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A Key Source of Minerals for North America

Western USA, where geology and geopolitics converge

Few countries contain vast land extensions rich in minerals comparable to the US. From the discovery of gold in California's Sierra Nevada mountains during the gold rush, to the emergence of copper mines in the deserts of Arizona, and the wild and untapped Alaskan wilderness, the Western US hosted some of the most prolific mining operations in history. Mining for silver and gold is embedded in the early history of many Western states. However, in today's world order, mining has gone way beyond precious metals, and is playing a pivotal role in geopolitics by extracting critical minerals and rare earth elements (REE).

Moreover, the Western United States, including Washington, Oregon, California, Nevada, Idaho, Montana, Utah, Arizona, Wyoming, Colorado, New Mexico, and Alaska, stands out as the primary hub for extracting and processing metals and metallic minerals. In 2022, this region contributed over US$27 billion in production, comprising 77.8% of the entire output of the US.

The Paris Agreement of 2015, which set ambitious goals to reduce emissions by 45% by 2030 and reach net zero by 2050, is an opportunity for many critical minerals-producing states like Arizona, the copper state, or Nevada, where lithium is abundant, to help achieve these targets. Amidst escalating political tensions between the West, China, and Russia, certain minerals essential for achieving decarbonization goals have become a national priority for the US.

In this context, where jurisdictions like Ontario or Québec have been working in the last years on a critical minerals strategy, the Western USA applauded and welcomed the decision of the US Department of Energy (DOE) to include copper for the first time in its 2023 Critical Materials Assessment, published in July 2023.

Copper: The critical material, but not mineral

According to the USGS, for a mineral or commodity to be categorized as `critical´ it must meet specific criteria: It should be essential to the economy and national security, produced from a supply chain vulnerable to disruption, and serve a crucial role in the manufacturing of products whose absence would have substantial consequences on domestic economy and security. Copper fulfills all three: It is the cornerstone of the electric transition, which is set to drive the American economy, particularly in the context of EVs; additionally, copper is the second most widely used material by the US Department of Defense (DOE), making it crucial for national security. However, it is still not listed as a critical mineral.

In this context, where jurisdictions like Ontario or Québec have been working in the last years on a critical minerals strategy, the Western USA applauded and welcomed the decision of the US Department of Energy (DOE) to include copper for the first time in its critical material list, published in July the 2023 Critical Materials Assessment.

Even though this could be a game changer for the US mining industry, we must consider the difference between critical minerals and critical materials. The USGS designates the critical minerals list, while the DOE designates the critical material list. While the DOE recognizes the role of copper in the US economy, many claim that the USGS copper evaluation is "out of date". Among them is the Copper Development Association (CDA), which slammed the USGS for "misleading" and denying a bipartisan request to add copper to its critical mineral list.

The inclusion of copper by the DOE could result in enhanced scrutiny from the USGS regarding marketing trends and reserves and could, potentially, lead to streamlined permitting processes, facilitating domestic production. This is something that the entire industry, or at least the copper segment, should push for, since copper, by not being currently listed as a critical mineral, does not qualify for the Inflation Reduction Act (IRA) tax credits, and demand for it will rise as it is the cornerstone of the electricity transition.

Pushing for new policies: From off-shoring to friend-shoring

The Biden Administration passed the IRA in August 2022, thereby incentivizing clean vehicles that require critical minerals and a strengthened supply chain for metals. House lawmakers passed the Bipartisan Infrastructure Investment and Jobs Act, which will fund a federal study of the use of abandoned mine lands and mine waste for critical minerals extraction; then the CHIPS & Science Act became the third legislative piece of a new industrial strategy; and even more recently, the House Energy and Commerce Committee is advancing a bill that would ban the import of low-enriched Russian uranium into the US.

While regulations like the IRA aim to accelerate the domestic energy transition and promote the re-shoring or friend-shoring of critical mineral production, it remains to be seen how the possible expansion of BRICS, including Argentina, Egypt, Ethiopia, Iran, Saudi Arabia, and the UAE, will impact energy trades and its consequences for the US. Some analysts argue that the expanded BRICS may adopt a similar approach to the Minerals Security Partnership, a US-led initiative aimed at enhancing critical energy security for itself and its 13 allies. This raises concerns mainly because Argentina accounted for 51% of lithium imports from 2018 to 2021.

Regulatory resilience

The well-established and comprehensive mining regulation framework in the US makes the Western US a safe jurisdiction in the eyes of mining investors. According to the Fraser Institute's Annual Survey of Mining Companies published in May 2023, the US is the region with the most jurisdictions in the top 10 rank in terms of the Policy Perception Index. Nevada is the leader both at a national and international scale, followed by Utah (4/62), Arizona (7/62), and Colorado (9/62). The Fraser Institute acknowledged that the US median investment attractiveness score increased 0.9 points compared to the previous report, making the country the third most attractive region globally for mining investment, behind Australia and Canada. The convergence of environmental and political goals offers a promising horizon for mining in the Western US. Nevertheless, the industry remains entangled in challenges like permitting hurdles and labor shortages. The following pages relate what GBR learned during our conversations with mining leaders in the region and how they perceive and manage this unique opportunity.

Mining labor shortage: Just like the minerals, critical

Many companies across the Western US mining value chain share the same concern: labor shortage. The fact that we need more mines than ever to meet the increasing demand for copper, lithium, silver, and other minerals accentuates this issue.

The numbers are alarming. According to different sources, based on the information provided by Walter Copan, VP of research

Source: Society for Mining, Metallurgy & Exploration (SME)

and technology transfer at Colorado School of Mines, more than half the current domestic mining workforce will need to be retired and replaced by 2029 (221,000 workers). A study published by Deloitte earlier in 2023 supports these statements, according to which nearly 50% of skilled engineers are reaching retirement age in the next decade. Figures from the US Bureau of Labor Statistics show that US mining employment has experienced a long-term decline from 2008 until early 2020. However, since then, it has been gradually increasing.

One can only wonder why working in the industry is not currently popular when the median annual wage for mining and geological engineers was nearly double the national average at US$97,590 in May 2022. Among the Western US states, California is the only one that comes close to matching the mining industry's average salary, with an annual average wage of US$73,222.

If not the salary, then working conditions may be a contributing factor. Mining occurs in remote areas with limited amenities, which may not appeal to younger generations. Additionally, the pandemic has shifted people's attitudes toward work-life balance, with a preference for remote work in many cases. A survey published by McKinsey & Company targeting individuals aged between 15 and 30 revealed that 42% of respondents do not find the mining industry attractive and would "definitely not work" in mining. This places mining at the bottom of the rankings, with other sectors like oil and gas, high tech, and healthcare being more appealing to this age group. Another issue the mining industry must tackle is the gender imbalance. According to the latest data from the IEA, updated in November 2022, women represent only 15% of the labor force in the US mining industry.

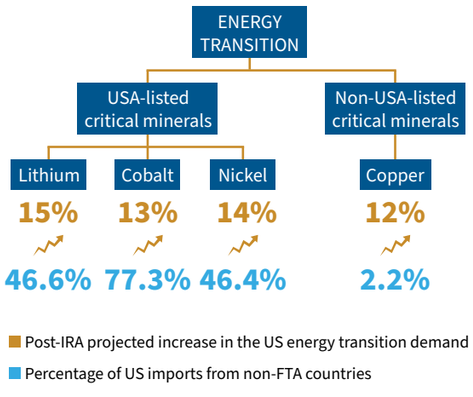
"With copper now designated as a critical material, it should open avenues for accessing Federal grants and funds through the IRA, providing valuable support for mining projects in the US."

