (a 15% increase from 2019) and accounted for 31% 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 $268 million in 2020, a slight 1.6% decrease from 2019, and accounted for 20% of the total industrial mineral value. Together, these three commodity groups contributed 85% of the total 2020 value of industrial minerals produced in Utah. The remaining value came from phosphate, uintaite, clay and shale, silica and industrial sand, 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 461,000 st in 2020 and contributed the most value to this commodity group (figure 13). The 2020 estimated value of produced potash is approximately $227 million, a 10% decrease from 2019. The lower value is due to a decrease in both production and price of potash. 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 (+$376 per ton) market value than potassium chloride. The primary use of both types of potash is fertilizer.

Utah salt production in 2020 amounted to approximately 3.3 million st and had a production value estimated at $207 million (figure 13). About 76% 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 24% 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), producing salt from the Jurassic-age Arapien Shale. Willow Creek Salt also produced 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 OGM. Salt produced in Utah is used for a variety of purposes including road deicing, water treatment, agricultural supplements, and industrial applications. Redmond Minerals also produces food-grade salt from their underground operation.

In 2020, magnesium chloride brine production in Utah increased to 842,000 st and had an estimated production value of about $30 million. The magnesium chloride brine was produced by Intrepid Potash-Wendover and Compass Minerals Ogden; the latter also produced 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 3.0 million st of total materials was produced from Great Salt Lake brine in 2020, including salt, potash, magnesium chloride, and magnesium metal. Production in 2020 was slightly lower than in 2019. 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 2020 was $529 million, which is about 10% lower than 2019.

## 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 2020, approximately 40 million st of sand and gravel was produced in Utah, up about 11% from revised 2019 estimates, and was worth $309 million (USGS, 2021b). About 14 million st of crushed stone was worth $105 million (USGS, 2021b), which was a 13% production increase from revised 2019 estimates, and several thousand short tons of dimension stone was also produced. Prices for crushed stone and sand and gravel increased slightly from 2019 to 2020. A strong construction market in Utah, particularly in the residential sector, has kept construction aggregate demand relatively high for the last several years (figure 14).

## Portland Cement, Lime, and Limestone

Together Ash Grove Cement and LafargeHolcim produced about 1.8 million st of Portland cement in Utah during 2020, having an estimated value of $207 million. Ash 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 7.6% in 2020 due to increases in production. 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 2020, Graymont Western U.S. was the sole producer of lime in Utah and production decreased about 24%. Graymont produces high-calcium quicklime and dolomitic quicklime from their quarry and plant in the Cricket Mountains about 35 mi 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.

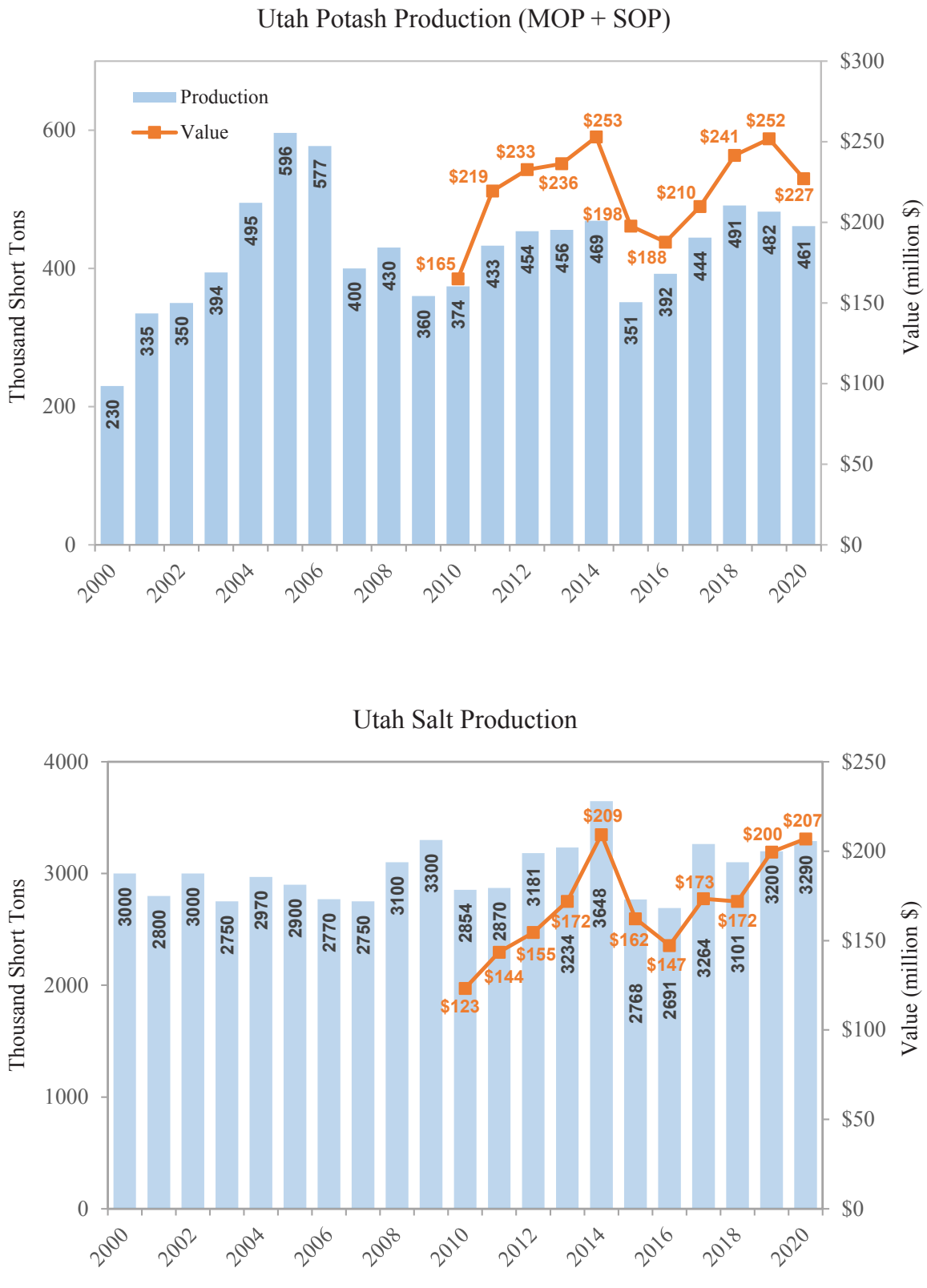



***Figure 13.*** *Production (since 2000) and value (since 2010) of potash (all types) and salt. Values in nominal dollars. Data source: Utah Geological Survey.*

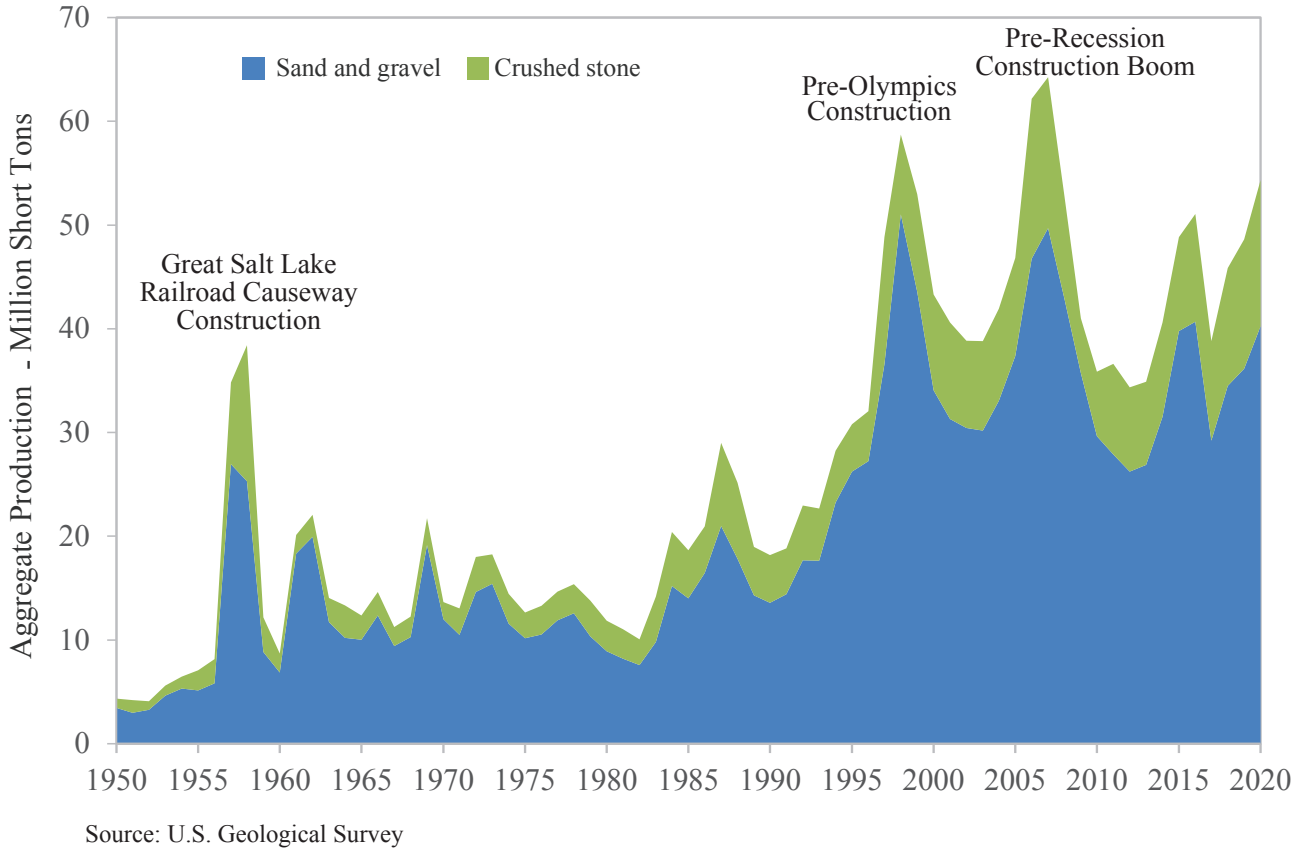



***Figure 14.*** *Utah aggregate production, 1950–2020.*

During 2020, several million short tons of limestone was 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 major phosphate producer in Utah, mining the Meade Peak Member of the Permian Phosphoria Formation. Their phosphate operation is located 12 mi north of Vernal in Uintah County (figure 2). In 2020, the mine produced nearly 3.2 million st of ore, which was 7.6% less than 2019 production. The ore yielded about 1.2 million st of phosphate concentrate (about 30% $P_2O_5$) after processing. The concentrate is transported in slurry through a 96-mi 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, 2021a).

