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Image courtesy of Rio Tinto Kennecott

Mining Sovereignty

From a legal principle to mineral policy

Princeton University defines sovereignty as the 'authority over all others within its field of operation and the absence of any other superior authority in the same field.' Traditionally, a legal concept applied to states, sovereignty is also used in resource policy debates. At its core, the concept of mineral sovereignty implies that a country must hold decision-making authority over the extraction and use of its critical and strategic minerals – directly or indirectly.

When Donald J. Trump assumed office for the second time on January 20, 2025, he highlighted the importance of sovereignty during his inaugural address: "Our sovereignty will be reclaimed," he proclaimed. For the mining industry, this statement carries a lot of weight.

Fulfilling the conditions for mineral sovereignty has been elusive for the United States; the US remains dependent on imports of many of the USGS-listed critical minerals, most of which are outsourced, directly or indirectly, from China. In today's geopolitical context, where the US has historically led the liberal international order and China has emerged as its primary rival across economics, military reach, technology, and political soft power, the reliance is worrying. Steve Trussell, executive director of the Arizona Mining Association, said: "The Trump Administration has re-emphasized mining as a significant economic and national security matter, particularly in the face of foreign relations challenges and reliance on the import of 40 of 50 of our critical minerals."

The Trump Administration's aggressive mining agenda may seem new, but the groundwork was laid years earlier. Kwame Awuah-Offei, chair of mining and explosives engineering at Missouri University of Science and Technology, stressed the momentum previous administrations have built: "Critical minerals and supply chain vulnerability are a bipartisan issue. Both the Biden administration and the Trump administration showed interest in critical minerals, and hopefully, future changes in administration will not make this issue less important."

"We have an unprecedented opportunity that is not open-ended to strengthen the mining industry in the US, and we must strike while the iron is hot."

Mark Compton, Executive Director, American Exploration & Mining Association

Indeed, Trump's first mandate included Executive Order (EO) 13817 (2017) to strengthen management of critical minerals management and energy security. Fast-forwarding to the Biden-Harris Administration, they continued the momentum by signing EO 14017, *America's Supply Chains*, which mandated a 100-day review of the US' critical minerals supply chains. Biden also announced more than US$120 billion in investment in battery and critical minerals supply chains. Meanwhile, the Department of Energy (DOE) launched over US$3 billion across 25 projects in 2024 under the Bipartisan Infrastructure Law to extract, process, recycle, and manufacture key components for the energy transition.

The difference today lies in pace and scale. Since January 2025, Trump has issued a cascade of executive orders, each touching – directly or indirectly – on the North American nation's mineral base. These include:

January 2025:

- **EO 14154**, *Unleashing American Energy*
- **EO 14153**, *Unleashing Alaska's Extraordinary Resource Potential*

February 2025:

- **EO 14123**, *Establishing the National Energy Dominance Council*

March 2025:

- **EO 14241**, *Immediate Measures to Increase American Mineral Production*

April 2025:

- **EO 14261**, *Reinvigorating America's Beautiful Clean Coal Industry and Amending EO 14241*
- **EO 14272**, *Ensuring National Security and Economic Resilience through Section 232 Actions on Processed Critical Minerals and Derivative Products*
- **EO 14285**, *Unleashing America's Offshore Critical Minerals and Resources*

May 2025:

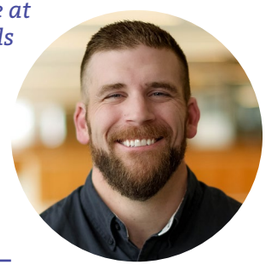
- **EO 14302**, *Reinvigorating the Nuclear Industrial Base*

"Policies change and projects like ours take years to come to life. You cannot base billion-dollar decisions on short-term political cycles –incentives might help in the near-term, but we invest based on long-term fundamentals."

Joshua Olmsted, President and COO – Americas, Freeport-McMoRan

"Producing closer to home, under high environmental standards and with low emissions, is a compelling proposition. My hope is that this perspective transcends administrations, because at its core, our country needs these materials."

Nathan Foster, Managing Director Kennecott, Rio Tinto



Industry reception of this agenda has been positive. As Travis Deti, executive director of the Wyoming Mining Association, explained: "Under the Trump administration, we are noticing a shift as executive orders are issued to roll back regulations on the coal industry. Additionally, with the Big Beautiful Bill, we are also seeing royalty relief at the federal level and a reduction in severance taxes at the state level, helping make our coal more competitive."

Beyond orders on paper in the White House, Trump's personal defense of particular projects has marked a new chapter for the industry. For example, when the Ninth Circuit in August 2025 blocked the land swap that would allow Resolution Copper - the Rio Tinto and BHP joint venture expected to supply 25% of domestic copper demand - to build its mine in Arizona, Trump responded on Truth Social: "A copper mine in Arizona, "Resolution" was just delayed by a Radical Left Court for two months – 3,800 jobs are affected, and our Country, quite simply, needs Copper – AND NOW!..."

Executive support is evident, but the key question remains: will four years be enough to push all these reforms and achieve mineral sovereignty? Mark Compton, executive director of the American Exploration & Mining Association (AEMA), highlighted both the opportunity and the limits: "The current administration will be here for four years, but we do not know what Congress will look like after the 2026 elections", continuing however: "Policy makers on both sides of the aisle recognize the importance of secure mineral supply chains to our economic and national security, so we are seeing more bipartisan support for mining in Congress than we have had in years."

Filling a void

US mining governance has lacked centralization. In 1995, Congress voted to close the Bureau of Mines, which officially shut down the following year. While many countries have since created centralized ministries, the US has spread oversight across multiple agencies. "There is no single agency overseeing mining — we fall under several different federal departments; it is a maze of red tape. I think a one-stop-shop model would be great, and it would make life easier for everyone involved," shared Travis Deti, executive director of the Wyoming Mining Association.

Permitting is the first of many bottlenecks. "Permitting in the US takes far too long, averaging 29 years to move from discovery to production, a number that is absolutely true for Alaska," confirmed Deantha Skibinski, executive director of the Alaska Miners Association.

Calls for a central authority are growing. Mark Compton, from the AEMA, for instance, argued: "We have been strongly advocating for a high-level entity at the White House level – the equivalent to a 'Minister of Mines' or someone who can pull all those pieces together and ensure everyone is moving in the same direction to secure our mineral supply chains."

Again, Trump, through an EO, responded to this urgency with the establishment of the National Energy Dominance Council (NEDC), formally established in February 2025. Interior Secretary Doug Burgum and Energy Secretary Chris Wright lead the NEDC, with Jarrod Agen, as executive director. For Adam Eckman, president and CEO of the Colorado Mining Association, this is a welcome start: "It is a good starting point, but I think we need to go further, and what we truly need is a central authority or leadership structure dedicated to overseeing and aligning mine planning and permitting efforts in the US."

"Today we're doing copper" (but also gold)

Gold's designation as a critical mineral by EO 14241 has already awakened the interest of many companies. Deantha Skibinski, from the Alaska Miners Association, explained why: "Historically, gold has always been the most sought-after resource. Still, antimony is often found as a byproduct in gold mines […] Suddenly, several projects in Alaska that were looking for gold were gathering data that showed antimony potential."

Copper is following a similar trajectory. Although not always classified as "critical" due to domestic supply, copper remains vital to electrification and defense. "Copper appears on certain lists, but it is often overlooked because there is some domestic supply and several large projects in the United States that have been delayed in permitting for years. Current production, mainly from Arizona, meets present needs," answered Scott Petsel, president at Metallic Minerals.

That may be, finally, changing. The USGS is now reviewing its list of critical minerals, with copper already included in the 2025 draft.

Trump himself has addressed the red metal: "Today we're doing copper. I believe the tariff on copper, we're going to make it 50%." The measure ultimately applied to pipes, tubes, and semi-finished products.

One can only wonder whether these changes, or perhaps the early signs of a structural shift in the US, are actually shaping the strategies of mining companies. For producers, strategy remains anchored in long-term fundamentals. "We do not build our strategy around any one administration. Policies change, and projects like ours take years to come to life. You cannot base billion-dollar decisions on short-term political cycles. Incentives might help in the near-term, but we invest based on long-term fundamentals and what is right for our business," emphasized Joshua Olmsted, president and COO – Americas for Freeport-McMoRan.

Gerard Bond, CEO of OceanaGold, echoed the sentiment: "Mining is a long-term business. The investments we make last for decades, so they need to hold up through different political cycles. Our best strategy to work across political administrations is to earn and sustain the trust of communities, regulators and non-governmental organizations."

A new chapter: Private-public realignment

In less than a year, federal action has begun what appears to be a tsunami of changes for the US mining industry. Public-private partnerships, once rare, are now expanding. In September 2025, the Department of Defense – renamed the Department of War, also, by an executive order – invested US$400 million in MP Materials, operator of Mountain Pass in California, the world's second-largest rare earth mine, and a company that is developing a new magnet facility in Texas. With the deal, the government became MP's largest shareholder.

Then we have the Export-Import Bank of the United States (EXIM), which has also increased support for mining projects. As David Thomas, VP of minerals and metals for the Southwest USA at Ausenco, observed: "Support from the current administration, particularly from a financial standpoint from institutions like the EXIM Bank, has played a significant role in driving demand for large-scale projects. This trend is expected to continue growing over the next three to five years with further opportunities emerging in the US market."

Ultimately, as Steve Trussell of the Arizona Mining Association reflected: "Progress will ultimately hinge on streamlining permitting to avoid 10–29-year delays, community and tribal involvement, continually improving environmental and water management, and investment in workforce recruitment and skills development."

Given today's unprecedented pace of change, this pre-release aims to capture how producers, juniors, service providers, universities, and technology companies are navigating the present and how they envision the future of the United States of America's mining industry. ■

2025 Draft List of Critical Minerals

USGS METHODOLOGY

84 Mineral Commodities

Commodities are grouped into supply chains

Are the impacts of trade disruptions on the US economy significant?

Economic Effects Assessment

400+ Industries

Scenario Probabilities Assessment

1,200+ Trade Disruption Scenarios

Risk Categorization

Likelihood of a scenario occuring **X Impact** of the scenario **= Risk** probability weighting

If **Risk** is high, elevated or moderate → **Listed**

If **Risk** is limited, negligible, negative → **Not**

Is there a single domestic producer for that mineral? → **Listed**

2025 DRAFT LIST OF CRITICAL MINERALS		NET IMPORT RELIANCE (2024)	MAJOR IMPORT SOURCES (2024)
Gallium	High	100	Japan, China, Germany, Canada
Tungsten	High	>50	China, Germany, Bolivia, Vietnam
Aluminium	Elevated	47	Canada, UAE, Bahrain, China
Antimony	Elevated	85	China
Graphite	Elevated	100	China
Vanadium	Elevated	40	Canada
Palladium	Elevated	36	Russia
Manganese	Elevated	100	Gabon
Titanium	Elevated	>95	Japan
Copper	Elevated	45	Chile, Canada, Mexico, Peru
Platinum	Elevated	85	South Africa
Zinc	Elevated	73	Canada, Mexico, Rep. of Korea, Peru
Cobalt	Elevated	76	Norway, Finland, Japan, Canada
Silver	Elevated	64	Mexico, Canada, Rep. of Korea, Poland
Tin	Elevated	73	Peru, Bolivia, indonesia, Brazil
Bismuth	Elevated	89	China, Rep. of Korea
Nickel	Moderate	48	Canada, Norway, Australia, Brazil
Lithium	Moderate	>50	Chile, Argentina
Lead	Moderate	28	Canada, Rep. of Korea, Mexico, Australia
Rare Earths*	High	80	China

*Lanthanides cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, terbium, thulium, and ytterbium

Source: Federal Register, Mineral Commodity Summaries 2025 | U.S. Geological Survey. In this table, Global Business Reports focused specifically on the 19 minerals mentioned throughout the report out of 84 that USGS marked.