George Ogilvie, President and CEO, Arizona Sonoran Copper

The industry requires a makeover, and it is likely that the next generation of miners will be very different than the last. Technology is set to lead this transformation. In this evolving post-pandemic working landscape, where millennials are entering the employment market, mining companies can leverage technological disruptions, such as automation and AI, to make the sector more attractive and have access to a broader talent pool: "In industries such as construction and mining, a significant labor shortage has made it difficult to find skilled workers to operate machines. By blending machine learning with the skills of human operators, we can take advantage of where autonomous technology is today while increasing productivity and addressing labor shortages," commented Vinay Shet, CEO and co-founder of Teleo.

While adopting new technologies can present challenges for experienced miners or already existing mines, it is crucial for the industry to position itself as open to embracing new solutions like AI and automation, as well as embracing diversity, like employing more women. This is necessary to reshape societal perceptions if the Western US aims to maintain resilience and remain one of the world's top-performing mining jurisdictions. The ability to adapt to new technologies and promote inclusivity —especially women—, will not only boost the industry's competitiveness but also set an example for progress in a changing world. In this context, as Steve Trussell said, executive director of the Arizona Mining Association: "Reaching new

USA mineral needs



Source: S&P Global

"While we have undertaken personnel transfers from Mexico to the United States, navigating the requisite authorizations for talent importation across jurisdictions proves intricate."

Óscar González Rocha, CEO, Asarco

audiences, communicating why minerals are vital to our future, how we obtain them responsibly, and how everyone can be a part of the solution is more important than ever."

Universities: A hotbed of new miners

Besides mining employment decreasing, enrollment in mining-related fields at universities has been falling in recent years. According to Steve Trussell, executive director of the Arizona Mining Association, college and high school students do not see mining as a career option because they do not know enough about it. "One crucial aspect is transforming young people's narrow perspective of mining, who often perceive it as a dirty profession. Instead, we want to showcase the industry's advanced technological aspects," stated Misael Cabrera, director of the University of Arizona's School of Mining and Mineral Resources, accompanying the words from Trussell.

According to Data USA, a comprehensive website and data visualization platform for public US Government data powered by Deloitte and Datawheel, the institutions that awarded the most degrees in mining & mineral engineering are the Missouri University of Science and Technology, the University of Arizona, and the Colorado School of Mines. The latest figures indicate that the total number of degrees awarded in 2021 was 314, representing a decline of 41.09% compared to the peak of 533 degrees awarded in 2016. "The shortage of mining engineers in the US demands immediate attention. While the US needs 500 to 1,000 mining engineers annually, we only graduate around 200," stated Misael Cabrera, director of the University of Arizona's School of Mining and Mineral Resources.

This decline is accompanied with a decrease in the availability of mining and mineral engineering programs at US colleges and universities. According to a report from the Society for Mining, Metallurgy & Exploration (SMNE), in 1982, there were 25 mining and mineral engineering programs at US colleges and universities; this number had declined to 14 by 2014 and has remained unchanged since.

Today's North American mining industry requires that academia and universities not only help in transforming young people's narrow perspectives of mining, but also to function as hubs where ideas, technology, and talent converge to develop new research and methodologies to apply to the real-world mining problems.

The University of Arizona School of Mining and Mineral Resources has a long-standing history supporting the industry, dating back to 1885. Today, the School of Mining and Mineral Resources brings together existing mining and geological engineering departments, economic geology, public health, and social and environmental science disciplines to facilitate education and research.

"Addressing the pressing workforce shortages is a significant challenge for the university and the industry. One crucial aspect is transforming young people's narrow perspective of mining, who often perceive it as a dirty profession."

Misael Cabrera, Director, School of Mining and Mineral Resources (University of Arizona)

The US Government has already taken actions to boost geological and mining education. According to Cabrera, the Mining School Act proposes to allocate US$10 million to support and strengthen mining schools, a breath of oxygen to enhance mining education. Even if this budget is not enough to increase the number of mining schools or centers to 25, as in 1982, it will help boost education, especially now that the enrollment rate is decreasing and the demand for miners is increasing. However, this is not solely a government problem; it is an issue that the entire mining value chain should tackle: "Academia, industry, government, and NGOs need to collaborate to solve real-world problems connecting students with opportunities to help," said Steve Trussell, executive director of the Arizona Mining Association. ■

Mineral Production

The perks and challenges of reshoring mining development

According to the Mineral Commodity Summaries for 2023 from the US Geological survey, nonfuel mineral production in the US reached US$98.2 billion in 2023, an increase of 4% from US$94.6 billion in 2021. The top 10 producing states and their respective production values were as follows: Arizona (US$10.1 billion), Nevada (US$8.9 billion), Texas (US$8.0 billion), California (US$5.6 billion), Minnesota (US$4.8 billion), Alaska, (US$4.5 billion), Utah (US$3.6 billion), Michigan (US$ 3.4 billion), Missouri (US$3.2 billion), and Florida (US$2.8 billion).

Conversely, the estimated value of American metal mine production in 2022 amounted to US$34.7 billion, reflecting a 6% decrease compared to 2021. According to the data from USGS, the Western US, encompassing the states of Washington, Oregon, California, Nevada, Idaho, Montana, Utah, Arizona, Wyoming, Colorado, New Mexico, and Alaska, emerged as the leading region in metal and metallic mineral production, accounting for over US$27 billion of production, or 77.8% of the total us production. While some Western states like Washington, Oregon, Idaho, Montana, Wyoming, and New Mexico did not secure positions in the top-10 list of producing states, others such as Arizona, Nevada and California compensated for this, effectively balancing the overall production compared to the other regions of the US.

Finally, in terms of commodity, the principal contributors to the total value of metal mine production were copper, gold, iron ore, zinc, and molybdenum, accounting for 33%, 28%, 15%, 9%, and 5%, respectively.

In the context of a growing demand as we transition into a more sustainable world, the Western US plays a pivotal role in the mineral production segment. Its dominance in metal and metallic production underscores its significance in meeting both domestic and global demand for critical minerals.

Copper production: Arizona leads the rank

In 2022, copper production in the US was estimated at 1.3 million tons (t), an increase of 6% compared to 2021. Arizona, the copper state —where major copper mines belong to big players such as Freeport-McMoRan, Asarco, Carlota Copper (a subsidiary of KGHM International), Taseko Mines' Florence Copper asset, and Excelsior Mining—, maintained its position as the leading copper-producing state, accounting for approximately 70% of domestic output (copper was also mined in other Western States like Nevada, New Mexico, and Utah). The most significant increase in 2022 in copper production was due to Rio Tinto's Bingham Canyon mine in Utah —more commonly known as Kennecott, but 2022 also saw a significant rise in copper production thanks to Freeport-McMoRan's Morenci and Safford mines in Arizona, which offset Asarco's decline.

However, during the first half of 2023, most US copper mines have declined in production compared to the first half of 2022. According to USGS's figures, Freeport produced 7% less than during the same period in 2022 (362,000 t of copper vs. 391,000 t), mainly due to unplanned maintenance and lower ore grades and mining rates. KGHM's Robinson Mine in Nevada also decreased its production by 66% because of lower-grade copper ores from inventories and the transition zone of the mine deposit. Rio Tinto's Kennecott produced 55,100 t of copper in concentrates during the first six months of 2023, 25,900 t (32%) less than 811,000 t in the first six months of 2022, mainly due to record snowfall in the first quarter and a conveyor belt motor failure at the concentration plant in March. What is interesting about this first half of 2023 compared to the first half of 2022 is that these decreases were partially offset by higher production at Asarco's mines in Arizona, where total copper output increased by 5% from that in the first half of 2022 (60,900 t).

According to a report by McKinsey & Company, the demand for copper is expected to reach 36.6 million t/y by 2031 due to electrification. However, current supply projections offer only 30.1 million t, leaving a significant gap. In response to this challenge, many copper-producing companies are developing new techniques and implementing innovative technologies to ramp up operations by producing from brownfield settings, tailings ponds, or stockpiles. One example is Freeport-McMoRan.