In 2019, Simplot completed a significant revision to their mine plan with OGM. 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.

In 2020, Falcon Isle Resources became the second phosphate producer in Utah. They received approval for a small mine permit from OGM and produced a few thousand short tons of organically certified phosphate from their Diamond Creek phosphate mine near Diamond Fork, Utah County (figure 12). Keras Resources acquired a controlling interest in the project in July 2020. The current plan is to initially extract a few thousand short tons of phosphate rock per year from a roughly 7-ft-thick zone of the Meade Peak Member of the Permian-age Phosphoria Formation. Future extraction is anticipated to reach up to 48,000 st per year and Falcon Isle Resources reported a resource of about 3.9 million st of phosphate rock averaging 28% $P_2O_5$. An older resource estimate for the area from 1980 indicated about 4.6 million st of surface mineable phosphate with additional potential tonnage in an underground resource. The area was previously mined in 1980 but was idle until 2020.

## Uintaite (Gilsonite®)

Uintaite (also spelled "Uintahite"; commonly referred to as Gilsonite, a trademarked name) 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 2020, American Gilsonite Company was the primary uintaite producer, with mining and processing at their operation in southeastern Uintah County (figure 2). A small amount of uintaite 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 st of uintaite per year. The mine is in the Cottonwood vein.

Over the past decade, uintaite production from the Uinta Basin has ranged up to about 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 uintaite, 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 uintaite as an additive in drilling fluids. Uintaite helps control fluid loss and seepage, increase wellbore stability, prevent loss of circulation, and stabilize shale formations.

## Clay and Shale

Clay and shale production (including bentonite, common clay, high-alumina clay, and expanded shale) in Utah totaled at least 341,000 st in 2020. Clay is produced at various small and large mines, often on an intermittent basis. Consequently, year-over-year production and value estimates are subject to significant change. 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 and shale products are Utelite (expanded shale), Interstate Brick (common clay), 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. intermittently produces a small amount of specialty clay (halloysite) and iron oxide from the Dragon mine in the Tintic Mountains. They have been researching potential applications and markets for halloysite over the past several years.

Expanded shale in Utah is produced by Utelite at their quarry and plant near Wanship in Summit County (figure 2). Expanded shale is a lightweight aggregate, sometimes called "bloated shale," mainly used by the construction industry. It is produced by rapidly heating high-purity shale, derived from the Cretaceous-age Frontier Formation, to about 2000ºF 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. Roughly half of Utelite's production is used locally along the Wasatch Front and the rest is shipped out of state.

## Silica and Industrial Sand

Silica and industrial sand production in Utah during 2020 had an estimated value of about $19 million. On Stansbury Island, Bolinder Resources mines quartzite from the Devonian-Mississippian Stansbury Formation as a source of industrial silica that is being used as a flux at the Kennecott smelter. Some of the quartzite there is also used as construction aggregate. North of Vernal, Ramsey Hill Exploration produces frac sand from unconsolidated Quaternary mixed alluvial and eolian deposits. Frac sand is relatively pure silica sand that is used for hydraulic fracturing stimulations in oil and gas wells, and Ramsey Hill is supplying this sand for local use in the Uinta Basin. They began production in late 2019. Ramsey Hill has also received tentative approval from OGM to begin mining the Triassic-Jurassic Nugget Sandstone that is adjacent to the Quaternary unconsolidated deposits as an additional source of sand. A large fraction of the sand in the unconsolidated deposits is likely derived from the Nugget Sandstone.

## Gypsum

Four operators reported combined gypsum production in Utah of about 553,000 st in 2020, a significant 31% increase from the 2019 reported production. The estimated value of 2020 gypsum production is $6.6 million. 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. Diamond K Gypsum received approval from OGM in 2021 for a 160-acre expansion of their Chalk Hills Quarry in the northwest part of the San Rafael Swell in Emery County. Their mine plan anticipates an annual production of about 34,000 cubic yards of gypsum for about 28 years. Diamond K mines gypsum from the Jurassic Carmel Formation and they

report that their ore zone ranges from 5 to 25 ft thick, including lenses of waste rock. The San Rafael Swell is known to have large, pure gypsum resources (Rupke and Boden, 2013).

### Lithium

For the first time, lithium was produced in Utah in 2020. US Magnesium has considered producing lithium as a byproduct for many years (Tripp, 2002) and finally did so in 2020. Lithium is concentrated along with magnesium in U.S. Magnesium's solar evaporation ponds and as part of the magnesium refining process, lithium is separated from magnesium. US Magnesium has been stockpiling lithium from this process for many years. Their estimated capacity for lithium production is about 10,000 st of lithium carbonate per year.

## Exploration and Development

Recent exploration and development activities for industrial minerals in Utah have focused on lithium, hydraulic fracturing sand (frac sand), fluorspar, potash, and pozzolan (table 3). 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, OGM records, and personal communications.

### Lithium

As demand for lithium batteries continues to increase, Utah has remained a target for lithium exploration over the past few years and the focus has been on Utah's potential in brine resources. Thousands of lithium claims have been staked in Utah since 2016. As previously noted, US Magnesium became Utah's first lithium producer in 2020, producing lithium carbonate as a byproduct of their magnesium refining process from Great Salt Lake brine. In mid-2021, Compass Minerals, also a mineral producer on Great Salt Lake, announced the identification of a lithium resource with intent to develop production. Compass reported an in-place indicated resource of 2.56 million st of lithium carbonate equivalent in the waters of Great Salt Lake in addition to an indicated and inferred 140,000 st of lithium carbonate equivalent contained in the interstitial brine of salts accumulated in their evaporation ponds. Compass is investigating "direct lithium extraction" (DLE) technology, which is a potential avenue towards economic extraction of lithium that overcomes some of the problems with contaminants such as magnesium. However, no DLE technology is currently used in commercial production of lithium at this time.

Anson Resources holds a large block of claims (their Paradox Brine project) near Moab in Grand County (figure 12) and re-entered four oil and gas wells during 2018 and 2019 to test brine flow rates and chemistry from the Paradox Formation. Analyses of brine from the tested wells have yielded lithium concentrations up to 253 ppm. They released an updated JORC-compliant resource estimate in 2020 as well as a preliminary economic assessment (PEA) (Anson Resources, 2020). Their most recent resource estimate contains an indicated and inferred 210,000 st of lithium carbonate equivalent in brine. This resource is found in multiple, deep subsurface horizons and average lithium concentration for the horizons is estimated to range from 73 to 175 ppm. Anson is also evaluating coproduct/byproduct bromine, boron, and iodine and reported an indicated and inferred bromine resource of 1.3 million st (Anson Resources, 2020). Other companies pursuing lithium in Utah brines hold land positions elsewhere in the Paradox Basin, the Bonneville Salt Flats, and Pilot Valley (Box Elder and Tooele Counties). Because of high magnesium content, DLE technology would likely be needed to exploit these other potential lithium brine deposits in Utah.

### Frac Sand

As horizontal oil and gas wells reach ever greater lengths—laterals in the Uinta Basin now reach up to 11,000 ft—oil and gas companies have increased the amount of frac sand used in hydraulic fracturing stimulations in the past decade. As a result, demand for frac sand increased and specifications for frac sand shifted or relaxed to some degree, opening opportunities in Utah for production from deposits 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. As noted above, frac sand has been produced in Utah since 2019 near Vernal, but exploration is also occurring in other parts of the state. Over the past few years, companies have investigated potential resources in southwestern, western, and central Utah as well as other parts of 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 12). They intended to produce about 700,000 st 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 waned significantly in early 2020 likely due to substantial drops in oil price, but as prices have regained ground some interest has resumed in the Uinta Basin.