Image courtesy of Sandfire Resources

Mining for Talent

America's universities feeding the industry

According to Benchmark Mineral Intelligence, meeting global battery demand by 2030 will require approximately 293 new mines and processing plants across lithium, cobalt, nickel, graphite, manganese, copper, phosphate, and rare earth elements. How many people will be needed to run these mines? That is hard to tell, as mines vary widely in workforce, size, depending on the mineral, scale of operations, location, and now, with the rise of AI and automation, the level of technology applied within the mine. What we can be sure of is that there are not enough miners today.

Based on the Bureau of Labor Statistics, the US mining industry has 26,000 vacancies, a thousand more than a year ago. “One of the biggest challenges we face is not just building mines, but also rebuilding the mining workforce. Many experienced people in the industry have retired, and we have not replaced that talent. It is on us – companies, schools, governments, and universities, to train the next generation of miners,” commented Vicky Peacey, president and general manager at Resolution Copper.

The problem is felt throughout the entire mining cycle: on one side, who will actually mine the critical minerals? On the other hand, who will process the permits and approvals for new projects? As Mark Compton, executive director at the American Exploration & Mining Association, put it: “We also need more mining expertise within federal agencies. If we want more efficient federal permitting, agency personnel charged with that need to understand how the mining industry works.”

Writing about the US mining workforce presents an additional challenge: there is no central body, such as Canada’s Mining Industry Human Resources Council, that tracks and updates workforce data. The Bureau of Labor Statistics combines data from the oil and gas industry and logging with mining, and there is no Ministry or Bureau of Mining in the US. In the absence of such resources, most online references still cite a 2013 Society for Mining, Metallurgy and Exploration (SME) report, which highlights the decline from 25 accredited mining schools in 1982 to just 12, and warns that half of the mining workforce would retire by 2029. In fact, according to the National Mining Association, 14 US universities now offer

"As a public institution, Missouri S&T offers lower fees, expanding access to high-quality education. By reducing financial barriers to accessing higher education and offering high-quality academic programs, Missouri S&T is serving the mining industry by training its future talent."

Kwame Awuah-Offei, Chair of Mining and Explosives Engineering Department, Missouri University of Science and Technology

“Scholarships are great, but real impact comes from giving students hands-on experience, exposure to industry tools, internships, and international work opportunities. That is what inspires interest in mining and builds the workforce companies need.”

Alistair Smith, Chair Department of Earth and Spatial Sciences and Professor, University of Idaho

mining programs that match those accredited by the Accreditation Board for Engineering and Technology (ABET).

GBR conducted interviews with universities across the USA to estimate the current state of the mining talent pipeline. For instance, Alistair Smith, chair of the Department of Earth and Spatial Sciences at the University of Idaho, highlighted the long-term education gap: “We used to have a College of Mines and Earth Resources, but, like many other schools, it was closed when gold prices dropped around the turn of the century. Consequently, over the last couple of years, we have been leading efforts to revive mining education.”

The University of Idaho will launch a new bachelor’s degree in Geological Engineering in fall 2025, jointly led by the Colleges of Science and Engineering and supported by North Idaho College in Coeur d’Alene - based in the Coeur d’Alene Mining district, also known as the Silver Valley and home to Hecla’s Lucky Friday Mine, Idaho Strategic Resources’ operations and Bunker Hill project. “Many companies had been asking them [North Idaho College] about pathways to the Colorado School of Mines, and the question naturally came up: Why not the University of Idaho? Partnerships really helped us relaunch the geological engineering program,” said Smith.

Some knowledge was lost with the closure of the College of Mines at the University of Idaho, but Smith acknowledged that collaboration with the Idaho Mining Association, Hecla, Idaho Strategic Resources, Bunker Hill, Perpetua Resources and Integra Resources now allows the University to address the real opportunities and needs of today’s mining industry: “We are establishing research areas in ore deposits, metal transport, element recovery, and environmental remediation. In a way, starting fresh is an advantage because we can be strategic about where we are heading. While we are still shaping our new engineering program, we can watch where the field is crowded and then go in a different direction, carving out areas where we can really make an impact,” concluded Smith.

Utah State University (USU) is also moving forward, launching an Energy Engineering program in fall of 2026 through its College of Engineering at Logan and its statewide campuses. “It will be a big step forward, and we are excited about the impact it will have on both our students and the mining sector in Utah […] Utah has unique resources, such as uranium mining and milling capabilities, that provide opportunities for our energy engineers to have real-world impacts. Beyond the technical side, we are making energy policy, implementation, and community engagement a core piece of the program,” said Christopher Fox, associate dean for research.

USU has recently joined the Critical Materials Innovation Hub, a US Department of Energy program led by Ames National Laboratory, whose goal is to bring together science and technology partners to strengthen the supply chain for rare earths and other minerals. According to Fox, as the USU expands more into mining, collaboration will be key: “We do not want to do this alone; we want to work side by side with industry, government, and other institutions. Together, we can make a real difference in advancing energy and mining research, innovation and implementation.”

Enrollment figures, while still modest, are moving in the right direction. Missouri University of Science and Technology reported 83 undergraduate and 38 graduate students in mining engineering in 2024. “Although it is still not where we would like it to be, we have seen an uptick in the enrollment rate in mining-related fields,” said Kwame Awuah-Offei, chair of mining and explosives engineering. He credits the growth to increased research funding at the graduate level and renewed interest in mining among undergraduates, thanks to the national conversation on critical minerals.

Simon Jowitt, director of the Nevada Bureau of Mines and Geology and State Geologist at the University of Nevada, Reno, agreed with Awuah-Offei: “Enrollment is steady overall, but we are working to grow it. At the undergraduate level, the number of students is increasing, but perhaps not as quickly as we would like, so we are starting to invest more in encouraging students to recognize the importance of mining in everyday life. Graduate enrollment is a different story, and we have no trouble in attracting students there.”

When trying to understand and engage with the youth, storytelling matters, as Mark Compton at AEMA, highlighted, when discussed AEMA’s *I Am Mining* campaign to help everyday Americans connect the dots between mining and their own daily lives by focusing on the individuals behind the work: “We want to convey the message that mining is comprised of people who share the same hopes, interests, and values as everyone else. In a context where the US is only producing about 200 to 300 mining engineering graduates a year, that kind of storytelling really matters, especially for workforce development.”

What can the industry do?

Some of the key takeaways from GBR's conversation with university representatives on how they can better position themselves to attract new talent include government involvement, tuition fees, and support from the private sector.

Governments play a crucial role in strengthening mining education. One example in the US is the proposed *Mining Schools Act*, which would provide approximately US$10 million per year over eight years to support mining programs and recruit more students.

For Christopher Fox, government involvement is not only about funding, but also about connections: "They can help facilitate connections between research institutions and industry partners - sometimes it just takes a well-connected government partner to help bring those two sides of the equation together. Another key area, of course, is in providing relevant funding sources or pointing researchers toward resources that are often hard to navigate without guidance."

Affordability is another factor shaping access to mining education. Globally, the US, China, and Switzerland consistently rank among the most expensive countries for students. At Missouri S&T, Kwame Awuah-Offei emphasized the advantage of being a public institution with lower fees: "By reducing financial barriers to accessing higher education and offering high-quality academic programs, Missouri S&T is serving the mining industry by training its future talent."

Industry, too, has its role in preparing the next generation of mining professionals. As Smith at the University of Idaho explained: "Scholarships are great, of course, but real impact comes from giving students hands-on experience, exposure to real company tools, internships, and global work abroad opportunities. Universities cannot always afford expensive mining hardware or software, so when companies provide access to datasets or equipment, it is hugely valuable and greatly appreciated."

"We want to work side by side with industry, government, and other institutions. Together, we can make a real difference in advancing energy and mining research, innovation, and implementation."

Christopher Fox, Associate Dean of Research - College of Engineering, Utah State University

Governments play a crucial role in strengthening mining education. One example in the US is the proposed *Mining Schools Act,* which would provide approximately US$10 million per year over eight years to support mining programs and recruit more students, as explained by Mark Compton from AEMA. "For several years, there has been an effort to pass the Mining Schools Act (H.R. 2457), which would recognize universities with mining programs and provide support for them. All mining schools really need that act to pass because, without resources, it is tough to hire faculty, invest in specialized equipment, and keep programs strong," emphasized Smith from the University of Idaho. ■

Image courtesy of Sandfire Resources

Production and Development

US output snapshot: What is critical now?

In 2024, US nonfuel mineral production totaled US$106 billion, up from US$105 billion in 2023. Of that amount, US$33.5 billion came from metal production, a minimal increase from US$33 billion in 2023. The main commodity contributors to the US metal mine production by value were gold (35%), copper (30%), iron ore (16%), zinc (7%), and molybdenum (5%). Regionally, the West –from New Mexico, Colorado, Wyoming and Montana to the Pacific Coast, continues to dominate production, having generated US$26 billion of the US$33.5 billion in metal output, which accounts for almost 78%. The Midwest followed, then the South, and finally the Northeast.

While production figures are important, the broader conversation around US mineral production centers on security, consumption and import dependence. "Mining is an international arena, but in the US it is a national security issue because of our reliance on foreign suppliers for many of our critical minerals," outlined Alistair Smith, chair department of Earth and Spatial Sciences and professor at the University of Idaho.

In 2024, the US imported more than half of its supply of different minerals. From the 50 minerals identified as "critical" in the 2022 list that the USGS published, the US was 100% net import-reliant on 12, and more than 50% reliant on another 28. China and Canada supplied the largest number of these nonfuel mineral commodities, with 21 mineral commodities each.

Over the last year, the debate has sharpened about critical minerals' importance, and President Trump has taken decisive measures in this area.

In March 2025, for instance, Trump issued Executive Order 14241, also known as *Immediate Measures to Increase American Mineral Production*, which broadened the definition of "critical" to include uranium, copper, potash, and, interestingly, gold. The move was definitely welcomed with enthusiasm by gold producers, but why would gold be considered a critical mineral? According to the strict definition from the USGS, the entity that provides the critical minerals list for the US, a mineral is considered critical only if it is essential to the US economy or security and is vulnerable to supply disruptions. However, neither the US is import-reliant on gold (actually, it is the fifth world producer), and neither is gold vital for advanced manufacturing. By pure and technical criteria, gold does not qualify as a critical resource. This year, the USGS is due to update the critical metals list, and so far, the USGS has not proposed gold for inclusion, leaving a discrepancy: gold is "tagged" as critical by executive order, but excluded under the agency's framework.

One possible rationale lies in the byproducts from gold mining. As Henri Gonin, managing director of Nevada Gold Mines, explained: "Onshore mining within the US is important and increased domestic mineral production will be highly beneficial for the country in the long run. Considering critical minerals and the reshoring of supply chains, gold is often an indicator of the presence of other mineral deposits also."

Perpetua Resources' Stibnite gold project in Idaho, which received approval in September 2025 to advance development, serves as an example of this designation. Although primarily a gold project (which

is also the revenue driver for the company), it also hosts the largest identified reserve of antimony in the US, which has served as the catalyst to move the project forward.

