

UTAH MINING 2021

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

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



CIRCULAR 134
UTAH GEOLOGICAL SURVEY
UTAH DEPARTMENT OF NATURAL RESOURCES
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Cover Photo: Core from 2022 drilling at the West Desert Zn-Cu-In deposit in Juab County showing massive chalcopyrite and sphalerite mineralization with magnetite. The West Desert deposit is enriched in indium, a critical mineral.
Photo courtesy of American West Metals Ltd.

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UTAH MINING 2021

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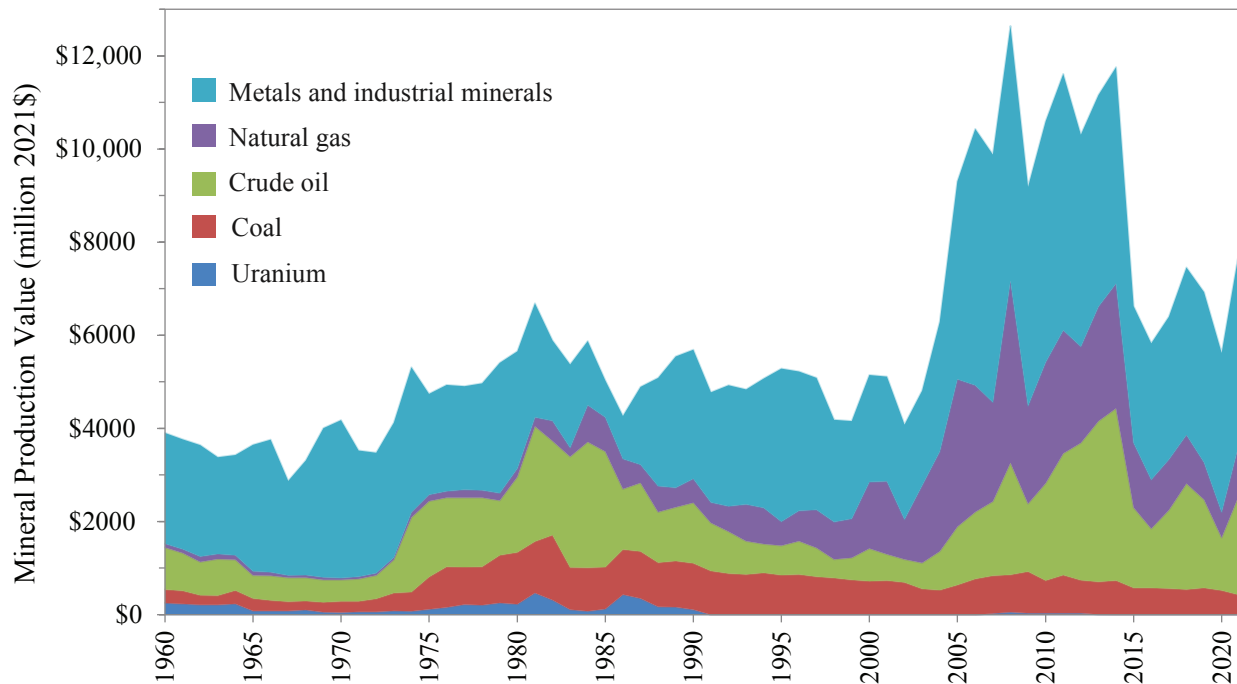
by Stephanie E. Mills, Andrew Rupke, Michael D. Vanden Berg, and Taylor Boden

INTRODUCTION

2021 Utah Mining Industry Summary

The estimated combined value of Utah's extractive resource production in 2021 totaled approximately \$7.8 billion, including production of metals and industrial minerals (\$4.1 billion), natural gas and natural gas liquids (\$1.1 billion), crude oil (\$2.2 billion), and coal (\$430 million) (figure 1). Utah's diverse mining industry (metals, industrial minerals, and coal) accounted for \$4.6 billion (58%) of total extractive resource production, an increase of \$790 million (21%) from 2020's revised value, but lower than peak values reached in 2011 (\$5.2 billion, nominal dollars). Mining activities in Utah currently produce base metals, precious metals, industrial minerals, and coal (figure 2). Base metal production contributed \$2.2 billion and includes copper, magnesium, beryllium, molyb-

denum, and iron (figure 3). Notably, copper alone accounted for 34% (\$1.5 billion) of Utah's mining production value and for 20% of Utah's total extractive resource production value. Precious metals produced in Utah include gold and silver, and 2021 production was valued at \$410 million (figure 3). Precious metal production value increased 14% from 2020 to 2021, and base metal values increased 45%, primarily due to increased metal prices and copper production. Industrial minerals produced in Utah include sand and gravel, crushed stone, salt, potash, cement, lime, phosphate, lithium, uinitaite (Gilsonite®), clay, gypsum, and other commodities (figure 2). The estimated value of industrial mineral production in 2021 was \$1.5 billion (figure 3), an 8.7% increase over the revised 2020 estimate. The most valuable industrial mineral group in 2021, estimated at \$490 million, was the construction aggregate group (sand and gravel and crushed stone). The value of Utah coal production decreased 14% in 2021 to \$430 million, down



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 2021 dollars, 1960–2021.

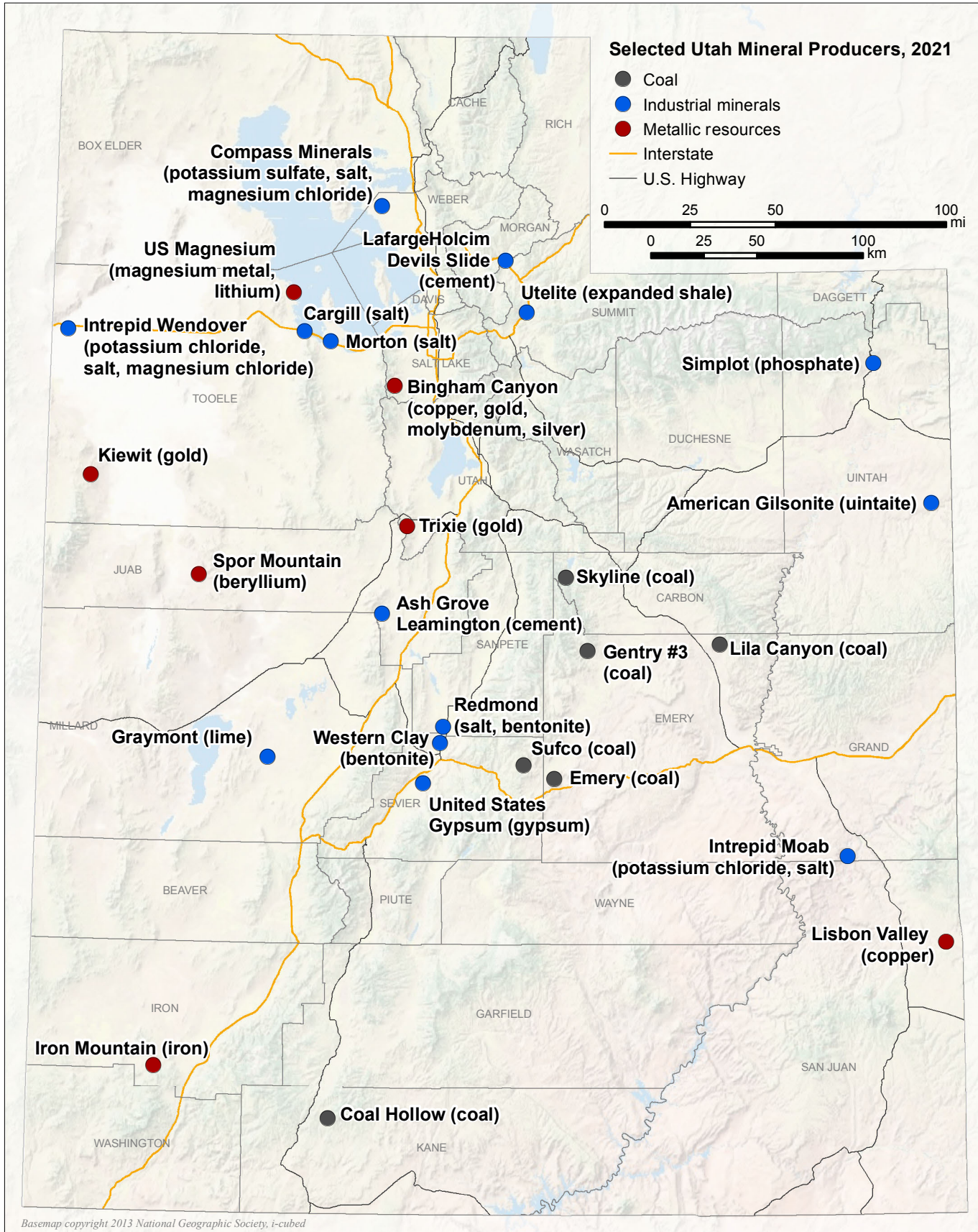


Figure 2. Select metal, industrial mineral, and coal production locations active in 2021 in Utah.

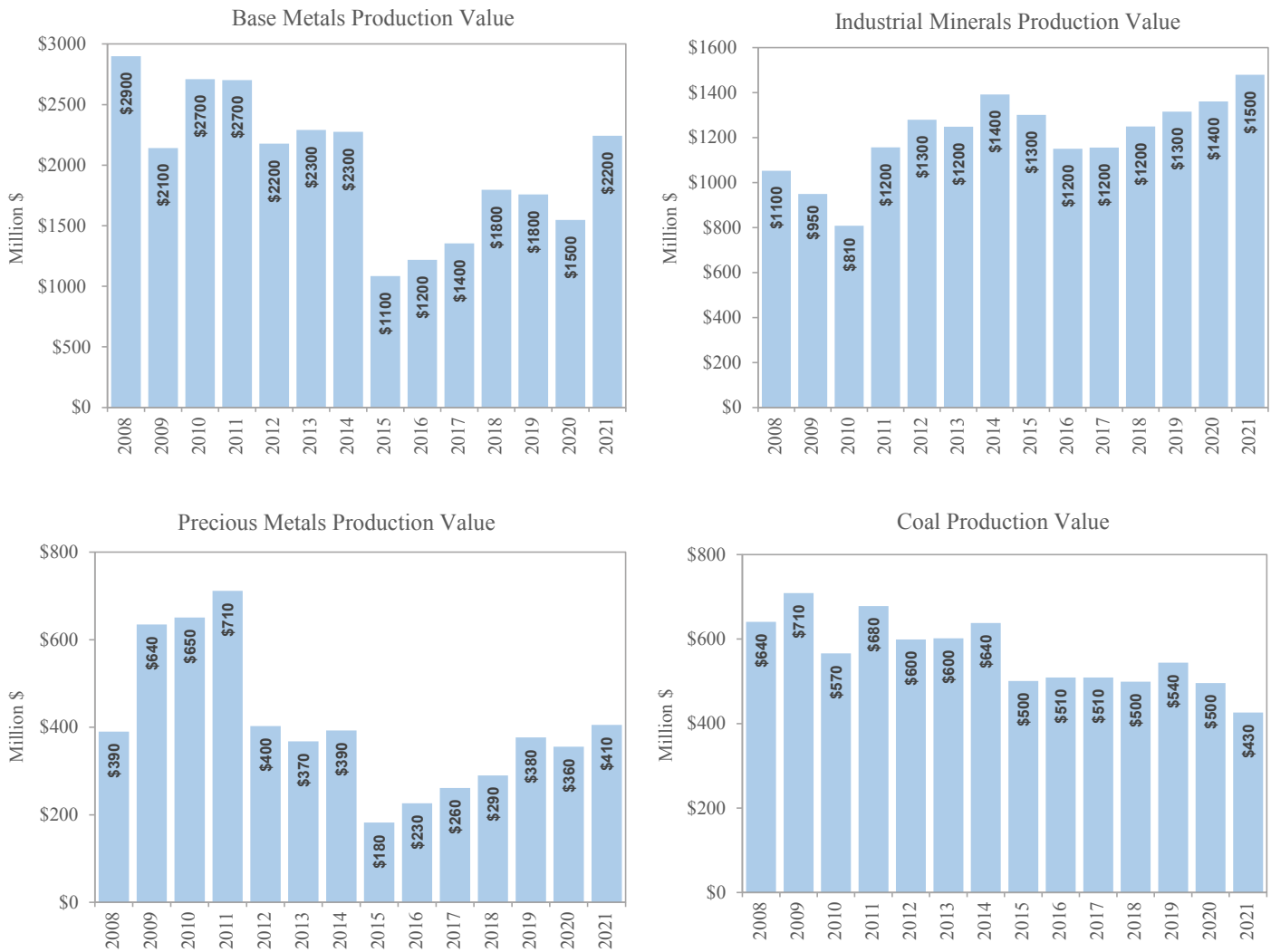


Figure 3. Annual value of Utah mineral production in nominal dollars, 2008–2021. Data source: Utah Geological Survey.

from \$500 million in 2021 (figure 3). Notably, Utah remains the only state to produce magnesium metal, beryllium concentrate, potassium sulfate, and uintaite (Gilsonite®); of these mineral commodities, magnesium metal and beryllium are included on the U.S. Geological Survey’s (USGS) 2022 list of critical minerals (U.S. Geological Survey, 2022a). 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. Great Salt Lake continues to be an important mineral resource and an estimated \$540 million of production came from the lake in 2021, not including some byproducts.

In 2021, the USGS ranked Utah as 7th nationally for production of nonfuel minerals (up one position from 2020), which include metals and industrial minerals (table 1). The USGS estimated Utah’s nonfuel mineral production value at \$3.8 billion (compared to the Utah Geological Survey [UGS] estimate of \$4.1 billion), which accounted for 4.2% of the U.S. total, with copper, magnesium metal, molybdenum mineral concentrates, potash, and sand and gravel for con-

struction listed as principal commodities (U.S. Geological Survey, 2022b). 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 21 coal-producing states in 2021 and accounted for 2.1% of total U.S. coal production (U.S. Energy Information Administration [EIA], 2022a). Throughout this report, production is given in tons (t) and million tons (Mt) unless otherwise indicated.

In the 2021 Fraser Institute annual survey of mining companies, Utah was ranked as the 11th most favorable state/nation out of 84 international jurisdictions (87th percentile) in terms of overall investment attractiveness with regard to mining (table 1) (Yunis and Aliakbari, 2022). This ranking represents a 14-spot increase from 2020 and places Utah back in line with its past rankings. 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 ranked the 5th most favorable jurisdiction in the United States.

Table 1. Utah mining rankings and statistics.

Utah mining ranking or statistic	2013	2014	2015	2016	2017	2018	2019	2020	2021
USGS rank of U.S. nonfuel mineral production value (metals and industrial minerals)	7th	5th	8th	10th	8th	8th	7th	8th	7th
Fraser Institute annual survey of mining companies (favorability of mining jurisdiction)	15th of 112	14th of 122	9th of 109	11th of 104	15th of 91	7th of 83	14th of 76	25th of 77	11th of 84
U.S. EIA rank for coal production by state	14th	13th	14th	10th	11th	12th	11th	10th	10th
New OGM approved large mine permits	4	2	2	0	0	1	4	2	1
New OGM approved small mine permits	13	11	12	7	11	13	11	4	12
New OGM approved exploration permits	9	14	17	11	9	6	8	9	18
SITLA mineral leases issued	62	56	32	53	57	36	41	38	68
New BLM mining claims filed	2400	3100	980	5400	5700	5400	2300	3600	5100
Total BLM mining claims (end of year)	19,500	19,800	18,500	21,500	21,900	23,000	21,600	23,100	28,000

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

The minerals regulatory program within the Utah Division of Oil, Gas and Mining (OGM) approved one large mine permit, twelve small mine permits, and eighteen exploration permits in 2021 (table 1). The large mine permit was issued for construction aggregate and the small mine permits included four construction aggregate or stone mines, two metal mines, two clay mines, one gypsum mine, and three mines for other commodities. Eighteen exploration permits were approved for base and precious metals (10), uranium and vanadium (2), fluorspar (1), gypsum (1), lithium/bromine/iodine (1), limestone (1), shale (1), and geodes (1) (Kim Coburn, OGM, written communication, March 2022).

The Utah School and Institutional Trust Lands Administration (SITLA), which manages about 3.4 million acres of state-owned lands in Utah, issued 68 new mineral leases in 2021, up significantly from 38 in 2020 (table 1). These leases were issued for the following commodities: metalliferous minerals (41), sand and gravel (17), building stone (3), bituminous sands (2), potash (1), limestone (1), mineral salts (1), humic shale (1), and gemstone/fossil (1) (Andy Bedingfield, SITLA, written communication, March 2022).

In 2021, approximately 5100 new unpatented mining claims (based on unique serial numbers located in 2021) were filed

on federal lands in Utah, a 41% increase from 2020 (figure 4). The majority of claim activity in 2021 occurred in the following counties in decreasing order: Tooele, Beaver, Juab, Piute, Sevier, Box Elder, and Millard, each recording over 200 new claims. At the end of 2021, there were approximately 28,000 active unpatented mining claims in Utah, up 22% from 2020 (table 1).

Contributions by the Utah mining industry to the state tax base during 2020–21 were significant (figure 5). The metal, industrial mineral (non-metal), sand and gravel, and coal mining industries paid over \$70 million in property taxes in 2020 (down 15% from 2019; calendar year; 2021 data will not be available until August 2022) and over \$14 million in mining-related severance taxes in 2020 (up 7% from 2019; state fiscal year). Severance tax contributions decreased slightly in 2021 to about \$13 million. All extractive industries, including oil and gas, paid nearly \$45 million in federal mineral lease disbursements in 2021 (state fiscal year). About 1.6% of Utah's gross domestic product came from the mining industry in 2021, 2.4% if oil and gas are included. Mining employment in Utah was up about 2% from 2020 to 2021, and had a small wage increase of slightly over 1% (figure 6).