### Fluorspar

During 2019, Ares Strategic Mining began acquisition of the Lost Sheep fluorspar mine in the Spor Mountain district in Juab County (figure 12) in anticipation of re-starting and expanding production. Historically, the Lost Sheep mine was the most productive fluorspar mine in Utah and has produced about 170,000 st of fluorspar from a series of mineralized breccia pipes. OGM records indicate that the mine produced about 8000 st of ore from 1993 to 2007 and a nominal amount of production in 2018. An NI 43-101 technical report for the property was completed in 2019 (Hughes, 2019), but the report did not include a resource estimate. Ares completed the acquisition

***Table 3.*** *Select industrial mineral exploration and development projects in Utah, 2020.*

| Project | Commodity; Deposit | Location | County | Company | Progress |
|---|---|---|---|---|---|
| Compass Minerals Lithium | Lithium; Great Salt Lake brine and interstitial brines of evaporation ponds | Great Salt Lake | Box Elder | Compass Minerals | Announced in mid 2021 pursuit of lithium production at their Great Salt Lake operation; in-place resource estimate is about 2.6 million tons lithium carbonate equivalent |
| Diamond Creek mine | Phosphate; Meade Peak Mbr. of Phosphoria Fm. | Diamond Fork | Utah | Falcon Isle Resources, Keras Resources | Completed a mine permit with OGM and mined a few thousand tons of organically certified phosphate in 2020; reported a resource of appx. 3.9 million tons of phosphate rock at 28% $P_2O_5$ |
| Lost Sheep mine | Fluorspar; breccia pipes | Spor Mountain district | Juab | Ares Strategic Mining | Completed a 20+ hole, ~6000-foot drilling program in 2020; expanded land holdings in 2020; completed geophysical surveys in 2021 that revealed potential targets |
| Paradox 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; completed PEA in 2020 |
| Ramsey Hill | Frac sand; unconsolidated sand and Nuggest Sandstone | North of Vernal | Uintah | Ramsey Hill Exploration | Began producing frac sand from a mine north of Vernal in 2019; received tentative approval from OGM to begin mining Nugget Sandstone in addition to the currently mined unconsolidated sand deposits |
| Rush Valley | Pozzolan; volcanic ash | Rush Valley | Tooele | Geofortis | Drilled 39 holes (2300 feet) in 2019 and 2020 to evaluate a potential pozzolan deposit in the Salt Lake Formation; began plant construction in 2020 and plans to begin production in 2021 |
| Sevier Playa | Potash (SOP); shallow brine | Sevier Playa/ Dry Lake | Millard | Crystal Peak Minerals Inc. | Received necessary permits to begin operations, but failed to raise sufficient capital for development; Crystal Peak Minerals abandoned the project and the future of the project is unknown |
| US Magnesium Lithium | Lithium; Great Salt Lake brine | Great Salt Lake | Tooele | US Magnesium | US Magnesium began producing lithium carbonate in 2020; they have the capactity to produce about 10,000 tons per year |

of the mine in early 2020 and subsequently drilled over 20 reverse-circulation holes (~6000 ft) in 2020 to delineate the fluorspar resource. The mine has an active small mine permit with OGM. Ares expanded their land position in 2020 to a total of 108 claims that span much of the Spor Mountain area and contain multiple potential mining areas (including the Bell Hill mine area, another previously producing fluorspar mine). In early 2021, they completed geophysical surveys (induced polarization) that confirmed existing fluorspar pipes and revealed some potential new targets. A preliminary 10-year mine plan showed production of about 180,000 (short?) tons per year at 45% fluorite with an anticipated

fluorite recovery of 90%. 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.

### Potash

For the past decade or so, interest in Utah potash has led to several potash exploration projects, but recent development of those projects is limited. 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 also received tentative approval of their mine permit from OGM. However, in the second half of 2020, Crystal Peak Minerals abandoned the project because it was unable to raise sufficient capital to begin development and the project was relinquished to its primary creditor, EMR Capital. Crystal Peak Minerals had been developing an SOP project in a shallow brine deposit on the Sevier Playa/Lake in Millard County (figure 12). The company intended 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. The future of the project is uncertain. Elsewhere in Utah, a few potash projects remain in the Paradox Basin and at Blawn Mountain (Beaver County), but development of these projects has stalled in the last few years.

### 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 reductions in manufacturing cost and greenhouse gas emissions. 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 12). In 2018 and 2019, they drilled a total of 2300 ft in 39 holes to evaluate the potential deposit in the Tertiary-age Salt Lake Formation and have plans for additional drilling in hopes of expanding their resource. In 2020, Geofortis announced that they received approval from the Utah Department of Transportation (UDOT) for use of their pozzolan in concrete and they commenced construction of a plant in Tooele from which they plan to begin production in 2021. In 2021, they expanded an existing small mine permit with OGM from 5 to 20 acres; the mine is located at Faust. In 2018, Applied Minerals (see Clay and Shale section) sold about 4.5 million st of mixed high-alumina clay and iron oxide from old, existing surface piles at their Dragon mine for use as pozzolan.

## URANIUM

The uranium market in 2020 had many influences, including global production cuts related to the COVID-19 pandemic, a reluctance of utilities to sign long-term contracts, and continued effects of the Section 232 of the Trade Expansion Act of 1962 petition submitted to the U.S. Department of Commerce by Energy Fuels and Ur-Energy in January 2018.

Many major uranium producers such as Kazatomprom and Cameco had been making minor production cuts prior to 2020 in hopes of stimulating the sluggish uranium market; however, the COVID-19 pandemic accelerated cuts due to operational shutdowns. Cameco shut down Cigar Lake (Saskatchewan, Canada), the world's largest uranium mine, for five months from March 2020, and again from December 2020 to April 2021. Similarly, Kazatomprom, the world's largest uranium company responsible for producing over 40% of global uranium in 2019, had announced production cuts starting in 2018. Along with a four-month COVID-19-related shutdown of operations, the production cuts have now been extended through 2022. Production cuts are used to stimulate low commodity prices; however, the uranium market has yet to respond as hoped by producers. Instead, utility companies have been opting to purchase uranium feedstock at spot prices rather than commit to long-term contracts. The lack of long-term commitments has taken an additional toll on companies' ability to plan production increases. Global uranium production in 2020 is estimated to hit a 12-year low due to the combined ongoing and COVID-19 pandemic-related production cuts.

The Section 232 petition itself was resolved in 2019 when the Trump administration declined to take regulatory action, instead creating a Nuclear Fuel Working Group tasked with examining the entire nuclear fuel chain. In 2020, the Trump administration proposed the creation of a domestic uranium reserve funded at $150 million annually for 10 years. The funding recommendation was later downgraded to a one-off $150 million investment. Ultimately, the Bipartisan-Bicameral Omnibus COVID Relief Deal passed by Congress on December 20th, 2020, that provided a second round of COVID-19 pandemic-related relief measures contained a one-time $75 million allocation for a domestic uranium stockpile. In October 2020, the United States and Russia signed the Russian Suspension Agreement, effectively lowering the export of Russian uranium to U.S. utilities. Although the Russian Suspension Agreement was not a direct part of the Section 232 petition, uranium purchases from Russia and other potentially state-subsidized entities was cited as a potentially unfair degree of competition for U.S. producers.

As might be expected, the variety of influences on the uranium market in 2020 produced considerable price fluctuations. Uranium started the year at a subdued $25/lb $U_3O_8$, consistent with low prices over the past several years ($50/lb $U_3O_8$ is often cited as an economic viability point for the indus-

try). The onset of the COVID-19 pandemic in February and March 2020 had surprisingly little impact on uranium prices, likely due to predictions of market deficits arising from ongoing production cuts and new mine shutdowns. These bull market expectations caused the price to jump to over $33/lb $U_3O_8$ in April 2020 and peak in May 2020. Prices stabilized around $30/lb $U_3O_8$ for the remainder of the year, though the start of 2021 has seen a sharp drop and rebound. The price fluctuations in early 2021 are likely related to the $75 million allocation for a domestic uranium reserve and speculation about the new Biden administration's stance on nuclear energy, and may be indicative of another tumultuous year for uranium prices.

## Production

No uranium was mined in Utah in 2020. Active uranium mining in the state has been suspended since 2012, despite several established resources (table 4) and mines with active mining permits. However, Utah is home to the White Mesa Mill, the only active conventional uranium mill in the United States. White Mesa, owned by Energy Fuels, did not produce any uranium concentrate in 2019 as the mill had switched to a vanadium recovery circuit in hopes of a strong vanadium market; however, vanadium market expectations failed to materialize. In 2020 White Mesa returned to combined uranium and vanadium concentrate production. The materials processed at White Mesa are primarily alternate feeds, or uranium-bearing materials not derived from conventional ore (e.g., radioactive waste from old uranium mining operations). In 2020, 190,500 lbs of $U_3O_8$ and 67,000 lbs of $V_2O_5$ were recovered at the White Mesa Mill from alternate feeds and in-circuit solutions from a recent vanadium pond-return program. Because the uranium and vanadium produced are not the result of active mining in Utah, these values were excluded from our mining production value calculations.

In addition to the uranium and vanadium produced at White Mesa, Energy Fuels began investigating the potential of processing REE ores. The investigation resulted in a pilot-scale test of monazite sands (monazite being a main ore mineral for REEs) mined by Chemours in Georgia that were shipped to the White Mesa Mill where uranium contained in the ores was recovered and a REE carbonate was produced. The REE carbonate concentrate was then shipped to a refinery owned by Neo Performance Materials in Estonia for final separation into REE materials used in permanent magnets and other advanced materials. Although the ore-to-refinery chain was not completely domestic, it demonstrated a complete REE production chain independent of China. Following the successful pilot scale study, Energy Fuels entered into a 3-year contract with Chemours to purchase additional monazite sand ore and an agreement with Neo Performance Materials to continue shipping some of the produced REE carbonate to the refinery in Estonia. Energy Fuels estimates the REEs contained in the monazite sand ores will represent close to 10% of total current U.S. REE consumption.

Despite the current focus on REE separation, the process only requires a small part of White Mesa's production capability, and Energy Fuels intends to continue producing uranium concentrate in 2021. Vanadium production is suspended indefinitely. Energy Fuels continues to maintain active mining permits at the La Sal Complex and Whirlwind mines in anticipation of restarting active mining. The company also plans to continue evaluating the Bullfrog project in its Henry Mountains Complex, but will likely look at options to divest non-core assets such as the Tony M and Daneros deposits.

## Exploration and Development

Exploration for uranium in Utah was more active in 2020 compared to 2019, with the mid-year price spike and long-term predictions about market undersupply encouraging a new wave of junior-driven exploration in many of Utah's historically producing districts. A summary of uranium exploration in Utah is presented in table 4, and select projects are discussed below.