The technicalities surrounding critical minerals and their connection to gold were not the main story here, but rather a preamble to set the stage and establish the angle for the subsequent pages on production, development, and exploration. Minerals, like oil and gas previously, will shape the rhetoric of nationalism and national security. "It is hard to go a day without seeing something in the national news about minerals needed for national defense, AI, or medical technology. Most people in the sector are aware that the US relies heavily on China for its critical minerals supply, which creates both economic risks and national security concerns. This goes beyond mining; it is about competition across the entire mineral supply chain", concluded Adam Eckman, president and CEO at the Colorado Mining Association (CMA).

Precious metals

The US gold output in 2024 is estimated at 160 metric tons (approximately 4.6 million ounces), the lowest level since 2010, However, the country remains the fifth-largest gold producer in the world. Domestically, Nevada once again dominated the ranking, contributing roughly 70% of the production, largely thanks to the world's largest gold-mining complex, Nevada Gold Mines (NGM) – a joint venture between Barrick Mining (61.5%) and Newmont (38.5%).

Alongside NGM, the state is also home to SSR Mining's Marigold, Kinross' Round Mountain, and several operations where gold is produced as a secondary product.

Alaska followed with 16% of domestic output through Kinross' Fort Knox, Coeur Mining's Kensington mine, Norther Star's Pogo operations, and the recently commissioned Manh Choh from Contango Ore.

The decline in gold production comes from reduced output at several large operations, mainly NGM and Marigold; for instance, Barrick announced a 7% reduction in production in 2024 for NGM, but the outlook seems positive for this 2025: "We again achieved our guidance for Q1 and Q2 2025 and remain on track for the full year," commented Henri Gonin, managing director at NGM, also noting that deliberate cost-cutting measures, such as deploying new trucks and adjusting mine plans, helped reduce open-pit costs by 30-35% at Carlin and Cortez.

Growth also comes in the form of greenfield development for NGM, as it will explore integrating into its business Fourmile, a 100%-owned Barrick project, and what Mark Bristow, former president and CEO of Barrick Mining, called "the greatest gold discovery of this century". With a new PEA, at the heart of NGM's complex, along with processing and infrastructure, it offers a low-cost development: "We continue to expand the resource at Fourmile, and we believe that Goldrush and Fourmile combined will eventually be greater than 20 million ounces. There are no other gold mines in the world that are currently in the discovery phase that are as big and promising as much growth," added Gonin.

The ramp-up of the Goldrush mine (an underground mine within the Cortez complex) should reach 400,000 oz/y within the next two years.

The slight fall in production contrasts with gold's remarkable price performance. Record highs have dominated headlines throughout the year. "Gold miners have never seen margins this wide, for this long, where input costs have not caught up with the rise in the commodity price [...] Gold is playing its role as a free-market hedge in a world where governments are deliberately devaluing their currencies to boost exports," said Sean Roosen, chairman and CEO at Osisko Development.

Osisko's flagship project is the Cariboo project in British Columbia, Canada, which is fully permitted, financed, and awaiting a construction decision. In the US, the company is also advancing the Tintic project in Utah, where its Trixie deposit already hosts around 200,000 oz of defined resources and has been producing 40,000 oz/y from test mining, which they have been stockpiling. Roosen emphasized Tintic's longer-term copper porphyry potential and noted the presence of tellurium and manganese tailings, as he highlighted that Kennecott (the copper mine operated by Rio Tinto) has recently added a circuit at its smelter for tellurium. "Right now, our main focus is Cariboo, but as we head into 2026, Tintic may also become a bigger part of the story."

Other producers are likewise capitalizing on high prices. OceanaGold, for instance, does not hedge its gold sales: "When prices move higher our shareholders capture the full benefit to the bottom line," proclaimed Gerard Bond, the CEO, adding: "For the 12 months to June 30, 2025, OceanaGold generated ~US$400 million in free cash flow, representing an 18% yield on our market value over that same time period. With that

"Resolution Copper could be a nation-building project, creating a stable industry that keeps families rooted. For years, children here were told there was nothing for them, but now they have a reason to stay and build a future."

Vicky Peacey, President and General Manager, Resolution Copper

strong financial performance, we have repaid all of our debt and on 30 June had around US$300 million in cash on our balance sheet."

OceanaGold's only producing asset in the US, the Haile mine in South Carolina, is the only producing gold mine east of the Mississippi River: "For us, Haile is our largest producer and will continue to be our primary source of near-term growth in 2026 and beyond," said Bond.

With an annual output between 170,000 and 200,000 oz, Haile is pursuing organic growth through projects like Horsehoe Underground, Palomino, and Ledbetter Phase 4, supported by a 20% increase in the designated exploration budget for 2025, which has risen to US$10 million.

While gold production slipped, American silver production grew from 1,010 t/y in 2023 to 1,100 t/y in 2024, positioning the country as the ninth top producer globally.

Growth, in part, was driven by Hecla's excellent year, a company that accounted for 37% of total output through its Greens Creek mine in Alaska and Lucky Friday in Idaho. "2024 was our second-best silver production year in our 134-year history, with 16.2 million oz produced. 2025 could surpass that, as our production guidance ranges between 15.5 and 17 million oz," commented Rob Krcmarov, Hecla's new president and CEO.

After recovering from a 2023 fire at Lucky Friday and having brought the mine back online in 2024, the company is also advancing exploration at its Libby copper-silver project in Montana, which recently received FAST-41 transparency status, as well as a portfolio of Nevada projects. Krcmarov stressed his preference for organic growth rather than M&A: "I still lean toward exploration over M&A: it might take longer, but the value goes straight to our shareholders.

Copper production

In 2024, US copper production declined by 3% compared to 2023, totaling 1,130 t. The decrease reflected several operational factors: changes in the mine plan at Rio Tinto's Bingham Canyon (also known as Kennecott) in Utah, lower ore grades and reduced mill throughput at Lundin Mining's Eagle mine in Michigan, and finally, weaker grades in both New Mexico and Arizona. These setbacks were only partly offset by higher production at KGHM's Robinson mine in Nevada. Arizona alone contributed about 70% of domestic copper output, followed by Utah, New Mexico, Nevada, and Michigan.

Upstream bottlenecks remain, as the US has only two operating copper smelters: Rio Tinto's Garfield smelter in Utah and Freeport-McMoRan's Miami smelter in Arizona. "Once home to nearly 80 copper mines, the US now has only a handful left. With grades declining roughly half of domestic demand is met through imports," reflected Vicky Peacey, president and general manager

at Resolution Copper, one of the US's flagship copper projects under development.

Policy developments under the Trump administration have added volatility as well as temporary headwinds to the copper space. In July 2025, Trump floated the idea of imposing 50% tariffs on all copper imports—a bold move, as the US relies on imports for 46% of its copper consumption. Later that month, the White House confirmed that tariffs would apply only to pipes, tubes and other semi-finished products, an announcement that erased a temporary US premium over global prices, with COMEX copper falling by 17% and aligning with the LME. “About a third of Freeport’s production comes from the US, so we benefited from stronger copper prices, especially domestically, where the gap between LME and COMEX worked in our favor, giving us a temporary boost,” said Joshua Olsmted, president and COO – Americas for Freeport McMoRan.

Nathan Foster, managing director of Kennecott, emphasized the importance of being nimble in such a context of volatility: "The tariff environment can change rapidly and often differs from expectations, so our strategy is to remain agile, run safe and efficient operations, understand customer needs, and maintain strong relationships through any tariff scenario."

Freeport-McMoRan owns several assets in the US, and its Morenci mine contributes to 2.6% of the world's copper supply. Its growth in the US is anchored in three pillars: in the short term, the copper producer continues leaching stockpiles, producing 200-250 million lb/y; looking further ahead, growth in the medium to long term comes from advancing the Lone Star project in Arizona’s Safford district, currently undergoing a PFS, as well as the Bagdad mine’s 2X

“Haile is the largest producing gold mine in the eastern US, a region with a 200-year mining history in the Carolinas. It is our largest producer and will remain our primary growth source in 2026 and beyond."

Gerard Bond, President and CEO, OceanaGold

expansion project, which could add another 200-250 million lb/y at a CapEx of around US$3.5 billion.

“Engineering is nearly completed, and we are getting closer to being ready to make a decision, depending on market conditions. In the meantime, we are implementing key enablers, including the transition to an autonomous haulage fleet, which we anticipate completing by the end of the year. We are also building a new tailings facility that we will need even without an expansion,” noted Olmsted.

Rio Tinto’s Kennecott, the world’s largest open-pit mine, has also taken steps to secure future production, having recently returned to underground mining for the first time in decades. “I expect it to add, on average, roughly 30,000 t/y of mined copper for about six to seven years, taking us out toward 2032 or 2033,” Foster explained.

"Cathodes as the finished product can be sold directly to US industry without requiring further processing abroad, reducing transportation costs for the buyer, and improving supply chain security, while also avoiding potential tariffs."

George Ogilvie, President and CEO, Arizona Sonoran Copper Company

Meanwhile, Capstone Copper is working to stabilize operations at Pinto Valley in Arizona and design throughput rates by improving maintenance practices, modeled after the success they recently achieved at the Mantos Blancos mine in Chile. The copper producer has felt the downside of the domestic smelting bottleneck and the impact of tariffs: “The majority of Pinto Valley’s production is a copper concentrate, which is priced based on the LME, primarily due to the lack of smelting capacity in the US relative to the current level of mined copper concentrate production. A smaller portion of our production is in the form of copper cathodes, a refined product that we sell to domestic fabricators based on COMEX prices,” said COO James Whittaker.

Another producer focusing on efficiencies and mine extensions is KGHM – the operator of the Robinson and Carlota mines, and contributor to 6% of US copper output. "Looking at the efficiency of business activities is definitely a must. It is something you must constantly monitor regardless of market conditions. Nonetheless, exploring new investments is also key, although perhaps more difficult in terms of discovering fresh opportunities," shared Marek Bednarz, president and CEO of KGHM.

At Robinson operational improvements have allowed the mine to extend its life beyond original expectations.

In Arizona, the next wave of US copper projects is already transitioning from vision to reality. With the lack of US smelting capacity, many new projects are designing facilities to produce cathode onsite, bypassing this chokepoint. Gunnison Copper’s Johnson Camp mine (JCM) began producing in August 2025, ahead of schedule, marking one of the first tangible milestones in what industry investors and policymakers are framing as “Made-in-America copper".

Stephen Twyerould, president and CEO of the company, explained that the plant’s initial capacity is already being tested: “In the fourth quarter of 2025, we plan to start leaching sulfides using Nuton’s technology and, if all goes as expected, we should see copper coming off the sulfide leach pad in December or January 2026, proving that the technology works at scale. JCM’s plant has a nameplate capacity of 25 million lb/y, and our goal is to achieve this capacity by mid-2026.”

Beyond market demand, policy support is favoring domestic producers. “We were awarded the 48C tax credit program to receive up to US$13.9 million in tax credits as part of a federal program supporting US critical mineral production. It is a fully transferable credit that we expect to monetize in 2025. We are currently working through the certification process, and once it is complete, we will be able to realize the benefits,” Twyeroud concluded.

Copper development

In Arizona, five other copper-cathode projects are under development: Hudbay’s Copper World, Arizona Sonoran’s Cactus mine, Taseko Mine’s Florence Copper, and Ivanhoe Electric’s Santa Cruz. “By producing cathodes onsite thanks to a concentrate leach facility and a solvent extraction and electrowinning plant, we are not only eliminating emissions from overseas shipments, but also from inland transportation, bypassing the US smelting bottleneck,” commented Javier del Río, SVP US business unit at Hudbay Minerals.