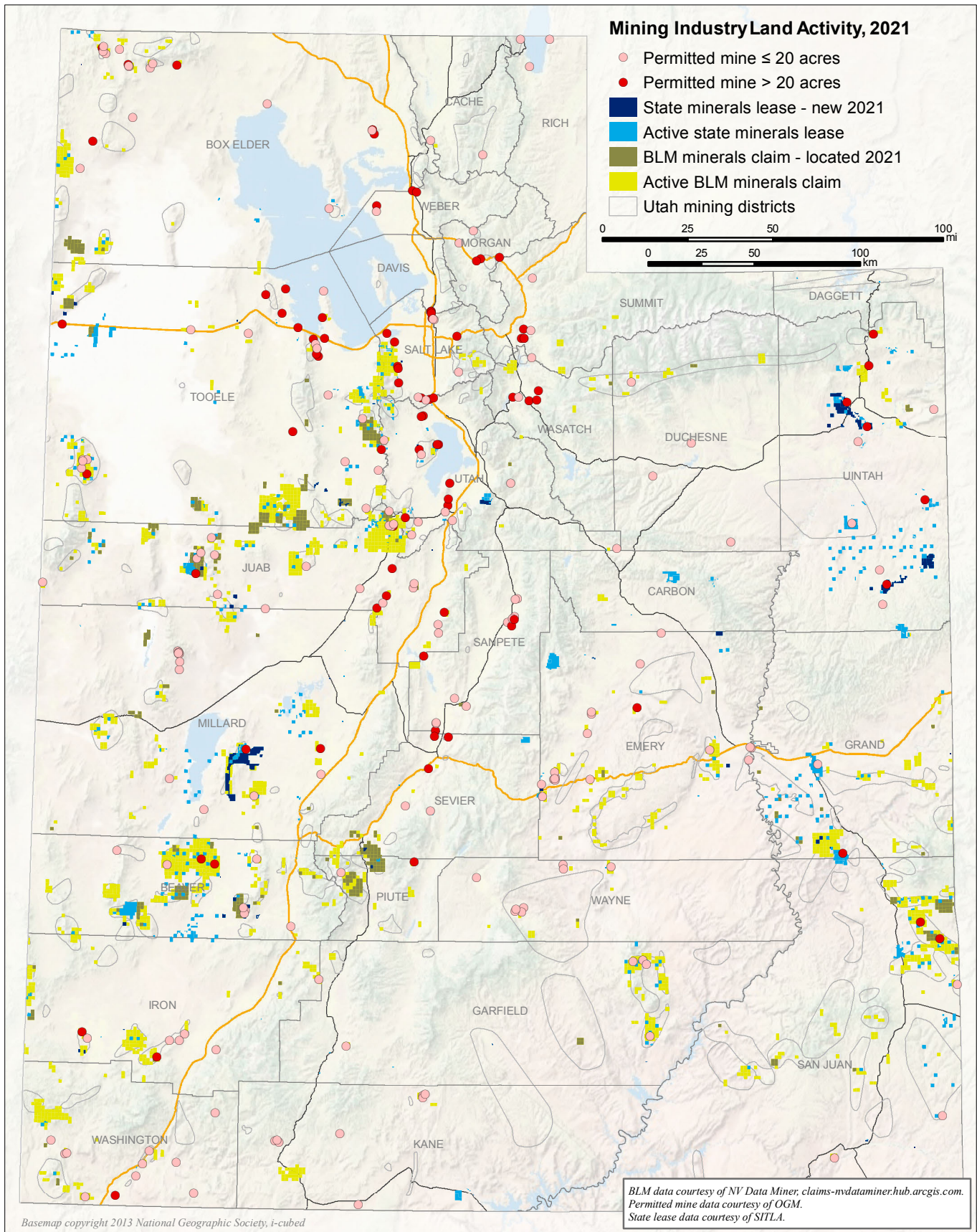


Figure 4. Summary of active and new BLM claims and SITLA leases in Utah.

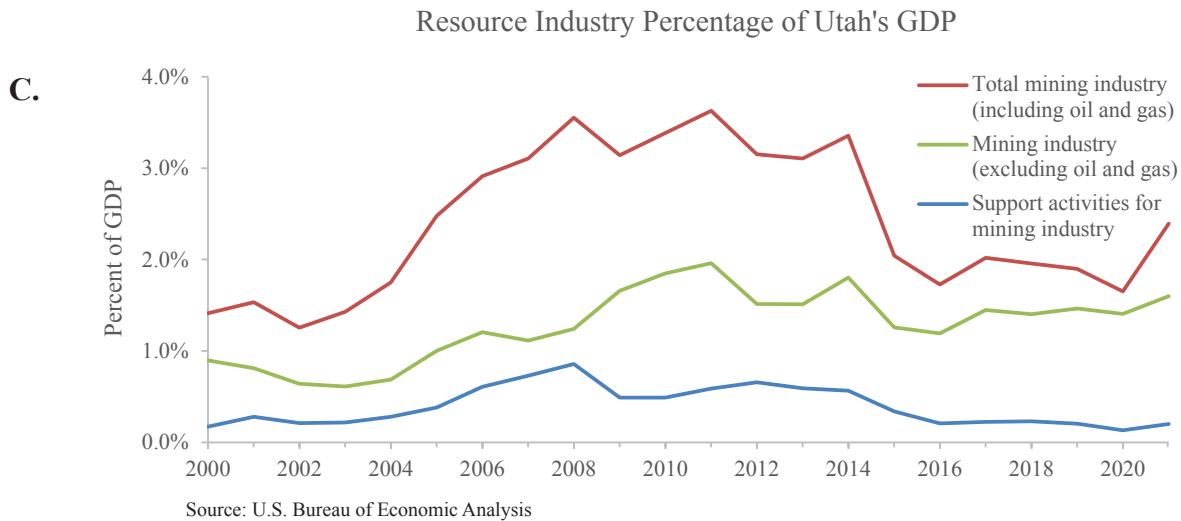
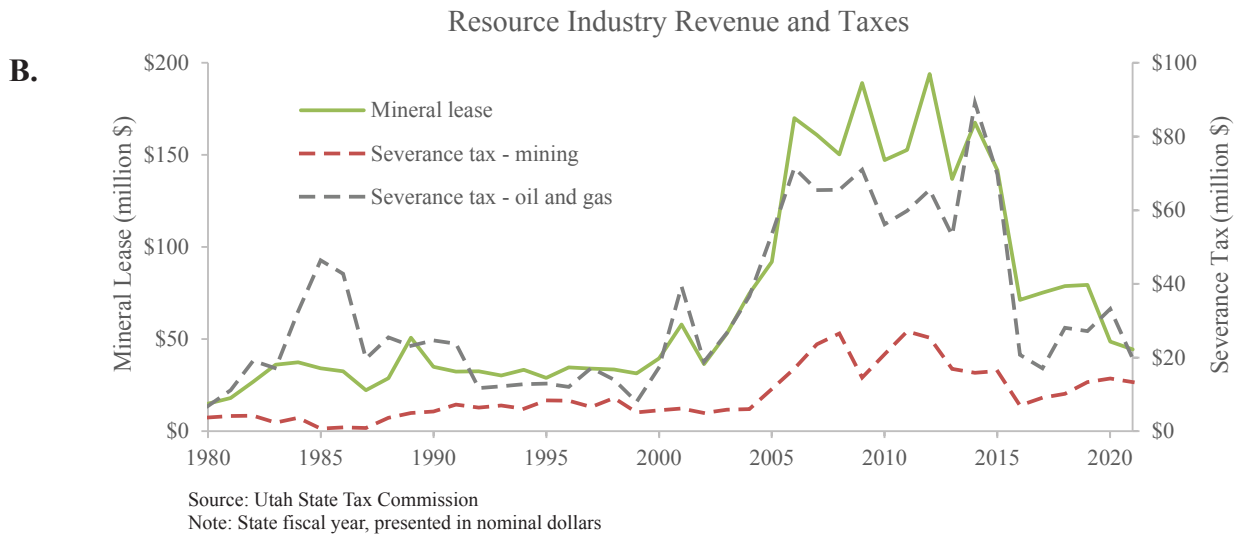
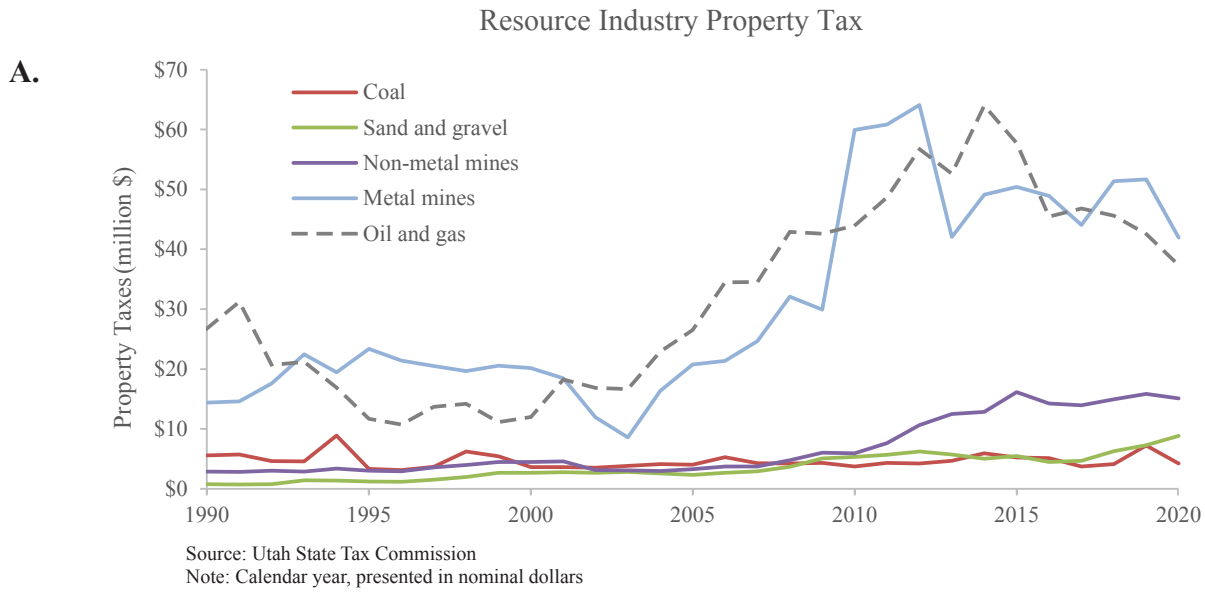


Figure 5. Utah mining economic indicators. **A.** Property taxes charged against the mining industry, 1990–2020. **B.** Mineral Lease revenue and severance taxes, 1980–2021. **C.** Percentage of Utah's gross domestic product (GDP) from mining-related activities, 2000–2021.

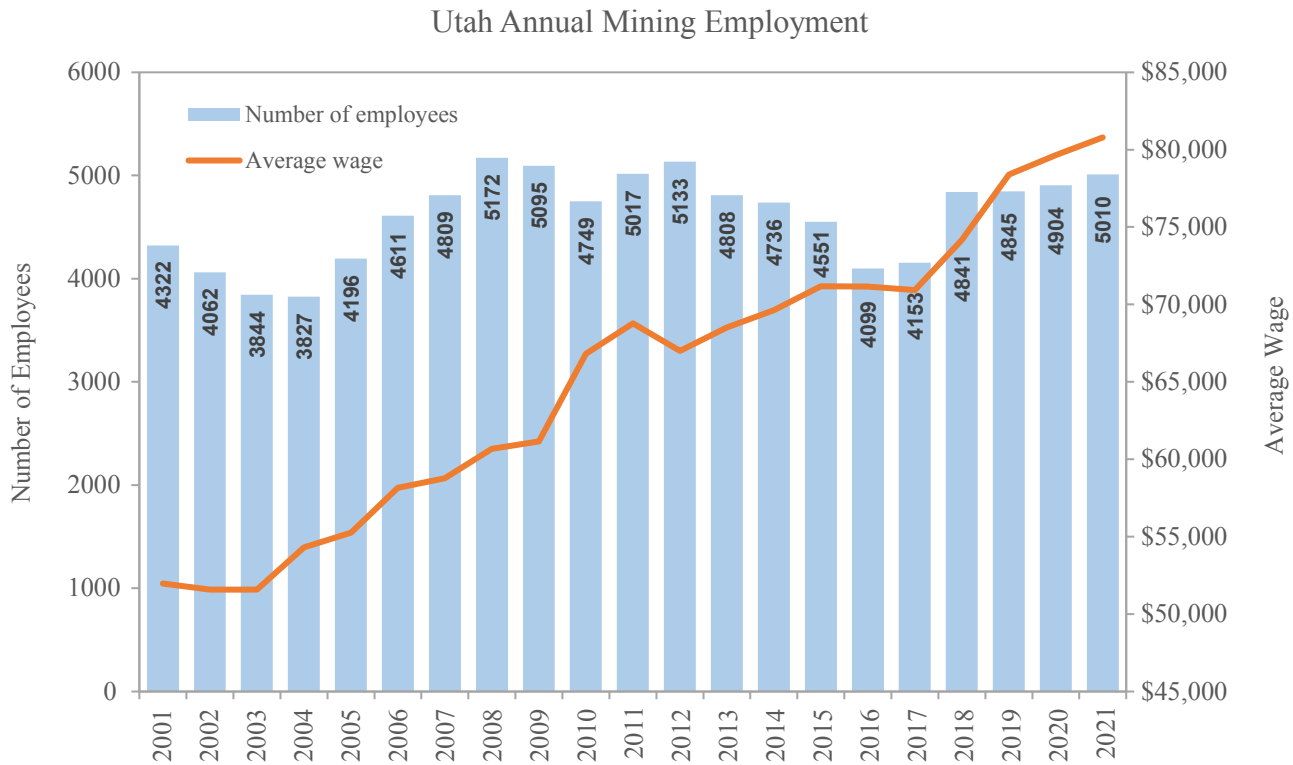


Figure 6. Average annual mining employment and salaries (in nominal dollars) in Utah. Includes metal, industrial mineral, and coal mines and facilities; excludes oil and gas. Source: Utah Department of Workforce.

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. Mills and Rupke (2020) provide a more detailed summary of the 2018 critical minerals in Utah. The federal list was updated to 50 critical minerals as of 2022 (U.S. Geological Survey, 2022a). The primary discrepancy in the number of critical minerals between versions is due to Platinum Group Elements (PGEs) and Rare Earth Elements (REEs) being grouped in the 2018 list whereas each PGE and REE has been listed as an individual critical mineral in the 2022 list. Changes to the U.S. critical mineral list are summarized on figure 7.

In 2021, Utah hosted production of five critical minerals (beryllium, lithium, magnesium metal, platinum, and palladium) and two other critical minerals have or are planned to commence production in 2022 (fluorspar and tellurium). A summary of the distribution of Utah’s critical mineral production is given on figure 8. More details on these operations are given below.

- **Beryllium:** Utah is the only domestic producer of beryllium and is the global leader in the sector, with the Spor Mountain mining district in Juab County, owned by Materion Resources, producing 61% of global beryllium output in 2021.

- **Lithium:** There are multiple established resources of lithium in Utah but the only production has been as a byproduct of magnesium metal production from Great Salt Lake brines by US Magnesium. Lithium was produced in Utah starting in 2020 and production is being ramped up to a capacity of about 10,000 t of lithium carbonate equivalent (LCE) during 2022.
- **Magnesium (metal):** Utah is the only domestic producer of magnesium metal, which is produced from Great Salt Lake brines via solar evaporation and electrolytic processing by US Magnesium.
- **Platinum and palladium:** Bingham Canyon, operated by Kennecott Utah Copper Company (a subsidiary of Rio Tinto), produces modest platinum and palladium as a byproduct of the precious metal refining process. The platinum and palladium are hosted in a crude selenium product and are not refined to pure elemental form.
- **Fluorspar:** Fluorspar (also known as fluorite) has historically been produced from the Lost Sheep mine in Juab County. The mine has been idle since the mid-2000s, but in 2020 Ares Strategic Mining began modern exploration and drilling to delineate the fluorspar resource and is currently developing a mine plan.

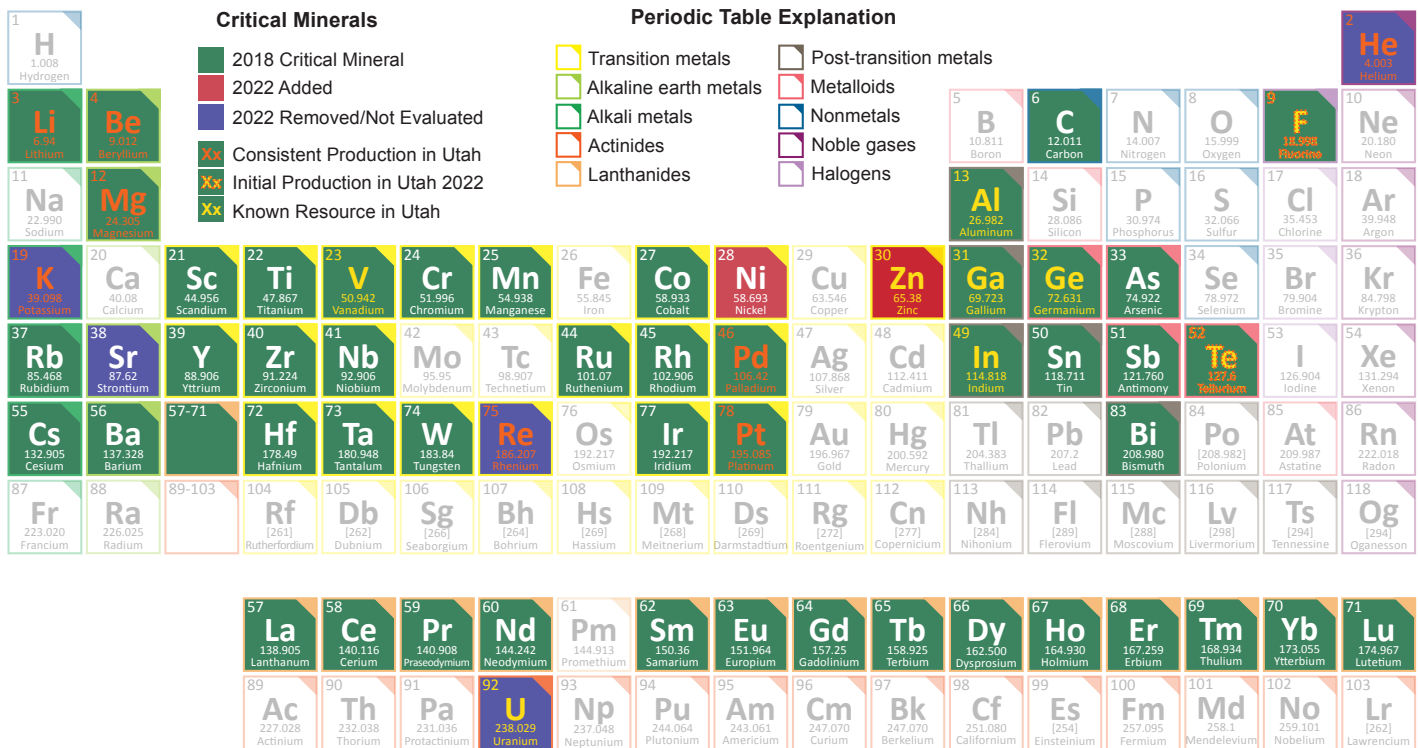


Figure 7. Summary of changes to the federal critical mineral list from 2018 to 2022.

- **Tellurium:** Like platinum and palladium, tellurium is a byproduct of the Bingham Canyon mine. A new tellurium recovery plant was built in 2021 and initial production began in May 2022. Annual production is estimated at 20 t tellurium, and Bingham Canyon is one of only two tellurium producers domestically.

In addition to the seven production-level critical minerals, Utah hosts known resources of six more (aluminum, indium, gallium, germanium, vanadium, and zinc) plus additional resources of lithium (figure 8). More details on these deposits are given below.

- **Aluminum:** The Blawn Mountain deposit in Beaver County is the largest domestic alunite resource, hosting a measured and indicated resource of 150,000,000 t of alunite, which contains 56,000,000 t aluminum oxide and 32,000,000 t potassium sulfate (potash) in the alunite (Kerr and others, 2017).
- **Indium:** The West Desert deposit in Juab County is the only domestic indium resource (800 t indium indicated and inferred resource), representing enough indium to supply U.S. imports for consumption for over nine years at 2021 import levels, and also hosts copper and zinc resources (Dyer and others, 2014).

- **Lithium:** Great Salt Lake is producing lithium as a by-product of magnesium metal production on the western side of the lake, and in-place resource of 2,600,000 t LCE has been demonstrated at the lake. Subsurface brines of the Paradox Basin are being explored through old oil and gas wells and thus far represent an indicated and inferred resource of 210,000 t of LCE.