Freeport's president and COO for the Americas, Joshua Olmsted, unveiled that the Phoenix-headquartered company had adopted a 'leach to the last drop' approach, looking for incremental copper growth through the solvent extraction, electrowinning, and leaching processes: "This initiative is about leveraging our resources in stockpiles. With innovative leaching technologies, we can tap into

"With innovative leaching technologies, we can tap into this 38-billion-pound resource in our stockpiles to produce incremental copper. The `leach-to-last-drop´ innovative leaching process is much more sustainable, and allows us to produce the lowest carbon footprint copper."

Joshua Olmsted, President and COO for the Americas, Freeport-McMoRan

"At maximum production, Resolution Copper will use approximately 4.5 gallons of water per pound of copper (lb Cu), compared to other operating mines that consume approximately 10 to 50 gallons of water per lb Cu."

Victoria Peacey, President and General Manager, Resolution Copper

38-billion pounds (lb) of contained copper in our stockpiles that were previously deemed unrecoverable and now produce incremental copper with the benefits of not having to mine," said Olmsted.

According to Olmsted, in the US, Freeport is targeting production of 200 million lb/y of copper with the 'leach to the last drop' approach, and then driving that growth up to 800 million lb/y. In the meantime, the company continues to spend significantly in the Safford district around the Lone Star project to understand the resource. "Several years ago, we decided to go after incremental copper at Safford via the Lonestar oxide project to take the production capacity up to approximately 300 million lb/y. We are well on our way to that, and in the longer term, as we develop and invest in exploration, we are developing a model to help us define the potential for a much broader footprint at Safford," explained Olmsted.

Another major player in Arizona is Asarco, part of Grupo Mexico, that possesses the Ray, the Mission Complex, and Silver Bell mines in the copper state. The largest operation is Ray, which consists of an open-pit mine with a concentrator and a solvent extraction-electrowinning (SX/EW) operation that generates copper concentrates, followed by the Mission Complex, which also has its concentration plant.

According to Grupo Mexico's fourth quarter and annual results published in February 2023, Asarco's Arizona production totaled 112,232 t/y of copper in 2022, an 11.4% decrease compared to 2021. It is imperative that major copper producers like Freeport and Asarco ramp up operations to meet the previously mentioned decarbonization goals, however, this is not an easy task. Copper producers not only face permitting obstacles and rising costs due to inflation, but also labor shortage. Asarco, in particular, has experienced the impact of a shrinking workforce in its operations. "We confront a scarcity of personnel, resulting in operations functioning below our desired capacity. Nevertheless, we are adeptly adjusting to the projected pace and have successfully met our financial targets for 2022 and the initial half of 2023," said Óscar González Rocha, Asarco's CEO.

Besides the mines in Arizona, Asarco owns the Hayden smelter and the Amarillo copper refinery in Texas. Because both assets had been operating at a low rate, Asarco decided to suspend the Amarillo refinery, while the Hayden smelter recently started processing slag in 2023 to recover the remaining copper from the company's operations: "We are primarily selling the concentrates we send to the northern border of Mexico, specifically the port of Guaymas, where they are shipped to Asia and, to a lesser extent, Europe," added Rocha.

According to several media outlets, Asarco was in talks with Freeport-McMoRan at the end of October for a potential smelter sale. However, it seems that no agreement was forthcoming. When asked about Asarco's goals for the upcoming years, González responded that they have a long-term work horizon by sustaining Asarco's operations for another 10 to 15 years by leveraging existing reserves: "We aim to restore operations at the Hayden smelter and the Amarillo refinery to produce copper cathodes and rod, which are primarily sold in the eastern region of the United States."

Copper development

With the scarcity of new copper projects coming online to meet the looming deficit, companies are making strides to advance their existing projects. Arizona Sonoran Copper (ASCU), an emerging SX/EW and heap leach copper developer on private land, is focusing on developing its brownfield Cactus project, including the new Parks/Salyer deposit. The Toronto-headquarter company is working on the forthcoming PFS for the first quarter of 2024. According to George Ogilvie, president and CEO of ASCU: "The upcoming PFS promises to be transformational for Arizona Sonora. In contrast to the 2021 PEA, which excluded Parks/Salyer, this PFS will integrate the deposits and target a 45,000-50,000 t/y heap-leach and SX/EW processing to produce copper cathodesover a mine life of 25-30 years," said Ogilvie.

In September 2022, ASCU released the maiden mineral resource estimate on Parks/Salyer, not considered in the 2021 Cactus PEA, which boasts 2.9 billion lb resource with a grade exceeding 1% of total copper. Since then, it has completed a 105,000 feet infill drilling program targeting the indicated category, completed in March 2023 with all assays confirming robust thickness and aligning with the interred mineral resources announced in 2022.

Copper producers and developers not only play a pivotal role by supplying the red metal but also bear the responsibility of sticking to the highest socio-environmental standards. This responsibility ensures that the increasing demand for copper does not result in the environmental damage they want to reduce. Thus, technological disruptions should be leveraged to enhance production and make it more sustainable and environmentally friendly. In this context, ASCU, like many other copper projects worldwide, collaborates with Nuton, a Rio Tinto company, to research copper recovery from primary sulfides. Their goal is to reduce water consumption and lower GHG relative to traditional milling, ultimately opening the door for an additional 1.7 billion lb of copper.

Locating high-quality copper deposits is becoming more complex: mature jurisdictions have been already exploited, deposits are found at more remote and economically challenging areas, or ore grades are declining. According to Victoria Peacey, president and general manager of the Resolution copper project, a joint venture between Rio Tinto and BHP, US mines are often a century old with low and declining copper grades: “New supply is needed to replace lost and declining production and meet current and future domestic demand. Copper deposits such as Resolution are rare and exceptional.”

Located in the Copper Triangle, the Resolution copper project has a projected LOM of 60 years and would generate approximately 3,700 direct and indirect jobs, not to mention the potential to fulfill up to 25% of the current US copper demand. The JV between Rio Tinto and BHP has faced the opposition of several Native American groups and a delay in the Final Environmental and Social Impact Statement (FEIS) by the USFS. It continues to engage with several neighboring local communities and 11 Native American tribes, as well as numerous federal and state agencies: "The collective voice of communities, Tribes and regulators have driven major changes to the original mine plan including the relocation of major project facilities and foregoing mining some sections of the ore body to avoid hundreds of areas of traditional importance, ancestral sites, seeps, springs riparian areas and medicinal plants," explained Peacey.

Resolution has recognized the current labor shortage and understands that, given the 60 LOM for the project, it is imperative to start developing a skilled local workforce. It has invested in K-12 education, technical colleges, and apprentice programs to achieve this. This strategic initiative is ahead of the curve, particularly when considering the impact of labor shortage on mining operations like

"There has never been a better time to invest in American-producing gold assets. We are experiencing the most turbulent geopolitical situation in a generation, and inflation remains persistent, which compel smart investors to move into the sector first, and then the rest will follow."

Tim Swendseid, CEO, Elevation Gold

Asarco. Moreover, this should benefit local communities: “We want our employees to be able to live and thrive in the local communities they were born and raised in,” commented Peacey.

One of society’s concerns about the project is the mining method selected: block-caving. Resolution Copper’s deposits boast around 1.5. billion t, containing copper at about 1.5%, and the depth reaches 7,000 feet below ground level. According to Peacey, the deposit’s characteristics dictate the mining method, and block-caving has been successfully utilized, serving as the initial mining technique employed in the Copper Triangle and worldwide. Moreover, it would have several benefits: “Firstly, being underground eliminates the need for a large open pit and no permanent waste rock dumps, resulting in a significantly less disturbed footprint.”