If Gunnison represents the first wave of new cathode copper production, Hudbay Minerals’ Copper World is shaping up to be one of the most advanced project in the pipeline in Arizona. Developed under the same “Made-in-America copper” slogan, Copper World is advancing toward a feasibility study with results expected by mid-2026 to support a sanctioning decision. The project recently made a landmark deal when Mitsubishi Corporation acquired a 30% joint venture interest and committed US$600 million to support its development.

As we have seen, permitting remains one of the key bottlenecks for the industry, and Hudbay has outlined a phased approach to mitigate both investment risk and timelines. As Javier del Río, SVP of US business unit, explained: “Phase one will take place entirely on Hudbay's property, only requiring state and local permits. It is expected to produce 85,000 t/y of copper and to have a mine life of approximately 20 years, which will position Copper World as one of the largest producers in the country. Phase two, located on federal lands, needs federal approval and will extend mine life, fostering multi-generational job opportunities and long-term economic benefits in Arizona.”

Arizona Sonoran Copper Company (ASCU), following the publication of a positive PEA for the Cactus project in 2024, has gained positive market interest. In January 2025, Hudbay Minerals acquired a 9.99% equity stake for CA$20 million, followed by an additional investment of CA$5.8 million in a buy-deal financing that raised CA$51.75 million in June. George Ogilvie, president and CEO of ASCU, said: "The proximity of our projects creates the potential for synergies in operations and development, particularly in relation to sequencing the commissioning of assets."

ASCU is now advancing a PFS, expected before the end of 2025, followed by a definitive FS in the second half of 2026. Ogilvie also expects financing discussions to begin as the company prepares for a potential investment decision by late 2026. "Supplying cathode directly within the US reduces transportation costs for the buyer and improves supply chain security while also avoiding potential tariffs. We are already seeing interest from potential strategic industry partners requiring copper cathode for their own supply chains, as they reach out to us and follow project progress closely. This demand could play a role in our project financing process," concluded Ogilvie.

Of course, we cannot finish this section on copper development without addressing Resolution Copper, the flagship copper asset for future US copper supply. Located in Arizona's Copper Triangle, approximately 60 miles east of Phoenix, the JV project between Rio Tinto and BHP could meet at least 25% of the current US annual copper demand. Yet, despite its scale, the project remains in a permitting and legal dispute.

The Ninth Circuit decision to halt the project drew responses from the Secretary of the Interior, and the chair of the recently

"Looking at the efficiency of business activities is something you must constantly monitor regardless of market conditions. Nonetheless, exploring new investments is also key, although perhaps more difficult in terms of discovering fresh opportunities."

Marek Bednarz, President and CEO, KGHM International

established National Energy Dominance Council, Doug Burgum, who commented: "The Ninth Circuit needs to lift the stay immediately and allow the project to move forward after years of delay. Continued judicial interference not only impedes progress, but it also weakens our strategic position at a time when the US must lead in critical mineral production."

For Vicky Peacey, president and general manager at Resolution Copper, the critical mineral designation of copper signals a growing awareness of America's chronic copper deficit. She also emphasized how community input has shaped the project over the years: "From the very beginning, six nearby communities and 11 Native American tribes worked to redesign the project. A great example is the Tribal

Monitor Program, where tribal representatives joined us in the field to identify cultural sites, natural springs, and traditional plant areas across all project alternatives. With their input, we relocated pipelines, buildings, and processing facilities, avoiding hundreds of ancestral sites, cultural properties, and sensitive environmental areas. The same applied to local communities, who had the same opportunity to participate."

While the court has temporarily halted the land transfer, the project is ready to proceed with underground development once the necessary approvals are secured.

Peacey stressed that the benefits of the project go well beyond copper output: "It is about giving them tools to build their vision and diversify their economy. Resolution Copper has the potential to be a nation-building project on a regional scale, creating a stable base industry that keeps families rooted in their communities. For so long, children from this area were told there was nothing for them here, but Resolution Copper gives them a reason to stay and build a future," she concluded.

Beyond Arizona, other projects are moving ahead to strengthen the domestic supply. In Montana, Sandfire Resources America is advancing the Black Butte copper project toward a PFS in late 2025, followed by a bankable feasibility study. "The lower zone in the Johnny Camp deposits carries extremely high grades, while the upper zone has more tonnage but lower grades. The overall copper grade of the deposits sits just under 3%. This will be a fully underground mine, as these are small, high-grade deposits. Our plan is to develop a tunnel (decline) to access both zones," explained Lincoln Greenridge, CEO of Sandfire Resources.

Like Peacey, Greenridge views positively the wake-up call the country is experiencing regarding the importance of mining. "What is encouraging is that there is now clear recognition at the federal level that the US needs to increase domestic supply. This puts a smile on the face of anyone developing a mine here," he added.

The beauty of covering a jurisdiction for the fifth year in a row is witnessing how companies cross the value chain grow and meet their goals, especially evident in the US copper sector. Numerous projects have advanced in the past year, with some entering production and others awaiting a final construction decision between 2026 and 2027.

Although copper production figures for 2024 may not have been the best, I can assure you that they are poised for significant growth in the years ahead.

Lithium and boron production and development

Nevada is the heart of US lithium production, as it is home to Albemarle's Silver Peak mine, a brine operation, which is the country's only producing lithium asset. Because of limited domestic lithium production, the US imports more than half of its lithium needs, mainly from Chile and Argentina. Albemarle is advancing a hard rock play at Kings Mountain in North Carolina. "From a mining perspective, the project proposes to expand the open-pit and build a new facility to produce spodumene concentrate. The resource is over 90 million tons grading at 1.3% lithium, making it one of the largest and richest deposits globally and home to one of the few known hard rock lithium deposits in the US," commented Jennifer Skurski, VP resources at Albemarle.

Alongside the ongoing dewatering of the open-pit, Albemarle currently operates a conversion facility on Kings Mountain that

"The US produces less than 2% of the world's lithium supply today, and that comes from our single brine operation in Nevada. That is why bringing the Kings Mountain Mine into operation is so important."

Jennifer Skurski, VP Resources, Albemarle

processes lithium carbonate from its Silver Peak and La Negra operations in Chile into battery-grade lithium hydroxide. "The US produces less than 2% of the world's lithium supply today, and that comes from our single brine operation in Nevada. That is why bringing the Kings Mountain mine into operation is so important," explained Skurski, adding that they are awaiting the approval of the submitted permits in the upcoming months.

In 2024, a flooded market with an 18% increase in worldwide lithium production coupled with a decline in demand, led to the price of lithium carbonate falling below US$10,000/t. For developers, this is a challenging environment as they are refining CapEx and OpEx estimations. However, some projects benefit from government-public endorsement, as well as from unique economic advantages.

Ioneer's Rhyolite Ridge in Nevada will co-produce lithium and boron and is now 70% through detailed design while seeking a strategic equity partner to move towards construction. "The economics of the project are unique because of the presence of boron, which provides a substantial revenue contribution. Think of it as a credit. For every tonne of lithium carbonate equivalent produced, we will also produce seven to eight tonnes of boric acid. The co-production of lithium and boric acid using a single mining and processing flowsheet positions the project in the bottom quartile of the global lithium cost curve," explained Bernard Rowe, Ioneer's managing director.

The Australian-based company's economics, released in September 2025, show an all-in sustaining costs of US$5,626 per tonne over the first 25 years of mine life.

Another Nevada-based project is Tonopah Flats, led by American Battery Technology Company (ABTC). Following a 2024 Initial Assessment, the company expects to release a PFS in 2025. The project will use a proprietary Selective Leach Extraction (SLE) process to recover lithium from claystone. "SLE extracts lithium out of the claystone while in solid form, eliminating the need for most of the acid and creating a much simpler leach solution, decreasing the scale and intensity of tailings. It lowers production costs, infrastructure needs, and environmental footprint," shared Ryan Melsert, ABTC's CEO.

Access to financing has been a recurring theme among lithium developers in today's landscape. Ioneer secured a US$966 million debt facility with the DOE, while ABTC received a letter of interest (LOI) from the US Export-Import Bank (EXIM) for US$900 million to advance the Tonopah Flats project. Both financial instruments align with US federal programs such as "Make More in America" or the "China and Transformational Export Programs", aiming to boost domestic production of critical minerals.

Similarly, 5E Advanced Materials, developing the Fort Cady boron-lithium project in California, received a LOI for up to US$285 million in debt financing from EXIM. According to CEO Paul Weibel, the project could turn 5E into the world's second-largest boron producer: "Our demonstration plant has been incredibly helpful in putting us in a position to potentially be the third-largest boron producer in the world. The second largest producer currently is Rio Tinto, but they are depleting, and considering the size of our resource and our mine life, we may have the second largest deposit globally – it is quite a large, multi-generational resource."

"The US became the world's largest oil and gas producer not through major companies, but through smaller operators who figured out how to drive the shale revolution. I believe the lithium industry could follow the same path."

Joseph Mills, CEO, International Battery Metals

Uranium production: The tide has turned

It seems that the world is moving back to embracing nuclear energy: Japan, for instance, has restarted 14 nuclear reactors since the Fukushima disaster in 2011, including two in 2024.

The reason is clear. Global power needs are accelerating, driven by the rise of data-intensive industries such as AI and crypto, and renewables alone will not be enough to meet demand. "We will need everything: coal, nuclear, and gas – and it is not about picking winners and losers; it is about keeping the lights on. You cannot power a country on weather and sunlight alone, and here is where Wyoming comes in. Our coal and uranium will be central to meeting the US's growing energy demand today and long into the future," expressed Travis Deti, director of the Wyoming Mining Association.

Wyoming, alongside Colorado and New Mexico, remain the only states in the country that produce uranium. Although uranium mining in the US is currently limited and small-scale, production is increasing. Output grew from just 50,000 pounds of triuranium octoxide (U3O8) in 2023 to 677,000 pounds in 2024.

One of the few companies contributing to the rebound is Ur-Energy, which recently restarted its Lost Creek mine in Wyoming. Lost Creek has a licensed capacity of 1.2 million lb/y of U308, but, at the same time, growth will also come from the Shirley Basin project, a satellite plant now halfway complete. "Once Shirley Basin comes online, it will be our second production site, taking our combined licensed and constructed capacity to 2.2 million lb/y U3O8," shared John Cash, CEO of the company.

As of August 11, 2024, the import of unirradiated low-enriched uranium and natural uranium from Russia or any Russian entity was prohibited in the US, a move intended to both weaken Moscow and strengthen domestic supply. Additionally, earlier this year the Trump administration reinforced this direction with four executive orders aimed at quadrupling US nuclear generation capacity by 2050. "From an investor standpoint, this reduced the risk and uncertainty that has always been tied to permitting, and we are starting to see a new acceptance that environmentally responsible projects can move forward and become operational in a much shorter timeframe than we are used to," concluded Matthew Gili, president of Ur-Energy. ■

Western USA Associations

"Progress will depend on streamlining permitting to avoid decade-long delays. Addressing community involvement, improving environmental and water management, and investing in the workforce will determine whether Arizona can realize its potential as the leader of responsible, safe, sustainable, next-generation US mining."

Steve Trussell,
Executive Director,
Arizona Mining Association

"Population-wise, Wyoming is relatively small, so it is easier to work things out where the regulator and the regulated community actually know each other and are committed to finding practical solutions."

Travis Deti, Director,
Wyoming Mining Association

"Establishing the National Energy Dominance Council is a good starting point, but I think we need to go further, and what we truly need is a central authority or leadership structure dedicated to overseeing and aligning mine planning and permitting efforts in the US."

Adam Eckman,
President and CEO,
Colorado Mining Association

"The FAST-41 process introduces timelines, accountability and transparency. If an agency misses a deadline, it must file a report with an independent body explaining why, and what it needs to complete the task. That accountability is what we need."