### Henry Mountains Project, U-V – Henry Mountains District, Garfield County

The Henry Mountains project in the Henry Mountains district of Garfield County is held by GTI Resources, who have identified the Jeffery, Rats Nest, and Moki prospects within the project as a priority. Sandstone-hosted ores have been mined in the Henry Mountains region since 1904, and the combined Henry Mountains and East Henry Mountains districts have produced over 1 million lbs $U_3O_8$ at an average grade of 0.4% $U_3O_8$ and over 3 million lbs $V_2O_5$ at an average grade of 1.4% $V_2O_5$ (Mills and Jordan, 2021). GTI acquired the Henry Mountains project in September 2019 through acquisition of Voyager Energy. The project is immediately east of the Tony M mine, which is part of Energy Fuels' Henry Mountains Complex and has an indicated and inferred resource of over 20 million lbs $U_3O_8$.

GTI's 2020 activities included a drilling campaign of 12 core holes averaging 65 ft depth, completed in June 2020 and yielding assay results up to 4.1% $V_2O_5$ and gamma logging results up to 0.76% equivalent $U_3O_8$. In addition to their own drilling, GTI gamma logged 26 historical drill holes to estimate additional equivalent $U_3O_8$ values in the project area. GTI also carried out a surface and underground sampling program at Rats Nest comprising both face-cut channel samples in historical underground workings and grab samples. Assay results from the sampling yielded values ranging up to 0.87% $U_3O_8$ and 1.07% $V_2O_5$. At the end of 2020, GTI completed a land and historical data deal with Anfield Energy to create a contiguous land position over the Jeffery and Rats Nest prospects and consolidate ownership across 3.4 mi of a potential mineralized trend. The historical data package included records for 362 holes covering the Jeffrey–Rats Nest project area (135 of which intersected uranium mineralization) and 107 holes covering the Moki prospect (42 of which

***Table 4.*** *Select uranium projects in Utah, 2020. District locations are shown on figure 12.*

| Property | District[1] | County | Company | 2020 Activity | Existing Resource[2] |
|---|---|---|---|---|---|
| Cottonwood Project | East Henry Mountains | Garfield | Nortec Minerals Corp. | Rock chip sampling up to 1.8% $V_2O_5$ and 0.8% $U_3O_8$ | |
| Daneros | Red Canyon | San Juan | Energy Fuels, Inc. | | 30,000 t at 0.36% $U_3O_8$ (190,000 lbs $U_3O_8$) indicated, and inferred resource |
| Dunn | Dry Valley | San Juan | Western Uranium and Vanadium Corporation | | 210,000 t at 0.13% $U_3O_8$ (560,000 lbs $U_3O_8$) and 1.1% $V_2O_5$ (4,490,000 lbs $V_2O_5$) indicated and inferred resource |
| East Canyon Project | Dry Valley | San Juan | TNT Mines Ltd. (Vanacorp USA LLC) | TNT acquired project from Vanacorp and expanded land position on 4 BLM sections, geologic mapping, channel sampling (including 3 ft at 1.27% $U_3O_8$ and 4.53% $V_2O_5$); drilling planned for 2021 | |
| Frank M | South Henry Mountains | Garfield | Anfield Energy Inc. | | 1,140,000 t at 0.10% $U_3O_8$ (2,280,000 lbs $U_3O_8$) indicated and inferred resource |
| Henry Mountains Complex (Tony M, Southwest, Copper Bench, Indian Bench) | South Henry Mountains | Garfield | Energy Fuels, Inc. | | 4,020,000 t at 0.26% $U_3O_8$ (20,880,000 lbs $U_3O_8$) indicated, and inferred resource |
| Henry Mountains Project | Henry Mountains | Garfield | GTI Resources Ltd. (Voyager Energy Pty Ltd.) | Drilled ~700ft (12 holes) with assay results up to 4.1% $V_2O_5$ and gamma logging results up to 0.76% equivalent $U_3O_8$, geochemical sampling (up to 0.87% $U_3O_8$ and 1.07% $V_2O_5$), acquired 2 leases and historic data package from Andfield Energy; drilling planned for 2021 | |
| La Sal Complex (Beaver, Pandora, La Sal, Energy Queen, Redd Block) | La Sal | San Juan | Energy Fuels, Inc. | | 1,330,000 t at 0.17% $U_3O_8$ (4,460,000 lbs $U_3O_8$) and 0.9% $V_2O_5$ (23,430,000 lbs $V_2O_5$) measured, indicated, and inferred resource |
| Red Canyon | Red Canyon | San Juan | Gone Fission LLC | Expanded land position on 2 BLM sections | |
| Sage Plains | Ucolo | San Juan | Energy Fuels, Inc. | | 490,000 t at 0.17% $U_3O_8$ (1,650,000 lbs $U_3O_8$) and 1.4 % $V_2O_5$ (13,540,000 lbs $V_2O_5$) measured, indicated, and inferred resource |
| San Rafael Complex (Deep Gold, Down Yonger, Jackrabbit, 4484, North) | San Rafael River | Emery | Western Uranium and Vanadium Corporation | | 1,210,000 t at 0.22% $U_3O_8$ (5,260,000 lbs $U_3O_8$) and 0.3% $V_2O_5$ (7,110,000 lbs $V_2O_5$) indicated and inferred resource |
| Tidwell (Cedar Mountain, Probe, Snow) | Cedar Mountain, San Rafael River, Temple Mountain | Emery | enCore Energy Corp. | | 2,070,000 t at 0.06% $U_3O_8$ (2,334,000 lbs $U_3O_8$) historic resource |
| Vanadium King Project | Thompson | Grand | Thor Mining Plc (American Vanadium Pty Ltd, Cisco Minerals Inc.) | Site visit and historic data review of Brushy Basin vs. Salt Wash prospectivity | |
| Velvet-Wood | Lisbon Valley | San Juan | Anfield Energy Inc. | | 900,000 t at 0.29% $U_3O_8$ (5,180,000 lbs $U_3O_8$) measured, indicated, and inferred resource |
| Whirlwind | Gateway | Grand | Energy Fuels, Inc. | | 610,000 t at 0.25% $U_3O_8$ (3,000,000 lbs $U_3O_8$) and 0.8 $V_2O_5$ (9,770,000 lbs $V_2O_5$) indicated and inferred resource |
| White Canyon (Blue Jay, Geitus, Marcy Look) | White Canyon | San Juan | enCore Energy Corp. | | 190,000 t at 0.15% $U_3O_8$ (568,000 lbs $U_3O_8$) historic resource |

[1]As defined in Krahulec (2018)
[2]t = ton; from Mills and Jordan (2021)

intersected uranium mineralization). An additional 253 drill hole records were outside the company's current land position. GTI subsequently completed underground mapping of more than 4200 ft of historical workings at two mines, the East mine and the West mine, located on the newly acquired land. Handheld XRF analysis at these sites yielded values up to 19% $U_3O_8$ and 6% $V_2O_5$.

Activities in 2021 appear to be as fluid as in 2020, starting with completing handheld XRF analysis of the mine ribs at the East and West mines. In addition to this geochemical work, additional geophysical logging of exploration holes is planned, as well as surface and underground drilling to test mineral continuity.

### Cottonwood Project, U-V – East Henry Mountains District, Garfield County

The Cottonwood U-V project is held by Nortec Minerals and is located in the East Henry Mountains district in Garfield County. Energy Fuels' Henry Mountains Complex is located 9 mi south on the same geological trend and contains a 20 million lb resource of $U_3O_8$ (grading 0.26% $U_3O_8$). Uranium-vanadium mineralization in the area is known to occur in Jurassic Salt Wash Member sandstones and Triassic Shinarump conglomerates. Average uranium grade in the greater Henry Mountains area is 0.30% $U_3O_8$ and vanadium 1.35% $V_2O_5$. In September 2020, Nortec announced it was beginning exploration on the project with a phase 1 exploration program to define potential targets for phase 2 drilling. The phase 1 project was planned to include compilation of historical data, geological mapping, rock sampling, channel sampling, systematic scintillometer surveys, and radiometric surveys. They also planned a radon gas survey to delineate the location of blind uranium mineralization. Phase 1 exploration was planned for October 2020.

In March 2021, Nortec announced phase 1 rock chip sampling (20 samples from altered and unaltered Salt Wash sandstones) had yielded up to 1.8% $V_2O_5$ and 0.8% $U_3O_8$. The company has stated intentions of completing an NI 43-101 technical report on the property, though no timeline for the technical report or phase 2 drilling has been established.

### East Canyon Project, U-V – Dry Valley District, San Juan County

The East Canyon project was acquired by TNT Mines from Vanacorp in May 2020. The project is located in the Dry Valley district in San Juan County. The district represents the westernmost extent of the Uravan mineral belt, which occurs mainly in Colorado and has produced over 1.8 million lbs $U_3O_8$ at an average grade of 0.28% $U_3O_8$. Dry Valley is also the third largest historical vanadium-producing district in Utah. The area around the East Canyon project hosts several significant U-V resources, including Anfield Resources' Velvet-Wood deposit (measured, indicated, and inferred resource of 5.2 million lbs $U_3O_8$ at 0.29% $U_3O_8$) and Energy Fuels' La Sal Complex (measured, indicated, and inferred resource of 4.5 million lbs $U_3O_8$ at 0.17% $U_3O_8$).