Precious metals production

Precious metals production results in the US presented opposite trends, with gold production declining while silver production rose. In 2022, domestic gold production was estimated to be 170 t, 9% less than what was produced in 2021, a trend that goes back to 2018, since when, US gold production has declined since its peak of 245 t/y. The opposite happened with silver. In 2022, US produced 1,100 t, slightly above the 2017 production of 1,020 t.

Nevada, known as the ‘Silver State,’ is no longer the leading state for silver production since Alaska overhauled it in 2022. Coeur Mining has assets in both jurisdictions Mitchell Krebs, Coeur Mining’s president and CEO, stated that the company is on track to produce between 10 to 12 million oz of silver and 300,000 to 350,000 oz of gold this year. During the last years, Coeur has been in the spotlight because of the expansion at Rochester mine, where it allocated between US$710-730 million.

By the end of August 2023, the expansion at Rochester was 99% complete, comprising a stage VI leach pad, a Merrill-Crowe processing plant, and a three-stage crushing circuit. “We expect to reach a run-rate processing rate of approximately 32 million t/y in the first quarter of 2024, which will drive production levels up and costs down and is expected to generate free cash flow, not only at Rochester but for the company, which we can then use to reduce the debt we have incurred to partly fund this expansion,” explained Krebs.

For the gold segment, and following the national gold declining trend, Elevation Gold Mining produced 31,094 oz gold at its Moss mine in Arizona. “This is slightly below our guidance range of 32,000 to 34,000 oz,” stated Tim Swendseid, CEO of the company.

To offset this slight decline, Elevation Gold has changed contractors at the end of 2022, bringing Ledcor in. “We have now begun reaping the benefits of Ledcor’s expertise and operational

“If we are serious about transitioning away from fossil fuels, there will be a need for more mining, and we do not want to be overly dependent on other countries, some of which are not friendly to the US, to drive that transition”

Mitchell Krebs, President and CEO, Coeur Mining

efficiencies. Because of our efficiency improvements and mine plan optimizations this year, we expect to produce between 34,000 to 36,000 oz/y of gold,” claimed Swendseid.

The gold producer has spent around US$9.5 million to construct a new 3A-Ph2 leach pad, which is expected to be finalized by October 2023 and will provide the company with sufficient leach pad capacity until the end of 2025.

Except for around a month of low performance from February to March 2023, the gold price has been on the rise since November 2022, providing cash flow for gold producers and allowing them to continue exploring focusing on organic growth. In this context, Elevation Gold has been focusing on the Reynolds pit and the Mordor area adjacent to the Moss mine. Both targets, situated on fully permitted ground, would enable Elevation to commence mining operations promptly, a relevant fact considering how challenging the permitting landscape can be.

Another company that plans to invest in infrastructure is Idaho Strategic Resources, which operates the Golden Chest gold mine in the Murray Gold belt area of the Coeur d’Alene mining district in Idaho. The company shifted to underground operations at the beginning of 2023, producing 5,000 to 10,000 oz/y. “Our focus lies in building a new mill at our mine, which would not only open up exploration opportunities but also give us control over the entire gold district and would be highly beneficial to our bottom line, leading to costs saving, increased revenue, and higher production capacity,” explained John Swallow, president and CEO of the company.

Despite being a gold producer, Idaho Strategic Resources has an RRE story coming to light with three projects spanning the southern to the northern regions of the underrecognized Idaho Rare Earth Element-Thorium trend: “On the REE side, our upcoming work includes trenching, which is set to commence in July 2023. We have also obtained permits for drill plans, with drilling expected to occur later in 2023. These activities form a crucial part of our exploration efforts to understand further and assess the potential of our REE projects,” added Travis Swallow, stakeholder and corporate development of the company.

New precious metal projects: JVs and M&A

Contango Ore is a US-listed company that was developing and constructing the Manh Choh project in Alaska through the Peak Gold Joint Venture, an association with Kinross. Contango is a 30% owner, with Kinross managing and owning the remaining 70%. The Manh Choh project boasts a 1 million oz gold deposit with a high-grade ore averaging 8 g/t. To process Manh Choh’s ore, the company will leverage Kinross’ underutilized mill at the Fort Knox mine in

"It is uncertain if miners can bridge the gap and supply the new forecasted uranium demand. It is still unsure if supplies from Russia and former Soviet satellites like Kazakhstan and Uzbekistan could be cut off, which would impact uranium prices."

John Cash, President and CEO, Ur-Energy

Fairbanks. According to Rick Van Nieuwenhuyse, president and CEO of Contango Ore, this decision was beneficial from an economic point of view: “Our decision not to build another mill and tailings facility has significantly expedited the project’s progress, reduced capital requirements, and shortened the permitting timeline.”

The company announced on August 30, 2023, that mining operations started at Manh Choh and, according to Van Nieuwenhuyse, estimate an annual gold output of 225,000 oz: “Our 30% share being 67,500 oz/y, generating over US$50 million in free cash flow”, he concluded.

Despite the perception of unfavorable market conditions in the precious metal segment, Hycroft Mining is a Nevada-based company with a solid financial status with US$117 million in cash. According to Diane Garrett, president and CEO, many companies are struggling to raise money. While they hope for a market turnaround, there are opportunities under these conditions: “With a robust treasury and the ability to raise additional capital, we are actively exploring potential M&A opportunities to expand our portfolio,” shared Garrett.

The company has been actively drilling its Hycroft mine to determine higher-grade intercepts and better define the starter pit of its ultimate mine plan. Hycroft is a past producing mine and is transitioning from heap leach operations to milling operations to process the sulfides: “We have a large amount of infrastructure already in place, from crushers to a refinery and on-site laboratory, which puts us well ahead of any other development company in that regard. We will need to install mills and autoclave for processing the sulfide ore,” explained Garrett.

Critical minerals production and development: Uranium and lithium

Unlike other minerals and metals, uranium is not traded on an organized commodity exchange. Instead, it trades in most cases through contracts negotiated directly between a buyer and a seller. In recent years, low prices made it difficult for uranium producers to secure long-term contracts. "After the Fukushima incident, uranium prices fell significantly, making contracts scarce outside Kazakhstan," explained John Cash, president and CEO of Ur-Energy, a company with a uranium in-situ mine, the Lost Creek project, located in Wyoming's Great Divide Basin.

However, given the increasing recognition of nuclear power's carbon-free benefits and growing geopolitical concerns, uranium prices have risen during the last few months. Ur-Energy secured three long-term contracts and incentivized a ramp-up at its Lost Creek project: "180,000 lb of uranium are contracted for 2023, increasing to 600,000 in 2024 and 700,000 in 2025," informed Cash.

While the Lost Creek project is permitted to produce up to 1.2 million lb/y of uranium, the processing plant has a capacity of 2.2 million lb/y. "It provides the flexibility to process additional uranium from other sources, such as competitor mines or other facilities, allowing the Lost Creek to serve as a toll processing site," concluded Cash.

Despite years of headwinds faced by uranium companies, the current tension between Moscow and Washington is favorable for uranium producers and developers. The US is keen to reduce its reliance on Russian uranium and post-Soviet satellite nations like Kazakhstan, which accounted for 43% of worldwide uranium production in 2022. Consequently, from exploration to production, players in the uranium industry are capitalizing on current spot prices and the projected supply shortfall.

Just as crucial for its carbon-free benefits in an electrified world, lithium has been under the spotlight of the mining industry for its use in batteries. Noram Lithium is a Canadian-based company advancing its Zeus lithium project to production in the Clayton Valley in Central Nevada, immediately adjacent to Albemarle's Silver Peak lithium brine operation.