Deantha Skibinski,
Executive Director,
Alaska Miners Association

America's Mineral Future

Copper

"Johnson Camp began producing run-of-mine mineralized material in August 2025. In Q4, we plan to start leaching sulfides using Nuton's technology and should see copper coming off the pad in December or January 2026."

Stephen Twyerould,
President and CEO,
Gunnison Copper

Precious Metals

"Greens Creek and Lucky Friday produce ~13 million oz/y silver, making us the largest US silver producer. Greens Creek also produces gold, and both assets generate significant lead and zinc, with ongoing focus on optimizing existing operations."

Rob Krcmarov, President
and CEO, Hecla Mining

Lithium

"In 2025, we increased mineral resources by 45% and upgraded ore reserves by 308%, reaffirming strong project economics. Rhyolite Ridge is fully permitted with a US$996 million DOE-backed debt facility, set to become a cornerstone of the US's critical minerals supply chain for decades to come."

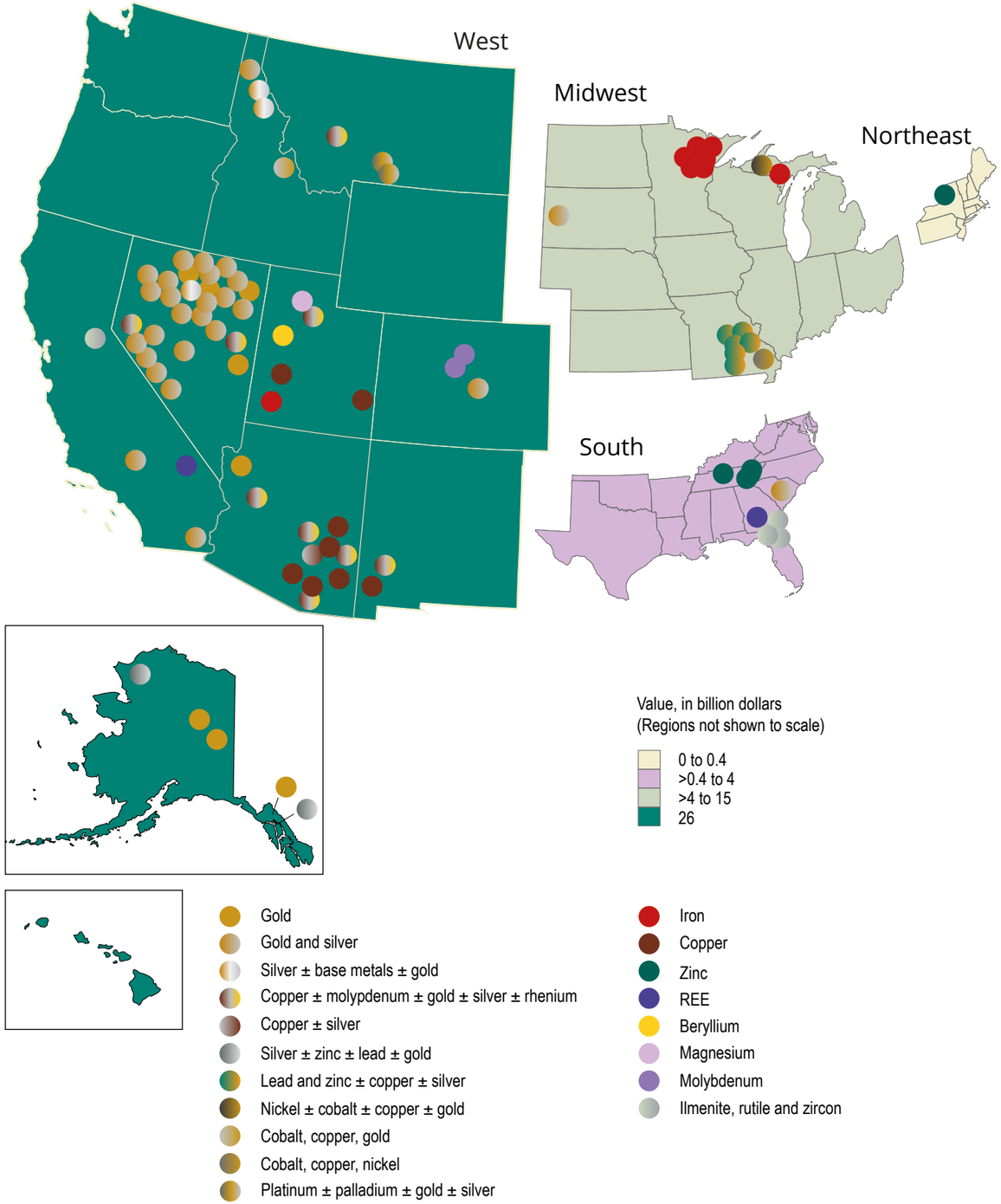
Bernard Rowe,
Managing Director, Ioneer

Uranium

"We are ramping up production at our Lost Creek mine. Once Shirley Basin comes online in early 2026, our second production site, our combined licensed and constructed capacity will be 2.2 million lb/y U3O8."

John Cash,
CEO,
Ur-Energy

Value of Metals and Metallic Minerals Produced in 2024, by Region



Source: Mineral Commodity Summaries 2025 | U.S. Geological Survey

Image by Terry Davis at Adobe Stock

Mining Exploration

Juniors begin to catch the cycle

Exploration spending in the United States concluded 2024 with its fourth consecutive year of growth. The US accounted for the third-largest share of global nonferrous exploration budgets, increasing 2.2% year-on-year, reaching US$1.65 billion, marking the second-highest allocation ever recorded by S&P in the US, just below the US$1.67 billion peak in 2012. The number of companies exploring in the country also increased, rising from 350 to 394.

Interestingly, unlike the global scenario in which majors dominated, in the US, juniors accounted for a larger share of exploration spending, with gold leading at 50% of budgets, followed by copper, lithium and silver. Juniors have been the last to benefit as the market turned, struggling to raise funds even as commodity prices rise. Has the time arrived for juniors to start enjoying the benefits of high commodity prices, close financing, and for share prices to move upward?

In Q2 2024, alongside Canada and Australia, the US remained one of the top destinations of funding, as gold prices continued to hit record highs. "The market sentiment is helping. Gold is at an all-time high, with silver closely following, as energy infrastructure needs and the rise of AI drive demand for metals. We have political momentum, societal acceptance, and global demand converging all at once. That is why I think this could be one of the most powerful metal cycles we have ever seen, as we have never had so many catalysts driving the momentum for all metals," determined Rob Bergmann, CEO at Relevant Gold.

Founded in 2020, Relevant Gold is advancing two camps in Wyoming, South Pass and Bradley Peak, stretching over 200 km along a major structural belt. A 2024 airborne magnetic survey validated the company's thesis linking Wyoming's gold potential to Canada's Abitibi belt. "Our thesis connects Wyoming to the Abitibi gold belt, tracing back 2.7 billion years to one of the largest known gold mineralization events in Earth's history, when these rocks were still connected. Later, plate tectonics tore the landmass apart, leaving a piece of the Abitibi in Wyoming," explained Bergman.

"What is encouraging is that there is now clear recognition at the federal level that the US needs to increase domestic supply. This puts a smile on the face of anyone developing a copper mine here."

Lincoln Greenidge, CEO, Sandfire Resources America

The survey not only validated the thesis and put the belt firmly on the map, but also drew industry attention, with Kinross taking a 19.9% stake in the company.

Western Exploration is also making strides in Nevada. In June 2025, the junior published a PEA for the Doby George deposit within the Aura project, which currently hosts around 1.5 million ounces of gold equivalent. CEO Darcy Marud, in an interview with GBR, remained cautious about market conditions, however, he stated: "We remain focused on execution because quality and delivery ultimately drive value. Producers have re-rated with the gold price, and developers with permits or clear development pathways are beginning to follow as capital seeks the next layer of leverage. At the same time, juniors have lagged even as access to capital has improved compared to 2023."

Fully funded to continue advancing Aura, Western Exploration also sees potential for industry consolidation to improve efficiency and unlock shareholder value. "Ten juniors each spending roughly $1.5 million per year on public-company overhead could be combined into two entities with total overhead on the order of $4–5 million, thereby redirecting $10+ million annually from duplicative regulatory, legal, and audit costs into drilling and development, and in our view, creating more shareholder value per dollar deployed," concluded Marud.

"Whether or not the US government gets directly involved with gold development remains to be seen. But if gold is now being framed as a critical mineral, that could open the door to more support," commented Tony Reda, CEO of Tectonic Metals, a junior exploring in the Tintina province in Alaska.

Geopolitical risk is pushing investors to reconsider where they put capital, and resource nationalism is rising. In Mali, for example, a revised mining code in 2023 raised royalty rates and state participation in mining projects. In June 2025, a Malian court ordered Barrick's Loulo-Gounkoto complex into state control under a provisional

administrator. “What investors and companies want is predictability: they want to know if they invest in a place like Alaska or Chile, the rules will not suddenly change, or they are not going to lose the asset or get hit with a surprise tax or royalty. The US stands out here,” said Reda.

The company recently launched its largest drilling campaign at its Flat project, which sits just 40 km away from the giant Donlin gold project, testing three new targets. “You have to ask yourself: if this belt has already produced something of that size, why would it stop at just one? We believe the Flat project sits in a mineral belt that is incredibly fertile, and while Donlin is the most prolific discovery in it, we are the next most advanced project,” he finalized.

Copper

Porphyry deposits account for 70% of the world’s copper supply and often host valuable byproducts such as gold and molybdenum. Because of their scale, developing them requires companies to rethink traditional approaches to optimize both CapEx and OpEx. In Idaho, the CuMo project stands out as a unique type of porphyry known as a stockwork system, where about 96% of the mineralization occurs in very thin veins, making ore sorting essential to the project’s viability. “Given the current geometry and understanding of the ore body, it is going to be a large pit, likely 3,000 feet deep. The CuMo project will be the largest project in Idaho, and we will be producing copper, molybdenum, silver, tungsten, and rhenium,” explained Andrew Brodkey, CEO of Idaho Copper.

While a 2020 PEA envisioned a 150,000 t/d mill, Brodkey believes that the recommended scale and associated CapEx are too high, and a smaller mill combined with staged ore sorting provides a more realistic pathway. “I believe that we are moving towards a breakthrough in technology where smelters may not be needed in the future, and if we can efficiently re-leach sulfide copper, then we can actually produce everything domestically instead of importing over 40% of our refined copper from overseas,” commented Brodkey.

Meanwhile, in Arizona, the nation’s stronghold for copper, Faraday Copper is advancing its Copper Creek project. The company expects to release an updated MRE and PEA targeting a significant throughput increase (from 30,000 t/d to 45,000 t/d), which would support an average annual production of around 75,000 tonnes. “This will put us among the top five or six copper mines in the US in terms of scale,” assured Paul Harbidge, president and CEO at Faraday.

Lithium and the oilfield pivot

Over the past four years, much of GBR’s attention was fixed on the McDermitt Caldera along the Nevada-Oregon border, home to Lithium Americas’ Thacker Pass, Jindalee’s McDermitt project, as well as Ioneer’s Rhyolite Ridge. Nevada may be the Mecca of US lithium exploration, but the next frontier is emerging far from the desert: the Smackover Formation.

Stretching from the Gulf of Mexico through Alabama, Mississippi, Louisiana, Arkansas and Texas, the Smackover Formation covers an area larger than the Permian Basin, the highest-producing oil field. Historically known for oil and gas, it has now attracted energy majors hungry for lithium.