After its acquisition in May, TNT added 31 claims to expand its overall land position to ~7 $mi^2$ and extend an interpreted mineralized trend between the historical None Such and Bonanza historical mines to >0.5 mi. Initial exploration work included geochemical mapping and sampling in the northern part of the project area following up on 2018 and 2019 sampling by Vanacorp that yielded results up to 0.47% $U_3O_8$ and 9.21% $V_2O_5$. TNT's own underground channel samples from None Such and Bonanza yielded results up to 2 ft at 0.69% $U_3O_8$ and 2.82% $V_2O_5$ at None Such and 3 ft at 1.27% $U_3O_8$ and 4.53% $V_2O_5$ at Bonanza. A grab sample taken at None Such yielded 8.3% $V_2O_5$.

TNT plans a first round of drilling in 2021 once final drill permitting is approved. The first round of drilling will focus on the northern part of the claim holdings, particularly around the None Such and Bonanza workings, to better define the prospectivity of the project.

## COAL

### Production and Distribution

Five Utah coal operators produced 13.3 million st of coal valued at $496 million from six underground mines and one surface mine in 2020 (figures 15, 16, 17, 18, and 19; table 5). After increasing slightly in 2019, production decreased by 7.1% in 2020, mainly due to the closure (idling) of the Dugout Canyon mine, the bankruptcy/sale of the Castle Valley (now Gentry) mines, and slightly reduced production at the Lila Canyon, Skyline, and Emery mines. In contrast, the Sufco mine increased production and the Coal Hollow surface mine more than doubled production after experiencing difficult mining conditions in 2019. After several years of decline, employment at active or recently active mines increased to 1397 employees in 2019—an 18% increase from a low of 1185 employees in 2016—but dropped slightly in 2020 to a total of 1345 employees (figure 18). Employment is expected to remain at about the same level in 2021. Demand at Utah coal-fired power plants was fairly stable from 2000 to 2015 at about 15.2 million st a year, but dropped to an average of 11.8 million st between 2016 and 2019, before dropping to only 10.5 million st in 2020 (figure 20). 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 historical lows. However, Utah operators have recently taken advantage of a stronger foreign export market, sending an estimated 1.6 million st of coal overseas to Asia in 2020 (figure 21). Even

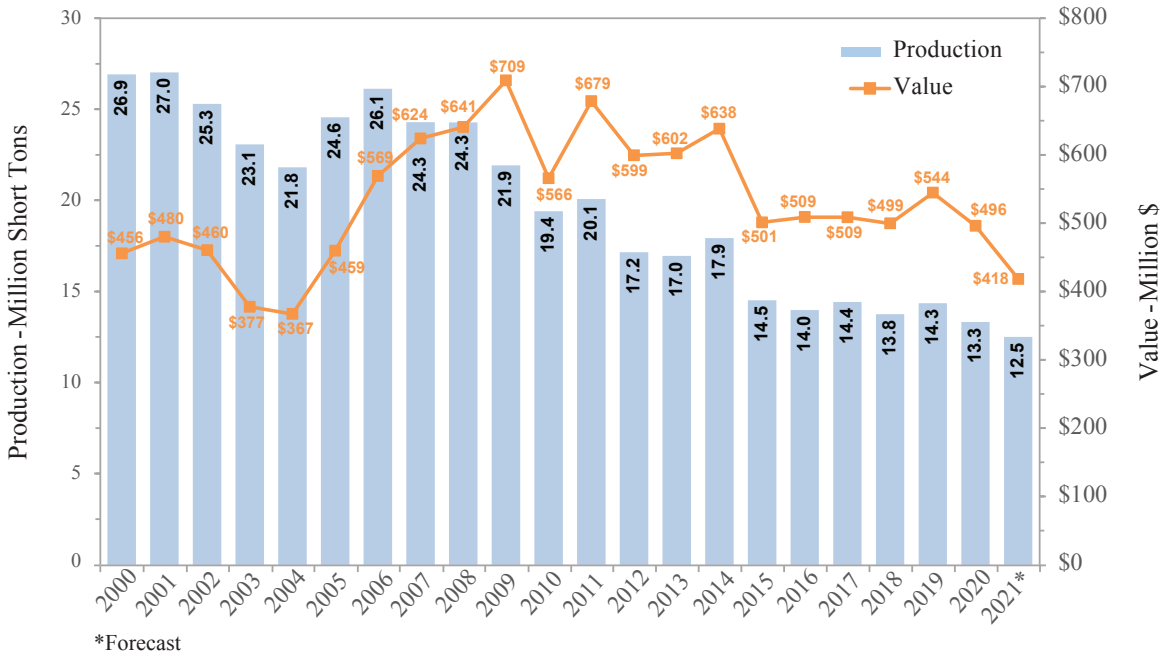



***Figure 15.*** *Utah annual coal production and value in nominal dollars, 2000–2021. Data source: Utah Geological Survey and U.S. Energy Information Administration.*