- **Gallium and germanium:** The Apex mine in Washington County is estimated to contain roughly 1 Mt remaining ore containing approximately 360 t gallium and 960 t germanium (Krahulec, 2018), which would be enough gallium and germanium to supply U.S. imports for consumption for over 30 years and 68 years, respectively, at 2021 import levels.
- **Vanadium:** Mills and Jordan (2021) demonstrated there are still over 58,340,000 lbs vanadium pentoxide in known resources (historical and established) located in southeast Utah, primarily in the Paradox Basin of the Colorado Plateau. This value is likely to be an extreme underestimate as vanadium has historically not been quantified accurately due to the focus on uranium in these deposits. Currently most exploration remains focused on uranium potential over vanadium.

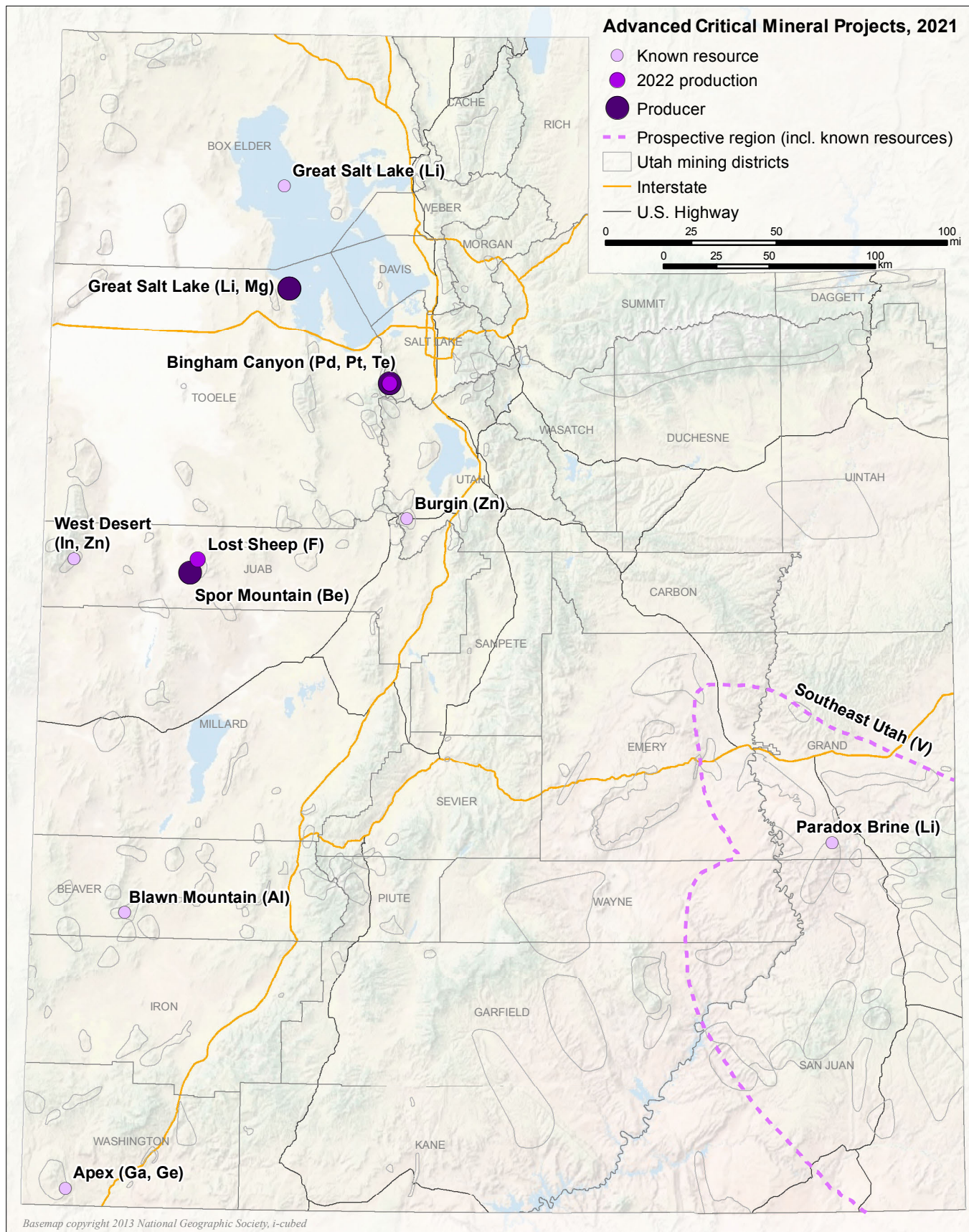


Figure 8. Location of significant critical mineral localities in Utah.

- Zinc: The Burgin mine in Utah County, currently on care and maintenance, has an indicated and inferred resource of 100,000 t zinc (plus silver, gold, and lead). The West Desert deposit in Juab County has an indicated and inferred resource of 1,500,000 t zinc in addition to indium and copper (Dyer and others, 2014).

\$400 million came from precious metals. Overall, the production value of metalliferous resources increased by 39% from 2020, largely driven by increased price and production of copper. Table 2 summarizes metallic resource production in Utah, and the locations of active mines are shown on figure 2. Individual commodity updates are given below in order of decreasing mineral production value.

BASE AND PRECIOUS METALS

Production

The global mining industry rebounded strongly in 2021 after significant challenges in 2020 due to the COVID-19 pandemic. Widespread availability of vaccines, reduced lockdown restrictions, and industry preparedness for safe work practices during surges of COVID-19 variants meant that the mining industry was largely able to return to work as usual during 2021, with the added support of climbing commodity prices. High commodity prices for everything from iron and molybdenum to copper and gold have given many mining companies a strong financial position and boosted exploration (see Exploration and Development), and this trend appears set to continue into 2022.

2021 Utah Mineral Production Value Summary

Utah’s total metalliferous resource production totaled \$2.6 billion in 2021, of which \$2.2 billion came from base metals and

- Copper: The price of copper increased by 50% from 2020 to 2021 (from \$2.87 to \$4.30), and production increased by 16% (figure 9). Copper experienced the most substantial increase in production of all metals due to the Bingham Canyon mine moderately increasing production and the Lisbon Valley mine, operated by Lisbon Valley Mining Company, returning to active mining. Production is expected to continue at current levels or slightly increase, given Bingham Canyon’s mining shift to access higher grade copper ore. The price of copper is expected to remain strong in 2022, and the long-term outlook for copper is also strong given the importance of copper to vehicle electrification.
- Gold: Production of gold in Utah increased by 11% from 2020, and price increased slightly from already near-record highs in 2020 of \$1774 to \$1800/tr oz in 2021 (figure 9). Gold output from Bingham Canyon decreased by over 30,000 troy oz, but this production deficit was covered by the substantial increase in

Table 2. Summary of metallic resource mining operations in Utah, 2021.

Operation	Owned By	County	Mining District	Copper	Gold	Molybdenum	Silver	Iron	Beryllium	Magnesium
Bingham Canyon	Kennecott Utah Copper Corporation (subsidiary of Rio Tinto Ltd.)	Salt Lake	Bingham	x	x	x	x			
Lisbon Valley	Lisbon Valley Mining Co.	San Juan	Lisbon Valley	x						
Trixie	Tintic Consolidated Metals Ltd.	Utah	East Tintic		x					
Kiewit	Desert Hawk Gold Corp.	Tooele	Gold Hill		x					
Iron Mountain	Utah Iron LLC	Iron	Iron Springs					x		
Spor Mountain	Materion Corp.	Juab	Spor Mountain						x	
Great Salt Lake	US Magnesium LLC	Tooele	n/a							x

production from the Trixie mine, operated by Tintic Consolidated Metals, and consistent minor production from the Kiewit mine, operated by Desert Hawk Gold. The price of gold is anticipated to stay near or above current levels in 2022 given ongoing supply chain uncertainty from the COVID-19 pandemic and the war in Ukraine, on the observation that geopolitical conflict and economic uncertainty have traditionally fueled gold’s status as a safe-haven investment.

- Molybdenum: Bingham Canyon was the only producer of molybdenum in 2021 and production decreased by 63% (figure 9). However, the price of molybdenum experienced a huge jump in 2021, recording an 81% price increase, so the overall decrease in mineral production value for molybdenum was 33%. The substantial decrease in production is due to a ramp up in molybdenum production by Bingham Canyon in 2020 to offset the impact of suspended copper production while the copper

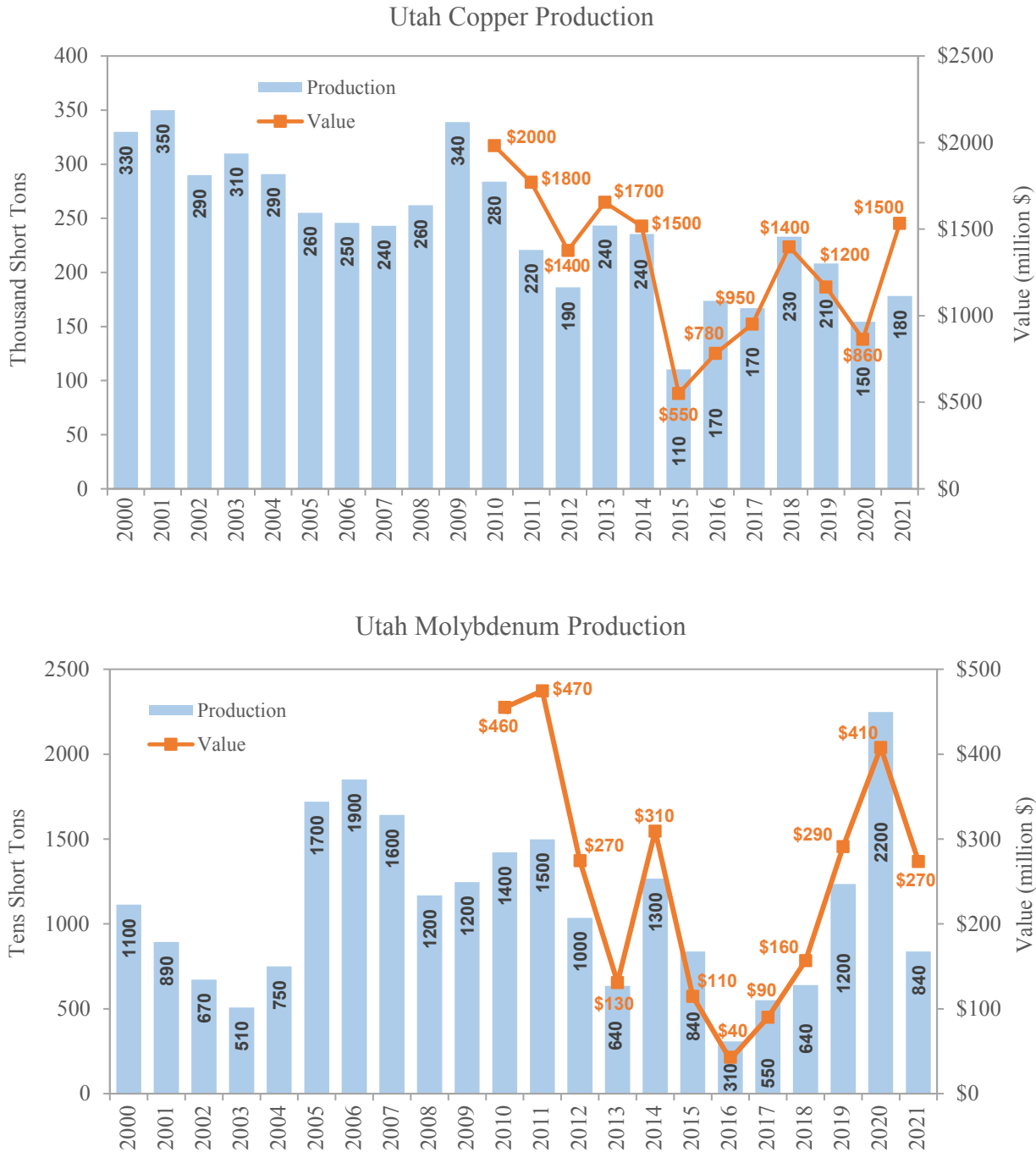


Figure 9. Production (since 2000) and value (since 2010) of select metals. Value in nominal dollars. Data Source: Utah Geological Survey.

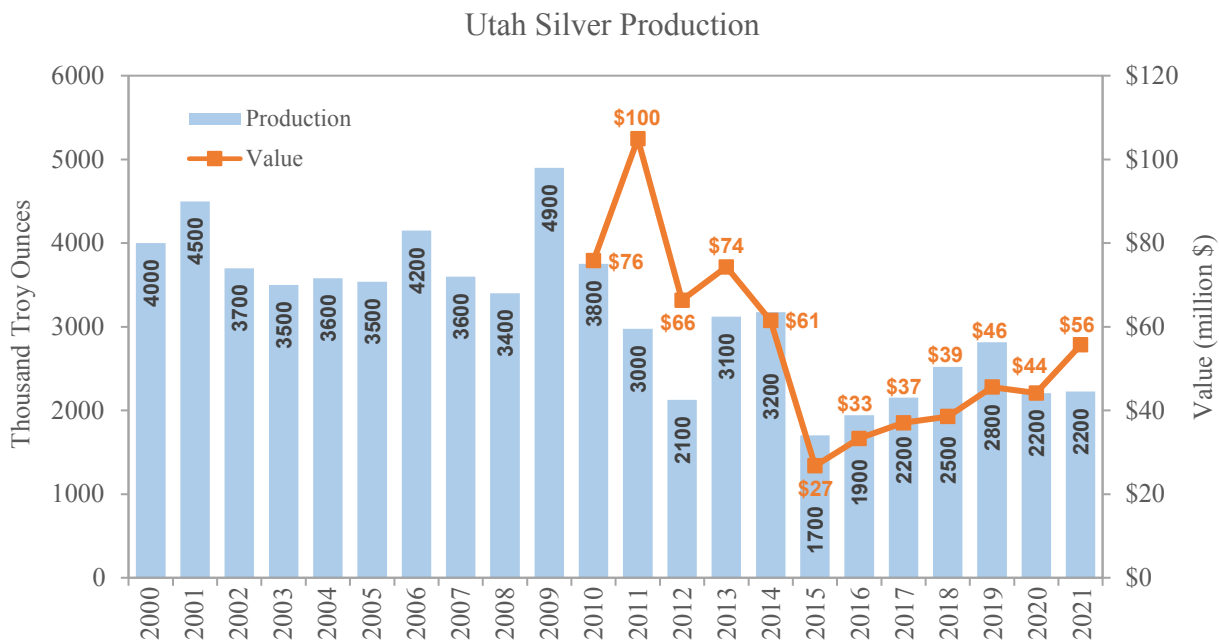
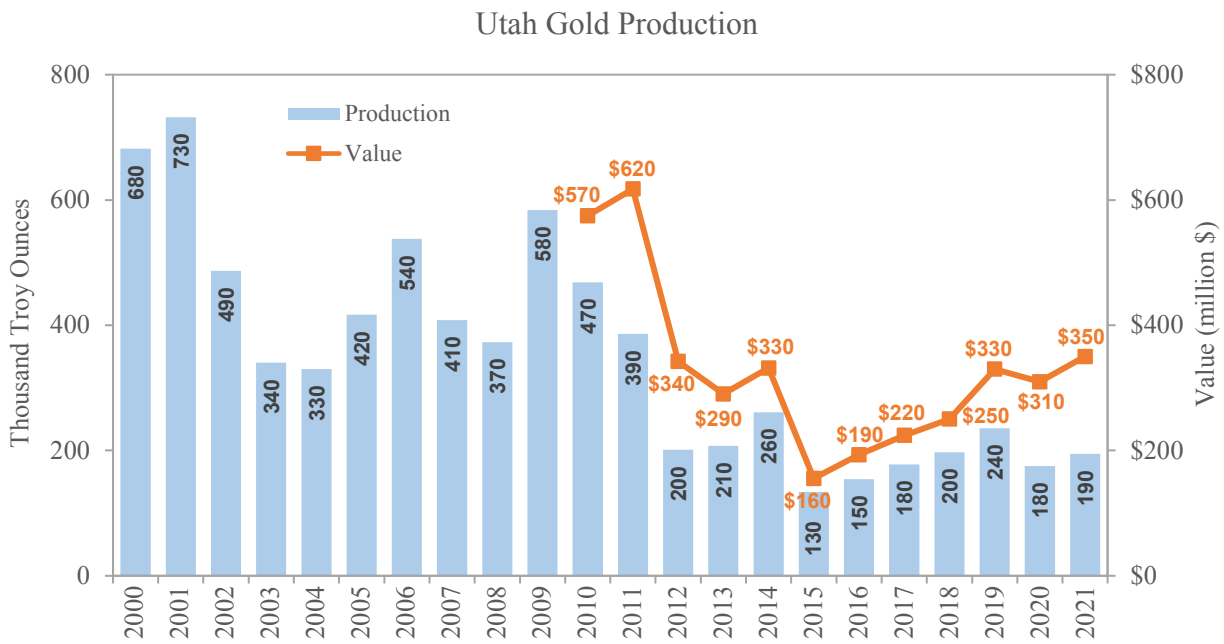


Figure 9. Continued.

refinery was down due to the 2020 Magna earthquake and maintenance delays. Bingham Canyon’s focus returned to copper in 2021, hence the decrease in molybdenum production. Molybdenum production in 2021 was still notably higher than pre-COVID-19 levels.

- Magnesium (metal): The price of magnesium metal had the second highest increase of any commodity from 2020 to 2021, increasing 57%. Production of magnesium metal by US Magnesium dropped by 25%, resulting in a net

mineral production value increase of 18% from 2020 to 2021. Magnesium metal is produced by electrolytic conversion of magnesium chloride concentrate, produced from Great Salt Lake brines through evaporation.

- Iron ore: Iron ore production increased substantially in 2021. Production from the Iron Mountain mine, the only iron mine in Utah, restarted at the end of 2020. Given that 2020 was not a full year of production and production also ramped up in 2021, there was a \$140

million production value increase between 2020 and 2021, reflecting more than an 18-fold increase in production and a relatively stable iron price. Iron production is expected to increase modestly in 2022 as Utah Iron, the company operating the Iron Mountain mine, hits target production levels, and price is expected to remain stable.

- **Beryllium:** Beryllium from the Spor Mountain mining district remained relatively stable both in terms of production and price, yielding only a slight increase (4%) in mineral production value from 2020 to 2021. Beryllium has been mined continuously from the Spor Mountain district since 1968 by Materion Resources, and proven and probable reserves indicate there is still 75 years of mine life remaining at current mining rates (Materion, 2021). Production and price for beryllium are expected to remain stable in 2022.
- **Silver:** Bingham Canyon was the only producer of silver in Utah in 2021, and production levels remained steady in comparison to 2020 with only a 1% increase (figure 9). However, the price of silver jumped by 21% in 2021, hence mineral production value increased by 23%. Silver production is expected to remain relatively stable, and the silver price is expected to remain strong given silver's dual role as a safe-haven investment and as a component in green energy technology (e.g., solar panels).

Utah Mining Updates for 2021

The Bingham Canyon mine accounted for 78% of Utah's total metalliferous mineral production value in 2021. Bingham Canyon produces copper, molybdenum, gold, and silver as well as byproducts such as platinum, palladium, lead carbonate, rhenium, and tellurium. It is outside the scope of this report to account for the mineral production value of any of Bingham's byproduct commodities.