Zeus has measured and indicated resources of approximately 6 million t of lithium carbonate equivalent (LCE) – 1,034 million t at 941 ppm lithium – and inferred resources of 1.09 million t LCE – 235 million t at 871 ppm lithium at a 400 ppm Li cut-off. According to Noram Lithium's CEO, Greg McCunn, the project has a PFS underway. He envisions a plant processing 6 million t/y of ore, which will translate into almost 33,000 t/y of lithium carbonate: "This will be approximately 5% of the world's lithium carbonate supply today, but maybe only 1% if we fast forward to the forecasted demand in 2030," explained McCunn. ■

Exploration

Critical minerals prime among investors

According to the article World Exploration Trends 2023 from S&P Global, the US exploration budget increased US$320.2 million in 2022, accounting for 10% of the worldwide budget, and junior exploration companies accounted for 68.7%, or US$220 million, of US gains. Gold and copper were the commodities that saw the most significant dollar increases. Moreover, the report Critical Minerals Market Review 2023 from the International Energy Agency states that exploration spending rose by 20% in 2022, with lithium's spending increasing by 90%.

Despite gold seeing the most significant dollar increases, there is a commonly shared sentiment among different companies across the value chain that investors are shifting toward critical minerals projects: "Accelerating the amount of investment and streamlining the permitting process for critical minerals will benefit other aspects of the mining sector – especially considering how many critical minerals are located in deposits that also contain non-critical mineral deposits and need to be mined together," shared Mitchell Krebs, president and CEO of Coeur Mining.

Despite this shift, many argue that there is insufficient funding for early-stage projects: "While ample funding is available for projects with identified resources in critical minerals, securing financing for early-stage, high-risk projects remains challenging. Many investors seek projects with scoping level studies or an initial resource, which are scarce as they are either being developed or have some sort of flaw," argued Stephanie Ashton, vice president of business development at IG Global Group.

Helping the juniors: AI-xploration

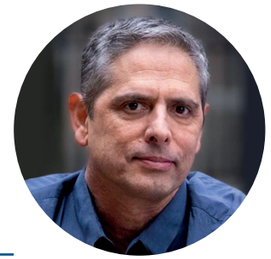
Even though the traditional boot-on-the-ground has its appeal related to mining discoveries, there is increasing pressure to make discoveries of good deposits faster, especially now that figures are alarming: According to the Society for Mining, Metallurgy & Exploration, the US needs 359 additional mines across all commodities to meet the needs of the clean energy transition. There is a lack of everything: New mines coming, good deposits at the surface, and labor - the perfect combination for failure. In this context, a company that has been trying to solve this problem is VerAI Discoveries, an AI-based mineral asset generator dedicated to sourcing critical minerals essential for the energy transition.

The company owns 73 exploration projects for critical minerals in eight portfolios of different commodities: Three portfolios, each focusing on cobalt, nickel, and lithium in Ontario; a copper portfolio in Arizona, which is undergoing advanced review and commercial discussion with several majors; and a gold-silver portfolio in Nevada, where they are seeking a partner; and two portfolios in South America (in Peru and Chile). The lack of success in project exploration and moving to production is disconcerting, according to Yair Frastai, co-founder and CEO of VerAI: "Roughly one in every 1,000 projects successfully transitions into a functioning mine, and existing exploration methodologies fall short in effectiveness, economic viability, and scalability," he explained.

Frastai is not the only one who thinks that AI can boost exploration discoveries. According to Michael Rowley, president and CEO of Stillwater Critical Minerals, apparent deposits have already been identified in today's context—a problem exacerbated by drilling costs at unprecedented levels. The elixir? "Integrating geophysics, AI, and machine learning becomes invaluable in uncovering previously concealed resources," he concluded.

"Cracking the code of unexplored cover terrains is the key to the next major mineral discoveries. Our thesis suggests that our portfolios of AI-generated, high-probability targets in Arizona and Nevada will lead to the discovery of new clusters."

Yair Frastai, CEO & Co-Founder, VerAI Discoveries



"The convergence of interest from the Democratic and Republican parties has fostered approximately six draft versions of a mining reform. Hopefully, these drafts will coalesce into a single unified version approved before the upcoming presidential elections."

Melissa Sanderson, Board Member and Spokesperson, American Rare Earths

The Americanization of the juniors

With the surge in demand for critical minerals and the policies and laws that the US Government is enacting to secure its supply chain of critical minerals and Rare Earth Elements (REE), many companies have recognized an opportunity to realign their corporate narratives with Washington's political interest.

Such is the case of American Rare Earths (ARR), an Australian company. Melissa Sanderson, ARR's board member and spokesperson, explained that they intend to be listed at the highest level of the OTC and, eventually, on the NASDAQ. "As we embraced the motto of 'mined and made in America,' we are confident in the security and reliability of our supply chain. We envision ourselves at the heart of the US strategy as we anticipate the surge in demand from 2030 onward when hopefully ARR will be in full production," she said.

ARR possesses three assets: Halleck Creek, the flagship in Wyoming, Searchlight in Nevada, and La Paz, in Arizona. In March 2023, the company published a JORC report for Halleck Creek of 1.43 billion t of rare earths, enabling it to produce approximately 4 million t of crucial materials, namely neodymium and praseodymium: "Halleck Creek and La Paz share a critical characteristic: They are low in thorium and uranium. This becomes especially advantageous during the permitting process as we will not require special permits from the National Regulatory Agency nor need to implement elaborate storage methods, which translates to significant cost and time savings as we venture toward production," concluded Sanderson.

On the gold segment, U.S. Gold Mining also saw an opportunity to focus solely on the US. The Alaska-focused junior is a spinout of GoldMining and completed an IPO at the end of April 2023, listing on NASDAQ and raising US$20 million to explore further the Whistler gold-copper project in Alaska. "With gold trading in the range US$1800-2000 over 2022, GoldMining saw the opportunity to launch the U.S. GoldMining 'spinco' to unlock value in the Whistler project," commented Tim Smith, president, and CEO of the company.

The Whistler project is a gold-rich copper porphyry style and has indicated resources of approximately 3.0 million gold equivalent oz and inferred resources of around 6.45 million oz.

A company that adopted a different approach from ARR and U.S. Gold Mining is Champion Electric. Originally established in 2016 under the name `Idaho Champion.´ the company primarily focused on assets in Idaho. However, in 2023, it rebranded itself as Champion Electric to better represent its expansion into Québec and its focus on battery metals, like lithium and cobalt. In Idaho, Champion Electric owns the cobalt Twin Peaks Project, a past producing mine located next to Electra Battery Materials' Iron Creek project: "The geologic structure at Twin Peaks is perceived as an extension of the Iron Creek Project. As a result, we hold high expectations for our upcoming drill program, anticipating similar levels of success that Iron Creek achieved in their drilling campaigns," explained Jonathan Buick, president and CEO, Champion Electric Metals. ■

Western USA Project Insights

Idaho

"Adjacent to our Twin Peaks property lies Electra Battery Metals' Iron Creek project. The geologic structure at Twin Peaks is perceived as an extension of Iron Creek; thus we expect our upcoming drill program to match Iron Creek's success."

Jonathan Buick,
President and CEO,
Champion Electric Minerals

Arizona

"We have the option to acquire 67.5% of Sunnyside. The goal is to fully execute the option earn-in as quickly as possible, which will take around a year, and a drilling program of 15,000 to 16,000 meters."

Rick Trotman,
President and CEO,
Barksdale Resources

Utah

"The resource published for Tony M. boasts 6.6 million lb of uranium at 0.28% and 2.2 million lb at 0.27% in the inferred category, making it one of the highest-grade undeveloped projects outside the Athabasca Basin in Canada."

Philip Williams,
CEO,
Consolidated Uranium

"We are currently focused on three projects: Felix and FS near Delta, Utah, and Pilot, just across the Nevada border. These projects are in early stages, primarily involving prospect identification, broad geology, and sample collection."