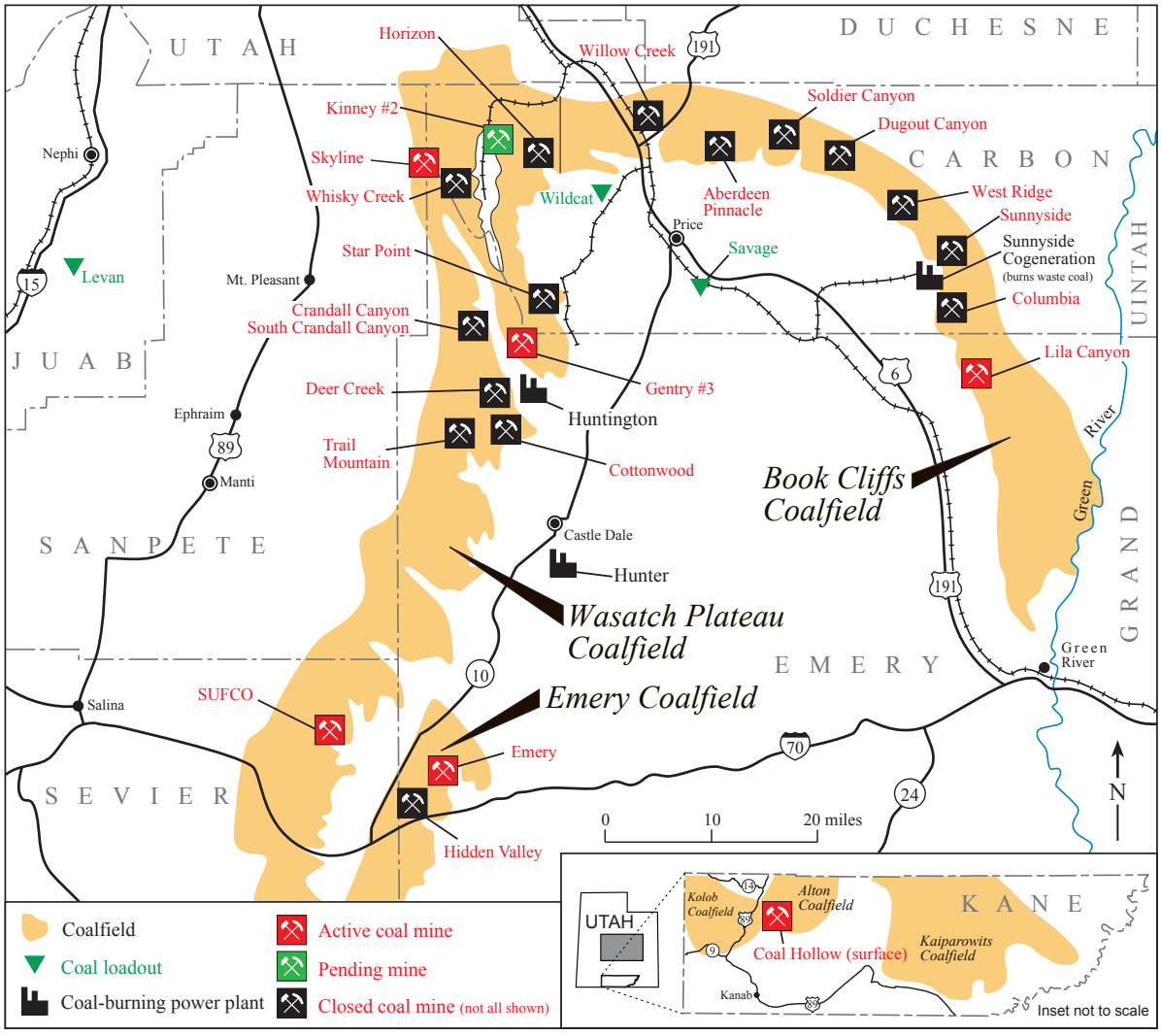



***Figure 16.*** *Location and status (at time of publication) of Utah coal mines and associated facilities.*

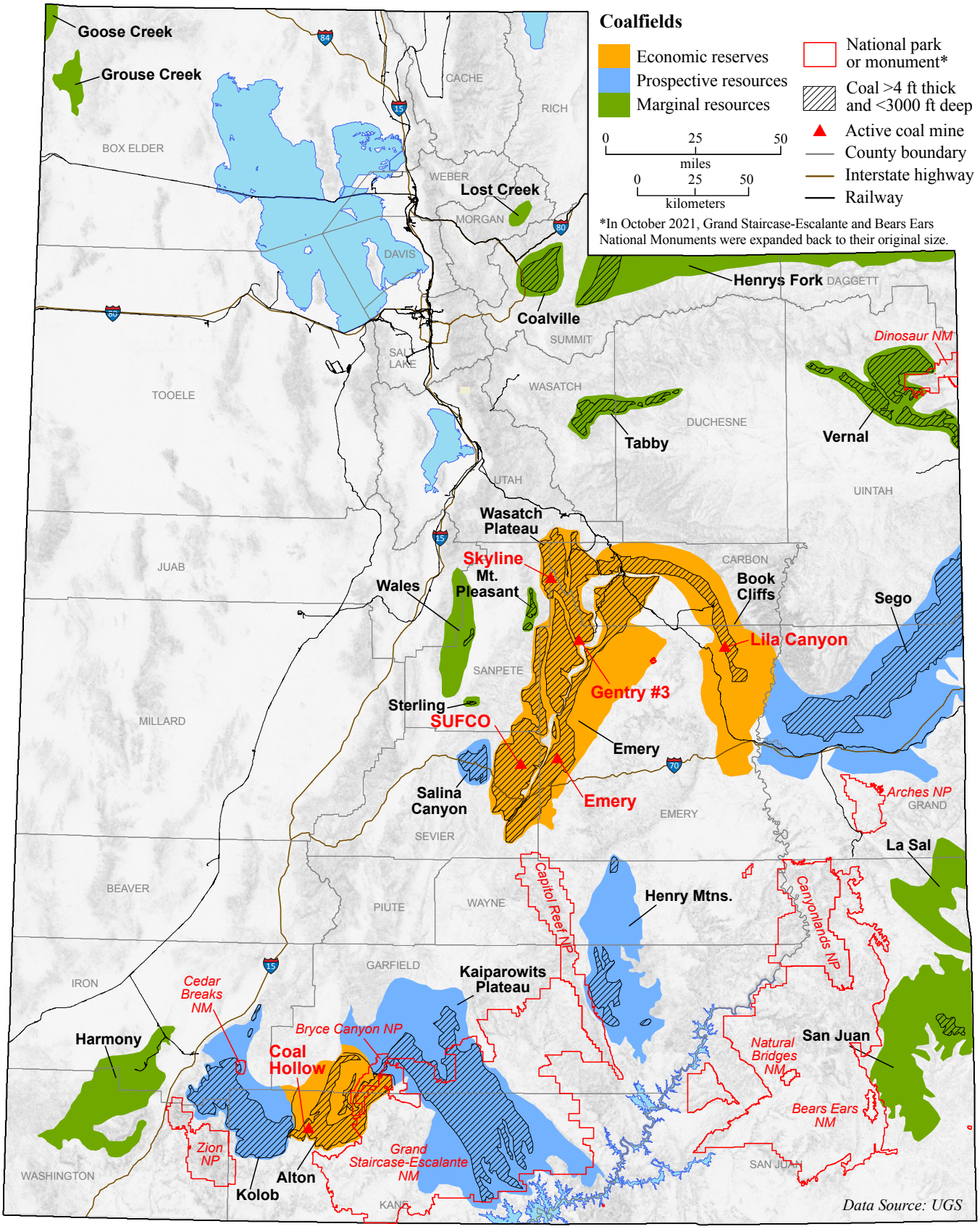



***Figure 17.*** *Location of active Utah coal mines and coalfields.*

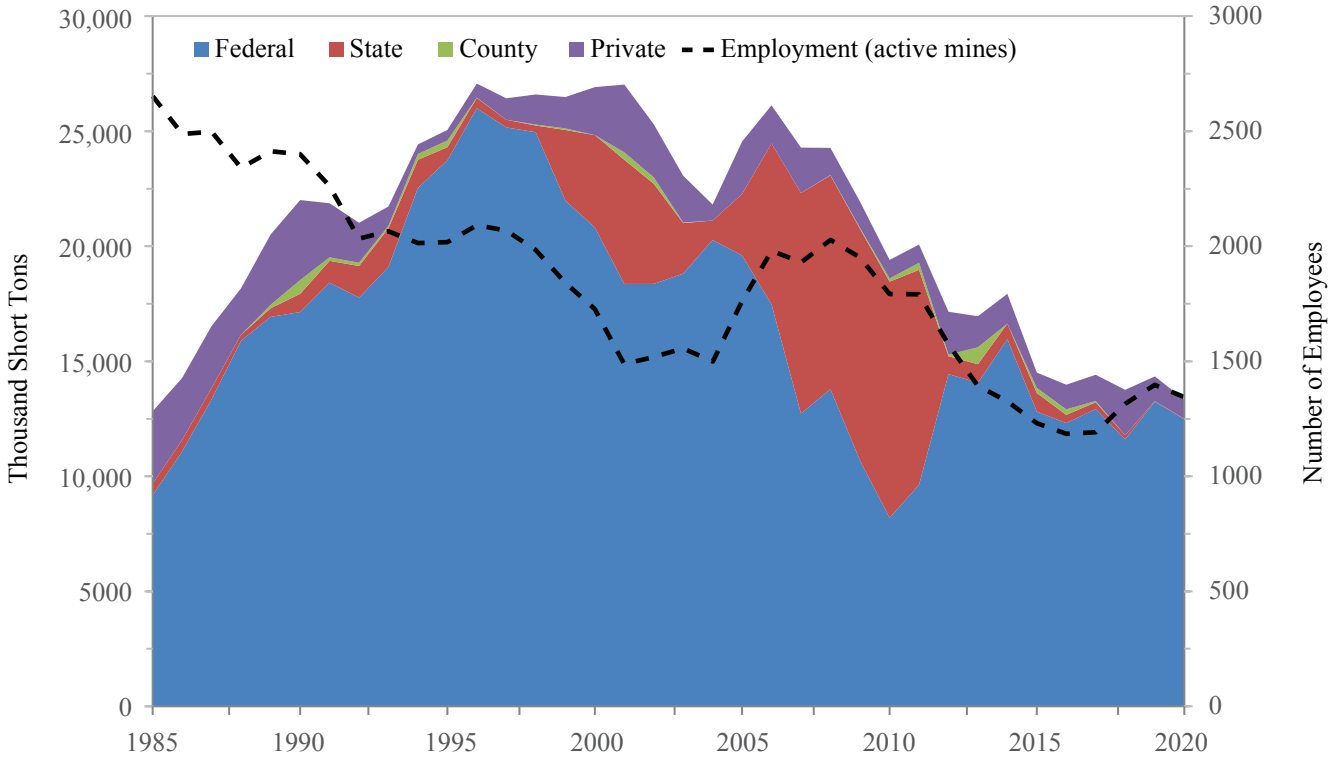



***Figure 18.*** *Coal production and employment in Utah by land ownership, 1985–2020. Data source: Utah Geological Survey and Mine Saftey and Health Administration.*