Mining in Bingham Canyon shifted to the south wall in late 2020/early 2021 following the first phase of the south wall pushback, a \$900 million investment that extended mine life to 2026. A second \$1.5 billion phase was announced in 2020 and began in 2021, extending current mine life to 2032. The shift to mining on the south wall accesses higher ($\geq 0.5\%$ Cu) and less variable copper grades. Production of mined copper in 2021 was impacted by a slope failure in the open pit in May, though the failure was predicted by slope monitoring instrumentation and there were no injuries or equipment losses. In September 2021 an incident at the smelter caused an immediate shut down, though no injuries were reported and the smelter was safely restarted in October. Rio Tinto in July 2021 announced a \$108 million feasibility study into underground mining, due to be completed in 2024, and the construction of a \$2.9 million tellurium recovery plant. The tellurium recovery plant began a commissioning phase in late 2021 and began initial production in May 2022, with an expected annual capacity of 20 tons.

Bingham Canyon also received approval for a 30 MW solar power plant, the first 5 MWs expected to be completed by 2023 and the remainder by 2025 (Rio Tinto, 2022).

Other production updates for 2021 include:

- **Resumption of open-pit mining at Lisbon Valley:** Lisbon Valley Mining Company (LVMC) shut down mining activity at the Lisbon Valley mine in March 2020, causing release of their surety bond and loss of active mining permit. LVMC re-permitted and re-bonded the operation in late 2020 and resumed open-pit mining at the Centennial pit in January 2021. Ore is processed on-site through heap leach and solution-extraction electro-winning to produce copper cathode. LVMC continues to pursue the permitting necessary to begin in-situ recovery (ISR) mining at Lisbon Valley.
- **Production development at Trixie:** The Trixie underground gold mine restarted in late 2020 and has had strong performance through 2021 with the discovery of the ultra-high grade T2 gold structure (individual samples exceeding 10,000 g/t Au). In early 2022 it was announced that Osisko Development would acquire Tintic Consolidated Metals and provide financing for further mine development and exploration. The acquisition is expected to be completed mid-2022. Plans to develop a decline into the Trixie mine are moving forward, which would remove reliance on the ore elevator and allow for increased production.
- **Ramp up at Iron Mountain:** Open-pit mining of magnetite ore at the Iron Mountain mine increased substantially in 2021 after the operation re-started in late 2020. Near-mine exploration resulted in the Lucky Knolls target being incorporated into the mine permit and reserve base, and Iron Mountain continues to increase mining capacity to reach target production in 2022.

Exploration and Development

The information compiled in this section is from a variety of sources, including the UGS annual survey of mine operators, the UGS annual exploration survey, mining company websites, press releases, technical reports, personal communication with industry geologists, and the OGM website.

The global minerals exploration industry experienced a substantial increase in expenditure in 2021, increasing 35% from 2020 levels, and exploration budgets are expected to continue to increase modestly into 2022 (S&P Global, 2022). Many factors came together in 2021 to spur the dramatic upswing in exploration. High commodity prices were a strong contributor, as were loosened COVID-19 restrictions coupled with better preparedness for virus surges (such as the Delta and Omicron variants) that meant exploration generally continued with modified precautions, rather than coming to a complete standstill as in 2020.

Additional factors spurring the intense interest in exploration is the growing acknowledgment of the long-term need for mined materials, and the recognition that current mining operations are in many cases nowhere near enough to cover the demand for raw materials (e.g., Jowitt and McNulty, 2021). Exacerbating the projected supply deficit is the global shift towards carbon neutral economies that require higher levels of commodities already in wide production (e.g., copper) and commodities that have never been mined on a large scale in the United States (e.g., lithium). The need for raw materials to support a green energy transition has led to much stronger financing in minerals exploration than seen since the global commodity supercycle in 2011. However, a shift in attitude towards the desire to get all possible value out of existing assets, rather than beginning new mines, can be seen in the distribution of funding with respect to project stage. Grassroots exploration remains underfunded with respect to traditional levels, whereas near-mine exploration has the highest share of exploration expenditure. Accordingly, the majority of exploration spending globally is by major mining companies rather than juniors (S&P Global, 2022).

A final factor that has yet to be fully understood with respect to its effect on the global commodity market is the war in Ukraine. The war may drive additional support for minerals exploration, particularly in developed countries, due to a growing desire to have more domesticated supply chains and reduced reliance on fossil fuels from foreign sources. The trend towards domestication of resources has been gaining traction in recent years, for example with the revival of a federal critical mineral list (e.g., Fortier and others, 2018). However, the war in Ukraine serves as a stark example of the risk to many global supply chains during times of geopolitical conflict.

Utah Exploration in 2021

The UGS conducted a survey in early 2022 of active exploration companies in Utah regarding a number of topics related to 2021 exploration including expenditure, employment, and perception of Utah's geology and permitting. Of the 104 companies contacted, the UGS received 42 responses (40% response rate). Sixty-three percent of respondents explore for base and precious metal targets, 32% for industrial minerals, 5% for energy minerals, and 7% are unknown. Key findings from the survey include:

- Exploration expenditure increased from 2020 to 2021 for the majority of respondents, with a notable increase in the number of projects that had an exploration budget over \$1 million (figure 10).
- Exploration employment increased slightly in 2021; the number of companies employing 11 to 25 people in Utah experienced the most growth (figure 10).

- The majority of exploration companies are expecting to increase exploration expenditure in 2022 as compared to 2021, whereas the majority of companies are expecting employment to remain the same for 2022 (figure 10).
- The impact of COVID-19 was generally less significant than in 2020, though the majority of exploration companies in Utah still experienced moderate disruption in 2021 (figure 11).
- Utah's geology and access to public/state land are perceived as two of the most positive aspects to exploration in Utah, whereas state government support for exploration and the cost/time to permit had the most negative perception (though still far outweighed by positive perception). Access to private land/collaboration with local landowners and the cost/time to permit had the largest neutral responses (figure 12).

The Utah exploration survey indicates that exploration had a strong resurgence in Utah in 2021 compared to 2020, and that the strong exploration activity is expected to continue into 2022. No metric demonstrates the increase in exploration in Utah more than the total drilling footage for the state, which totaled 265,000 ft in 2021, nearly 10 times the footage drilled in 2020. This is due not only to increases in drilling at large projects like Goldstrike in Washington County, but also because the number of projects drilled increased. In 2020 five exploration projects in Utah conducted a drill campaign; in 2021 there were 14. The majority of drilling that took place in 2021 was reverse circulation (RC) drilling, but 17% of total drill footage was diamond core. Drilling is in progress at or planned for at least 11 projects in 2022.

Utah Exploration Highlights

The following section provides details on some of Utah's larger exploration programs during 2021. Information on additional exploration projects can be found in table 3 and on figure 13. The information, table, and figure presented here are not an exhaustive list of all exploration being conducted in Utah, rather they represent significant exploration progress from companies who have made their projects public.

- Deer Trail project, Piute County: Deer Trail is a carbonate replacement and deep porphyry project operated by MAG Silver. In 2021 a 12,880-ft Phase I diamond drilling program intersected multiple narrow, high-grade mineralized zones, including 6 ft at 38.2 g/t Au, 952 g/t Ag, 5.03% Pb, 4.2% Zn, and 0.3% Cu (including up to 2,340 g/t Ag) from 1445 ft depth. Mineralization intercepted in Phase I drilling is interpreted as structurally controlled feeder zones. Phase II drilling began in late 2021 with results pending.

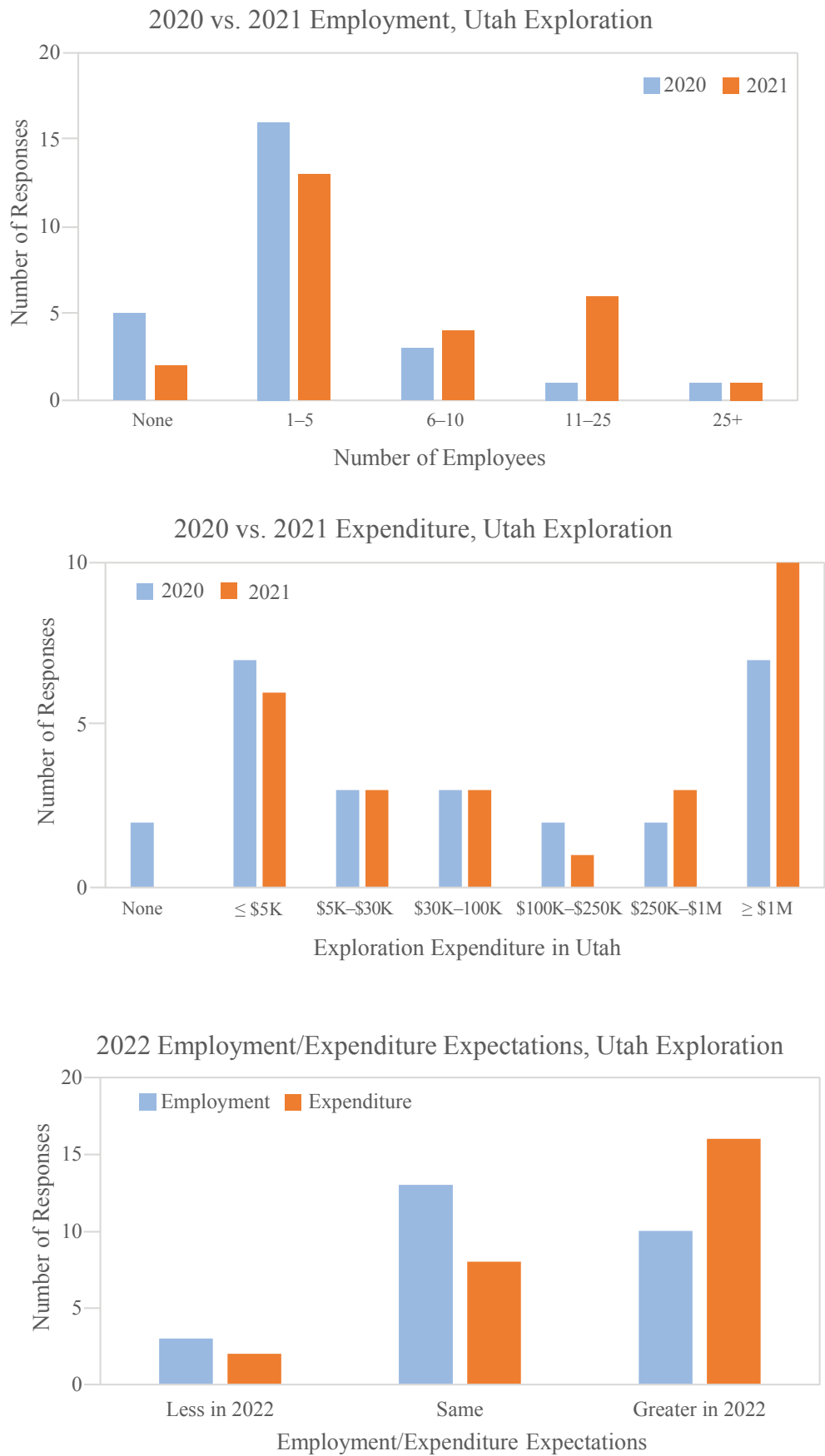


Figure 10. Summary of Utah exploration statistics. Data source: Utah Geological Survey industry survey.

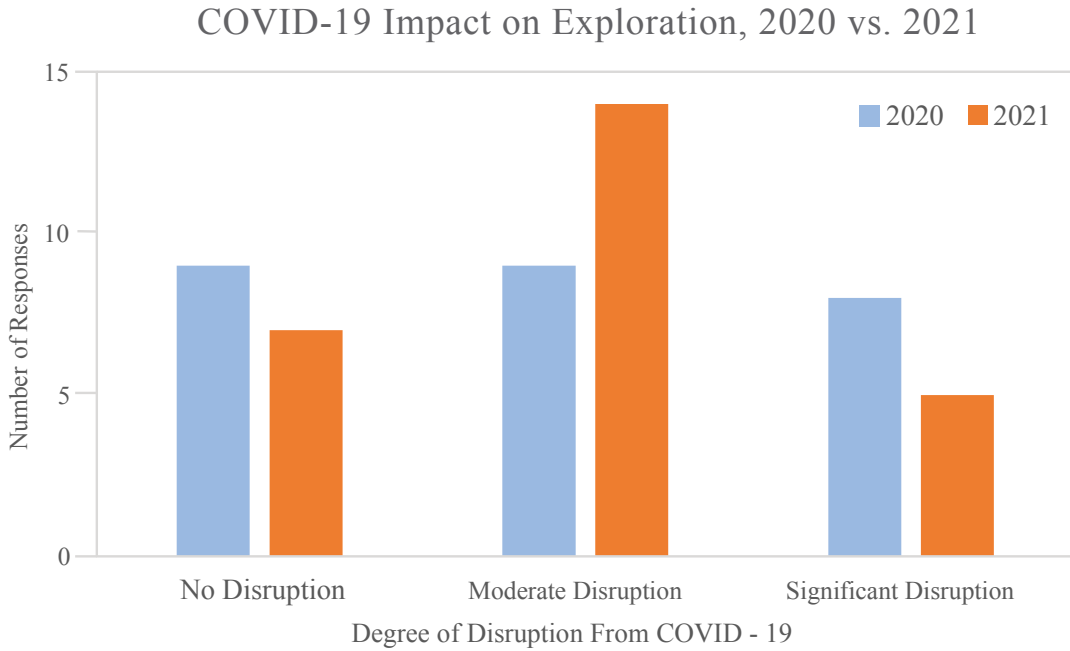


Figure 11. Impact of COVID-19 pandemic on exploration activities in Utah. Results are based on survey of active exploration companies.

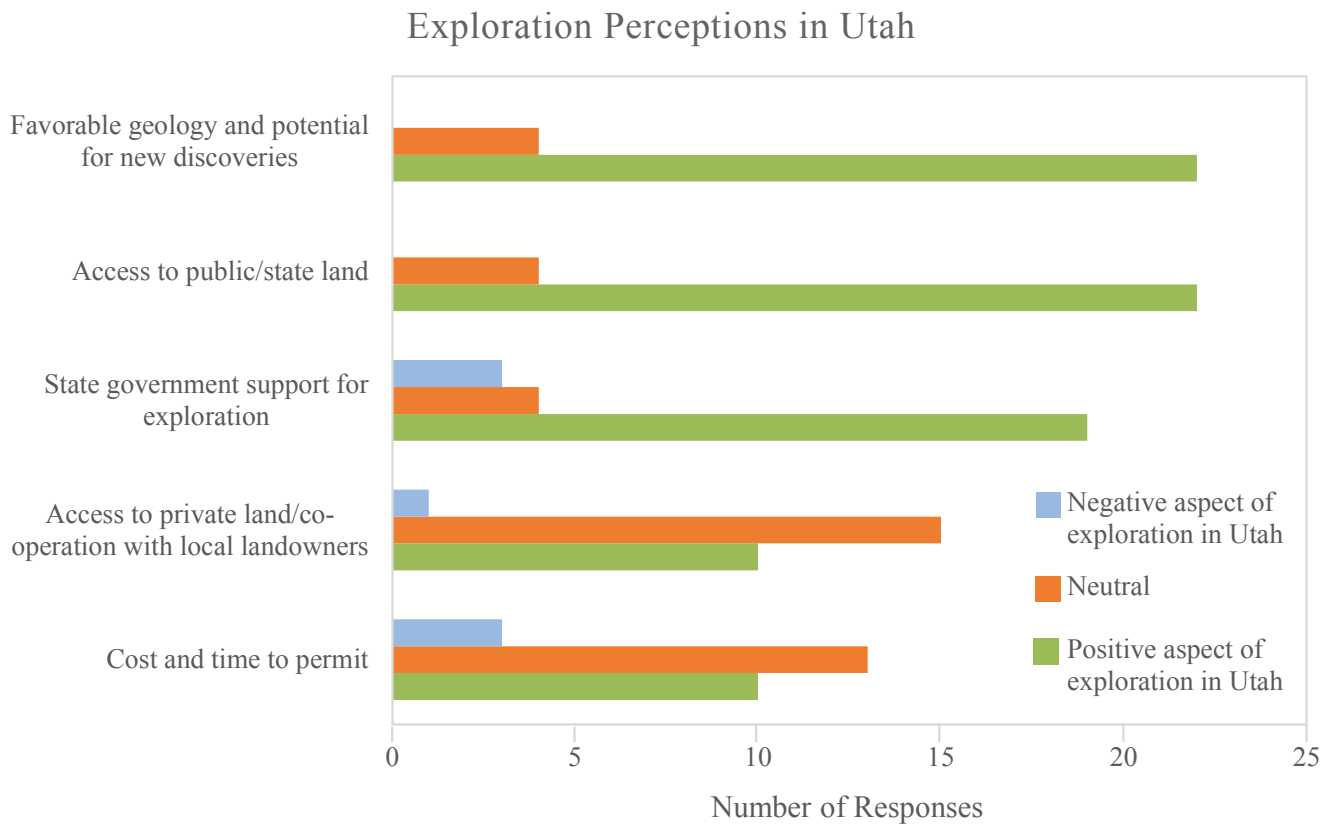


Figure 12. Perception of exploration factors in Utah. Data source: Utah Geological Survey industry survey.

Table 3. Select metal exploration and development projects in Utah, 2021. Districts are shown on figure 13.

Project	Company ¹	Mining District ²	Commodity	County	2021 Activity
Barton's Peak	Martinique Mining Corporation	Henry Mountains	Au	Garfield	Geochemical and electromagnetic survey targeting high-grade gold anomalies, drill program planning.
Bromide Basin	Prolific Mining Corp.	Henry Mountains	Au-Cu	Garfield	Historical data compilation and UAV-based studies.
Cerberus	Cerberus Venture LLC	West Tintic	Au	Juab	Geological reconnaissance, geochemical and alteration surveys, historical research.
Coyote	Gold Bull Resources Corp.	Desert Mountain	Ag-Au	Juab	Dropped March 2021.
Dal Cuinn	Dal Cuinn Exploration & Mining	South Uinta	Ag	Duchesne	Geochemical sampling and mapping; activity limited due to wildfires.
Deer Trail*	DT Mining LLC (MAG Silver Corp.)	Mount Baldy-Ohio	Cu-Au	Piute	Completed 12,900-ft Phase I diamond drill program and initiated Phase II drilling (in progress).
Detroit*	Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.)	Drum Mountains	Au-Cu-Mo	Juab	Added access to historic Drum Gold Mine to existing land position; began 10,000 ft drilling program (in progress).
Frisco	Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.) and Kennecott Exploration Company (Rio Tinto)	San Francisco	Cu-Au-Mo	Beaver	UAV magnetic and orthophoto survey.
Gold Springs*	Gold Springs Resources Corp. (TriMetals Mining Inc.)	Gold Springs	Au-Ag	Iron	Announced Resource Expansion Program and undertook 55,000-ft drill program, new intrusive system identified; began 3-stage resource expansion drilling (in progress).
Golden Dragon	Golden Dragon Capital LLC	Drum Mountains	Au	Millard	Geological reconnaissance and rock-chip sampling.
Goldstrike*	Liberty Gold Corp.	Goldstrike	Au	Washington	Completed 51,000-ft/108-hole RC drill program and progressed project de-risking; planned 83,000 ft RC/diamond drill program for 2022.
Iron Mountain	Utah Iron LLC	Iron Springs	Fe	Iron	Lucky Knoll exploration target identified as viable ore resource and incorporated into active mining permit.
Lisbon Valley*	Lisbon Valley Mining Company	Lisbon Valley	Cu	San Juan	RC drilling program increasing resource and reserve base at Lone Wolf target.
Mercur*	Ensign Minerals Inc. and Austral Gold Ltd.	West Dip, Mercur	Au	Tooele	Ensign and Austral together completed 65,000-ft drill program on West Dip and Mercur targets, plus geologic mapping and sampling; 82,000-ft drill program planned for 2022.