Richard Leveille,
Chief Consultant,
IG Global Group
and Co-founder,
IGX Minerals

Alaska

"Our objective is to make big discoveries and consolidate several high-grade projects within the Golden Triangle, with a particular emphasis on the Cantoo project, which has a 30-meterwide vein rich in gold, silver and copper proven by high-grade simples."

Morgan Lekstrom,
CEO, Blackwolf
Copper and Gold

"At the Flat project, we want to build upon the groundwork of the previous 55 drill holes by expanding along the strike and delving deeper into the Chicken Mountain anomaly to obtain additional information about the structural characteristics of gold mineralization."

Tony Reda,
President and CEO,
Tectonic Metals

Montana

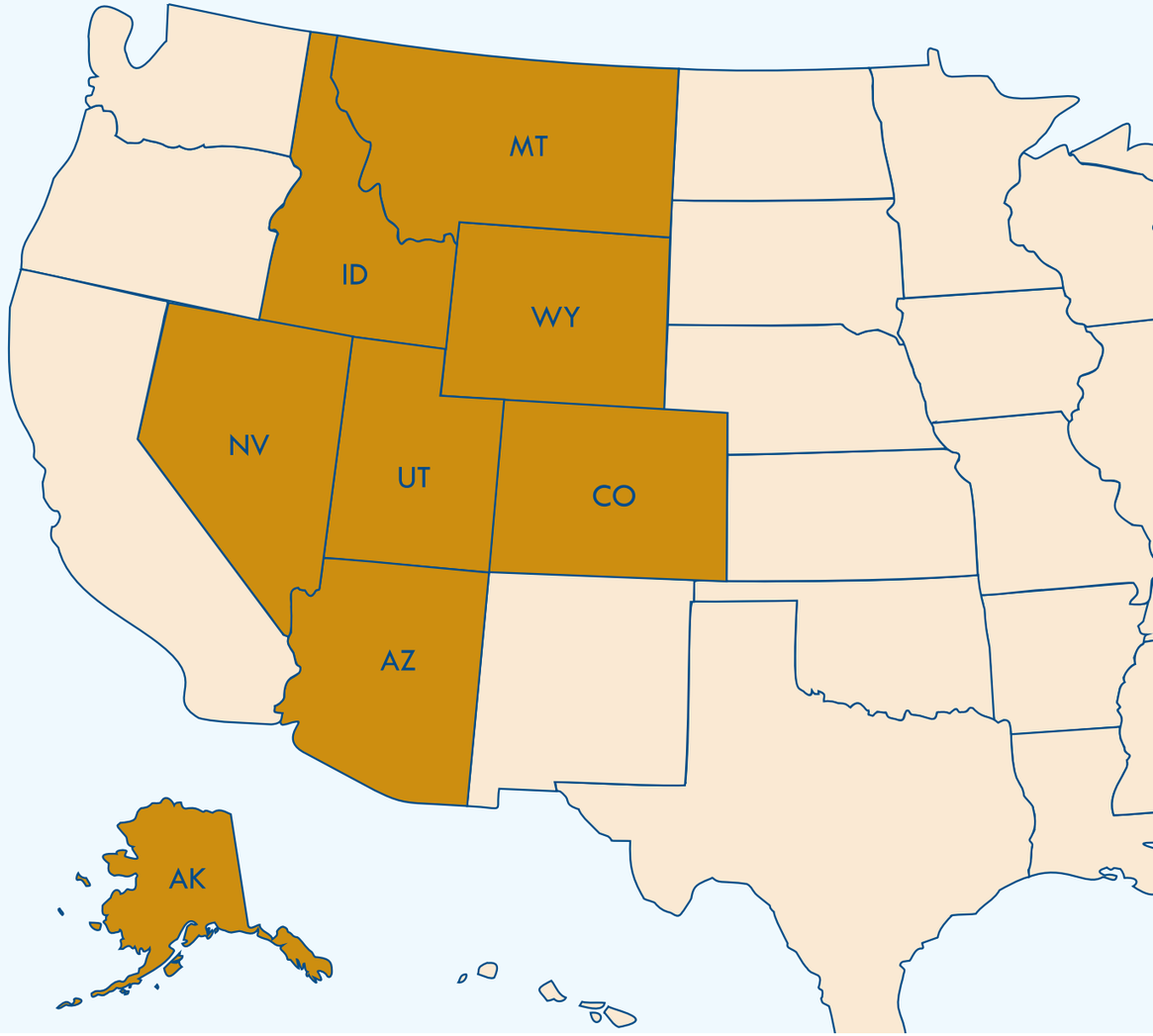
"In January 2023, we expanded our mineral resources by 62%, reaching 1.6 billion pounds of nickel, copper, cobalt, 3.8 million ounces of palladium, platinum, rhodium, and gold. On the other hand, Glencore invested nearly US$5 million, a 9.99% equity stake in the company."

Michael Rowley,
President and CEO,
Stillwater Critical Minerals

Colorado

"We are currently core drilling La Plata project, a copper, silver, gold, platinum, and palladium project in an alkaline porphyry system in southwestern Colorado where, in July 2023, we announced an updated mineral resource estimate of 1.3 billion lb of copper equivalent."

Scott Petsel,
President,
Metallic Minerals



Engineering, Construction and Consulting

Balancing environmental concerns with profitability

In September 2022, the global consultancy firm EY published its Top 10 business risks and opportunities for the mining and metals sector in 2023. According to the report, ESG factors remain paramount, ranking first. Geopolitics takes the second spot, followed by climate change, the license to operate, with costs and productivity in the fifth place.

All these trends are intertwined, affecting the entire mining value chain. Thus, across all five top trends, a segment comprising consultancy firms, engineering companies, and constructors plays a pivotal role in assisting mining clients. These key players help navigate complex permitting frameworks, develop strategic approaches, and ensure compliance with environmental stewardship, all while fostering positive relationships with stakeholders with different interests.

Long-term relationships prime

Just as risk and opportunities evolve, so do mining's demands. One of the main changes Jim Norine, director of Minerals and Metals at Ausenco, noted is that the traditional approach of clients seeking competitive bids from multiple firms solely based on price is becoming antiquated. The priority is to build long-term partnerships and establish trust to focus on delivering value. Ausenco has been focusing on emerging mineral processing technologies to help its clients maximize the return on investment and minimize energy usage in the case of declining ore grades. One area gaining momentum is ore sorting, a process in which artificial intelligence and advanced instrumentation can improve. "It becomes possible to downsize the process plant. For example, mining 150,000 t/d can be sorted down to 50,000 t/d, reducing capital costs, lowering energy demand, and improving efficiency," Norine stated.

Fostering long-term relationships has been the cornerstone of Practical Mining, a small geological and engineering service company based in Nevada, that proves that size is not an impediment. "In the dynamic landscape of mining projects, needs often evolve over time. Our ability to swiftly address these challenges and keep the project on track is pivotal in benefiting all stakeholders," continued Dagny Odell, owner of Practical Mining.

Odell argued that striking a balance between rising prices and escalating costs due to inflation is paramount to sustaining profitability. In recent years, Practical Mining has been incorporating technology to enhance its LiDAR scanning capabilities, and with drones becoming more autonomous and capable of flying longer

"Critical minerals present challenges and opportunities, a duality we are well poised to address, and our clients are keen on transitioning into critical minerals extraction and reprocessing historical impoundments."

Anne Thatcher, Senior Vice President, Arcadis

distances, they can now map inaccessible areas of underground mines without human intervention. "This convergence of technology is poised to revolutionize how we operate, making the mining industry more efficient, effective, and safer", explained Odell.

Another company that has seen the benefits of drones and LiDAR scanners is the high-tech geospatial engineering provider Darling Geomatics. When Artificial Intelligence is coupled and added to the equation, the outcome becomes revolutionary. "When combined with other data sources, such as drone surveys with LiDAR and hyperspectral imaging coupled with exploration drilling, AI can be used for optimum pattern recognition for advanced geological mapping," said Mary Darling, CEO and principal owner of the company.