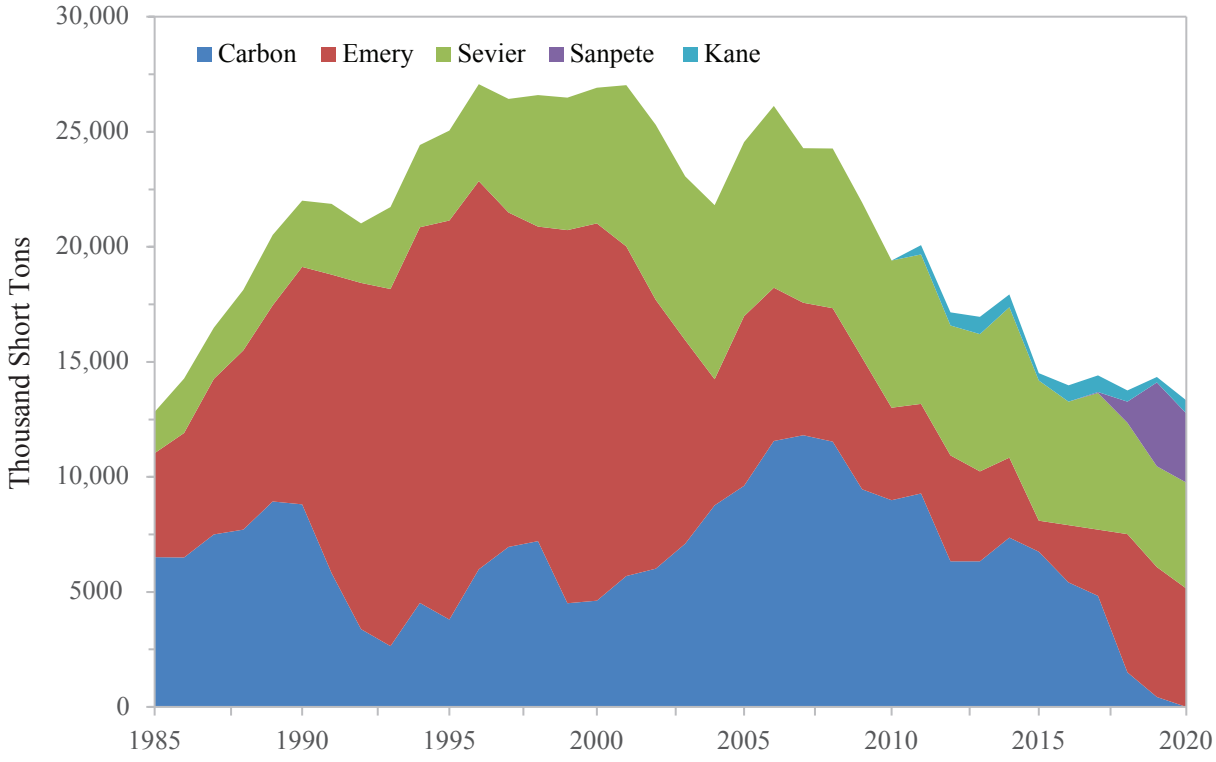



***Figure 19.*** *Coal production in Utah by county, 1985–2020. Data source: Utah Geological Survey.*

***Table 5.*** *Coal production in Utah by coal mine, 2009–2021.*

| Company | Mine[1] | County | Coalfield | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | thousand short tons | | | | | | | | | | | | |
| Canyon Fuel Company, LLC - Wolverine Fuels, LLC[2] | Dugout Canyon | Carbon | Book Cliffs | 3291 | 2307 | 2395 | 1588 | 561 | 676 | 763 | 650 | 626 | 557 | 430 | -- | -- |
| | Skyline #3 | Carbon/Sanpete/ Emery[3] | Wasatch Plateau | 2910 | 3050 | 2950 | 1954 | 3135 | 4170 | 4409 | 4767 | 4389 | 3614 | 3896 | 3713 | 3500 |
| | SUFCO | Sevier | Wasatch Plateau | 6748 | 6398 | 6498 | 5651 | 5959 | 6539 | 6095 | 5,75 | 5947 | 4842 | 4374 | 4601 | 3600 |
| Bronco Utah Operations, LLC[4] | Emery | Emery | Emery | 1238 | 999 | -- | -- | 4 | -- | -- | -- | 135 | 442 | 694 | 474 | 1100 |
| Gentry Mountain Mining, LLC - COP Coal Development Co.[5] | Gentry #3 | Emery | Wasatch Plateau | -- | -- | -- | -- | -- | -- | 218 | 170 | 205 | 102 | 562 | 660 | 500 |
| | Gentry #4 | Emery | Wasatch Plateau | 651 | -- | 592 | 1,004 | 875 | 1061 | 757 | 724 | 754 | 893 | 488 | 11 | -- |
| East Mountain Energy - PacifiCorp | Deer Creek | Emery | Wasatch Plateau | 3833 | 2954 | 3143 | 3295 | 2785 | 2083 | 15 | -- | -- | -- | -- | -- | -- |
| Hidden Splendor Resources, Inc. - America West Resources, Inc. | Horizon | Carbon | Wasatch Plateau | 194 | 270 | 370 | 210 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Utah Land Resources, Inc. - ACNR Holdings, Inc.[6] | West Ridge | Carbon | Book Cliffs | 3063 | 3355 | 3566 | 2579 | 2629 | 2514 | 1580 | -- | -- | -- | -- | -- | -- |
| Emery County Coal Resources - ACNR Holdings, Inc.[6] | Lila Canyon | Emery | Book Cliffs | -- | 72 | 157 | 304 | 257 | 335 | 350 | 1587 | 1638 | 2816 | 3664 | 3296 | 3300 |
| Alton Coal Development, LLC | Coal Hollow | Kane | Alton | -- | -- | 403 | 570 | 747 | 555 | 316 | 671 | 724 | 488 | 240 | 569 | 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 | 13,325 | 12,500 |

Source: UGS coal company questionnaire

*Forecast

[1]All mines are underground except Coal Hollow, which is a surface mine.

[2]Bowie Resources bought Canyon Fuel from Arch Coal in summer 2013. In late 2018, Bowie changed their name to Wolverine Fuels.

[3]2020 production by county: Sanpete = 3,000,319 tons; Emery = 712,681 tons. 2019 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.

[4]Bronco bought the Emery mine from CONSOL Energy in 2015.

[5]COP bought the Castle Valley mines when Rhino went into bankrupcy in late 2020, mines were renamed Gentry. In summer 2010, Rhino bought the Castle Valley mines from C.W. Mining (Co-op); mines were formerly called Bear Canyon.

[6]ACNR Holdings, Inc. was previously Murray Energy.

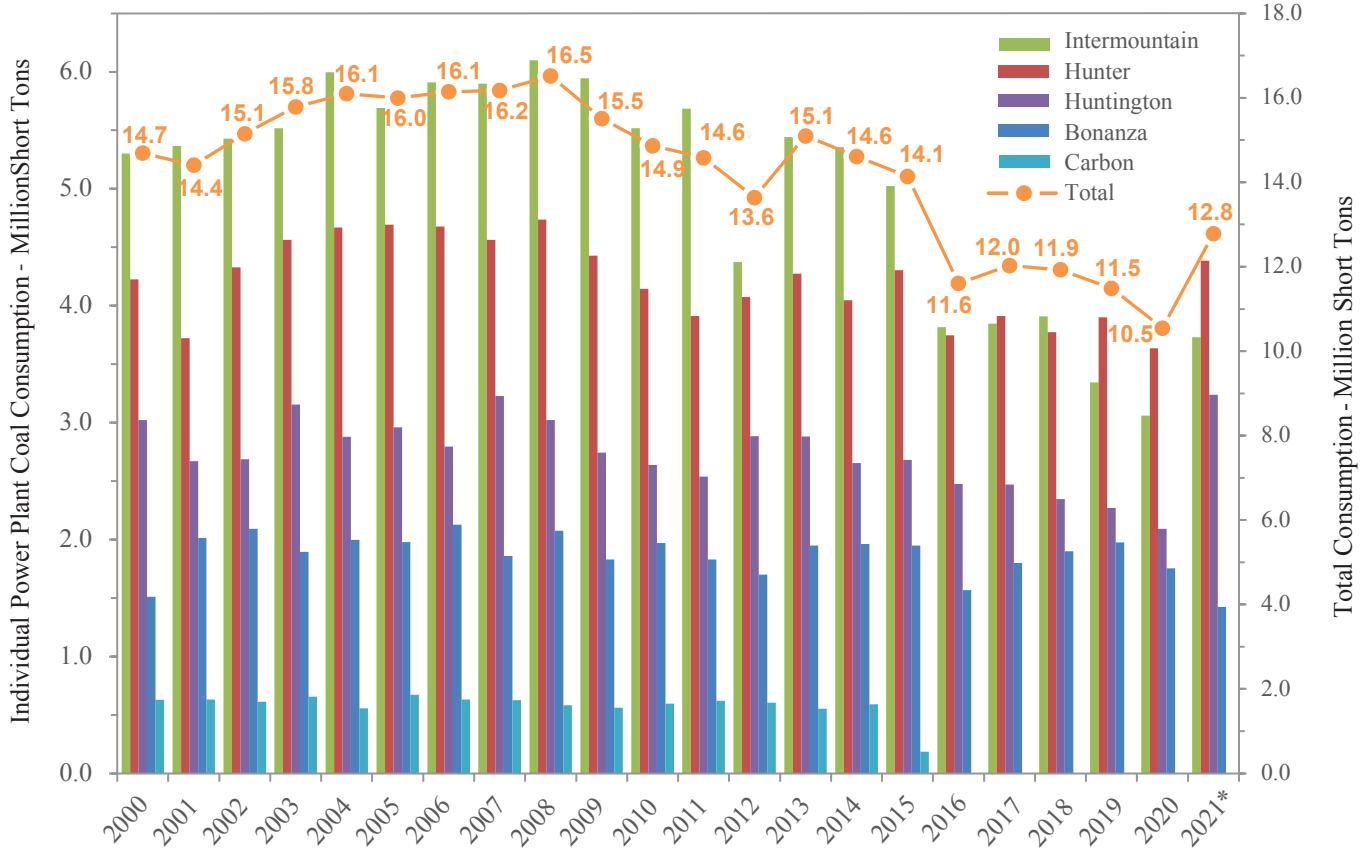



***Figure 20.*** *Consumption of coal at Utah power plants, 2000–2021. Data source: U.S. Energy Information Administration. Notes: (1) A generator at the Intermountain Power Plant was offline for several months in 2012, resulting in decreased coal consumption. (2) The Bonanza power plant in Uintah County gets its coal from the Deserado mine just over the border in Colorado. (3) The Carbon plant, Carbon County, shut down in spring 2015. (4) The Sunnyside plant in Carbon County is not included since it burns waste coal.*

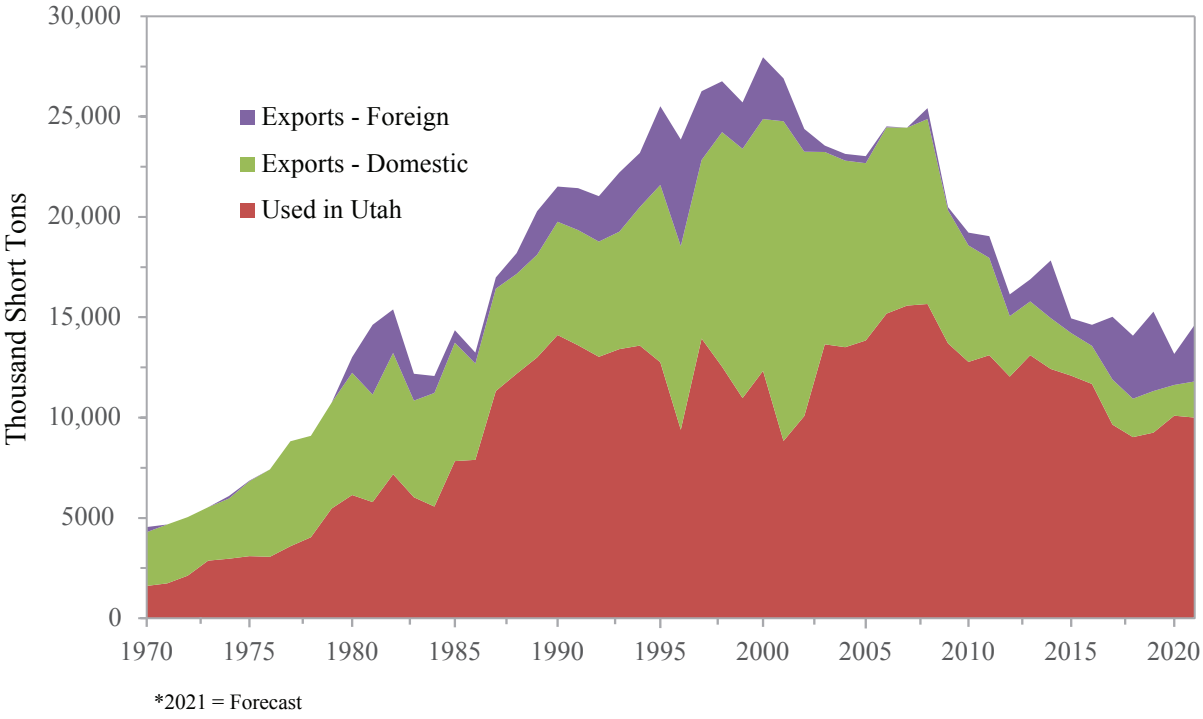



***Figure 21.*** *Distribution of Utah coal, 1970–2021. Data source: Utah Geological Survey and U.S. Energy Information Administration.*

with the export market contributing 2 to 3 million st per year toward Utah's coal demand, Utah's total production is expected to decrease again in 2021, to about 12.5 million st, the lowest since 1984.