Table 3. Continued.

Project	Company ¹	Mining District ²	Commodity	County	2021 Activity
Stateline	Alianza Minerals Ltd., Cloudbreak Discovery PLC, Allied Copper Corp.	Lisbon Valley	Cu	San Juan	Project acquired by Alianza and Cloudbreak, optioned to Allied Copper.
Thompson Knolls*	BCM Resources Corp. and Inland Explorations Ltd.	Kings Canyon	Cu	Millard	5200-ft/3-hole diamond drilling program, UAV magnetics survey, AMT survey; began 10,000-ft drilling program (in progress).
Tintic	Tintic Consolidated Metals LLC and Osisko Development Corp.	East Tintic	Au-Cu	Juab/Utah	Continued underground drilling and expansion of Trixie gold mine resource, development and surface drilling of regional exploration targets; takeover by Osisko Development announced early 2022.
Tintic	Ivanhoe Electric (High Power Exploration Inc.)	Main Tintic	Polymetallic	Juab	Completed drill program, geologic mapping, geochemical sampling, and geophysical surveys.
Valley-Crossroads	Alderan Resources Ltd. (Volantis Resources Corp., Valyrian Resources Corp.)	Rocky/Beaver Lake	Cu-Au	Beaver	Three-hole drilling program at the Black Rock prospect targeting mineralized magnetite skarn; results yielded no significant mineralization.
West Desert*	InZinc Mining Ltd. and American West Metals Ltd.	Fish Springs	Zn-Cu-In	Juab	Project acquired from InZinc by American West; American West expanded land position, completed gravity survey, and began 25,000-ft drilling program (in progress).
Western Desert	Arizona Lithium Ltd. (Hawkstone Mining Ltd.)	Crater Island	Au-Cu	Box Elder	Project dropped and company rebrand to Arizona Lithium.
Yellow Cat	Anson Resources Ltd. (Blackstone Resources Inc.)	Thompson	V-U	Grand	Geochemical reconnaissance and follow-up sampling program yielding assays up to 10.3% U3O8 & 25.6% V2O5; shallow drilling and downhole logging planned for 2022. Project focus shifting from V to U.

¹Parentheses indicate alternative or previous company names.

²As defined in Krahulec (2018).

*More detail on these projects provided in the text.

- Detroit project, Juab/Millard Counties: Detroit is a distal-disseminated oxide gold project operated by Alderan Resources. Alderan negotiated access to the historic Drum Gold Mine open pits in 2021, further consolidating their land position in the district and gaining exploration access to important historical mineralization. Six holes of a 10,000-ft drill program were completed in 2021, and results to date include 20 ft of 2.9 g/t Au from 216 ft depth. Drilling will continue in 2022 with nine more holes planned.
- Gold Springs deposit, Iron County: Gold Springs is a gold project operated by Gold Springs Resources Corp. Exploration in 2021 focused on resource expansion and consisted of 55,000 ft of drilling on multiple targets including the Jumbo trend targets. A new intrusive-related gold system (Tremor target) was intersected north of the Jumbo trend and included 535 ft of 0.9 g/t Au from 355 ft depth and 80 ft of 6.0 g/t gold from 390 ft depth.
- Goldstrike deposit, Washington County: Goldstrike is a sediment-hosted oxide gold deposit with an indicated and inferred resource of 1.1 million troy oz Au at an average grade of 0.5 g/t operated by Liberty Gold Corp (SRK Consulting, 2018). In 2021 Liberty completed 51,000 ft of RC drilling across 108 holes, confirming mineralization continuity across the deposit Main Zone (including 195 ft at 0.9 g/t Au from 110 ft depth) and highlighting potential for higher gold

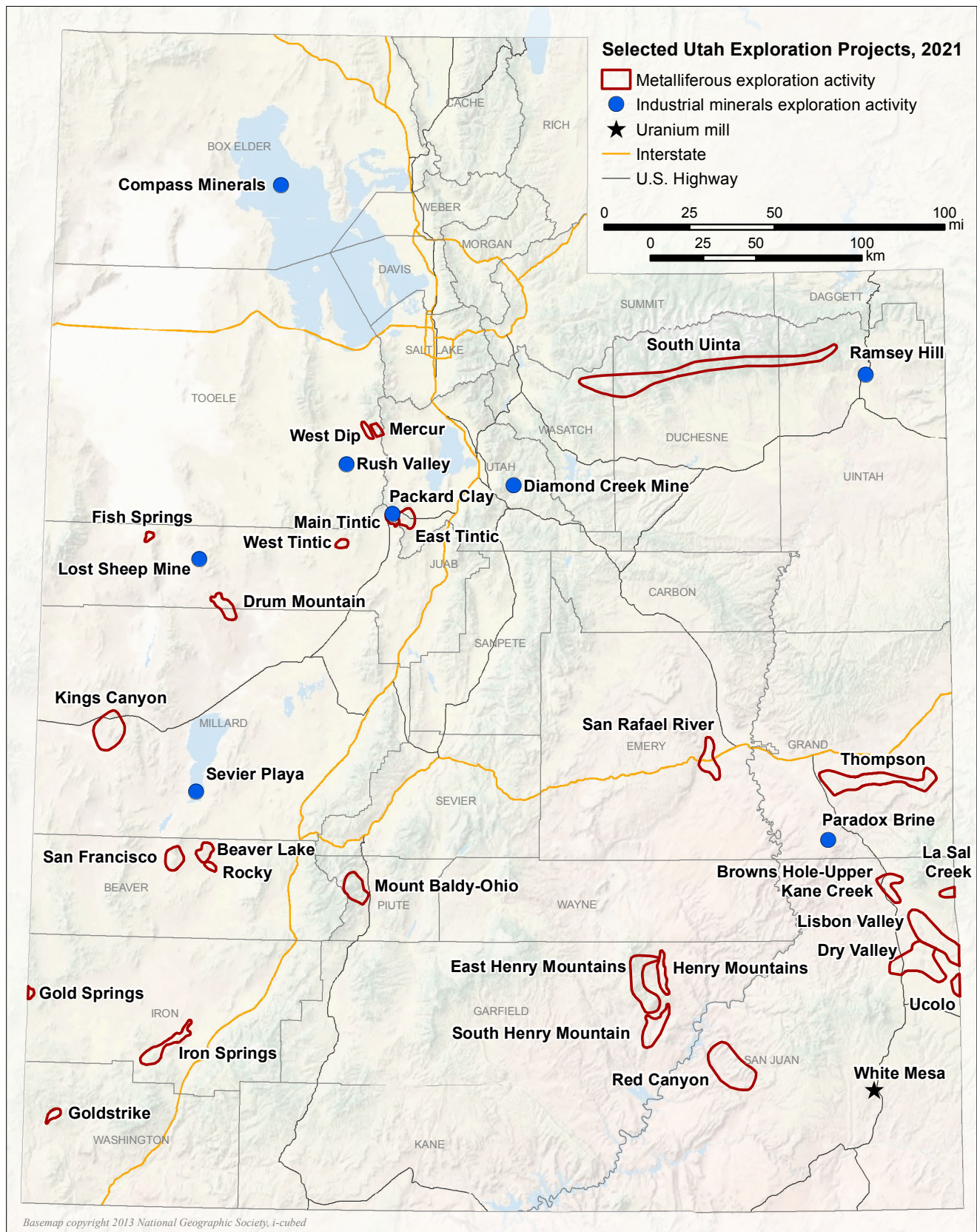


Figure 13. Select metal and industrial mineral exploration and development activity locations in Utah.

grades in the overall project area (including 20 ft at 7.5 g/t Au from 255 ft depth). Liberty has planned and initiated an 83,000-ft drill program in 2022 to prepare for a formal pre-feasibility study in 2023.

- **Lisbon Valley mine, San Juan County:** Lisbon Valley is a sediment-hosted copper mine operated by Lisbon Valley Mining Company. Exploration was focused on expanding the resource and reserve base of the Lone Wolf target, which has potential for both traditional open-pit mining and in-situ recovery. A large RC drilling program was completed at Lone Wolf, with intentions to continue brownfields exploration around Lone Wolf and other near-mine targets in 2022.
- **Mercur project, Tooele County:** The Mercur project (which includes the Mercur mine, the greater Mercur district, and the West Dip project) is a Carlin-type gold project operated by Ensign Minerals. A 65,000-ft drilling program that investigated multiple West Dip and Mercur targets was completed in 2021 and had multiple significant gold intercepts, such as 85 ft of 6 g/t Au including 20 ft of 24 g/t Au. A follow-up 45,000-ft drill program is planned for 2022.
- **Thompson Knolls project, Millard County:** Thompson Knolls is a porphyry copper target being explored by BCM Resources Corp. BCM completed three diamond holes in 2021 and intersected visual Cu skarn and Cu-Mo porphyry mineralization in the second hole (only the third hole drilled for the deposit overall). Final assay results are pending. UAV magnetic and audio magnetotelluric (AMT) surveys for further targeting were also completed. BCM has begun a 10,000-ft diamond drilling program for 2022.
- **West Desert deposit, Juab County:** West Desert is a copper-zinc-indium skarn resource. The project was acquired by American West Metals from InZinc Mining in 2021. American West expanded the project land position, completed a gravity survey, and began a 10,000-ft diamond drilling program in late 2021 to early 2022. Extensive visual copper and zinc mineralization has been intersected in the first two holes of the program. A second phase of drilling is anticipated to start mid-2022.

INDUSTRIAL MINERALS

Production

Industrial mineral production in Utah during 2021 had an estimated value of \$1.5 billion, which is an increase of 8.7% from the revised 2020 value (figure 3). The largest contributor was the sand and gravel, crushed stone, and dimension

stone commodity group. These products had a combined value of \$490 million in 2021 (a 16% increase from 2020) and accounted for 33% of the industrial mineral total. The second largest contributor was the brine- and evaporite-derived products group that includes potash, salt, and magnesium chloride. These products had a combined value of \$450 million, a 2% decrease from 2020, and accounted for 31% of Utah's total industrial mineral production value in 2021. 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 nearly \$280 million in 2021, a 3% increase from 2020, and accounted for 19% of the total industrial mineral value. Together, these three commodity groups contributed 83% of the total 2021 value of industrial minerals produced in Utah. The remaining value came from phosphate, uintaite, clay and shale, silica and industrial sand, lithium, and gypsum.

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 2021, approximately 47 million t of sand and gravel was produced in Utah, up 12% from revised 2020 estimates, and was worth \$370 million (U.S. Geological Survey, 2022c). About 16 million t of crushed stone worth \$120 million (U.S. Geological Survey, 2022c) represented a 10% production increase from revised 2020 estimates, and several thousand short tons of dimension stone was also produced. Prices for crushed stone and sand and gravel increased slightly from 2020 to 2021. Sand and gravel and crushed stone are used as construction aggregate in applications such as concrete aggregate, asphalt aggregate, and road base. A strong construction market in Utah, particularly in the residential sector, has kept construction aggregate demand relatively high for the past several years (figure 14).

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 potassium sulfate (or SOP) and potassium chloride (muriate of potash or MOP). Potash production in Utah totaled 440,000 t and was valued at approximately \$230 million in 2021 (figure 15). Compass Minerals 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 Penn-

sylvanian-age Paradox Formation (figure 2). Potassium sulfate has a significantly higher (+\$260 per ton in 2021) market value than potassium chloride. The primary use of both types of potash is fertilizer.

Utah salt production in 2021 amounted to about 3.3 million t and had a production value estimated at \$200 million (figure 15) (NOTE: some byproduct salt is not captured in our production estimate). About 78% of the salt was produced from Great Salt Lake brine by three operators: Compass Minerals, Cargill Salt, and Morton International (figure 2), in descending production order. The remaining production came from Redmond Minerals, Intrepid Potash-Moab, Intrepid Potash-Wendover, and Willow Creek Salt. Redmond Minerals operates an underground mine near the town of Redmond in Sanpete County (figure 2), producing salt from the Jurassic-age Arapien Shale. Willow Creek Salt also produced a small amount of salt 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 2021, magnesium chloride brine production in Utah increased to 830,000 t and had an estimated production value of about \$25 million. The magnesium chloride brine was produced by Intrepid Potash-Wendover and Compass Minerals; 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 3.1 million t of total materials was produced from Great Salt Lake brine in 2021, including salt, potash, magnesium chloride, and magnesium metal. Production in 2021 was slightly higher than in 2020. 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 2021 is \$540 million.

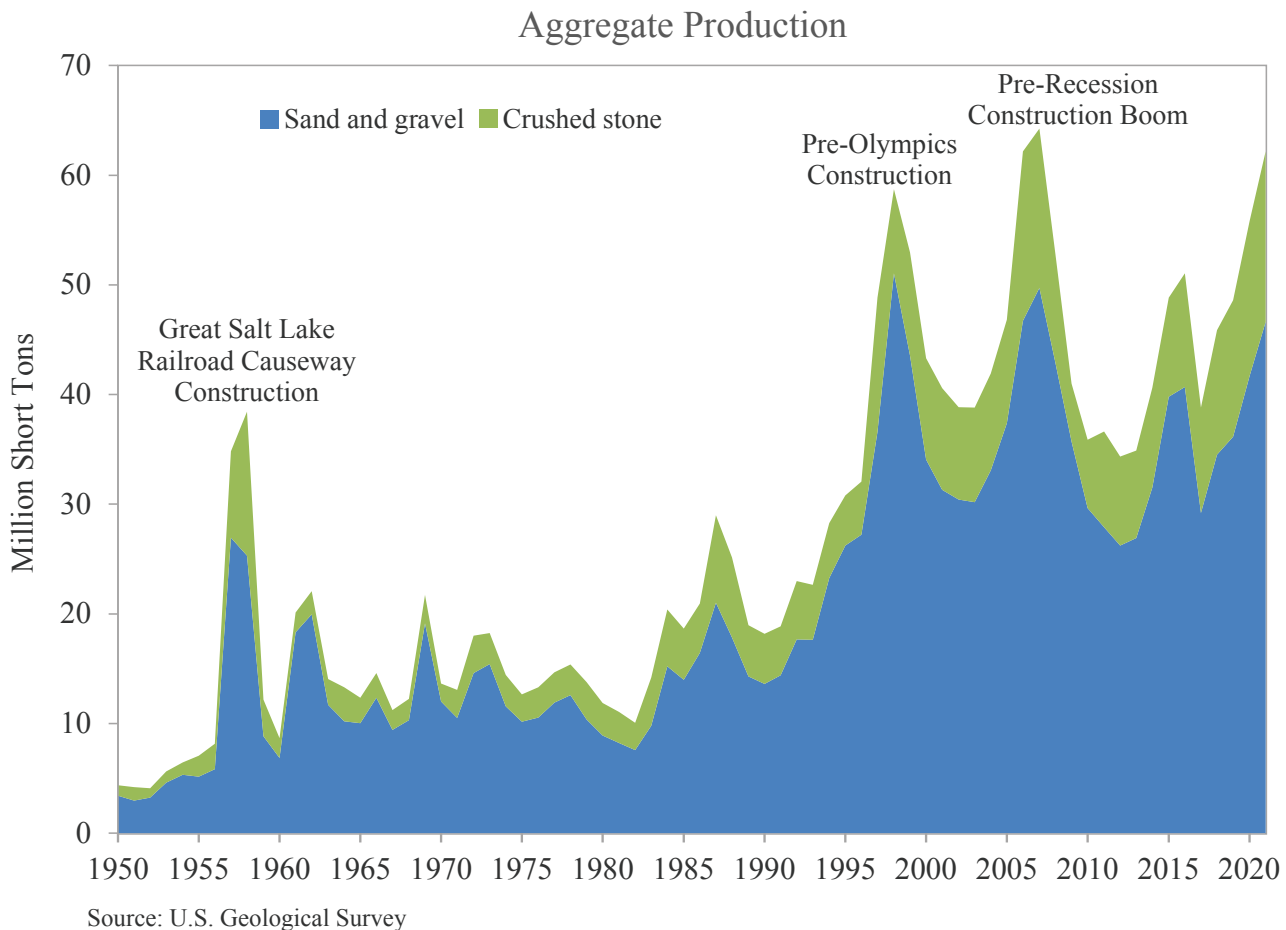


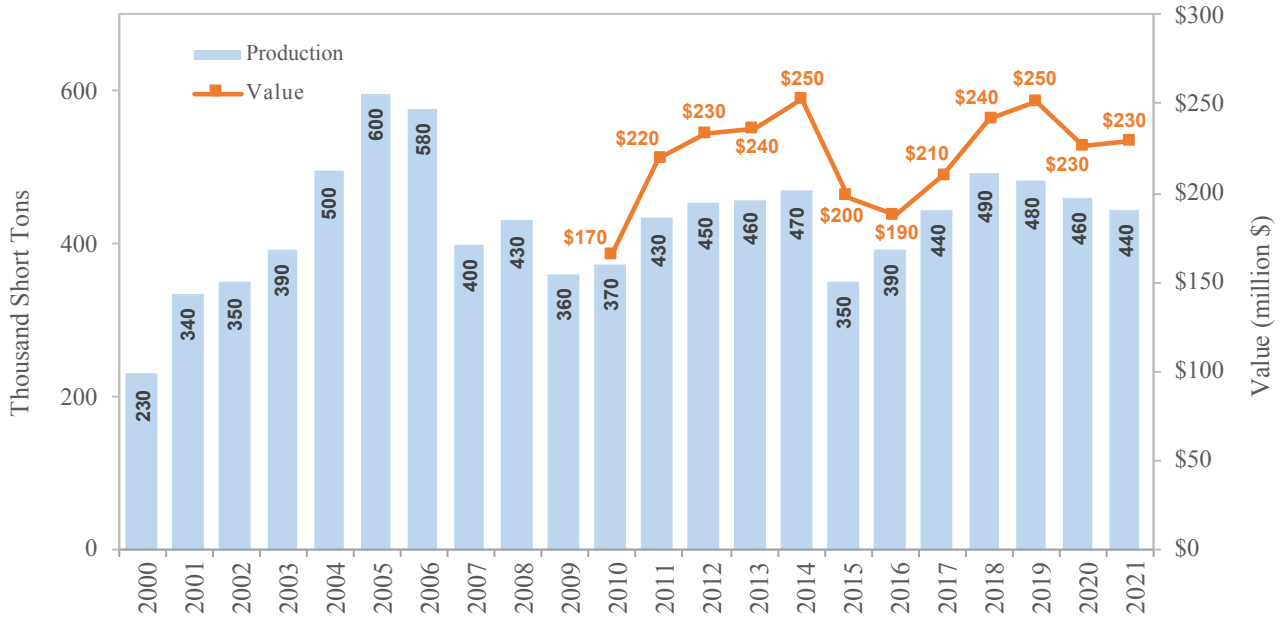
Figure 14. Utah aggregate production, 1950–2021. Values in nominal dollars. Data source: Utah Geological Survey.

Portland Cement, Pozzolan, Lime, and Limestone

Ash Grove Cement and LafargeHolcim together produced about 1.8 million t of portland cement in Utah during 2021, having an estimated value of \$210 million. Ash Grove Cement operates the Leamington quarry and plant east of Leamington in Juab County, and LafargeHolcim operates the Devils Slide quarry

and plant east of Morgan in Morgan County (figure 2). Portland cement production and value were roughly the same in 2020 and 2021. Besides mining limestone for portland cement, Ash Grove and LafargeHolcim also produce small amounts of sandstone, clay, and shale, which are lesser feedstock for their cement plants.