In 2023, ExxonMobil secured rights to 120,000 acres in southwest Arkansas with the hopes to finally launch its “Mobil Lithium” product. Equinor followed in 2024, joining Standard Lithium to form a JV, and in January 2025, the company received a US$225 million DOE grant for the South West Arkansas lithium project. Finally, Chevron announced plans in June 2025 to pursue Direct Lithium Extraction through Chevron New Energies (launched in 2021).

There must be something that is making traditional oil and gas companies pivot to lithium, despite depressed lithium prices. “The major players will play a big role in the development of the lithium industry as they have the capital, technology, and patience to see the technology evolve and become commercial,” said Joseph Mills, CEO of International Battery Metals, added a caution: the US shale boom was not built by Exxon or Chevron, but by countless smaller operators. “In the lithium industry, it could be the same,” he stated.

The common thread in the Smackover Formation is oil and gas giants backing lithium through advanced DLE. “Our process offers a recovery rate up to 98% of lithium, with a smaller footprint and scalable design that makes our modular facilities faster and less costly to build and operate. We have a very low operating cost as we do not use chemicals, and up to 96% of our processed water is recycled to be used again in our plant,” explained John Burba, Chief Technology Officer of IBAT, continuing: “We have built and operated a demonstration

“With the reshoring of mining and the growing emphasis on producing critical minerals within the US, we have seen increased demand for integrated infrastructure that helps mining companies meet both economic and sustainability goals.”

Jon Dunham, Client Segment Director – Mining, Metals and Fertilizers, Black & Veatch

“In Arkansas and other states, lithium development is also emerging as an important sector. The US market is becoming more integrated across the supply chain, with hard rock mining in the West and industrial minerals in the East.”

Anne Thatcher, Senior Vice President, Arcadis US

plant in Utah, and we believe it is the first commercial Direct Lithium Extraction (DLE) operation in North America.”

Scalability and modularity are becoming watchwords and may be the remedy for lithium developers in the current market. As Nicholas Lugansky, head of mining at SLB, stressed: “To deliver lithium in the short term, economies of scale are vital. Clients seek SLB’s subsurface expertise to characterize deposits and our integrated well-to-product solutions to boost efficiency and reduce costs. The entry of major mining and energy players into the lithium market is encouraging.”

Not all projects see lithium as viable. Texas Mineral Resource (TMR), owner of the Round Top project in West Texas, ultimately excluded lithium despite its presence. Anthony Marchese, chairman at TMR, commented: “I am fairly certain that our new project flow sheet will exclude lithium, as it is expensive to process, and the economics of including it in this project are not favorable, both from a production standpoint in terms of cost to produce, and from a market standpoint in terms of the price of lithium. It is not possible to produce all the minerals the Round Top deposit holds without incurring significant expenses.”

Rare earths

Lithium is only part of the US critical minerals puzzle. REEs, manganese, and other critical minerals remain dominated by China, which accounts for approximately 70% of the global supply. The US still relies on China for 80% of its REE supply.

Daniel Gorski, CEO of TMR, pointed to pricing manipulation as a setback for domestic explorers: “The major drawback of REE projects is that the prices of magnet metals are so low that it is difficult to make the economics look favorable. In the conversation with the administration, they are realizing that the only way to obtain a domestic source of REEs and other tech metals is for someone to purchase those commodities at a price that allows the producer to make a profit. Particularly in the case of REEs, the Chinese have fixed the price at such a low level that it is not feasible to capitalize and commission an REE operation; something must change in pricing before access to REEs becomes available in the US.”

This frustration is widely shared. Michael Rowley, CEO of Stillwater Critical Minerals – a junior that is developing the Stillwater West Ni-PGE-Cu-Co + Au in Montana, said: “How do you compete globally when you play by free market rules and others do not? This also relates to the fact that China's practices often disregard environmental and humanitarian standards, putting Western producers at a competitive disadvantage. Fortunately, this message seems to be resonating in Washington.”

On April 4, 2025, China’s Ministry of Commerce imposed new export restrictions on seven rare earth elements and magnets used in the defense, energy and automotive sectors, as a direct response to US tariffs on Chinese goods. This undoubtedly reinforced the idea of resource nationalism as a geopolitical tool.

The US government is reacting, and the USGS has identified the La Plata Mountains, Colorado, as a potential critical mineral and rare earth source area, according to Scott Petsel, president of Metallic Minerals. “Right now, we have geologists in the field mapping and collecting samples, working with that data to understand the distribution of these metals and how they might potentially affect project economics. The recognition of these elements raises the profile of the project and could attract additional focus from both local and federal levels,” commented Petsel, discussing how this recognition is shaping the La Plata project, which is a copper, silver, gold and platinum group

"It is well understood amongst industry participants and geologists in particular that existing methods of making new discoveries have not been working for some time, and they need to look at new approaches."

Matthew Grainger, VP of Portfolio Management, VerAI

"Space mining should be seen as another place to operate. While Earth's answer to declining ore grades has been to move more material, we extract a metric ton of PGMs in three months using roughly three kilowatts — less than a single mine truck."

Chapman Snowden, Head of Mining, AstroForge

element deposit with 1.21 billion pounds of copper and 17.6 million ounces of silver in an inferred mineral resource estimate.

Manganese highlights the extent of the US's reliance on foreign sources, with no domestic production and only one project in development: South32's Hermosa project in Arizona. "What is really important is the bigger picture, as there is currently no manganese ore production in the US, and everything is imported from China," stressed Brian Savage, CEO of Electric Metals, which recently published a PEA for its North Star Manganese project in Minnesota.

Savage added: "We are actively evaluating a redomiciling of the company to the United States, specifically to Delaware, to better align with our long-term strategic objectives. We believe this move will significantly enhance our eligibility for US government funding—particularly for feasibility studies and the development of a domestic processing plant."

Other companies are following the same path of "Americanization", mainly in the critical minerals space, particularly rare earths, where visibility is key for both investors and government engagement, especially given recent government funding for companies like MP Materials. Ranjeet Sundher, CEO of Tactical Resources - advancing the Peak project in Texas, highlighted: "The trend of North American-focused companies, particularly those in the critical minerals sector, listing on NASDAQ is just beginning, but it is real. There are currently very few rare earth companies listed there, and we intend to join that small and elite group."

Look at the stars and use AI

If lithium, REEs, and manganese highlight supply risks, the bigger question is where tomorrow's discoveries will come from. Success rates are declining, as are ore grades, while costs are rising, and investors are becoming reluctant.

Matthew Grainger, VP of portfolio management at VerAI, explained: "The exploration sector has been neglected for a long time, as it was considered to have poor performance by investors. Historically, most discoveries were made by junior companies, however the rapidly declining success rate of making discoveries lead investors to abandon the sector. However, we may see this changing with increased commodity prices and the development of new exploration technologies."

VerAI, an AI-driven explorer, has built a royalty-generation model rather than a service business. "We are not a service provider, and our whole model is based on partnership and sharing the risk/reward with the groups that we work with. We believe our business model is truly unique, combining the advantages of a royalty generation type model with our proprietary technology to generate significant value. Our technology allows us to generate targets quickly, and there are no fees or costs to our partner company unless the targets are successful. Offering this partnership capability differentiates us in the market and gives mining companies confidence in the technology," said Grainger.

For now, the company is prioritizing copper and gold targets, aligning with rising demand.

If Earth's best deposits are already found, where will future resources come from? Some believe the answer lies in outer space. According to Chapman Snowden, head of mining at AstroForge, which is preparing its Deep Space Two mission in 2026 to attempt a landing and surface sensing on an asteroid, which will cost around US$10.5 million. "On a per-ounce-of-platinum basis, it can be cheaper for us to fly a spacecraft 20 to 30 million miles than it is for a terrestrial mine to go a thousand meters underground. Earth mining rightly carries extensive environmental and human-safety obligations. Our missions are fully autonomous, so we do not have those human-exposure risks, and we are not altering Earth's environment," he explained. ■

Image courtesy of National EWP

Services

The gears for growth

The US mining industry is gearing up for growth, with both private and government investment flowing into the sector. The outlook is stronger than it has been in decades. For service providers, this translates into a full pipeline of work, but the sector's momentum does not come without challenges. Shifting legislations, inflation, and permitting delays are shaping how projects move, if they do not stall, and how service providers position themselves. Stakeholder dynamics, including those from surrounding communities and the government, as well as Native American tribes, can add further complexity to the equation. The US may not have a mining sector as developed as other jurisdictions where the industry represents a larger share of GDP, but today's Government support and investment wave is creating a fertile ground for suppliers and service providers to catch as many opportunities as they can. "All in all, there is no scarcity of bidding opportunities, and our project pipeline is larger than it has ever been," said Curtis Billow, executive VP at Ames Construction, noting that the current political emphasis on critical minerals is a key driver.

This wave of investment is not happening in isolation, but is part of a broader industrial shift reshaping global supply chains — driven by the energy transition, the growth of clean energy, and efforts to rebuild domestic capacity and secure critical resources. "Reshoring requires investment, with much of it being allocated to sustainable power generation to fuel the growth in demand. The energy transition, in turn, drives demand for mining, as the more energy demanded, the more raw materials are required for it. As a result, the need for engineering, environmental, and construction services is growing," commented Paul Ridlen, president of Knight Piésold USA.

For developers, permitting challenges often outweigh even inflation. "Inflation is always something mine operators need to keep an eye on. However, for our clients, who are mostly in the development stage, the bigger concern is navigating the permitting process," said Dagny Odell, owner of Nevada-based consulting firm Practical Mining.

With mine development in the US averaging nearly three decades, delays can undermine even the most robust project. Odell stressed that miners could help themselves by being proactive: "That means collecting the baseline data the agencies are going to ask for and doing that earlier in the project. It helps move things along. What we really need to see is a more streamlined review process," she emphasized.

Randal Huffsmith, senior VP and US mining sector lead at WSP, underlined the competitiveness issue in the United States, creating asymmetric advantages for countries processing resources with reduced commitment to environmental stewardship: "It is crucial to develop sustainable sources while facing challenges like permitting timeliness, without compromising environmental protection. Some countries are less concerned about environmental impacts, and in some cases, safety, which allows them to use older, less expensive production technologies, making it difficult for the US to compete."

Permitting and inflation are only part of the picture. Tariffs and ESG demands are also reshaping project economics. "Increasing ESG requirements have sharpened the focus on environmental performance, safety, and corporate governance on mining projects. Cost, schedule, and risk reduction remain central priorities in a market where intense competition exists for permits, financing, and expertise. For instance, although current tariffs apply only to goods, not services, they can still adversely affect production costs," said David Thomas, VP of minerals and metals for the Southwest USA at Ausenco.

Technology as the unlocker

For Richard Peevers, regional manager for the Americas at Whittle Consulting, these challenges (permitting, costs, prices, nationalism, and unpredictable markets) are not new: "These five challenges are not new and have always been problems in the mining industry; they might just be a little more dramatic currently. For most of us in the mining industry, it is business as usual - you have to work through a rigorous study process."

However, he pointed out an important difference in today's mining era: the role and access to technology: "There is a lot more technology around than there has been in the past, and industries, including the mining industry, are embracing these technologies to improve both the efficiency and sustainability of their operations," he concluded.

Yes, technology is there, but its adoption is uneven between top-tier and smaller companies. "Juniors typically apply it to a specific project or stage in the mine life cycle, majors tend to take a broader view, analyzing portfolio-wide datasets [...] By applying a machine learning approach to their existing datasets, we can reveal patterns and information they might not have noticed before," explained Tom Meuzelaar, founder and owner of Life Cycle Geo.