Similarly to Ausenco, Darling Geomatics is implementing digital twins with its customers. Richard Darling, the president and founding principal of the company, highlighted that with an AI model, a company can monitor everything, from the motors and crushers in a mill to the pH levels in the ore: "AI and automation allow operators to sit in a control room and see exactly what is happening throughout an operation instead of being on the ground, taking tests, monitoring equipment, etc."

Mined in America: The potential of tailings and brownfield sites

Mining Plus' US director, Scott Britton, is noticing two major industry trends in the Western USA. The first is that the increased potential for expanding existing mines and rising mining costs outweigh the potential for developing new mines. The second is that the times required for new mining projects are becoming longer, thus companies are opting to sustain existing operational mines for longer duration, exploring deeper or at brownfield sites rather than investing in new greenfield projects. S&P Global reports that, in the early 2000s, nearly half of the world's exploration budgets were allocated to grassroots exploration, but this has declined in recent years. According to PDAC's 2021 figures, the last year in which grassroots exploration reached a peak was in 2008 (around US$5 billion), followed by a drop to US$2 billion in 2020, and another peak in 2021, reaching US$3 billion. "Even though it seems grassroots exploration is recovering, "operating companies focus on expanding deeper and larger operations to capitalize on favorable commodity prices," said Britton.

The boom in critical minerals and various government policies aimed at promoting the mining of these may revive the appeal for greenfield exploration, although even here, caution predominates. Keaton Turner, founder and CEO of Turner Mining Group, noted that in the Western USA the demand for battery metals has surged: "This has sparked increased interest in capital expenditure projects, including reopening brownfield sites due to improved economic viability and new business opportunities."

Anne Thatcher, senior vice president at Arcadis, has noticed that mines that were supposed to be closed ten years ago have stayed open and that clients are exploring more in those sites, a decision also driven by the premium of producing in North America. "They are investing in the Western USA because they found that allocating their resources globally has not necessarily produced a return on investment," she added.

Arcadis, with expertise in tailings, is helping its clients to understand what type of critical minerals they have in their waste rock or tailings, as well as helping them to understand the geochemistry of what is there, how to reprocess it, and the chemical engineering needed to transform the waste into something profitable.

Tailings are a tricky asset or liability. They often contain harmful chemicals and heavy metals, and managing tailings is a critical concern, however, they can also contain value. In the Western USA, the principal contributor to the total volume of tailings is copper (33%). With a lack of new producing copper mines in the near term, technological advancements today have made it possible to extract value from what was once considered waste.

Arcadis has been busy helping its clients to meet the new Global Industry Standards on Tailings Management (GISTM) directrices: "Our clients are adapting to their evolving needs to comply with the 77 substandards of the GISTM. Many of those substandards relate to geotechnical engineering, but some also relate to community impact, risk, biodiversity, hydrology, and hydrogeological conceptual site models," stated Thatcher.

For Peter Kowalewski, Tierra Group International's founding principal, the GISTM represents a significant industry shift. Much effort has gone into improving tailings management and reducing overall operational and closure risks. "Companies have begun to understand the liabilities that tailing storage present to operations, ranging from the risk they pose to workers and inhabitants around the facilities to the financial impact on the company. In response, the companies have worked to reduce, or eliminate (where possible), these liabilities", he explained.

Besides being an area where companies must comply with stringent regulations, especially after disasters like Brumadinho that affected the mining industry's reputation in the eyes of the international society, tailings represent an opportunity: They can be re-mined or processed to extract remaining ores that were previously deemed unprofitable. This approach could involve lower costs and risk than starting new grassroots or greenfield explorations.

Water management and mine closure: Preventing "unexpected" surprises

With climate change threatening ever drier condition, water management plans and solutions are gaining momentum in an industry that operates under the scrutinizing eyes of society, especially in the Western USA. "The conditions in the American West that we are seeing around the Colorado River basin have been so dry for more than 20 years that we are no longer speaking a drought, we refer to it as `aridification´-a new very dry normal," stated Lis Mullin Bernhardt, an ecosystems expert at the United Nations Environmental Programme (UNEP).

"Not all mine tailings are suitable to make a paste backfill, and often we have to make some sort of an amendment, such as cycloning the tailings to remove slimes or dealing with certain mineralogy in the tailings unsuitable for making a paste."

David Stone, President, MineFill Services

Tom Meuzelaar, owner of Life Cycle Geo, sees room for improvement: "We are currently exploring water resource projects like aquifer storage and recovery, an area the mining industry should also consider, particularly in addressing water scarcity issues prevalent in regions like the arid Western USA."

Life Cycle Geo has been exploring the use of machine learning in water and materials management projects: "When properly implemented, machine learning can optimize the identification of different material types, leading to more accurate and efficient material sorting. Moreover, it offers opportunities to identify and classify more material types, opening doors to increased material reuse and recycling. The goal is to maximize the utilization of every material, minimizing waste and environmental impact," explained Meuzelaar.

Alan Driscoll, VP and director of mining services at Forsgren Associates, explained that water management in mining is a multifaceted challenge. "We explore options like using treated water for agriculture or ensuring compliance with regulations for water discharge. The challenge lies in making the most of this vital resource while preserving the environment and maintaining the economic viability of mining operations," he said.

For Angela Persico, director of mining services business development at INTERA, the most significant challenge associated with water management is dealing with "unexpected surprises" that can considerably impact progress and a company's reputation. According to Persico, these unexpected surprises can occur during all stages of the mining life cycle, such as discovering more water than initially anticipated and discovering that dewatering operations are affecting a local water resource or slope stability. To mitigate surprises, INTERA aims to provide comprehensive information and understanding by leveraging data from different project stages. "Informed decision-making and effective communication with stakeholders, including the company, investors, neighbors, NGOs, and regulators, is crucial to avoiding surprises and reducing pain points across the board," she said. "Mining companies are trying to recover from the legacy of historical mining practices in the Western US that have left scars on the landscape and risks to humans and the environment," she concluded.

Ideas how to remedy mining's environmental footprint and to build a better relationship with society are rife amongst the community of engineers and consultants in Western USA, and they will be crucial in ensuring that the region can fulfill the vital mission with which it has been tasked: To provide the USA with the minerals and metals for a cleaner future in a cleaner manner. The mining industry, the cornerstone of the energy transition, must prove to society that a transition to cleaner energy can be achieved through more environmentally friendly mining practices. ■

Service Providers

Helping alleviate inflationary pressures and environmental risks

Since the outbreak of COVID-19, inflation has been a significant concern for the mining industry. In response, mining companies have had to take measures to mitigate its impact, whilst also feeling pressure to upgrade processes to reduce harm to the environment. This has pushed the industry, especially service providers, to delve deeper into R&D, seeking technological advancements to enhance production efficiency and reduce environmental impact. Meanwhile, supply chain disruptions of chemicals, cyanide, flocculant, antiscalants, and ammonia, all necessary to either process minerals or fabricate explosives to extract minerals, have added an extra layer of complexity.

Steffen Gjorvad, President, TAKRAF USA

According to Brady Greifzu, Solenis' global corporate sales executive, these factors have not been compensated for by corresponding surges in mineral commodity costs. "The recent global supply chain crisis and inflation have not been matched by similar increases in mineral commodity prices, creating a gap for mine operators to fill. Thus, to enhance profitability, many operators have turned to Solenis to help reduce reagent costs and boost throughput and recovery," he explained.