Utah Potash Production (MOP + SOP)



Utah Salt Production

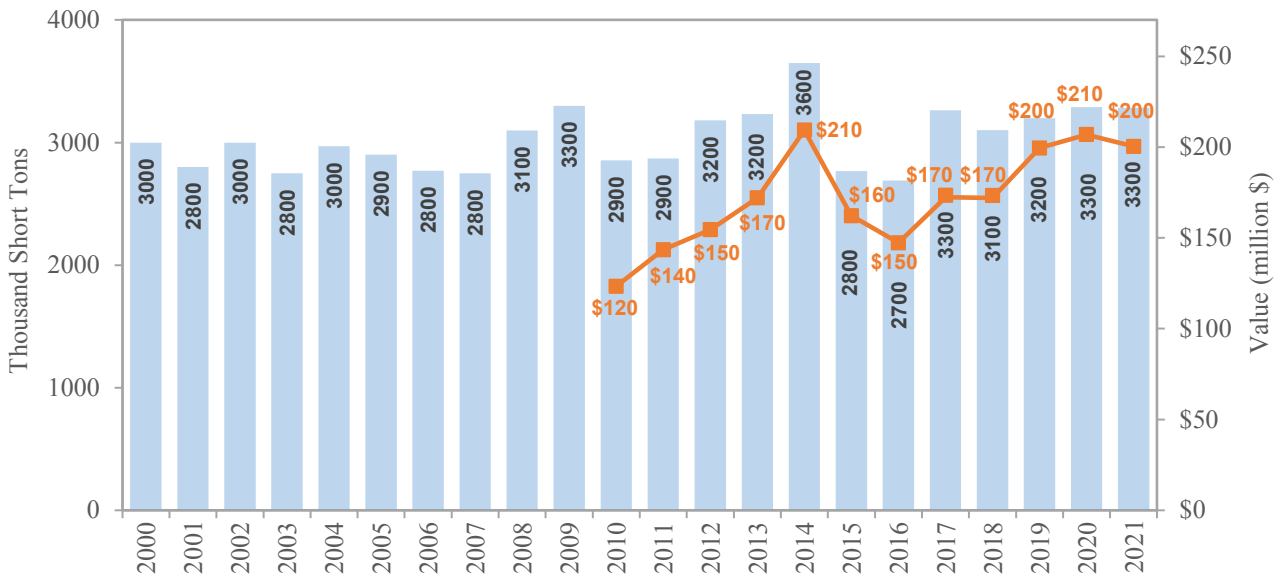


Figure 15. Production (since 2000) and value (since 2010) of potash (all types) and salt. Values in nominal dollars. Data source: Utah Geological Survey.

Pozzolan is a material, typically high in silica and alumina, that has cementitious properties and can be used as an additive to portland cement to extend and/or enhance the cement. The benefits of pozzolans over conventional cement production can include reductions in manufacturing cost and greenhouse gas emissions. Geofortis, after defining a resource, began pozzolan production at their mine in Rush Valley at Faust, Tooele County (figure 13). Their pozzolan resource consists of tephra (volcanic ash) in the Tertiary-age Salt Lake Formation. In 2021, they expanded an existing small mine permit with OGM from 5 to 20 acres and also completed a processing plant in Tooele.

During 2021, Graymont Western U.S. remained the sole producer of lime in Utah and production increased about 2.9%. Graymont produces high-calcium quicklime and dolomitic quicklime from their quarry and plant in the Cricket Mountains about 35 miles southwest of Delta in Millard County (figure 2). Lime is used for flue gas desulfurization, steel production, and a variety of other construction, chemical, and industrial applications.

In Utah, limestone is produced for specialty purposes and for crushed stone (or common construction aggregate that is tallied in the sand and gravel, crushed stone, and dimension stone commodity group). During 2021, several million tons of limestone were produced for specialty purposes and most of that production was used to manufacture the aforementioned cement and lime. However, 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-age Phosphoria Formation. Their phosphate operation is located 12 miles north of Vernal in Uintah County (figure 2). In 2021, the mine produced nearly 3.8 million t of ore. The ore yielded about 1.4 million t of phosphate concentrate (about 30% P_2O_5) after processing, which is an 18% increase over 2020. The concentrate is transported as a slurry through a 96-mile underground pipeline to the Simplot fertilizer plant near Rock Springs, Wyoming. More than 95% of the phosphate rock mined in the United States is used to manufacture phosphoric acids to make ammonium phosphate fertilizers and animal feed supplements (U.S. Geological Survey, 2022b).

In 2020, Falcon Isle Resources became the second phosphate producer in Utah. They received approval for a small mine permit from OGM and produced several thousand tons of organically certified phosphate in 2021 from their

Diamond Creek phosphate mine near Diamond Fork, Utah County (figure 13). The current plan is to initially extract a few thousand 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 t per year and Falcon Isle Resources reported a resource of about 3.9 million t of phosphate rock averaging 28% P_2O_5 . An older resource estimate for the area from 1980 indicated about 4.6 million t of surface mineable phosphate with additional potential tonnage in an underground resource. The area was previously mined in 1980 but did not produce again 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 2021, 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 t 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 t per year, depending on market conditions (specific production and price data are proprietary). 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 470,000 t in 2021. 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. 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). Bentonite was produced by Western Clay and Redmond Minerals in central Utah (Sanpete and Sevier Counties). Notably, Redmond Minerals acquired Western Clay in 2021. Uses for bentonite include well

drilling and foundry operations, various civil engineering applications, and as litter-box filler. 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 2000°F causing it to expand and vitrify. The resulting aggregate is durable, inert, uniform in size, and lightweight, having a density about one-half that of conventional aggregates. The material is used in roof tile, concrete block, structural concrete, and horticulture additives, as well as for highway construction and geotechnical fill. Roughly half of Utelite’s production is used locally along the Wasatch Front and the rest is shipped out of state. In 2021, LafargeHolcim acquired Utelite, and the operation will be part of their aggregates division.

Silica and Industrial Sand

Silica and industrial sand production in Utah during 2021 had an estimated value of about \$17 million. On Stansbury Island, Bolinder Resources mines quartzite from the Devonian-Mississippian-age 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-age mixed alluvial and eolian deposits (figure 13). 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-age 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 at least 770,000 t in 2021, a significant 40% increase from the 2020 reported production. The estimated value of 2021 gypsum production is \$8.3 million. The four Utah gypsum producers were Progressive Contracting, Inc., Diamond K Gypsum, United States Gypsum Co., and Sunroc Corp. (in descending production order). Utah gypsum is commonly used in raw or crude form by regional cement companies as an additive to retard the setting time of cement and by the agricul-

ture industry as a soil conditioner. Lesser amounts of higher value calcined gypsum are used to make wallboard by United States Gypsum, which operates a wallboard plant near Sigurd in Sevier County (figure 2). 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-age 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

Utah entered its second year of lithium production in 2021. US Magnesium considered producing lithium as a byproduct for many years (Tripp, 2002) and finally did so in 2020. Lithium is concentrated along with magnesium in US Magnesium’s solar evaporation ponds, and is separated from the magnesium as part of the magnesium refining process. US Magnesium has been stockpiling lithium from this process for many years. Their estimated capacity for lithium production is about 10,000 t of lithium carbonate per year and they hope to reach capacity by the end of 2022.

Exploration and Development

Significant exploration and development activities for industrial minerals in Utah have centered on lithium and fluorspar, but some activity exists in other commodities as well (table 4). 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 (Rupke and Boden, 2020). 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 2.6 million t of LCE in the waters of Great Salt Lake and contained in the interstitial brine of salts accumulated in their evaporation ponds (Havasi, 2021).

Compass is investigating direct lithium extraction (DLE) technology, which is a potential avenue towards economic extraction of lithium that overcomes problems with contaminants such as magnesium. Multiple DLE technologies exist, but DLE technology's widespread application to commercial production remains unproven. Compass is pursuing an annual production capacity of 22,000 to 28,000 t of LCE.

Anson Resources holds a large block of claims (their Paradox Brine project) near Moab in Grand County (figure 13) 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. Anson released a JORC-compliant resource estimate in 2020 that contains an indicated and inferred 210,000 t of lithium carbonate equivalent in brine (Anson Resources, 2020). This resource is found in multiple, deep subsurface horizons of the Paradox Formation, 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 t

(Anson Resources, 2020). In 2022, Anson plans to evaluate deeper brines by re-entering additional oil and gas wells to access Mississippian units (Leadville Limestone) in hopes of expanding their resource. Anson's lithium production would also rely on DLE technology.

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). One company, Global Battery Metals, is pursuing permits to drill and sample the subsurface brines of the Bonneville Salt Flats. Because of the high magnesium content of Utah's brines, DLE technology would likely be needed to exploit these other potential lithium brine deposits in Utah.

Fluorspar

During 2019, Ares Strategic Mining began acquisition of the Lost Sheep fluorspar mine in the Spor Mountain district in Juab County (figure 13) in anticipation of re-starting and expanding production. Historically, the Lost Sheep mine was the most productive fluorspar mine in Utah and has produced

Table 4. Select industrial mineral exploration and development projects in Utah, 2021.

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	Have mined several thousand tons of phosphate in 2020 and 2021 to be marketed as organic fertilizer
Lost Sheep mine	Fluorspar; breccia pipes	Spor Mountain district	Juab	Ares Strategic Mining	Completed geophysical surveys and geologic mapping in 2021; expanded land holdings to nearly 6000 acres; began construction of processing plant; released updated technical report
Paradox Brine	Lithium; brine	Paradox Basin	Grand	Anson Resources Ltd	Has a JORC resource estimate containing 210,000 tons of LCE; evaluating byproduct bromine, boron, and iodine; planning to evaluate deeper brines in Mississippian strata to expand their resource
Rush Valley	Pozzolan; volcanic ash	Rush Valley	Tooele	Geofortis	Producing pozzolan from a tephra deposit in the Salt Lake Formation; completed plant construction Tooele in 2021
Packard Clay	Halloysite	North Tintic mining district (NE of Eureka)	Juab	Ionic Minerals Technologies	Received a small mine permit for their Packard Clay halloysite project and drilled the deposit in 2022
US Magnesium Lithium	Lithium; Great Salt Lake brine	Great Salt Lake	Tooele	US Magnesium	US Magnesium began producing lithium carbonate in 2020 and continued production in 2021; working towards producing at full capacity (~10,000 tons per year)

about 170,000 t of fluor spar from a series of mineralized breccia pipes. The mine has an active small mine permit and OGM records indicate that the mine produced about 8000 t of ore from 1993 to 2007. Ares completed the acquisition of the mine in early 2020 and completed a drilling project to delineate the fluor spar resource. During the course of 2021, they completed geophysical surveys and geologic mapping and subsequently expanded their land holdings to over 6000 acres. Their total land holdings span much of the Spor Mountain area and contain multiple potential mining areas. In early 2022 they laid out an extensive drilling program to delineate their resources in coming years. A preliminary 10-year mine plan projects annual production of about 180,000 (short?) tons at 45% fluorite with an anticipated fluorite recovery of 90%. An updated NI 43-101 technical report for the property was completed in 2021 (Puritch and others, 2021), but the report did not include a resource estimate. The company also began construction of a processing plant in Delta, Utah. Fluorspar is considered a critical mineral and the United States is almost completely import reliant for the mineral, so if the Lost Sheep mine resumes significant production it would be the largest fluorspar producer in the United States.

Other Industrial Minerals

As previously noted, pozzolan is a material that has cementitious properties and can be used as an additive to portland cement to extend or enhance the cement. Interest in natural pozzolanic material has increased recently as availability of fly ash, a common manufactured pozzolan, has decreased. Multiple companies have been looking for potential natural pozzolan resources in Utah. Geofortis, an active pozzolan producer in Utah, reported on their website in late 2021 that they acquired 2200 acres on a pozzolan deposit in Sevier County to expand their pozzolan resource portfolio.

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. The project that was closest to development was a potassium sulfate project at Sevier Lake/Playa (figure 13). Crystal Peak Minerals had delineated a resource (Brebner and others, 2018) and received necessary permits and approvals for development, but were unable to raise sufficient capital to advance the project. Potash resource areas in Utah include the Paradox Basin, Great Salt Lake, the Bonneville Salt Flats, Sevier Lake, Blawn Mountain, and Pilot Valley (for additional details see Mills and Rupke, 2020). Exploration interest in potash may increase again due to the war in Ukraine because Russia and Belarus are major global suppliers of potash.

Ionic Mineral Technologies is delineating a halloysite deposit in the North Tintic mining district just west of Packard Peak and a few miles north of the Dragon mine, an existing halloysite producer. The company received a small mining permit for the area in 2021 and, in the first half of 2022, they completed a drilling project to define the halloysite resource in the area.

URANIUM

The price of uranium has been increasing since mid-2020, and hit the highest spot price in a decade in early 2022. The uranium price has been influenced by multiple factors, such as intentional production cuts by major producers, the reluctance of utilities to commit to long-term purchasing contracts, investors purchasing large quantities of physical uranium stockpiles, and lack of certainty about the uptake of nuclear power in the carbon neutral energy transition both at the investor and governmental levels (Mills and Jordan, 2021). The war in Ukraine has seen investors and policy-makers re-evaluating the potential of nuclear energy in the face of high fossil fuel prices. It is unclear how these factors will continue to play out in 2022 or how the price of uranium will affect production decisions by current and potential mining operations.

Production

No uranium was mined in Utah in 2021. Active uranium mining in the state has been suspended since 2012, despite several established resources (table 5) and existing mining permits (figure 16). 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 2021 because the mill has recently begun expanding its capabilities to produce rare earth carbonate from monazite sands imported from Georgia; however, the mill is capable of recovering both uranium and vanadium and plans to begin to recover uranium again alongside the new rare earth capabilities in 2022.

It is unclear if any active uranium mining will recommence in Utah in 2022, though recent strength in the uranium price and the proximity of the White Mesa Mill to the majority of Utah uranium projects means the economic outlook for uranium mining is improving.

Exploration and Development

Exploration activity for uranium in Utah increased in 2022 (table 5), though the majority of activity was related to companies acquiring projects or land positions. Very little grassroots exploration took place and there is a clear preference to acquire projects with some level of known resource potential.

The only project with significant exploration activity (versus acquisitions, land position expansion, and/or permitting) was GTI Resources' Henry Mountains project located in the Henry Mountains mining district (figure 16). GTI completed 96 shallow (generally less than 100 ft) holes across two drill programs and conducted downhole logging of another 32 historical holes on the Section 36 target. They also carried out field reconnaissance to locate and map out historic drill holes, mine workings, and outcrops on the Section 2 and Rat's Nest targets to confirm mineralization continuity. Further drilling is planned for 2022.

Table 5. Select uranium projects in Utah, 2021. District locations are shown on figure 16.

Property	District ¹	County	Company	2021 Activity	Known Resource ²
Cottonwood	East Henry Mountains	Garfield	Nortec Minerals Corp.	Received final assays from 2020 sampling including 1% V and 0.7% U.	
Daneros	Red Canyon	San Juan	Energy Fuels, Inc., Consolidated Uranium Inc.	Acquired by Consolidated Uranium from Energy Fuels.	30,000 tons at 0.36% U3O8 (190,000 lbs U3O8) indicated and inferred
East Canyon	Dry Valley	San Juan	TNT Mines Ltd. (Vanacorp USA LLC, Red Dirt Metals) and Uvre Ltd.	TNT expanded land position by 31 claims and permitted initial drill program, then rebranded to Red Dirt and sold project to Uvre Ltd.	
Energy Sands	San Rafael River	Emery	Pegasus Resources Inc.	Project acquired.	
Henry Mountains	Henry Mountains	Garfield	GTI Resources Ltd. (Voyager Energy Pty Ltd.)	Completed initial 56 hole program and follow up 40 hole program, including 4.5 ft at 0.143% U3O8 equivalent, plus downhole logging 32 historical holes.	
Henry Mountains Complex (Tony M, Southwest, Copper Bench, Indian Bench)	South Henry Mountains	Garfield	Energy Fuels, Inc., Consolidated Uranium Inc.	Tony M acquired by Consolidated Uranium from Energy Fuels.	4,020,000 tons at 0.26% U3O8 (20,880,000 lbs U3O8) indicated and inferred
Rattler	Browns Holes-Upper Kane Creek	San Juan	Okapi Resources Ltd.	Acquired project, preliminary mapping and sampling with initial drilling planned for 2022.	
Sage Plain	Ucolo	San Juan	Energy Fuels, Inc., Consolidated Uranium Inc.	Acquired by Consolidated Uranium from Energy Fuels.	490,000 tons at 0.17% U3O8 (1,650,000 lbs U3O8) and 1.4% V2O5 (13,540,000 lbs V2O5) measured, indicated, and inferred
Vanadium King	Thompson	Grand	Thor Mining Plc (American Vanadium Pty Ltd, Cisco Minerals Inc.)	Completed permitting, initial drilling planned for 2022.	
Wray Mesa	La Sal Creek	San Juan	Basin Uranium Corp.	Initiated project acquisition, initial drilling planned for 2022.	

¹As defined in Krahulec (2018)

²Mills and Jordan (2021)

COAL

Production and Distribution

Five Utah coal operators produced 12.5 million st of coal valued at \$430 million from five underground mines and one surface mine in 2021, the lowest production total since 1984 (figures 17, 18, and 19; table 6). Production in 2021 decreased by 6% compared with 2020 due to reduced production at Wolverine Fuels' Sufco and Skyline mines related to difficult mining conditions, slight production decreases at Gentry Mountain as the mine changed ownership, and production declines at the Coal Hollow surface mine. In contrast, the Emery mine more than doubled production in 2021, and the Lila Canyon mine

also increased production. After several years of decline, employment at active or recently active mines has stabilized in the 1300 employee range, totaling 1336 employees in 2021—a 13% increase from a low of 1185 employees in 2016—and slightly lower than the 1345 employees logged in 2020 (figure 17). Employment is expected to increase slightly in 2022 due to a projected increase in coal demand and production.