He illustrated the impact of AI with a closure scenario: "A company believed it would need to manage a vast water footprint; using a machine learning approach, we found that much of their impacted water was naturally present before mining began, allowing them to significantly shrink their water treatment footprint, which will likely save them eight figures."

Beauty is in the eye of the beholder

I like to think that a single landscape can be viewed in multiple ways and hold many kinds of beauty, depending on who is looking. To most people, it is the beauty above the ground. To geologists, the beauty lies beneath, deep down, where there is a promise of hidden metals and new discoveries. For consultancy and engineering firms, the beauty is in both: helping mining companies unlock those deposits, and later, when the life of the mine ends, restoring the land to what it was – or even better.

"Contractors used to be the last ones to join the conversation, but mining companies and engineers are increasingly involving them in early phases, like PFS or FS, to ensure constructability and cost awareness."

Curtis Bilow, Executive VP, Ames Construction

"Most North American mining projects were executed under an EPCM model. Today, the industry seems to be shifting toward an Integrated Project Management Team (IPMT) model in response to industry-wide staffing challenges."

David Thomas, VP Minerals & Metals - Southwest USA, Ausenco

As of today, in the mining industry beauty can even be found in what others overlook. Where many see only waste, others see opportunities. In tailings, engineering companies see the possibility of value, recovery and renewal.

The whole industry at a global scale is pushing to reprocess tailings and recover mainly critical minerals and rare earths that were never extracted in the first place. "The recovery of metals covers the operation costs and puts money in the pockets of those who are doing the work, and the final tailings are then put in a newly designed facility that has monitoring systems and is protective of the environment," explained Randal Huffsmith, SVP and US mining sector lead at WSP USA. "For example, ElementUSA is looking at recovering rare earths from red mud lakes. If we can re-mine waste piles, collect the minerals, and close the waste dumps sustainably, it is a win-win for everybody," he continued.

Nowhere is this shift clearer than in copper. Freeport-McMoRan has made strides with its "leach to the last drop" initiative, turning stockpiles into a meaningful production stream. "By leveraging AI, data analytics, and even developing new additives, our technical team has been able to improve recovery. One of those additives is heading into pilot-scale testing soon, and it could be a game changer," said Joshua Olmsted, president and COO – Americas for Freeport-McMoRan.

The results speak for themselves: an additional 250 million lb/y of copper with a run-rate goal of 300 million lb/y by late 2025 or early 2026. Ultimately, the company aims to reach 800 million lb/y through leaching.

Freeport-McMoRan is addressing reprocessing the material internally, but engineering and consultancy firms are also sharpening their focus on tailings. Anne Thatcher, SVP at Arcadis US, whose mining business has grown in large part due to its expertise in critical minerals and global tailings management, commented on the business model of reprocessing tailings: "Some miners are handling this internally rather than outsourcing, while others prefer to partner with us to explore the possibilities."

Arcadis' own study of a legacy site in California revealed an estimated US$60 million worth of critical minerals, but the economics did not justify building a reprocessing plant at the time. As Thatcher explained: "Over time, technology and digital innovation may reduce costs and shift the equation, but for now, it is a balance between strategy and financial feasibility. The opportunity landscape is shifting toward byproduct recovery (capturing critical minerals at an operating mill before they enter the waste stream), and Arcadis has shown strong capabilities to help clients with this option."

Other peers echoed this sense of cautious optimism. Jeremy Scott Collyard, US mining and minerals sector lead at SLR International Consulting, pointed out that re-mining has both economic and environmental benefits:

"Re-mining with current technologies and a better understanding of closure can have a positive environmental impact. If we are allowed to operate, that operation will fund historic mining cleanup, and we will leave the site to a closure standard of today, rather than a standard of 50 years ago. I believe several brownfield projects in the US are poised to move forward, fueled by rising commodity prices, advanced technologies, better knowledge, and growing support from both government and the communities," he concluded.

Contractors: feeling the pressure?

Contractors in the mining industry are not exposed to the same rollercoaster of commodity prices as producers. Their contracts are usually fixed, so they benefit indirectly from higher prices when new projects come online, but not from ongoing price swings. Still, their challenges mirror those of their clients. "Wages have gone up, and so have consumable and maintenance parts prices. At the same time, publicly traded companies remain highly sensitive to market signals. In this inflationary context, clients are pushing to cut costs, putting pressure on contractors like us and squeezing our margins. Unfortunately, there is little we can do as there is no magic button, for instance, to increase bit life underground," explained Keith Jones, general manager for Small Mine Development.

Despite the headwinds, Jones sees a shift in the mood, noting that the market is once again feeling bullish. The underground transition may be one reason for optimism. "Underground mining allows us to concentrate on the highest-grade ore with the least environmental impact. As open pits have obtained greater depths, it is easier to transition to underground mining where the orebody is amenable to underground mining," said Jones.

Contractors are also navigating broader infrastructure and supply challenges. "These factors can shift procurement strategies, delay critical equipment, and introduce cost variability that impacts schedules and project budgets. We mitigate these risks through early engagement with suppliers, flexible sourcing strategies, and scenario-based planning that helps clients navigate uncertainty with confidence," explained Jon Dunham, client segment director for mining, metals and fertilizers at Black & Veatch.

Doug Miller, vice president and managing director for mining, metals and fertilizers at the same company, commented that energy demands further complicate the picture: "As mining companies implement technologies to extend the mine life and production capacity, it often requires additional energy. However, power demands are increasing significantly, and there is great competition amongst industries for the electrons that are available."

One response to these pressures has been earlier collaboration. Mining companies are bringing contractors into the process at the pre-feasibility or feasibility stage to ensure cost realism and constructability, as it was the case of Hudbay with the FS of Copper World in Arizona, having engaged with Ames Construction, Sundt Construction, DRA Global, M3 Engineering & Technology, Knight Piésold, Mipac, and Stantec.

"Contractors used to be the last ones to join the conversation, but the value of incorporating us early is clear […] Mining companies and engineers are increasingly bringing contractors into the projects in early phases, like PFS or FS, to advance the projects and provide constructability with an understanding of the cost," said Curtis Bilow, executive vice president at Ames Construction.

Interestingly, some contractors report that labor is not the bottleneck many suppose. Both Billow and Keaton Turner, founder, president, and CEO of Turner Mining, see equipment availability as the bigger challenge. "In today's mining boom, where multiple projects are ramping up at once, equipment availability could become a real bottleneck. That is why working closely with our suppliers is critical," shared Bilow.

Turner agreed, noting that each project they work on requires a custom fleet: "Every time we win a new contract, we custom-build and order the fleet specifically for that operation, which means there can be delays. For instance, we currently have a US$40 million equipment package in place for an operation in Nevada. In the best-case scenario, we expect to have everything ready within 60 to 90 days. However, for some long-lead items, such as drills, we have been advised to expect a wait of eight months."

Drilling contractors

In the face of a new commodities cycle, everyone is bullish on the US mining industry; juniors are capitalizing on market changes to their benefit, producers are enjoying healthy margins, and politics are also contributing to the positive outlook. Denis Despres, CEO drilling services at Boart Longyear, said: "What is interesting is that, unlike past cycles where the increase often began in Canada or Australia, this time the first signs of strength have appeared in the US. That shift reflects supportive policies, as well as the underlying resource base, particularly copper and gold, in highly prospective geographies."

Renewed activity in the exploration market is welcomed across the industry, but after a prolonged downturn, many drilling contractors have to catch up. During periods of slow activity, they were forced to let skilled workers go, and today they must rebuild that capacity, as the industry faces a broader structural issue: a labor shortage.

The combination is creating intense pressure among them to deliver results faster and more efficiently, with competition for both people and resources. "In periods of lower activity, service providers must reduce scale, and when the market recovers, it is not easy to quickly rebuild the pipeline of experienced drillers and new trainees. Because safety is our top priority, we cannot compromise on training or competence […] Volatility works against that because contractions interrupt the development cycle," explained Depres.

Jeffrey D. Morgan, president and CEO of National EWP, a drilling company with a Western US focus and facilities in Arizona, Nevada, and a staging yard in Utah, commented that he expects this competition for workers to even get worse: "Shortage is expected to worsen as the US seeks greater independence. The energy, construction, manufacturing, and mining industries are also experiencing growth, further exacerbating the issue. All these industries are competing for the same workforce, and with a labor demand-supply imbalance, we expect labor costs to increase."

Building on Morgan's point, the problem is not only rising labor costs, which inevitably translate into either higher service costs or narrow margins for contractors - but also two additional factors: high labor turnover, and the fact that companies cannot compromise safety standards. "This year, we decided to shut down three of our rigs because we could not operate at the high standards we aspire to with the team we had in place," lamented Morgan, concluding: "My message to the industry would be to focus less on price and more on value. There is a relationship between price, safety and quality."

For the Finnish manufacturer of drilling consumables, Robit, there are two dimensions for today's new cycle; the customer side and the cost side. "On the customer side, some of our clients are drilling more because of higher mineral prices. Exploration drilling also appears to be trending upward this year,

Cindy Collins, VP Growth Americas, MSALABS

Braden Lusk, Chief Technology and Marketing Officer, Dyno Nobel

although we are not directly involved in exploration tooling. We will see the impact when exploration projects transition into development and production. Tariffs have increased our costs, which will most likely drive-up product prices. Many products have limited domestic manufacturing in the United States. Therefore, tooling prices are trending upward primarily due to steel prices and tariffs," commented Mikko Vuojolainen, vice president for North America.

Laboratories are full

Because of the reason above mentioned, linked to the fact that operations often take place in remote locations with complex logistics, Cindy Collins, vice president of growth – Americas at Capital Limited & MSALABS, commented that the drilling sector has suffered from low productivity and that clients are facing operating costs that have increased 50% or more: "There is a growing need for sampling directly at the rig and delivering information earlier to support faster decision-making," she emphasized.

In this context, labs like MSALABS or Skyline Assayers & Laboratories, are thriving. "Dill rigs are in high demand and expensive, coming in around US$125,000 per rig. With faster fire assay results, the client can more quickly redirect the rig to a more appropriate site," expressed John Rosso, president at Skyline A&L.

Rosso also warned that many do not understand that the turn-around time frame is always impacted by the volume and frequency of samples received, which means it can slow down the results and take longer as no labs have an infinite supply of personnel and equipment and the pipeline may get overloaded. "The best thing a client mine can do to ensure reliable and prompt assay results is to send regular shipments of regular volumes of samples. This allows the assay lab the opportunity to pre-plan their deployment of equipment and labor to get the samples received, double-check the sample submittals and Chain of Custody for accuracy, and then get samples into Sample Prep," he explained.

Companies are looking to innovation to increase efficiency, such as new assay technologies, like PhotonAssay, which NGM is implementing with MSALABS. Collins highlighted PhotonAssay as a cleaner, safer and faster alternative to traditional methods: "It checks all those boxes when compared to traditional metallic screen and fire assays, which result in significant waste and consumables use. It is chemistry-free, safer, non-destructive, and much cleaner, allowing for recycling containers and reuse of costly certified reference materials."

Rosso, from Skyline, acknowledged the promises of PhotonAssay, but stated that because of the conservative nature of mining, he would expect a natural "wait and see" approach to it: "I think most companies will want to see the technology more widely deployed and its effectiveness evaluated over time before they commit. Traditional 'fire assay' will still be the mainstay for exploration."

Blasting and chemicals

From reagents that drive metal recovery to blasting detonators that determine fragmentation, these are all products in which sustainability is driving innovation, yet are exposed to supply chain disruptions, making reliability and cost control just as important as technical performance.