For the first time in the history of Utah's coal industry (except for maybe the very early days), no coal was produced in Carbon County in 2020 after the idling of the Dugout Canyon mine (figure 19). In contrast, Sanpete County experienced coal production for the first time starting in 2017 (only minor past production many decades ago) when operations at the Skyline mine moved to the southwestern Flat Canyon area. Coal production in 2020 came from Emery (5.2 million st, 39%), Sevier (4.6 million st, 35%), Sanpete (3.0 million st, 23%), and Kane (569,000 st, 4.3%) Counties.

In 2020, the vast majority of Utah coal, 9.0 million st, was produced from the Wasatch Plateau coalfield; 3.3 million st came from one mine (Lila) in the Book Cliffs coalfield, 0.5 million st from the Emery coalfield, and 0.6 million st from the Alton coalfield (figure 17; table 5). The vast majority of Utah coal in 2020, 94% (12.5 million st), was produced from federal land, whereas only 17,000 st (less than 0.1%) was from state-owned land (figure 18). 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 2020 coal production came from private lands (6.3%, 835,000 st) at the Gentry, Emery, and Coal Hollow mines.

The total amount of Utah coal distributed to the U.S. market in 2020 was 11.6 million st, about 300,000 st more than 2019 (figure 21). 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 2020, only 1.5 million st of Utah coal was shipped to other states, whereas 10.1 million st was used locally. The vast majority of Utah coal, about 79% (10.1 million st), went to the electric utility market, mainly within the state. Utah coal deliveries to the industrial sector decreased to 1.5 million st in 2020, which is significantly less than peak deliveries of 4.4 million st in 2003. Total annual domestic deliveries of Utah coal in 2021 are expected to remain in the 10 to 11 million st range, consistent with low overall domestic demand. Data are similar for consumption of coal in Utah, with 10.9 million st consumed at Utah power plants in 2020 and 306,000 st used at industrial facilities, the latter being the lowest since before 1960 (figure 22).

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 capac-

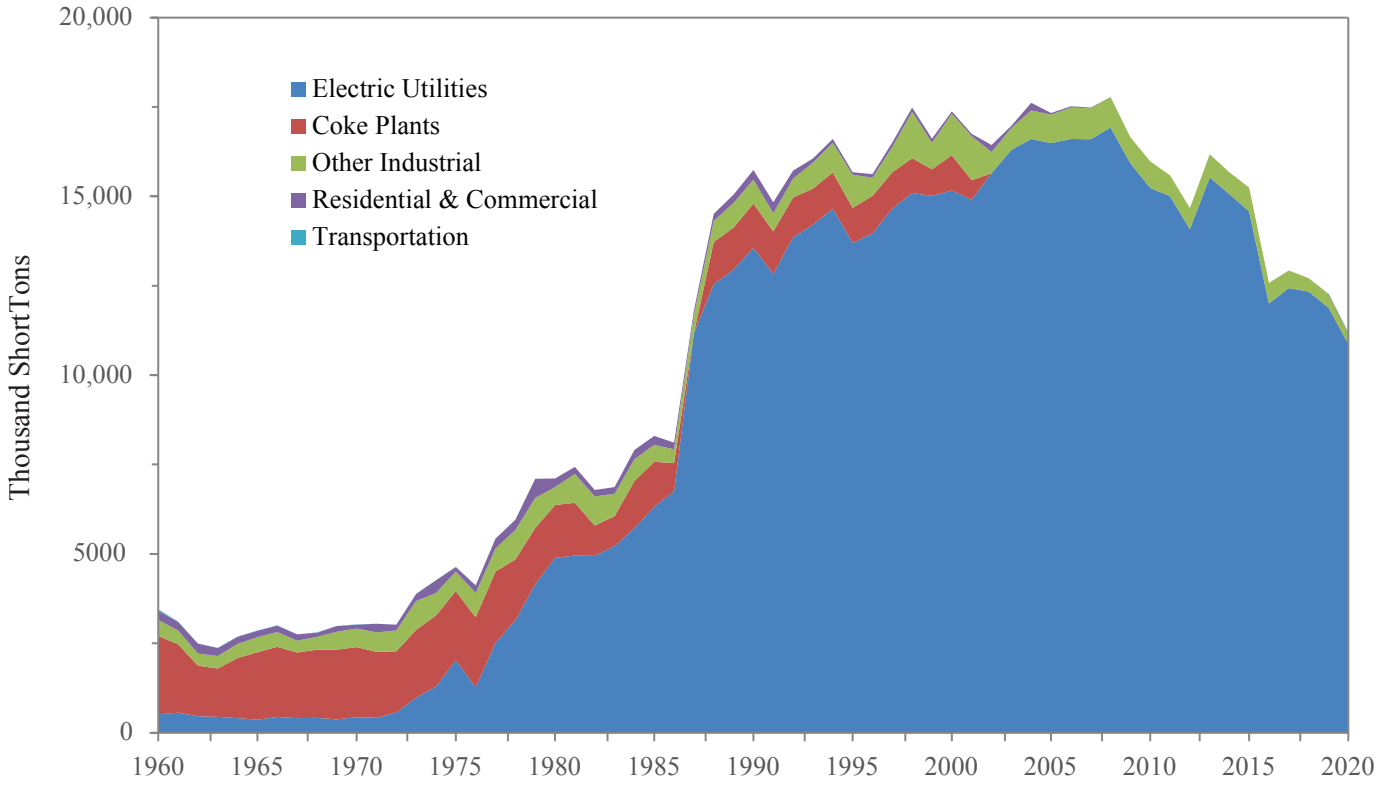



***Figure 22.*** *Consumption of coal in Utah by end use, 1960–2020. Data source: U.S. Energy Information Administration.*

ity of coal-fired power plants dropped from 317.6 gigawatts in 2011 to 228.9 gigawatts in 2020, a 28% reduction, with units supplied by bituminous coal (the type mined in Utah) accounting for 68% of the retired capacity (U.S. EIA, 2021b). 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. Between 2016 and 2019, consumption of coal at Utah's remaining coal-fired power plants averaged about 11.8 million st, a 17% drop from pre-2016 consumption (figure 20). Most of this reduction occurred at the Intermountain Power Plant (IPP) near the town of Delta (a reduction of about 1.3 million st) as the City of Los Angeles, the majority owner, has purchased less electricity from the plant due to favoring mostly renewable energy sources (figure 20). In fact, Los Angeles has stated it will no longer purchase any coal-fired electricity from IPP after its power purchase agreement expires in 2025, at which time the plant will be reconstructed to burn a combination of natural gas and "green/blue" hydrogen. In addition, starting in 2016, 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 lower their output during these peak solar times, thus consuming less coal (about 500,000 st less at Hunter and about 300,000 st less at Huntington) (figure 20).

Consumption of coal at Utah power plants again dropped in 2020 to only 10.5 million st, the lowest since 1986 when IPP came online (figure 20). This further drop was mostly attributed to lower electricity demand related to the COVID-19 pandemic. Available consumption data for 2021 (through August) shows a significant rebound in coal demand at Utah power plants, estimated at 12.8 million st for the year. This increase is in part a result of rebounding electricity demand as the country recovers from the pandemic-induced economic downturn. The increase is also a direct result of the doubling or even tripling of natural gas prices (up to $5 to $6 per thousand cubic feet in summer/fall 2021) compared to the relatively stable coal price, spurring more power generation at coal plants versus natural gas plants (U.S. EIA, 2021c). This increase in coal demand is not expected to continue and most likely will not contribute to any significant increase in future Utah production, especially since IPP will cease burning coal in the next few years.

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 21). 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, before 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, Utah operators have sought out alternate port facilities (e.g., Guaymas, Mexico) to send their coal overseas. Utah operators have exported between 1.5 to 3 million st per year for the past four years and are expected to ship about 2.8 million st of coal in 2021.

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/.

## 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 ft 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 12), 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 12). TomCo Energy is a United Kingdom-based oil shale company with 15,488 acres of SITLA leases (figure 12). 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 bbls and a prospective resource (2U) of 443 million bbls (McConachie and Kushkarina, 2019). Enefit, Red Leaf, and TomCo reported limited activity in 2020 related to oil shale.

### 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 bbls 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 relative ease of recent oil production from tight oil reservoirs, less incentive exists 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 group of SITLA leases within the PR Springs oil sand deposit in the southern Uinta Basin (figure 12). This project has been developed over the past decade and has an active mine permit from OGM. However, due to a variety of challenges, including several years of 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, Valkor, and TomCo Energy entered into a partnership (known as Greenfield Energy LLC) to explore oil sand extraction and production in the area (figure 12). They reported limited oil production in pilot tests in 2021 and the possibility of marketing the processed sand as frac sand. At least one other company, Vivakor, is operating in the Asphalt Ridge area and announced in early 2021 that they had successfully processed some oil sand into asphaltic cement.

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