Demand at Utah coal-fired power plants was relatively 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 decreasing to only 10.5 million st in 2020 due to COVID-related drops in electricity demand (figure 20). Utah power plant consumption rebounded significantly in 2021, to 11.9

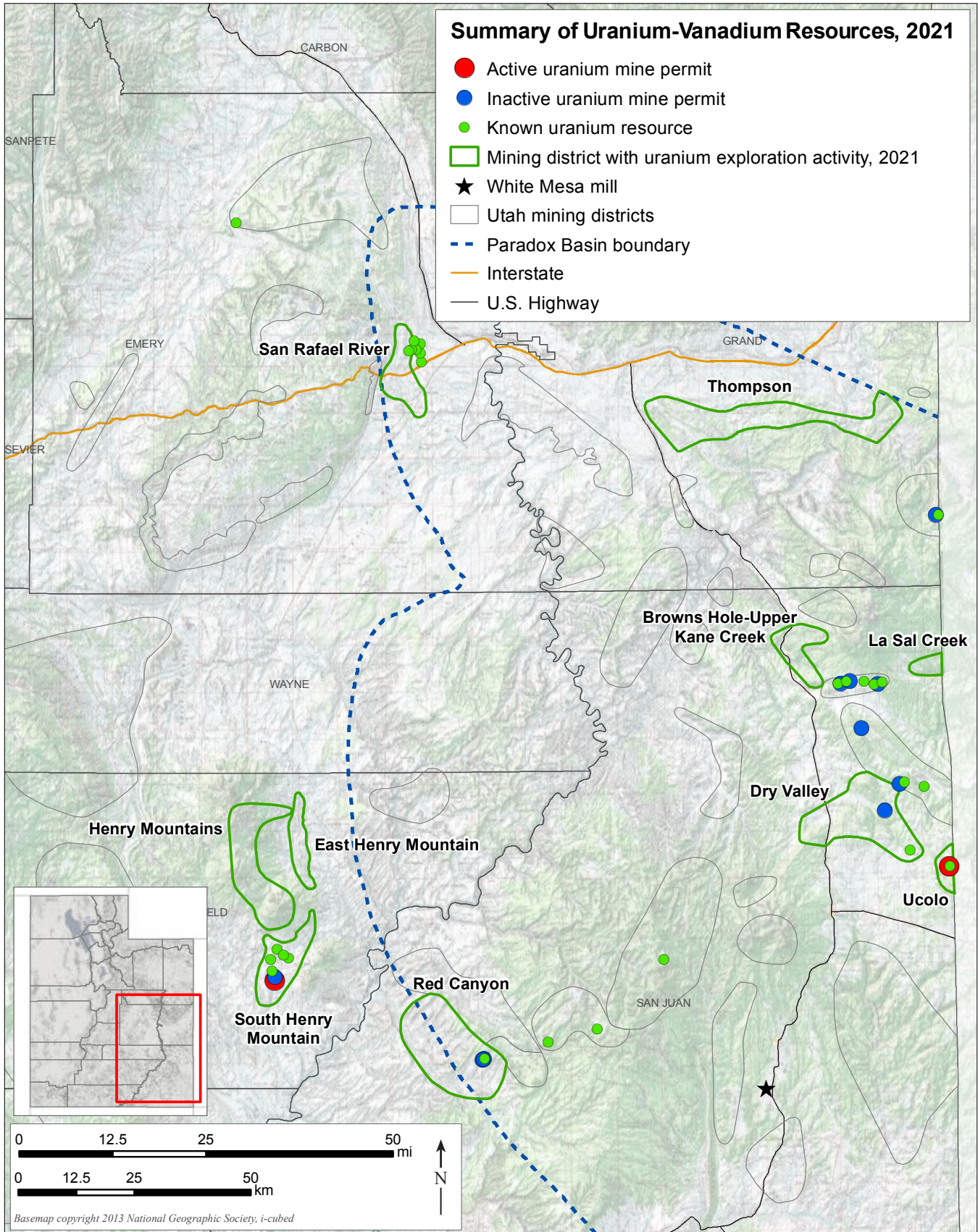


Figure 16. Location of uranium mine permits, resources, and exploration.

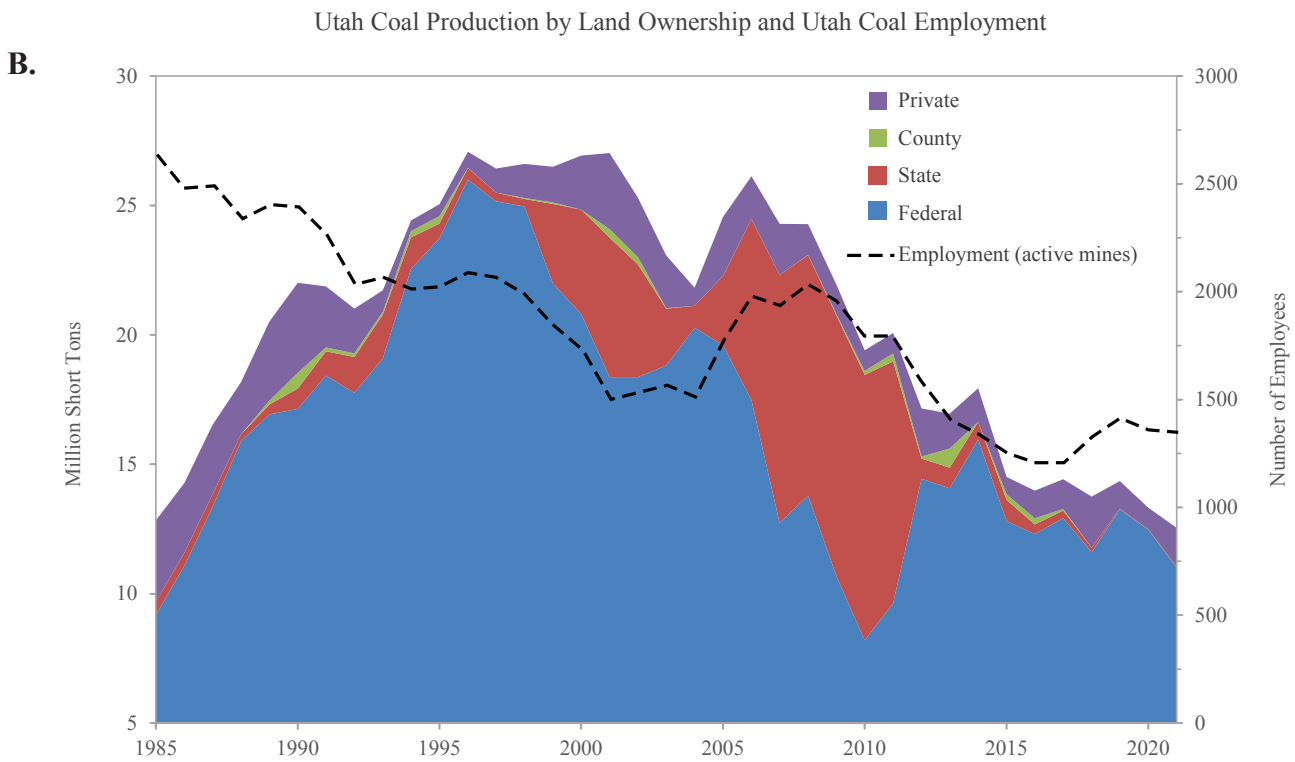
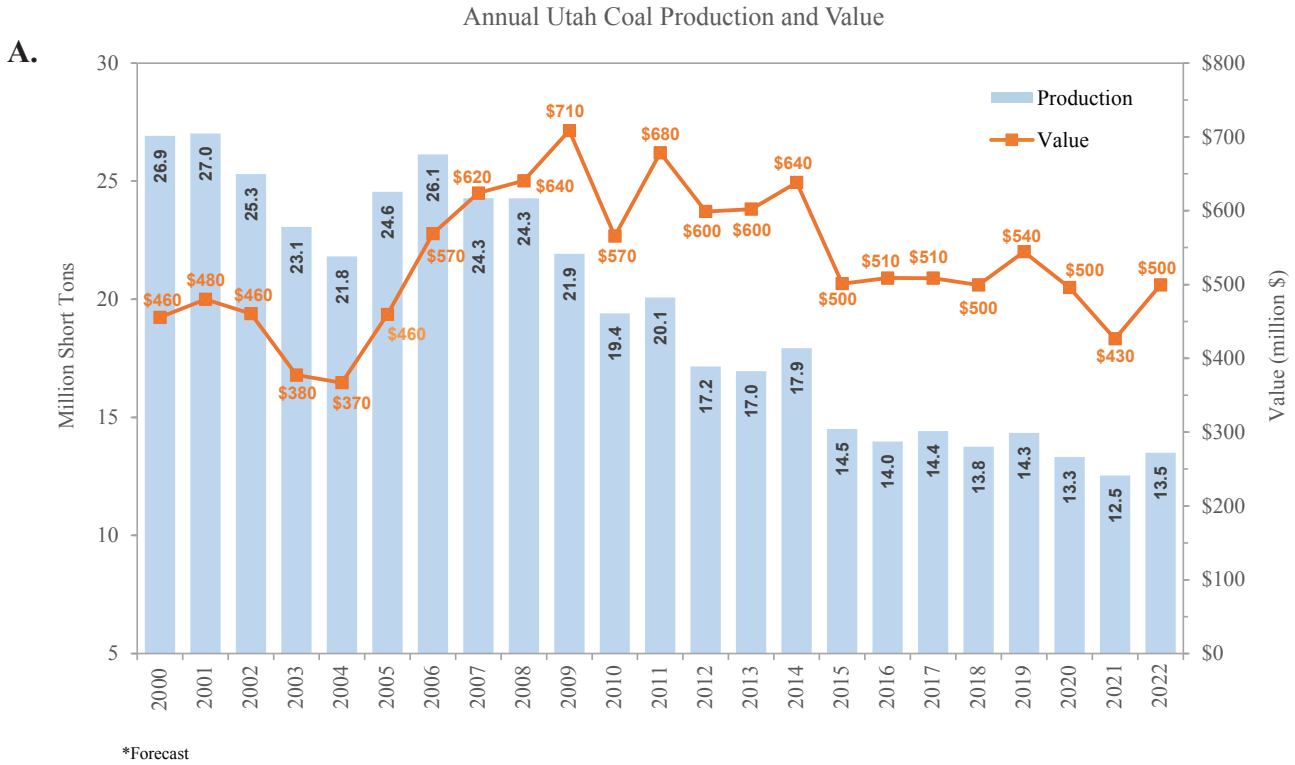


Figure 17. (A) Annual Utah coal production and value in nominal dollars, 2000–2022. Data source: Utah Geological Survey and U.S. Energy Information Administration. **(B)** Utah coal production by land ownership and Utah coal-related employment (jobs at active or recently active mines), 1985–2021. Data source: Utah Geological Survey and Mine Safety and Health Administration. **(C)** Coal production in Utah by county, 1985–2021. Data source: Utah Geological Survey.

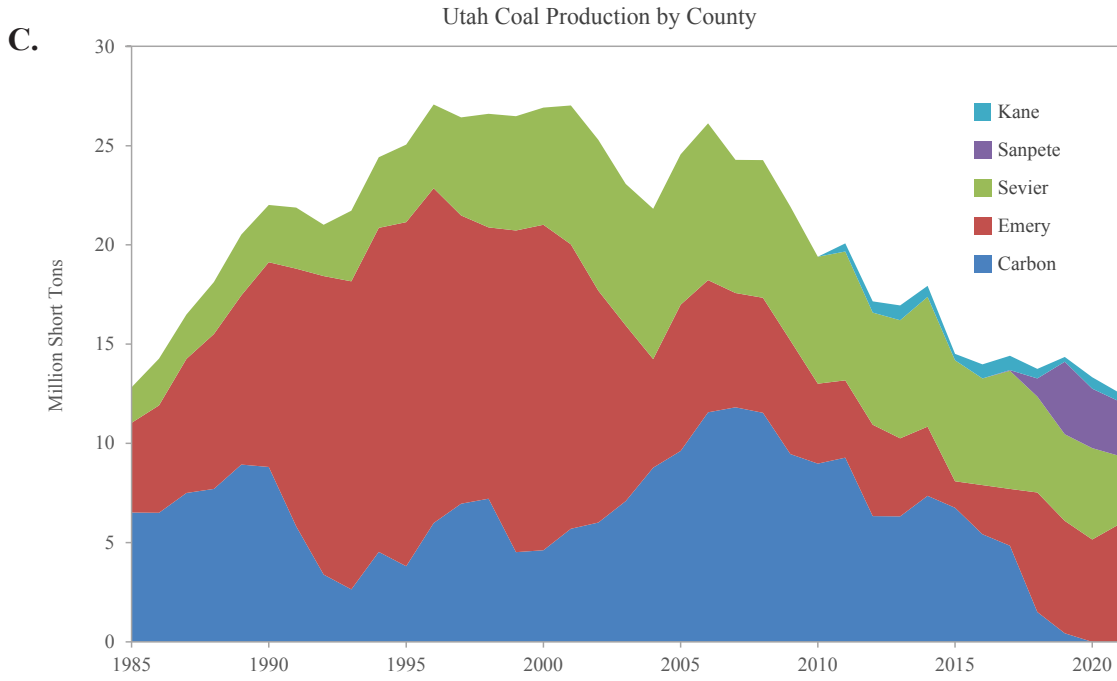


Figure 17. Continued.

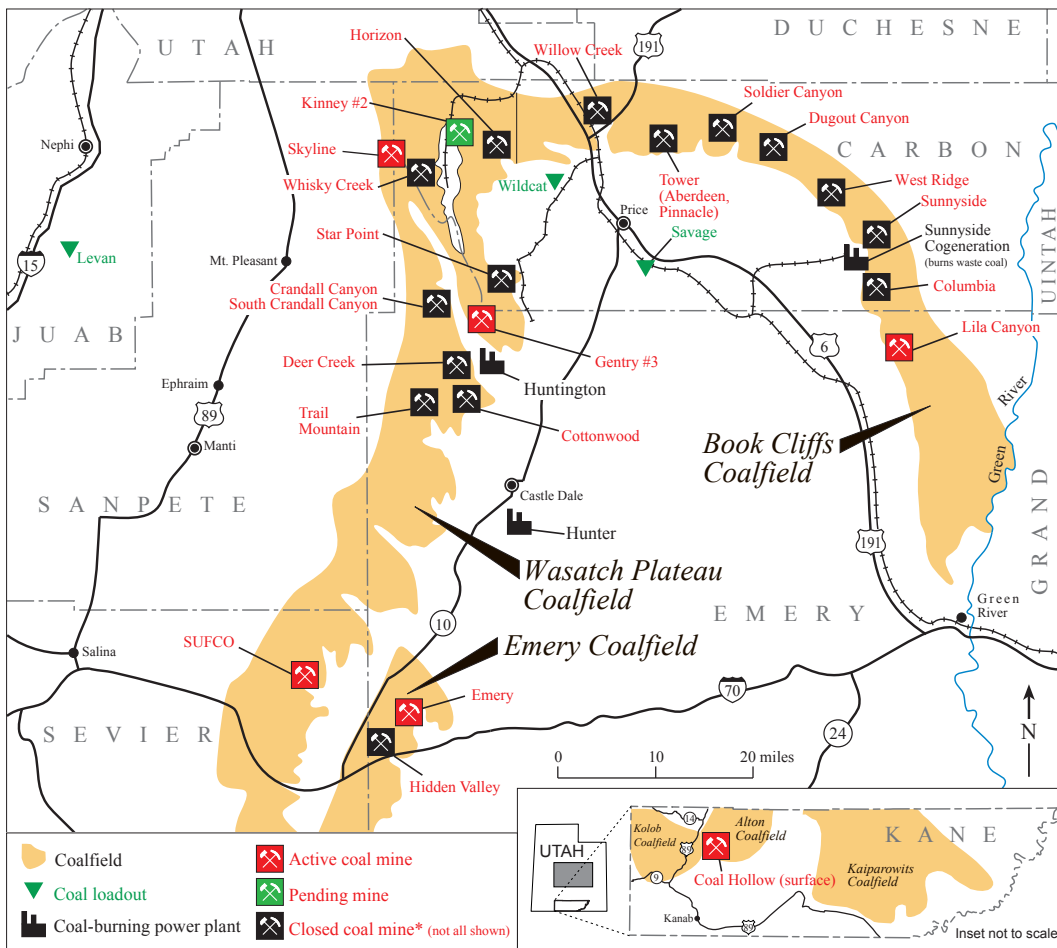


Figure 18. Location and status (at time of publication) of Utah coal mines and associated facilities.

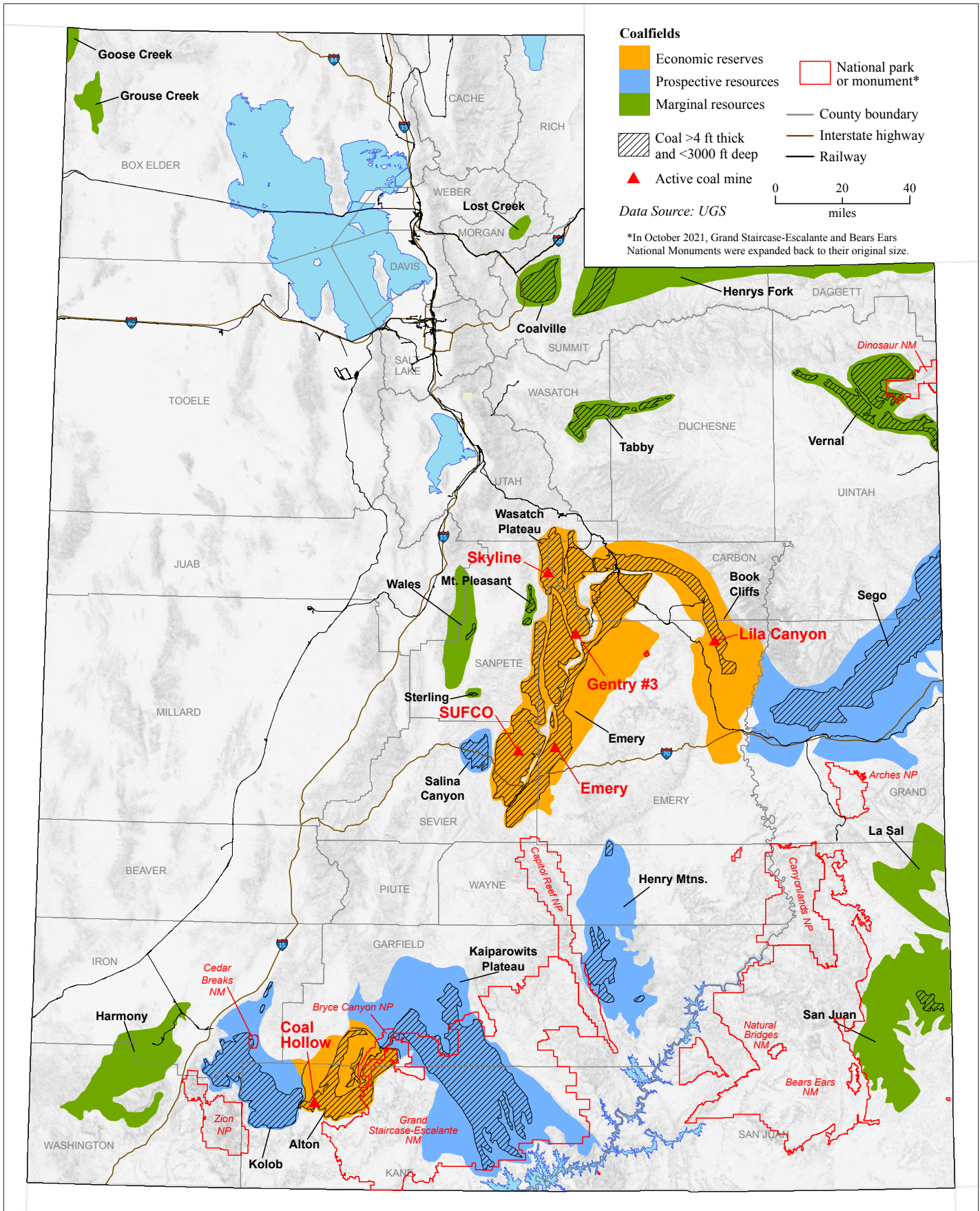


Figure 19. Location of active Utah coal mines and coalfields.

Table 6. Coal production in Utah by coal mine, 2010–2022.