Brenntag Essentials is responding to these demands and challenges by developing tailored solutions aiming at lowering reagents cost and ensure steady supply from different locations. As Alan Smith, director of focus industries for Brenntag Essentials North America, explained, customers are seeking long-term partners who can deliver value: "If service and distribution solutions continually help them achieve their goals, customers will want to continue that supplier relationship," and continued: "From a product perspective, we are increasingly asked for safer, more sustainable products across all types of mining. Gold and copper are our main mining sectors, but this trend is also visible in coal, uranium, and others. The challenge can be a trade-off with these products when it comes to performance and cost."

Jeff Morgan, President and CEO, National EWP

Keith Jones, General Manager, Small Mine Development

John Rosso, President, Skyline A&L

Scott Plourde, Executive General Manager – West Region, Austin Powder

These same pressures are reshaping the explosives market. Braden Lusk, chief technology and marketing officer for Dyno Nobel, noted that miners must boost productivity while advancing their ESG commitments. In response, Dyno Nobel is investing in renewable diesel emulsion, lead-free detonators, and advanced blasting systems. "One of our recent innovations, Differential Energy 2 (ΔE2), reduces the powder factor by up to 25% and improves fragmentation, resulting in lower energy use, reduced downstream processing costs, and a more sustainable solution," said Lusk.

Volatility in raw material availability is a constant challenge for blasting companies, as the world has not yet fully recovered from the COVID-19 pandemic and the ongoing war in Ukraine, which has led to additional constraints. For Dyno Nobel, this has reinforced the importance of building a strong domestic manufacturing base.

Austin Powder has taken a similar approach by strengthening both sustainability and domestic manufacturing capabilities. As Scott Plourde, executive general manager for the West region, explained, producing most of their key raw materials in-house and securing a domestic ammonium nitrate supply have given them a critical advantage: "As a US-focused company, we do not depend on overseas imports, which helps both our supply chain reliability and our environmental footprint," he explained.

Like others, Austin Powder is exploring how AI can add value: "One area is verifying blast hole locations and inspecting detonator connections to improve efficiency and reduce the likelihood of human error," shared Plourde. ■

Image courtesy of Darling Geomatics

Equipment and Technology

Smarter tools

In July 2025, Nevada Gold Mines (NGM) and Komatsu announced the implementation of the FrontRunner Autonomous Haulage (AHS) system to automate 300 to 230-tonne haul trucks across NGM's surface operations. Backed by Sedna and Nokia's tailor-made 5G network, two are already working in Cortez.

Freeport-McMoRan also is running an autonomous fleet. "It has been a two-year journey since we started the transition to an autonomous fleet of our 33 Caterpillar 793s. So far, we have had 15 of them running fully autonomously. In August, we will bring another 10, expecting to have the 33 running entirely autonomously by Q4," said Joshua Olmsted from Freeport-McMoRan.

The implementation of autonomous haulage systems by these major producers suggests that the US mining industry is finally embracing what was announced as the mining of the future in previous reports. However, Rome was not built in a day. Like any other technology, autonomous adoption is a process with steps and stages, and companies must put together different pieces of a puzzle, such as financial requirements, cultural shifts, and organizational changes. As Shawn Cheney, VP and business line manager for tools and attachments at Epiroc, put it: "The decision of upgrading or replacing machinery is influenced by safety, economic efficiency, and progressing toward sustainability goals."

Major companies may check the box of financial requirements, but others in the value chain, such as contractors, face a different reality. Turner Mining, for instance, evaluated autonomous haulage a year ago, but decided to hold off. "For our scale, the costs and efficiencies are not yet quite there to replace a person in the seat. As a mining service partner, we are hired to be nimble – quick to mobilize, to deliver, and to demobilize when the work is done. Autonomy, today, requires a significant upfront investment in infrastructure, setup, and support that does not always align with the agile model," commented Keaton Turner, the company's founder, president, and CEO.

"We partnered with Komatsu to deploy their FrontRunner Autonomous Haulage System (AHS). We do not envisage any retrenchments, as many new jobs are being created that did not exist before, and we are investing in training our employees to take on new opportunities."

Henri Gonin, Managing Director, Nevada Gold Mines

"Autonomy requires a significant upfront investment in infrastructure, setup and support that does not always align with the agile model. That is why contractors like us are slower to adopt it compared to the major producers."

Keaton Turner, Founder, President, and CEO, Turner Mining

Turner also brought up the employee's perspective: "Which may be the scariest because it is the loudest voice we have not yet fully heard. We were very close to deploying an autonomous haulage package, but the timing was not right, as it would have disrupted an entire network of employees at a site where we were trying to build trust," he added.

Freeport's experience reinforces the idea that change is not only about technology. "The biggest challenge has been change management: you are introducing something completely new, not just in terms of technology, but also in how people work, how processes flow, and how the site operates. One of our commitments since day one was no job losses due to this conversion, so we have been focusing on retraining and upskilling our employees either into new roles at Bagdad or at other operations," Olmsted added.

If autonomy is a journey, renewable fuels are the bridge in the decarbonization of mining operations. For example, Rio Tinto's Kennecott operations announced last year that it completed the transition of the 97-truck fleet to renewable diesel. The retrofit of the engines will allow the copper producer to reduce Scope 1 emissions by 450,000 tons of CO_2 equivalent yearly.

Komatsu's related company, Cummins, supported this transition at Kennecott. "Many of our solutions are designed for retrofit, reducing the CapEx because customers do not need to replace entire fleets. These retrofits also deliver operational expenditure benefits through fuel savings, lower maintenance costs, and improved productivity," commented on this regard Gbile Adewunmi, VP of industrial markets at Cummins, who believes that sustainability measures must also offer total cost of ownership advantages if they are to be widely adopted. "Miners will invest in decarbonization only if it also improves efficiency and profitability […] We intend to achieve zero emissions over time, but we know this will require transitional `bridge´ technologies that allow miners to reduce emissions without replacing entire fleets immediately," Gbile continued.

Epiroc's VP and business line manager for surface drills, automation, and digital, Matthew Inge, said: "The current market is interested in automation technology that can enhance productivity in mining operations. In the US, there are fewer mines opening to service the same, or even increasing demand. With that complex problem, a lot of customers are looking for solutions to do more with less."

However, these new solutions open a new dilemma: buying entirely new fleets or retrofitting existing ones? Inge pointed out the trade-offs of both approaches: "Customers who put a lot of effort into rebuilding machines in a specific period get more asset utilization, so they are more prone to converting fleets. The issue with fleet conversion is that there needs to be a plan for backfill, or you risk a drop in overall productivity while you take that machine out. When you buy new, you are usually continuing to run the existing fleet, and can cycle to retire the old fleet, so there is not much of a decrease in productivity during replacement, but this is usually more costly."

Technology adoption, like any journey, may have the same destination, but each company's path is unique, shaped by its own strategy and reality.

Who A(I)re the new miners?

As the workforce shrinks and decades of experience and knowledge fade, many view AI as a tool to preserve that knowledge and optimize operations. Ravi Sahu, CEO of Strayos, explained this idea: "With AI tools, training and knowledge resources can be captured in one place, and you can build a profile of use cases through experienced mining engineers, geologists, etc., transferring their knowledge into a database."

AI has long been used in industry, but now it is accessible to everyone, enabling diverse applications across the value chain. Darling Geomatics is a high-tech surveying company that specializes in providing comprehensive geospatial data solutions and which is also experimenting in the field of AI to improve its services and offer an added value through digital twins. "With LiDAR, we do not just monitor the moment;

we also save all our customers' data, which allows us to build a library that goes back more than 20 years for some clients. We are taking that data a step further by feeding it into AI, allowing companies to see how different parts of a site are moving – from buildings to crane rails – and using predictive analysis to forecast future changes. It is a powerful tool for planning and safety," commented Richard Darling, president and founder of the company.

His colleague, Mary Darling, the company's CEO, added that drones, combined with satellite imagery, are also helping within the exploration segment to reduce the cycle: "For example, we are combining satellite imagery with different types of aerial imagery and our own drone-based data. We use multispectral analysis to highlight indicators that point to certain minerals. This approach enables us to examine stockpiles, heap leach areas and other aspects of various mine sites to identify opportunities for both critical minerals and more traditional commodities."

"We believe this is a US$2 billion market, so it is a significant opportunity. Being a non-invasive tool is an extremely attractive feature for miners, as we do not have to be in the field with heavy equipment," shared Gary Eaton, chief of staff of Asterra, when speaking of the potential for growth within the mining industry as a provider of synthetic aperture radar (SAR) satellite data and AI to detect underground moisture.

Just as many are experimenting with AI to add value to the services they already offer, Asterra began experimenting and using SAR for other applications besides slope stability and tailings dam control, expanding to monitoring other infrastructure such as railroads or leaching pads: "Even a small percentage improvement in efficiency in a gold mine that uses chemicals in a leach field can have a huge impact on its share price. The possibilities for us in mining are massive, which is why we invested so much time in developing this market," continued the CEO of the company, James Perry.

In some cases, the lack of talent is pushing companies to adopt new technologies; sometimes, it is regulation. EcoVAP developed a system to accelerate tailings drying using solar radiation, gravity, and biomimicry. The company's VP of strategy, recounted how a REEs mine in the desert of the US adopted its technology due to tailings storage facilities restriction coupled with lack of permits for land use: "This system evaporates throughout the year - night, day, winter, summer - and on average, it evaporates 125 gallons per minute. As a result, the client was able to dramatically increase their production capacity," concluded Rowe Michels.

To answer the not-so-hypothetical question of whether AI will replace humans in mining, Simon Jowitt, director of the Nevada Bureau of Mines and Geology and State Geologist at the University of Nevada, Reno, stated: "As mining becomes more data-intensive, tools like machine learning and algorithm development will be critical. That said, AI is not a magic black box; you still need expert input, and geologists are always going to be essential. We will always need people in the field to generate geophysical, geological and geochemical data." ■


Image courtesy of Epiroc

Invest or Wait: Equipment and AI

"Right now, the product development cycle is so fast, and technology is changing so rapidly that people want to make sure that when they invest in something, it is going to be around for a significant amount of time."

Matthew Inge, VP and Business Line Manager Surface Drills, Automation, and Digital, Epiroc

"Sustainability measures must also offer total cost of ownership advantages if they are to be widely adopted. Miners will invest in decarbonization only if it also improves efficiency and profitability."

Gbile Adewunmi, Vice President - Industrial Markets, Cummins

"The US mining industry has focused on increasing production, but not necessarily on optimizing yield. As demand for critical minerals grows, faster output alone is insufficient. Technology and data-driven methods are key to improving efficiency from mine to mill."

Ravi Sahu, CEO, Strayos

"Too often, machine learning is approached as a one-and-done exercise. However, this approach rarely works. We get the best results when clients share site knowledge and their domain expertise, which really helps shape our conceptual model."

Tom Meuzelaar, Founder and Owner, Life Cycle Geo

"Our LiDAR archive spans more than two decades of client data. By combining it with AI, companies can track how each part of a site moves over time and use predictive analysis to forecast future changes. It is a powerful tool for planning and safety."

Mary Darling, CEO and Principal Owner, Darling Geomatics

"Even in the early stages of exploration, the sheer volume of data is increasingly challenging for geologists to assess. As mining becomes more data-intensive, tools like machine learning and algorithm development will be critical."

Simon Jowitt, Director, Nevada Bureau of Mines and Geology and State Geologist, University of Nevada, Reno

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If you wish to be interviewed for this edition, please contact Braulio Tresguerres Grima (btresguerres@gbreports.com) or Serena Sablone (ssablone@gbreports.com)

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