To help its clients prevent disruptions and determine the exact dosage of a product, Solenis has developed Solenis Cloud, an online performance monitoring, automation and data analytics platform paired with a set of sensors that can be customized based on the application and customer needs: "We have automation programs that use parameters like pH, flow rate, and ore body chemistry in real-time algorithms to determine the dosage of a product. When paired together with our online inventory, the demand can help in projecting usage. This allows us to forecast when a tank needs to be refilled and coordinate with the supply chain for timely and optimal delivery service," stated Nick Morrison, mining applications manager at Solenis.

Cyanco is another company that has witnessed an increase in the cost of essential raw materials, particularly ammonia and natural gas, which are vital for sodium cyanide production. Like Solenis, to tackle rising costs and assist its customers, Cyanco offers Cyanco's Vendor Managed Inventory (VMI) to have precise control over cyanide dosing, set specific targets, and receive continuous feedback.

Dagny Odell, Owner, Practical Mining

Mary Darling, CEO and Principal Owner, Darling Geomatics

Angela Persico, Director of Mining Services Business Development, INTERA

Tom Meuzelaar, Owner, Life Cycle Geo

"Having an online analyzer with real-time feedback is especially relevant in milling operations where cyanide is added at the front-end of the circuit to extract raw materials. By closely monitoring and controlling cyanide dosing at the beginning of the milling process, customers can reduce the need for detox reagents at the end, leading to additional, significant cost savings," explained Steve Cochrane, US sales manager at Cyanco.

In addition to cyanide, flocculants, and other chemicals, blasting can have a considerable influence on the economics of a project. The choice and usage of chemicals are intricately linked to the efficiency of explosives. "Chemical crushing achieved through explosives has long been recognized as more efficient than mechanical crushing involving steel, such as crushers and grinders. By optimizing chemical crushing through blasting, mill operations, which are significant cost drivers for the mine, can function more efficiently," explained Braden Lusk, America's president at Dyno Nobel.

Dyno Nobel is focusing on manufacturing ammonia to produce ammonium nitrate. "A strategic move considering the volatility of the ammonium nitrate and ammonia market in recent years," Lusk stated. Additionally, the company is also working on carbon dioxide sequestration at ammonia plants and nitrogen abatement projects across various facilities to provide customers with lower-carbon products.

Thomas Charmichael, VP-mining technology at Caid Industries, acknowledges: "Mining operations not only need to produce more copper but there is a recognition that energy consumption during copper plating must be reduced."

Caid's flagship product is a stainless-steel cathode, which, according to Carmichael, is the longest-lasting cathode in the market and are called "permanent cathodes" because with reasonable maintenance, they last at least 20 years.

Another way mining companies can reduce energy usage is through conveying systems. TAKRAF USA has employed electrically driven equipment and avoids using diesel or gas-powered machinery. According to Steffen Gjorvad, TAKRAF's president: "While many mining companies continue to depend on trucking solutions, we can innovate and develop environmentally friendly conveying system alternatives."

Gjorvad sees promising opportunities on the horizon for TAKRAF in the Western USA, particularly in the copper and gold segment: "As demand grows, we aim to foster organic growth and are keen to expand our involvement in projects across mining states like Nevada and Arizona," he concluded. ■

"Convincing customers using non-electric detonators to adopt better technology remains a challenge. Still, efforts are ongoing to transition them to more advanced solutions for improved results. In the future, electronic and wireless detonators will offer even more enhanced blasting solutions."

Braden Lusk, President-Americas, Dyno Nobel

Equipment and Technology

Innovation across the value chain: From AI to retrofitting

Today's mining industry bears little resemblance to what it was a decade ago. Terms and concepts like machine learning and Artificial intelligence (AI) have taken center stage in the Western USA mining industry, shaping its present and future. While some players in the mining value chain are tasked with developing these new technologies, others, such as junior exploration companies, producers, or OEMs, are leveraging these technological disruptions to meet the increasing demand for greener solutions.

The mining industry is no longer as reluctant to changes as before. "They are shifting towards a more open approach of conducting pilot and experimentation projects to test technologies," said Ravi Sahu, CEO of Strayos.

In the Western USA, Strayos works directly with blasting contractors, drilling companies, and copper producers, providing automation and AI solutions. Recently, Strayos has been incorporating greater intelligence into the ore extraction process with its Ore Dilution Control solution, which mitigates the common issue of dilution, a prevalent concern frequently encountered in copper-gold mines in the Western USA: "One area where significant costs are incurred is in drilling and blasting, and many mining operations believe that they can optimize their resource through better dilution control. We introduced our Ore Dilution Control solution as a generative digital twin to address this challenge," explained Sahu.

This virtual replica mimics the behavior of the process, considers various blasting parameters, and accurately predicts the distribution of waste and ore, reducing waste and maximizing recovery, mitigating the common issue of dilution. However, according to Sahu, in the Western USA, adopting AI is not easy since it requires a structured amount of data to build an adequate model, which many companies lack.

Besides the lack of structured data, another challenge in implementing new technological disruptions or software is unfamiliarity with new tools. Guido Pérez, general manager Americas of Micromine, commented that miners need guidance with these. "We have enhanced our onboarding process for new clients, providing dedicated support to improve the user experience when transitioning to Micromine products," explained Pérez.

Micromine has a strong relationship with Nevada Gold Mines. According to Pérez, they have standardized their mine solutions across all Nevada Gold Mines' underground projects, including Gold Rush and Turquoise Ridge: "Micromine Pitram has been the most successful and proven solution we supply to them. This mine control system manages day-to-day operations in underground assets and requires no in-site development, allowing for a record implementation time," Pérez concluded.

Retrofitting equipment: Making them autonomous

The pandemic shifted people's perception of how they engage with their work life and led to the proliferation of remote work, especially among younger generations. In this context, the mining industry has an opportunity that should not be missed. Considering that mining operations often occur in hazardous environments, automation can enable the industry to enhance safety, reduce risk for equipment operators, and attract young talent who may not have previously considered a career in mining.

"The industry is undergoing a significant transformation both in evaluating new technologies and embracing them. Technologies such as AI, autonomy, and advanced sensor systems are being adopted, marking a departure from the previous resistance and hesitancy towards innovative solutions."

Ravi Sahu, CEO, Strayos

Freeport-McMoRan is kicking off an effort to implement autonomous haulage at Bagdad in Arizona, and many operators are jumping into this trend. They expect that automation will allow operators to work from remote control centers miles away from the mining sites and thereby attract a new generation of talent that

might not be interested in working at mine sites. However, not every existing mining equipment and machinery is autonomous.

To solve this problem, Teleo is a company that builds technology to retrofit large construction mining equipment and is OEM agnostic: "We can retrofit any make and model of machine. We are introducing an incremental path to autonomy for mining equipment that allows for remote operation where a single operator can simultaneously control multiple pieces of equipment from a central command center," commented Vinay Shet, co-founder and CEO of Teleo.

The company's primary customers are contractors who operate heavy equipment in the construction and mining industries.

Retrofitting and autonomous solutions not only drive enhanced operational efficiency, but also contribute to the organization's ESG goals and also offer a strategic remedy to the labor shortage affecting the industry. In conclusion, it is evident that technologies like automation offer numerous advantages, not only in terms of increasing production and sustainability but also in terms of attracting new talent. Adopting new technologies, both in new operations, such as the Resolution Copper project in Arizona, and in existing ones, will be crucial, especially for critical mineral producers to meet the growing demand driven by the energy transition. "This will drive improved efficiencies, which will help us on the ESG front. It will help us overcome the labor shortage challenges the industry is facing, and it is also a steppingstone as we think about the path to electrification for decarbonization and autonomous fleets are going to be a key factor in our decarbonization journey moving forward," stated Joshua Olmsted, president and COO for the Americas, Freeport McMoRan. ■

GBR

GLOBAL BUSINESS REPORTS

Western USA Mining 2024

Pre-Release Edition

This publication is a pre-release edition of GBR's full series of reports on Western USA, that will be published in Q1 2024.

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