Company	Mine ¹	County	Coalfield	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022*
thousand short tons																
Canyon Fuel Company, LLC - Wolverine Fuels, LLC ²	Dugout Canyon	Carbon	Book Cliffs	2,307	2,395	1,588	561	676	763	650	626	557	430	--	--	--
	Skyline #3	Carbon/ Sanpete/ Emery ³	Wasatch Plateau	3,050	2,950	1,954	3,135	4,170	4,409	4,767	4,389	3,614	3,896	3,713	3,530	3,800
	SUFCO	Sevier	Wasatch Plateau	6,398	6,498	5,651	5,959	6,539	6,095	5,375	5,947	4,842	4,374	4,601	3,425	3,700
Bronco Utah Operations, LLC ⁴	Emery	Emery	Emery	999	--	--	4	--	--	--	135	442	694	474	1,171	1,600
Gentry Mountain Mining, LLC - COP Coal Development Co. ⁵	Gentry #3	Emery	Wasatch Plateau	--	--	--	--	--	218	170	205	102	562	660	511	700
	Gentry #4	Emery	Wasatch Plateau	--	592	1,004	875	1,061	757	724	754	893	488	11	--	--
East Mountain Energy - PacifiCorp	Deer Creek	Emery	Wasatch Plateau	2,954	3,143	3,295	2,785	2,083	15	--	--	--	--	--	--	--
Hidden Splendor Resources, Inc. - America West Resources, Inc.	Horizon	Carbon	Wasatch Plateau	270	370	210	--	--	--	--	--	--	--	--	--	--
Utah Land Resources, Inc. - ACNR Holdings, Inc. ⁶	West Ridge	Carbon	Book Cliffs	3,355	3,566	2,579	2,629	2,514	1,580	--	--	--	--	--	--	--
Emery County Coal Resources - ACNR Holdings, Inc. ⁶	Lila Canyon	Emery	Book Cliffs	72	157	304	257	335	350	1,587	1,638	2,816	3,664	3,296	3,471	3,200
Alton Coal Development, LLC	Coal Hollow	Kane	Alton	--	403	570	747	555	316	671	724	488	240	569	434	500
	Burton #1	Kane	Alton	--	--	--	--	--	11	34	--	--	--	--	--	--
Total				19,405	20,074	17,155	16,953	17,933	14,513	13,978	14,417	13,753	14,347	13,325	12,542	13,500

Source: UGS coal company questionnaire

*Forecast

¹All mines are underground except Coal Hollow, which is a surface mine.²Bowie Resources bought Canyon Fuel from Arch Coal in summer 2013. In late 2018, Bowie changed their name to Wolverine Fuels.³2021 production by county: Sanpete = 2,750,773 tons; Emery = 778,989 tons. 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. 2010-2016: all production in Carbon County.⁴Bronco bought the Emery mine from CONSOL Energy in 2015.⁵COP bought the Castle Valley mines when Rhino went into bankruptcy 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.⁶ACNR Holdings, Inc. was previously Murray Energy.

Consumption of Coal at Utah Power Plants

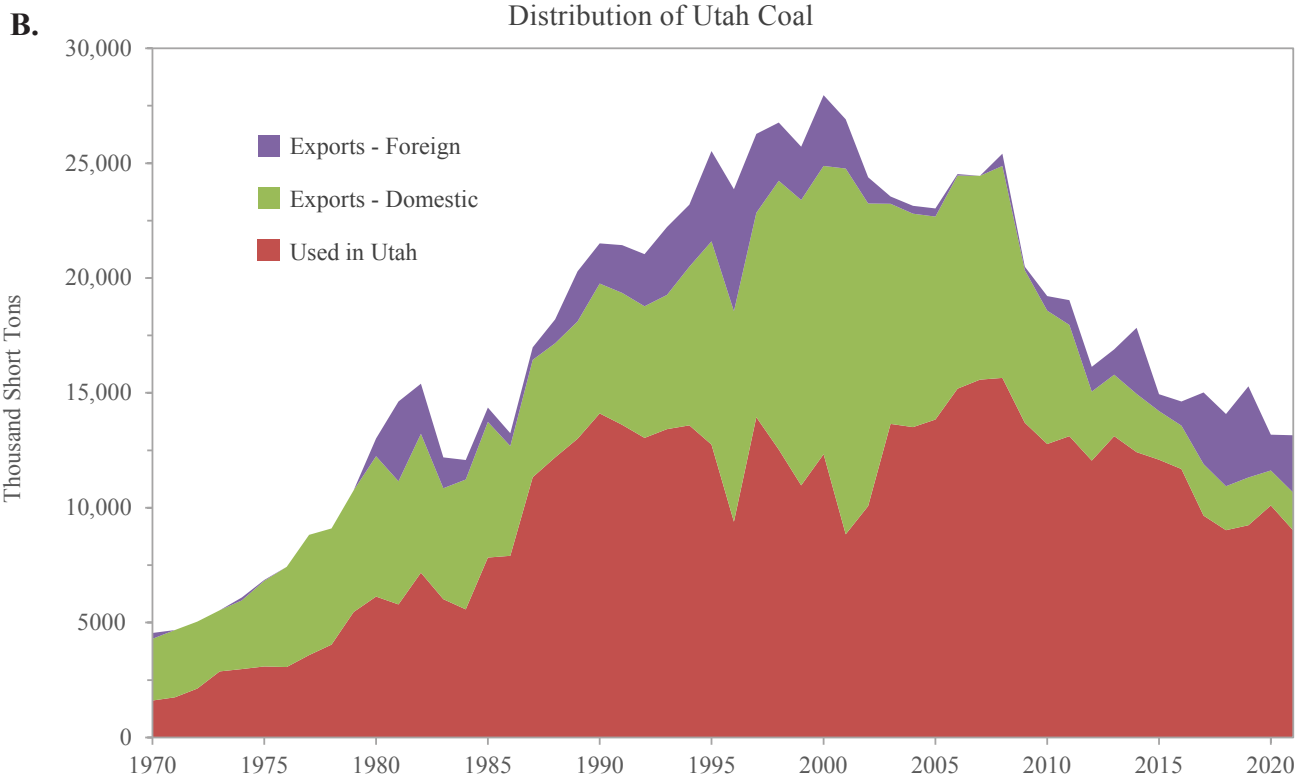
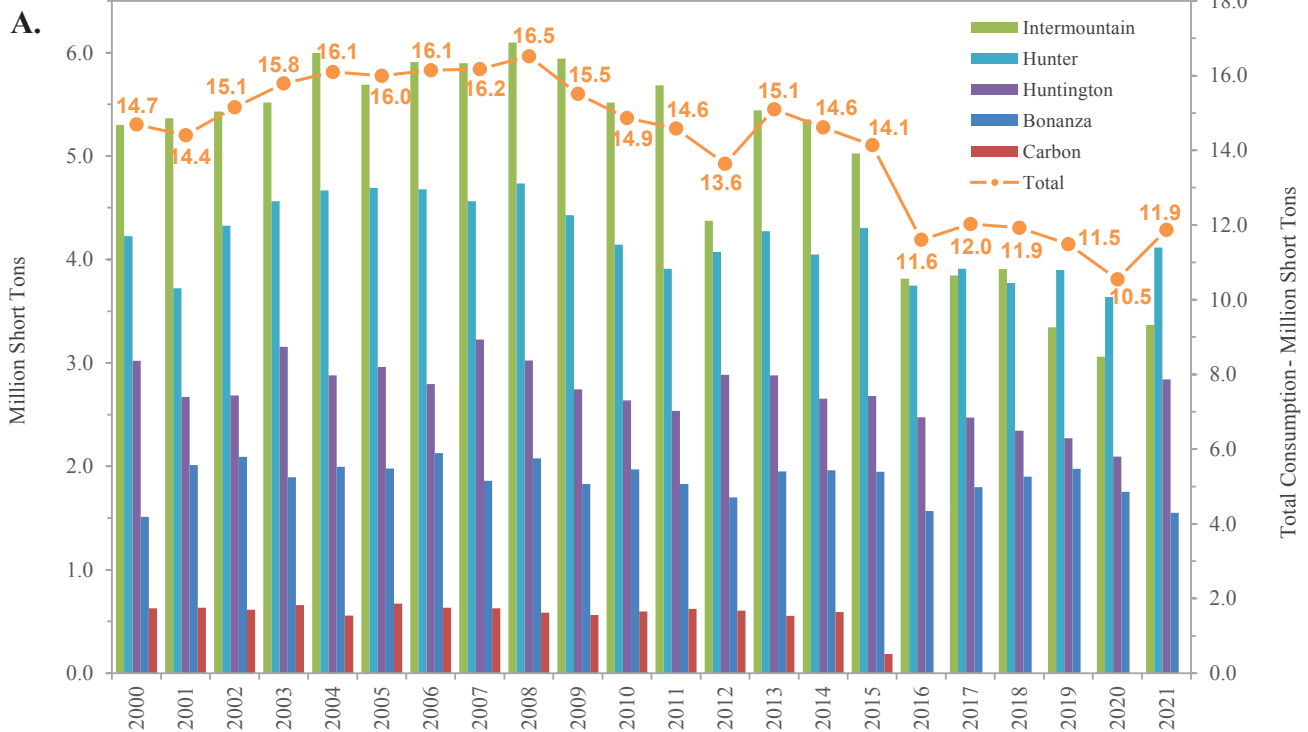


Figure 20. (A) Consumption of coal at Utah power plants, 2000–2021. Data source: U.S. Energy Information Administration. Notes: (1) A generator at the Intermountain Power Plant was offline for several months in 2012, resulting in decreased coal consumption. (2) The Bonanza power plant in Uintah County 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. **(B)** Distribution of Utah coal, 1970–2021. Data source: Utah Geological Survey and U.S. Energy Information Administration. **(C)** Consumption of coal in Utah by end use, 1960–2021. Data source: U.S. Energy Information Administration.

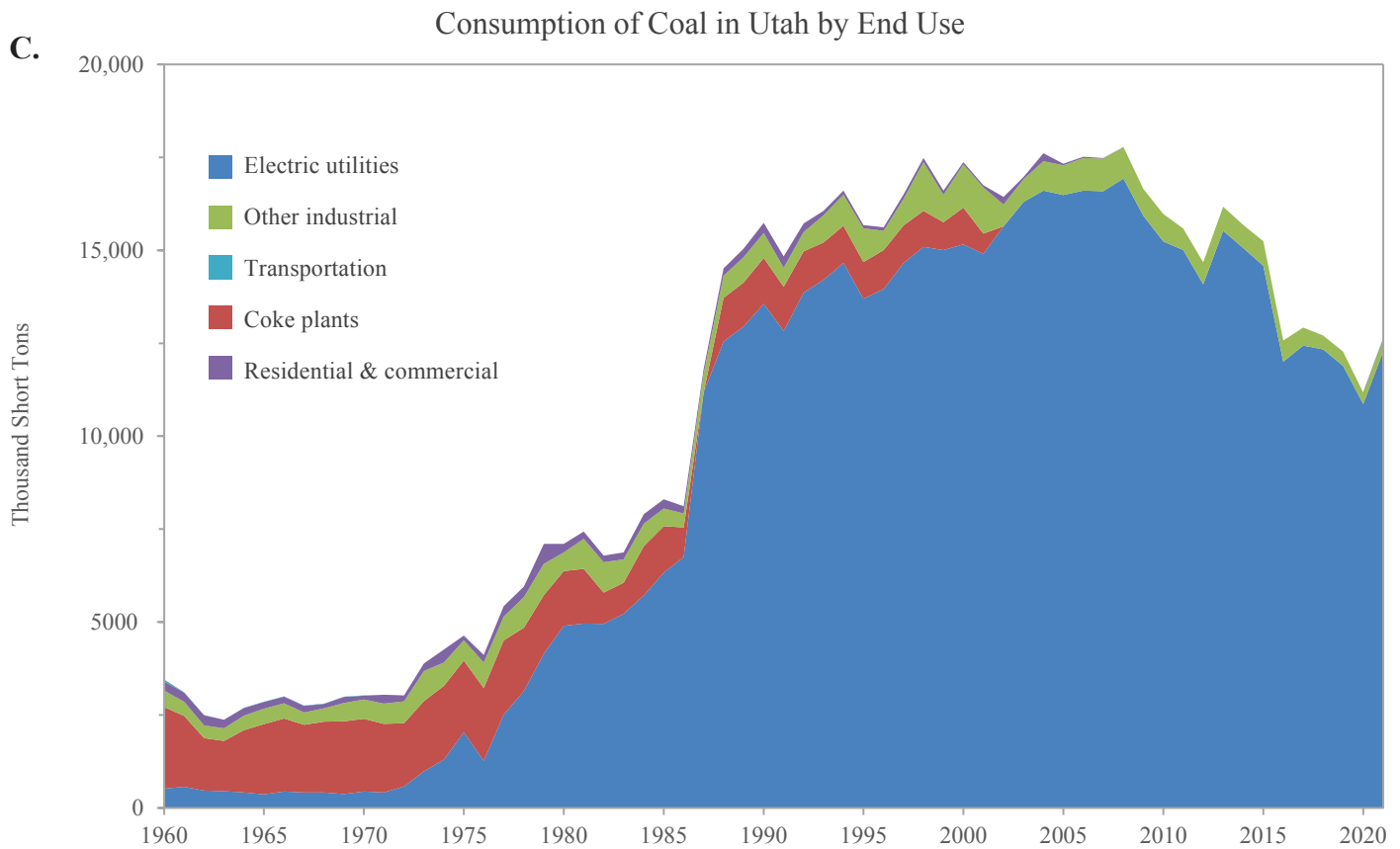


Figure 20. Continued

million st, as electricity demand recovered from pandemic-related lows. 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. Although fuel-switching or closure at other U.S. coal-fired power plants outside of Utah has reduced domestic demand for Utah coal, Utah operators have recently taken advantage of a stronger foreign export market, sending an estimated 2.5 million st of coal overseas to Asia in 2021 (figure 20). With the export market continuing to contribute 2 to 3 million st per year toward Utah's coal demand, and with the recent increase in demand at Utah coal-burning power plants, Utah's total production is expected to increase to about 13.5 million st in 2022.

Most mine operators report a current overall improvement in the Utah coal market, but meeting this new surge in demand has been challenging. Supply chain issues were cited as a serious problem, as well as significant labor shortages including miners, coal-haul truck drivers, and mechanics. In

addition, most of Utah's coal is trucked either to a train load-out or directly to a customer and the mines bear the burden of the high fuel prices. The defunding of the coal industry has affected the ability for operators to finance new mine equipment and improvements, and coupled with continued difficult mining conditions and a burdensome regulatory environment, the Utah coal industry will continue to struggle to maintain current activities.

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 or 2021 after the idling of the Dugout Canyon mine (figure 17). In contrast, Sanpete County hosted significant coal production for the first time starting in 2017 when operations at the Skyline mine moved to the southwestern Flat Canyon area. Coal production in 2021 came from Emery (5.9 million st, 47%), Sevier (3.4 million st, 27%), Sanpete (2.8 million st, 22%), and Kane (434,000 st, 3.5%) Counties.

In 2021, the majority of Utah coal, 7.5 million st, was produced from the Wasatch Plateau coalfield; 3.5 million st

came from one mine (Lila) in the Book Cliffs coalfield, 1.2 million st from the Emery mine in the Emery coalfield, and 0.4 million st from the Coal Hollow mine in the Alton coalfield (figures 18 and 19; table 6). In addition, nearly all Utah coal production in 2021 (88%, 11.0 million st) was produced from federal land, whereas only 46,000 st (less than 0.4%) was from state-owned land (figure 17). Federal coal production has dominated in Utah since 2012, when the now-closed Deer Creek mine's state-owned Mill Fork coal tract reverted back to federal ownership after a 22 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 2021 coal production came from private lands (12%, 1.5 million st) at the Gentry, Emery, and Coal Hollow mines.

The Lila Canyon and Emery mines will both see changes to surrounding land ownership when the John D. Dingell, Jr. Conservation, Management, and Recreation Act is finalized. Significant coal resource tracts near both mines will convert from federal ownership to state (SITLA) ownership, facilitating a more streamlined permitting process for future mining.

The total amount of Utah coal distributed to the U.S. market in 2021 was 10.7 million st, nearly 1.0 million st less than 2020 (figure 20). As recently as 2008, Utah operators distributed 25 million st of coal; over 9.2 million st were exported to other states and 15.7 million st was used in-state. In 2021, only 1.7 million st of Utah coal was shipped to other states, whereas 9.0 million st was used locally. The vast majority of Utah coal, about 85% (9.1 million st), went to the electric utility market, mainly within the state. Utah coal deliveries to the industrial sector totaled 1.6 million st in 2021, which is significantly less than peak deliveries of 4.4 million st in 2003. Total annual domestic deliveries of Utah coal in 2022 are expected to increase into the 12 to 13 million st range as demand for coal at electric utilities remains relatively strong in 2022. Data are similar for consumption of coal in Utah, with about 12 million st consumed at Utah power plants in 2021 (this includes about 400,000 tons of waste coal burned at the Sunnyside power plant) and 350,000 st used at industrial facilities, the latter being significantly lower than in the 1990s to mid-2010s (figure 20).

The demand for Utah coal has sharply decreased over the past several years as coal-fired power plants have closed or switched to natural-gas-fired generation. Nationally, coal will account for 85% of U.S. electric generating capacity retirements in 2022 (U.S. EIA, 2022b). 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 2021, consumption of coal at Utah's

remaining coal-fired power plants averaged about 12 million st, a 20% 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 1.7 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. 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, removing roughly 3.5 million st of coal from Utah's coal market. 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 300,000 st less at both Hunter and Huntington).

Foreign exports of Utah coal averaged 2.9 million st per year in the 1990s, peaking at 5.3 million st in 1996 (figure 20). 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., Gulf of Mexico) to send their coal overseas. Utah operators have exported between 1.6 and 4.0 million st per year for the past five years and are expected to ship about 2.7 million st of coal in 2022.

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

Exploration/Development Highlights in 2021/2022

- Lila Canyon mine: Production has held steady for the past few years and is anticipated to total about 3.2 million st in 2022. Production on current leases should last until 2027, and pending the implementation of the Dingell Act, could then move to new SITLA leases.
- Gentry mine: COP Coal Development, LLC bought the Castle Valley mines when Rhino Resources went into bankruptcy in late 2020—the mines were renamed Gentry. The Gentry #4 mine was closed in early 2020 and all mining now takes place in the Gentry #3 mine from the Bear, Blind, and Hiawatha coal beds.

- Emery mine: Production at the Emery mine more than doubled in 2021 as four continuous miner machines were brought online. Emery is also waiting for the finalization of the Dingell Act before leasing/permitting new coal reserves.
- Sufco mine: Longwall development started recently in the federal Greens Hollow tract while production finishes in the federal Pines district to the northeast. Longwall production in Greens Hollow should start in mid-2023.
- Trail Mountain/Cottonwood tract: Owned by Wolverine Fuels, this SITLA coal tract contains nearly 50 million tons of mineable coal in the Hiawatha seam. Wolverine recently re-entered the closed Trail Mountain mine to evaluate access to the adjacent Cottonwood reserves.
- Coal Hollow mine: Alton Coal Development has completed mining on the northern private lease and has moved back to areas in the south which are private surface but federal coal. They are waiting for final approval of their new permit before moving forward with continued surface mining on federal land. Plans still include some auger and highwall development to maximize efficiency.

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 have interests in Utah's oil shale resources: Enefit American Oil, Red Leaf Resources, and TomCo Energy. These companies all hold land in the southeastern Uinta Basin but have reported limited activity in recent years related to oil shale development.

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. One Utah oil sand deposit that consistently generates interest is Asphalt Ridge because of its proximity to Vernal, Utah. A few companies with land holdings or recent activities on Asphalt Ridge include Tar Sands Holdings II, Petroteq Energy, TomCo Energy, Valkor, and Vivakor. TomCo began a three-hole drilling program on Asphalt Ridge in early 2022 to confirm resources.

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